

1. PRODUCT IDENTIFICATION & COMPANY INFORMATION

Product name:	Various grades of welding and metal spraying consumable carrying the trademarks DURANICKEL, INCOLOY, INCONEL, INCO-CORED, INCO-WELD, MONEL, Nickel, NILO, NIMONIC, NI-ROD, INCOFLUX Full list given in tables 2.1-.2.4
Other/generic names:	Filler Metal, Flux, Flux Cored, Welding Electrode, Weldstrip, & Thermal Spray (TSW)
Product use:	Welding & metal spraying consumables, See applicable product technical data sheets on website for information of typical scope of use and application, not all products are suitable for all processes or applications. <i>Filler Metal</i> Used for joining and overlaying, using GTAW, GMAW, Plasma and SAW (with suitable flux) welding processes <i>Flux Cored</i> Used for joining and overlaying, using GMAW welding processes <i>Welding Electrode</i> Used for joining and overlaying, using SMAW welding process <i>Weldstrip</i> Used for overlaying, (with suitable flux) for submerged arc or electroslag welding process <i>INCOFLUX</i> Flux used for joining or overlaying with appropriate filler metal or weldstrip for submerged arc or electroslag welding process <i>Thermal Spray(TSW)</i> Used to apply nickel alloy coating by a variety of thermal spray process

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2. COMPOSITION/INFORMATION ON INGREDIENTS

Information on ingredients is given in Table 1 and the compositions of individual products in the alloy families or categories listed above are given in the product composition tables 2.1-2.4. Please refer to the appropriate alloy name or designation.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Silver to gray metal wire or strip. (Welding Electrode are flux coated, Flux Cored has a flux center; flux is granular powder). Not normally considered hazardous as shipped. Ends and edges can be sharp and gloves should be worn when handling.

POTENTIAL HEALTH HAZARDS

- Skin:** Although not normally hazardous, some individuals can develop allergic skin reactions to nickel and other metallic ingredients. Ends of wire and edges of strips may be sharp and can cause cuts. During welding and spraying - Fumes generated may be irritating to the skin. UV radiation produced can cause burns (ray burn). Hot metal can cause burns.
- Eyes:** As shipped, product does not pose a hazard to the eyes however ends of wire and edges of strip are sharp and can cause cuts. During welding and spraying - Fumes generated can be irritating to the eye. Ends of wire may be sharp and can cause cuts or hot and cause burns. UV radiation produced can cause burns (arc eye).

- Inhalation:** Fumes generated by welding and spraying processes can be irritating and toxic.
- Ingestion:** Not a likely route of entry. Metal ingestion can cause toxic effects.
- Delayed effects:** Inhalation of welding or spraying fumes may cause damage to the lungs and respiratory tract including but not limited to fibrosis of the lung which can reduce lung capacity and produce difficulty breathing. Cobalt and Nickel are animal carcinogens and inhalation of fumes and dusts should be avoided. Prolonged inhalation of Manganese fumes and dusts may cause irreversible damage to the nervous system resulting in Parkinson's Disease-like symptoms (tremors, weakness, paralysis, etc.)

	Nickel	Cobalt
EC Label No	231-111-4	231-158-0
Index No	028-002-00-7	028-001-00-9
Designation:	Xn Harmful	Xn Harmful
Risk Phrases:	R40 Possible risk of irreversible effects R43 May cause sensitization by skin contact	R42/43 May cause sensitization by inhalation and skin contact R53 May cause long-term adverse effects in aquatic environments

4. FIRST AID MEASURES

- Skin:** Wash skin with soap and water to remove any metallic particles. If a rash or burn develops, seek medical attention.
- Eyes:** Flush particles from eyes with clean water for at least 15 minutes. If irritation persists or burn develops, seek medical attention.
- Inhalation:** Remove from exposure. If respiratory irritation persists, seek medical attention.
- Ingestion:** If metallic particles are swallowed, seek medical assistance.
- Advice to physician:** Treat symptomatically.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

Flash Point & Method	Solid material – No flash point
Autoignition Temperature:	Not flammable
Flame Propagation Rate (solids):	Not flammable
OSHA Flammability Class:	None – solid material
Extinguishing Media:	Use agent appropriate for surrounding fire.
Unusual Fire And Explosion Hazards:	None
Special Fire Fighting Precautions/Instructions:	Wear self-contained breathing apparatus. Hazardous metallic fumes can be generated in a fire.

Nonflammable except for packaging, however sparks from welding or grinding in user operations could ignite flammable or combustible liquids, vapors and solids.

6. ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR OTHER RELEASE: Wear proper protective clothing. Pick up spilled articles and place into container.

7. HANDLING AND STORAGE

- Normal Handling:** Under normal circumstances the materials do not produce any hazardous products and as such do not require any special precautions. However, see Section 10 "STABILITY AND REACTIVITY". The transient handling of the materials would not be expected to produce any sensitization but it is good practice to use gloves for handling. The normal precautions for handling heavy objects with possible sharp edges should also be observed.
- Personal hygiene - Apply good standards, wash hands after use and before eating.

Storage Recommendations: Store in a dry place and protect from contamination with other materials.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide general ventilation and local exhaust ventilation when welding, spraying, cutting or grinding to maintain concentrations of metal dusts and/or fumes below allowable exposure values. Maintain exposures below the published exposure levels. Use industrial hygiene air monitoring to ensure that your use of this material does not create exposures that exceed the recommended exposure limits. Refer to the following sources for important additional information:

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

PERSONAL PROTECTIVE EQUIPMENT

Skin Protection: Wear gloves, face protection and flame retardant clothing, do not expose skin to the heat, radiation and spatter from welding or spraying operations.

Eye Protection: Eye protection, to the appropriate national standard, is recommended when welding, cutting, spraying or grinding. Do not expose eyes to the heat and radiation from welding operations, use appropriate grade optical filters (welding glass) for welding or spraying process operations.

Respiratory Protection: Respiratory protection is necessary when exposure limits for airborne contaminants are exceeded during welding, grinding or cutting operations. Use air-supplied respirator in confined spaces.

In the USA, use only NIOSH-approved respirators in accordance with 29 CFR 1910.134, or other nationally approved respirators.

In the EU, if required use protection to EN136 (full face respirators), EN140 (half mask respirators), EN149 (filtered half masks (disposable)) or other appropriate EN standard. In the rest of the world use respiratory protection to the appropriate national standard.

Additional Recommendations: Source of running water to wash skin and eyes
 Wear ear protection to the appropriate national standards where high levels of noise are experienced.

Exposure Guidelines See Appendix 1

9. PHYSICAL AND CHEMICAL PROPERTIES

	Filler Metal, Weld Strip and Thermal Spray Wire	Welding Electrode	Flux Cored Wire	Flux
Appearance:	Grey to silver or bronze metal	Varies grey, black, brown coating with metallic silver inner	Metallic silver outer with flux core	Varies grey, brown, green particles
Physical State:	Solid	Solid	Solid	Solid (Powder)
Molecular Weight:	Mixture	Mixture	Mixture	Mixture
Chemical Formula:	Mixture	Mixture	Mixture	Mixture
Odor:	Odorless	Odorless	Odorless	Odorless
Specific Gravity (water = 1.0):	8 – 9	4-7	5 - 8	
Bulk Density				0.8 – 1.1
Solubility In Water (wt. %):	Insoluble	Insoluble	Insoluble	Insoluble
Melting Point:	> 2300F (1260 °C)	> 1800F (>1000°C)	> 1800F (>1000°C)	> 1800F (>1000°C)
Flash Point	None	None	None	None

Other physical and chemical properties, e.g. as described in 91/155/EEC and in the Approved Code of Practice, ref. 11, have no safety implications in relation to these materials.

10. STABILITY AND REACTIVITY

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

11. TOXICOLOGICAL INFORMATION

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

As shipped, these complex alloys in massive form have no known toxicological properties other than causing allergic reactions in individuals sensitive to the metal(s) contained in the alloys. However, dust from flux or user-generated dusts and fumes may on contact with the skin or eyes produce mechanical irritation. Chronic exposures coupled with sweat could cause dermatitis (skin) or conjunctivitis (eyes).

Excessive inhalation of dust or user-generated fumes from welding or metal spraying may, depending on the specific features of the process used, pose a long-term health hazard. The International Agency for Research on Cancer (IARC) has concluded that welding fumes are possibly carcinogenic to humans.

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

More detailed toxicological information is given in APPENDIX 1

Composition of typical welding fume given in table 3.1 – 3.7,

Contamination or surface preparations etc can affect the composition of the produced fume.

Metals Spraying - Many variations of process are available; refer to table 2.1 in association with guidance from equipment manufacturers for likely constituents of produced fume.

DELAYED (SUBCHRONIC AND CHRONIC) EFFECTS:

Chromium	The International Agency for Research on Cancer (IARC) considers hexavalent chromium to be a carcinogen (lung, nasal) but does not have adequate evidence for chromium metal and trivalent chromium. Fumes have been associated with lung fibrosis.
Iron	Prolonged inhalation of iron oxide fumes can lead to siderosis, which presents as a benign pneumoconiosis.
Molybdenum	Repeated inhalation of fumes has caused kidney damage, respiratory irritation and liver damage in animals.
Nickel	Nickel metal is "reasonably anticipated to be a human carcinogen" (National Toxicology Program's 10 th Report). IARC states that nickel metal is possibly carcinogenic to humans. Epidemiological studies of workers exposed to nickel powders, dusts and fumes in the nickel alloy and stainless steel producing industries do not indicate a significant respiratory cancer hazard. Inhalation of nickel powder produced malignant tumors in rodent studies. Single intratracheal installations of nickel powder at levels close to the LD ₅₀ have caused malignancies in hamsters. Can cause skin sensitization in susceptible individuals through prolonged contact with skin.
Niobium	No data available.

12. ECOLOGICAL INFORMATION

As a solid metal object, Filler Metal products are not considered toxic to aquatic species.

Flux (being of mineral constituents) from flux coated electrodes, flux cored wire and flux may degrade over time.

Observe national and local standards for fume extraction systems

13. DISPOSAL CONSIDERATIONS

Unused consumable wastes are normally collected to recover metal values.

Dispose of fume, flux, slag, weld grinding residues, over-spray etc, from the work area, or from filters, in accordance with national, federal, state or local regulations. Refer to this MSDS, Table 3.1-3.7, for possible contents of collected fumes and other materials. These may be in the form of dust requiring special health precautions. Nickel is regulated in many countries as hazardous to the environment. Other metals may be regulated in specific jurisdictions. In UK most alloyed material would be regarded as special waste. Observe all National, State, and local environmental regulations.

Packaging - Dispose of by recycling

14. TRANSPORT INFORMATION

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

15. REGULATORY INFORMATION

Classification and labelling requirements

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

Product Labeling - UK Manufacture

WARNING: PROTECT YOURSELF AND OTHERS. READ AND UNDERSTAND THIS LABEL. TAKE PRECAUTIONS WHEN WELDING. ASK FOR YOUR EMPLOYER'S SAFETY PRACTICES WHICH SHOULD BE BASED ON MANUFACTURER'S HAZARD DATA

Fumes and gases can be dangerous to your health. Arc rays can injure eyes and burn skin. Electric shock can kill. Read and understand the manufacturer's instructions and your employer's safety practices. Keep your head out of the fumes. Use enough ventilation or exhaust at the arc to keep fumes and gases from your breathing zone, and the general area. Wear correct eye, ear and body protection. Do not touch live electrical parts.

DO NOT REMOVE THIS LABEL

Product Labeling – USA Manufacture

PROTECT YOURSELF AND OTHERS – READ AND UNDERSTAND THIS LABEL – TAKE PRECAUTIONS WHEN WELDING – ASK FOR YOUR EMPLOYER'S SAFETY PRACTICES WHICH SHOULD BE BASED ON MANUFACTURERS HAZARD DATA AVAILABLE TO HIM

Fumes and gas as can be dangerous to your health. Arc rays can injure eyes and burn skin. Electric shock can kill. Read and understand the manufacturer's instructions and your employers safety practices. Keep your head out of the fume. Use enough ventilation, exhaust at the arc or both, to keep fumes and gases from your breathing zone, and the general area. Wear correct eye ear and body protection. Do not touch live electrical parts. See WMA publication 236 hazards from welding fume available from the manufacturer.

DO NOT REMOVE THIS LABEL

WARNING POSSIBLE CANCER HAZARD OR LUNG DAMAGE IF INHALED – MAY CAUSE ALLERGIC REACTION – MAY CONTAIN FLUORIDES

PROTECT YOURSELF AND OTHERS – before use, read and understand this label, the manufacturer's instructions, Material Safety Data Sheets [MSDS's], and your employer's safety practices, which should be based on the manufacturer's hazard data available to him. See American National Standard Z49.1, Safety in Welding and Cutting and OSHA Safety and Health Standards 29CFR1910.

FUMES AND GAS can be dangerous to your health. Skin sensitization, irritation of skin, eye and respiratory tract, neurological damage, or death can result from over exposure. Keep your head out of the fumes. Use ventilation, preferably local exhaust ventilation, adequate to keep the concentration of the fumes and gases below the exposure limits. Special attention to ventilation is required in confined, small or crowded spaces. If adequate ventilation is not available, wear appropriate respiratory protection. Wash skin after contact with dust or fumes.

Arc rays can injure eyes and burn skin. Electric shock can kill. Do not touch live electrical parts. Wear correct eye, ear and body protection

DO NOT REMOVE THIS LABEL

SARA SECTION 313 SUPPLIER NOTIFICATION:

Individual consumables covered by this MSDS may contain the following toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372: Chromium, Copper, Manganese, and Nickel. Refer to "Section 2" of this MSDS for the filler metal name and the percent by weight, and "Table 1" for the CAS Number for each chemical.

16. OTHER INFORMATION

Current Issue Date: June 2009
Previous Issue Date: None
Changes to MSDS From Previous Issue Are Due To: Change of format which includes additional information

MSDS prepared by Special Metals technical department in compliance with directive 91/115/EEC, 93/112/EEC and HSE (UK) Welding Information Sheet No.1 and is provided in good faith based upon the experience and knowledge of the company. It should not be taken as a guarantee of alloy properties for ordering these materials. Users should make their own assessment of workplace risks as required by other health and safety legislation

Trademarks DURANICKEL®, INCOLOY®, INCONEL®, INCOFLUX®, INCO-WELD®, MONEL®, NILO®, NIMONIC®, NI-ROD®, 686CPT® & 725NDUR® are trademarks of the Special Metals Group of Companies

Bibliography:

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

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

Table 2.1
Nominal Composition (Weight %) Of
Filler Metal, Thermal Spray Wires and Weldstrips Covered By This MSDS

Trade Name	Al	Cr	Co	Cu	Fe	Mn	Mo	Ni	Nb	Si	Ti	W
DURANICKEL [®] 301 & 301TSW [™]	4	-	-	-	-	-	-	94	-	1	1	-
INCOLOY [®] 65	-	21	-	2	30	1	3	42	-	-	1	-
INCONEL [®] 52	<1	29	-	-	9	1	-	59	-	-	-	-
INCONEL [®] 52M [™]	1	30	-	-	9	1	-	57	1	-	1	-
INCONEL [®] 52MSS [™]	-	30	-	-	8.5	-	3.5	55	2.5	-	-	-
INCONEL [®] 53MD [™]	3	29	-	-	3	1	-	64	-	-	-	-
INCONEL [®] 601	1	23	-	1	14	1	-	61	-	-	-	-
INCONEL [®] 617	1	22	12	-	2	1	9	52	-	1	-	-
INCONEL [®] 62	-	16	-	-	8	1	-	74	3	-	-	-
INCONEL [®] 622	-	20	-	-	5	-	14	58	-	-	-	3
INCONEL [®] 625, 625T & 625TSW [™]	-	22	-	-	1	-	9	61	4	-	-	-
INCONEL [®] 718 & 718TSW [™]	-	19	-	-	19	-	3	53	5	-	1	-
INCONEL [®] 72 & 72TSW [™]	-	44	-	-	-	-	-	55	-	-	1	-
INCONEL [®] 72M [™]	1	37	-	-	0.5	-	1	57	1	-	0.5	-
INCONEL [®] 8020 TSW	-	20	-	-	-	-	-	78	-	1	-	-
INCONEL [®] 8020M TSW	-	20	-	-	-	-	-	78	-	2	-	-
INCONEL [®] 82 & 82T	-	20	-	-	1	3	-	72	3	-	-	-
INCONEL [®] 92	-	16	-	-	7	2	-	71	1	-	3	-
INCO-WELD [®] 686CPT [®]	-	21	-	-	1	-	16	58	-	-	-	4
INCO-WELD [®] 725NDUR [®]	-	21	-	-	9	-	9	57	3	-	1	-
INCO-WELD [®] C-276 & C276TSW [™]	-	16	2	-	6	-	16	57	-	-	-	3
INCO-WELD [®] HX	-	22	2	-	19	-	9	47	-	-	-	1
MONEL [®] 400 TSW	-	-	-	32	1	1	-	67	-	-	-	-
MONEL [®] 60, 60N & 60TSW [™]	-	-	-	27	-	4	-	65	1	1	2	-
MONEL [®] 67 & 67N	-	-	-	68	1	1	-	31	-	1	-	-
NC 80/20	-	20	-	-	-	1	-	79	-	-	-	-
Nickel 200 TSW	-	-	-	-	-	-	-	99	-	-	-	-
Nickel 61 & 61N	-	-	-	-	-	-	-	96	-	-	3	-
NILO [®] 365	-	-	-	-	52	-	-	43	3	-	1	-
NILO [®] CF36 [™]	-	-	-	-	61	-	-	36	2	-	-	-
NILO [®] CF42 [™]	-	-	-	-	56	-	-	42	2	-	-	-
NIMONIC [®] 263	1	20	20	-	-	-	6	51	-	-	2	-
NIMONIC [®] 86	-	25	-	-	-	-	10	65	-	-	-	-
NIMONIC [®] 90	2	20	17	-	-	-	-	60	-	-	3	-
NIMONIC [®] PE11	1	18	-	-	34	-	5	39	-	-	2	-
NIMONIC [®] PE16	1	17	-	-	34	-	3	44	-	-	1	-
NIMONIC [®] PK33	2	18	14	-	1	-	7	56	-	-	2	-
NI-ROD [®] 44	-	-	-	-	48	10	-	42	-	-	-	-
NI-ROD [®] 44HT [™]	-	7	-	-	37	11	-	43	1	-	-	-
NI-ROD [®] 55	-	-	-	-	44	-	-	55	-	-	-	-
NI-ROD [®] 99	-	-	-	-	-	-	-	99	-	-	-	-
UDIMET [®] L605	-	20	55	-	-	-	-	10	-	-	-	15
WASPALLOY	1	19	13	-	2	1	4	59	-	-	3	-

Table 2.3
Composition Of Flux-Cored Welding Wires Covered By This MSDS

Weight %	CaO	CaF ₂	C	Cr	Fe	Mn	MnO	Mo	NaAlF ₆	Na ₂ O	Nb	Ni	SiO ₂	TiO ₂	K ₂ ZrF ₆	ZrO ₂
INCO-CORED® 625 AP	1-5			15-20			1-5	5-10		1-5	1-5	50-60	0.1-0.5	5-10		
INCO-CORED® 625 DH	1-5			15-20			1-5	5-10		1-5	1-5	50-60	0.1-0.5	5-10		
INCO-CORED® 82 AP				15-20	1-5	1-5					1-5	57-63	0.1-0.5	5-10		
INCO-CORED® 82 DH				15-20	1-5	1-5	1-5			1-5	1-5	57-63	0.1-0.5	5-10	1-5	1-5
NI-ROD® FC55		7-13	1-5		30-60	1-5			1-5			30-60				

Table 2.4
Composition Of Flux Covered By This MSDS

Product Name	Al ₂ O ₃	CaF ₂	CaO	Cr ₂ O ₃	MgO	Mn	MnO	Nb	Ni	K ₂ SiO ₃	K ₂ O	SiO ₂	NaAlF ₆	TiO ₂	ZrO ₂	K ₂ ZrF ₆	NaF	Others
INCOFLUX® 4		60-100			1-5			1-5	1-5	1-5			3-7		1-5			
INCOFLUX® 5		60-100					10-30			1-5		1-5	3-7					
INCOFLUX® 6	15-40	40-70				3-7			1-5	1-5			3-7	3-7				
INCOFLUX® 7	15-40	40-70				1-5				1-5			3-7		5-20			Fe ₃ O ₄ 1-5
INCOFLUX® 8		60-100					10-30			1-5		1-5	3-7					Fe ₃ O ₄ 1-5
INCOFLUX® 9	1-5	15-20	28-33		2-6							28-33			4-8			
INCOFLUX® 10			85-95															CaTiO ₃ 1-5 NiMg 1-5
INCOFLUX® ESS1	10-15	65-80	10-15	3-8	3-7	1-5		1-5	1-5		1-3	1-5				3-7		Cr 1-5
INCOFLUX® ESS2	5-10	65-80		3-8	3-7	2-7		1-5	1-5	1-5	1-5	2-7	2-7			1-6	1-6	Cr 1-5
INCOFLUX® ESS3	20-40	45-70										5-15						
INCOFLUX® ESS4	5-10	65-80		5-10	3-7	2-7		1-5	1-5		1-5	2-7					1-6	Cr 1-5
INCOFLUX® NT100	15-40	40-70			3-7				1-5	1-5			3-7	3-7				
INCOFLUX® NT110	30-70	10-40					0-20			5-20		0-10		0-10				Cu 0-5 Na ₂ O 0-5 Na ₂ Si ₄ O ₉ 5-20
INCOFLUX® NT120	26-33	30-35				0-5	2-4	1-5	1-5			2-4		4-7	8-13		1-6	CaSiO ₃ 1-5 Cr 0-5 Fe 1-6 Mo 1-6 Na ₂ O 2-4 Na ₂ Si ₄ O ₉ 1-6
INCOFLUX® SAS1	30-70	10-40	0-10			0-5	0-5			5-20		0-10		0-10				CaCO ₃ 0-10 Na ₂ O 0-5 Na ₂ Si ₄ O ₉ 5-20
INCOFLUX® SAS2	35-45	35-45		2-8		5-10				1-5								CaSiO ₃ 5-15 Cr 2-6 CaTiO ₃ 5-15

**Table 2.5 - Nominal Composition (Weight %) Of
Stainless Steel Filler Metal Covered By This MSDS**

Trade Name	Fe	Cr	Ni	Mo	Mn	Si
INCO-WELD® 308, 308H, 308L, 308LSi	61-68	19-22	9-11	<0.5	1-2.5	<1
INCO-WELD® 309, 309H, 309L, 309LSi	54-61	23-25	12-14	<0.8	1-2.5	<1
INCO-WELD® 309LMo	52-59	23-25	12-14	2-3	1-2.5	0.6-1
INCO-WELD® 310	43-51	25-28	20-23	<.8	1-2.5	.3-.7
INCO-WELD® 312	51-59	29-32	8-10.5	<0.8	1-2.5	.3-.7
INCO-WELD® 316, 316L	57-65	18-20	11-14	2-3	1-2.5	.3-.7
INCO-WELD® 316LSi	57-65	18-20	11-14	2-3	1-2.5	.6-1
INCO-WELD® 347	61-68	19-21.5	9-11	<.8	1-2.5	.3-.7

**Table 2.6 - Nominal Composition (Weight %) Of
Aluminum Filler Metal Covered By This MSDS**

Trade Name	Al	Si	Mn	Mg
INCO-WELD® 1050	>99.8			
INCO-WELD® 1080	>99.5			
INCO-WELD® 4043	Bal	4.5-6		
INCO-WELD® 4047	Bal	11-13		
INCO-WELD® 5154	Bal			3-4
INCO-WELD® 5183	Bal			4.3-5.2
INCO-WELD® 5356	Bal			4.5-5.5
INCO-WELD® 5556	Bal			4.7-5.5

Trace impurities and minor addition material names not listed above may also appear.

**Table 2.7 - Nominal Composition (Weight %) Of
Copper Filler Metal Covered By This MSDS**

Trade Name	Cu	Sn	Mn	Fe	Si	Ni	Al
INCO-WELD® AIBZ8							
INCO-WELD® CuSN-A	Bal	4-6					
INCO-WELD® C11	Bal	5.5-8					
INCO-WELD® Cu	>98	<1	<0.5		<0.5		
INCO-WELD® CuSi-A	Bal	<1	<1.5	<.5	2.8-4		
INCO-WELD® CuAl-A2	Bal			<1.5			8.5-11
INCO-WELD® CuAl8-Ni2							

Table 2.2
Composition (Weight %)
Of Flux Coated Electrodes Covered By This MSDS

PRODUCT NAME	Al	Al ₂ O ₃	BaCO ₃	BaF ₂	C	CaCO ₃	CaF ₂	Cr	Co	Cu	Fe	Fe ₂ O ₃	K ₂ O	K ₂ SiO ₃	Li ₂ CO ₃	Mn	MnO	Mo	Nb	Ni	SiO ₂	NaAlF ₆	Na ₂ SiO ₃	SrCO ₃	Ti	TiO ₂	W
INCOLOY® 135						5-10		15-40		1-5	15-40					1-5		1-5		30-60	0.1-1	5-10	1-5		1-5	1-5	
INCONEL® 112 & 112T						5-10		15-40			1-5							5-10	1-5	40-70	1-5	5-10	1-5			1-5	
INCONEL® 112AC						5-10		15-40			1-5		1-3	1-5				5-10	1-5	40-70	1-5	5-10	1-5			1-5	
INCONEL® 117						5-10		15-40	5-10		1-5					0.5-2		5-10		40-70	0.5-2	5-10	1-5			1-5	
INCONEL® 122						5-10	1-5	15-40			1-5							10-30		40-70	0.1-1	5-10	1-5			1-5	1-5
INCONEL® 152						1-5		10-30			5-10					1-5			1-5	40-70	0.1-1	5-10	1-5	1-5		1-5	
INCONEL® 152M						1-5		10-30			5-10					1-5			1-5	40-70	0.1-1	5-10	1-5	1-5		1-5	
INCONEL® 152MSS						1-5		20-30			5-10							2-4	1-5	40-70		5-10	1-5	1-5		1-10	
INCONEL® 182 & 182T						5-10		10-30			5-10					1-5	1-5		1-5	40-70	0.1-1	1-10	1-5		1-5	1-5	
INCO-WELD® 686CPT®		1-5				3-7		10-30										10-30		30-60			1-5			3-7	1-5
INCO-WELD® A						5-10		10-30			6-12					1-5		1-5	1-5	30-60	0.1-2	5-10	1-5			3-7	
INCO-WELD® B						5-10	3-7	10-30			7-13					1-5		1-5	1-5	30-60	0.1-2		1-5				
INCO-WELD® C		1-5				1-5		10-30			30-60		1-5			1-5				5-10	1-5	1-5	1-5			5-10	
INCO-WELD® C-276						1-5		10-30	1-5		3-7					1-5		10-30		30-60	0.1-1	5-10	1-5			5-10	1-5
INCO-WELD® G3								15-25	1-3		15-21							4-8		45-55	3-6	1-10	1-5				0-2
MONEL® 187 & 187N						5-10	1-5			40-70					0.7-0.9	1-5				15.40	1.5	5-10	1-5		1-5	1-5	
MONEL® 190 & 190N			1-5			1-5	1-5			15-40						1-5				40-70	1-5	5-10	1-5		1-5	1-5	
Nickel 141 & 141N		1-5				5-10														40-70	0.5-2	5-10	1-5		1-5		
NI-ROD®	1-5		0-1		1-5	1-5	1-5				1-5	1-5								60-100			1-5	7-13			
NI-ROD® 44			1-5	1-5	1-5	1-5				1-5	30-60					7-13				30-60					7-13		
NI-ROD® 55					1-5	1-5	1-5				30-60	1-5								30-60					7-13		
NI-ROD® 55X			1-5	1-5	1-5	1-5				1-5	30-60					1-5				30-60					5-10		
NI-ROD® 60			1-5	1-5	1-5	1-5					30-60									30-60					7-13		
NI-ROD® 99X			1-5	1-5	1-5	1-5				1-5	1-5					1-5				60-100							

Table 3.1
Composition Of Welding Fume For Filler Metal Wires Covered By This MSDS (Weight %)

	Si	Ti	Al	Fe	Mn	Ni	Cr	Mo	Nb	Cu	Co
INCOLOY® 65	0.2	0.6	0.2	23	0.4	39	19	2	<0.1	2.8	-
INCONEL® 617	0.2	.0.3	0.7	1	0.6	40	16	8	<0.1	0.4	8
INCONEL® 625, 625T & 625TSW™	0.1	0.2	0.2	0.3	0.2	49	17	9	2	<0.1	-
INCONEL® 718 & 718TSW™	<0.1	0.9	0.6	15	0.4	44	15	3	3	0.4	-
INCONEL® 82 & 82T	0.3	0.3	0.2	1	6	56	15	<0.1	1	<0.1	-
INCO-WELD® C-276 & C276TSW™	0.1	<0.1	1	14	3	28	10	11	<0.1	0.8	-
MONEL® 60, 60N & 60TSW™	0.3	2	<0.1	2	5	47	<0.1	<0.1	<0.14	24	-
MONEL® 67 & 67N	0.4	1	0.6	2	2	10	<0.1	<0.1	<0.1	64	-
NC 80/20	0.4	0.1	0.1	0.4	2	57	16	<0.1	<0.1	0.6	-
Nickel 61 & 61N	<0.1	2	0.1	0.2	0.7	69	<0.1	<0.1	<0.1	1.3	-
NIMONIC® 263	0.2	2	0.4	0.7	0.7	43	17	5	<0.1	<0.1	14
NIMONIC® 90	1	1	2	3	0.4	35	15	<0.1	<0.1	0.4	9
NIMONIC® PE11	0.7	1	1	24	1	30	15	2	<0.1	0.4	-
NI-ROD® 44	<0.1	0.3	0.2	32	16	30	<0.1	<0.1	<0.1	<0.1	-
NI-ROD® 55	0.8	<0.1	0.1	33	4	31	<0.1	<0.1	<0.1	<0.1	-

Table 3.2
Composition Of Welding Fume For Flux Coated Welding Electrodes Covered By This MSDS (Weight %)

	Ni	Cr Total	Cr 6	Fe	Mn	Cu	Co	Ti	Ba	F
INCOLOY® 135	0.88	3.13	0.91	2.15	2.99	0.60	0.02	3.51	<0.1	21.3
INCONEL® 112 & 112T	1.95	2.80	0.79	0.76	0.16	0.06	0.03	2.58	<0.1	26.7
INCONEL® 117	2.32	3.14	0.93	0.54	0.84	0.03	0.91	1.05	<0.1	28.4
INCONEL® 182 & 182T	1.59	2.14	0.55	0.94	10.5	0.06	0.03	3.29	<0.1	23.2
INCO-WELD® A	2.10	2.33	0.61	1.00	1.62	0.03	0.03	0.23	0.90	29.3
INCO-WELD® B	4.18	3.70	1.1	2.62	3.80	0.15	0.03	0.22	<0.1	20.9
INCO-WELD® C	0.77	4.38	1.49	9.62	3.19	0.09	0.20	2.91	<0.1	11.6
INCO-WELD® C-276	5.0	4.0	2.7	2.0	2.0	0.2	-	3.0	<0.1	-
MONEL® 187 & 187N	0.76	0.02	<0.01	0.42	2.33	10.7	0.03	3.36	2.90	30.4
MONEL® 190 & 190N	1.79	0.04	<0.01	0.26	2.43	8.7	0.04	1.23	1.83	24.9
Nickel 141 & 141N	3.15	0.02	<0.01	.56	.60	0.02	0.03	1.91	<0.01	30.2
NI-ROD®	13.9	0.01	0.01	3.77	0.27	0.02	0.05	0.64	<0.1	8.4
NI-ROD® 44	2.41	0.03	0.01	9.73	11.8	1.40	0.02	0.13	7.25	3.4
NI-ROD® 55	2.1	0.03	0.01	1.45	0.37	0.02	0.02	0.23	0.49	3.1
NI-ROD® 55X	1.23	0.02	<0.01	5.30	1.14	1.40	0.03	0.10	9.88	3.0
NI-ROD® 99X	3.23	0.03	<0.01	3.21	3.69	1.29	0.04	0.03	8.30	5

Table 3.3
Composition Of Welding Fume For Flux-Cored Welding Wires Covered By This MSDS (Weight %)

	Si	Ti	Al	Fe	Mn	Ni	Cr	Mo	Nb	Cu
NI-ROD® FC55	1	0.3	3	13	7	13	<0.1	<0.1	<0.1	0.2

Table 3.4
Composition Of Welding Fume For Stainless Steel Welding Wires Covered By This MSDS (Weight %)

	Fe	Mn	Ni	Cr	Cu	Mo
INCO-WELD® 308, 308H, 308L, 308LSi	40.30	4.10	6.30	11.10	0.16	0.06
INCO-WELD® 309, 309H, 309L, 309LSi	33.50	7.00	7.00	16.30	0.16	0.33
INCO-WELD® 309LMo						
INCO-WELD® 310	34.50	4.20	10.00	16.50	0.16	0.06
INCO-WELD® 312	34.00	7.10	6.20	18.50	0.10	0.06
INCO-WELD® 316, 316L, 316LSi	31.00	7.10	6.50	8.50	0.70	1.80
INCO-WELD® 347	34.5	5.70	6.20	10.20	0.17	0.14
318	31.00	7	6.5	9	0.16	1.8
410	35	3		5.5		
18/8/Mn	40.3	8.20	6.20	11.20	0.15	1.06

Table 3.5
Composition Of Welding Fume For Low Alloy Steel Welding Wires Covered By This MSDS (Weight %)

	Fe	Mn	Ni	Cr	Cu	Pb
A15 / A18	55	6.5			1.1	
A31	62	16			1.5	
A32	55	9	0.2	1.5	2	03
A33	53	6	0.3	2	2.2	0.5

Table 3.6
Composition Of Welding Fume For Aluminum Alloy Welding Wires Covered By This MSDS

	Fe	Mn	Ni	Cr	Cu	Al ₂ O ₃
INCO-WELD® 1050	1	0.1			0.2	90
INCO-WELD® 4043	2	0.1			0.40	80
INCO-WELD® 4047	2	0.1			0.4	80
INCO-WELD® 5356	1	0.1			0.50	83
INCO-WELD® 5556	1	0.1			0.40	80

Table 3.7
Composition Of Welding Fume For Copper Alloy Welding Wires Covered By This MSDS

	Fe	Mn	Ni	Cr	Cu
INCO-WELD® Cu	0.30	0.60	0.10	0.10	75
INCO-WELD® CuSi-A	0.20	1.00	0.20	0.10	73
INCO-WELD® C12	0.30	0.10	0.10	0.10	75
INCO-WELD® C13	2.00	0.10	0.20	0.10	80
INCO-WELD® C26	5.0	1.00	0.50	0.10	75

Appendix 1

INGREDIENTS, TOXICOLOGICAL AND EXPOSURE LIMIT INFORMATION

The following information is primarily directed to the ingredients of the complex alloys listed in table 2.1, 2.2, 2.3, 2.5, 2.6, and 2.7. Although it is the user's responsibility to assess end products, intermediates, or fugitive emissions arising out of the use of these alloys, information is also provided for common fume ingredients. *UK EH40 limits for the ingredients are shown in italics at the end of each section.*

Ingredient		EINECS Number	CAS Number	Exposure Limits ⁽¹⁾ :	Comments
Symbol	Name				
Al	Aluminum		7429-90-5	TLV: 10 mg/m ³ (Metal dust); 5 mg/m ³ (Welding fumes) PEL: 15 mg/m ³ (Total metal dust); 5 mg/m ³ (Metal dust – respirable fraction) LD50: Not Available <i>EH40 - Aluminum metal: Total inhalable dust OES 10 mg/m³ (8 hours TWA), Total respirable dust OES 4 mg/m³ (8 hours TWA)</i>	Aluminum is not readily absorbed through the skin or the GI tract and only poorly through the lungs. Foreign literature between 1958 and 1962 reported cases of severe and sometimes fatal pulmonary fibrosis in workers exposed to aluminum dust. In one of the fatal cases, the worker developed fibrosis and encephalopathy after 13.5 years of exposure to aluminum dust. In rodent studies and currently in US industry, no fibrosis or encephalopathy have been reported from the inhalation of aluminum powder. Acute exposure to alumina fume may cause bronchial irritation; however reports of pulmonary fibrosis and emphysema in alumina abrasive workers are no longer seen, owing to improved environmental control.
Al ₂ O ₃	Aluminum Oxide (Alumina)		1344-28-1	TLV: 10 mg/m ³ PEL: 15 mg/m ³ (Total dust); 5 mg/m ³ (respirable) LD50: Not Available <i>EH40 Total inhalable dust OES 10 mg/m³ (8 hours TWA), Total respirable dust OES 4 mg/m³ (8 hours TWA)</i>	Acute exposure to this material may cause bronchial irritation; however reports of pulmonary fibrosis and emphysema of alumina abrasive workers are no longer seen, owing to improved environmental control.
BaCO ₃	Barium Carbonate		513-77-9	TLV: 0.5 mg/m ³ (Soluble compounds, as Ba) PEL: 0.5 mg/m ³ (Soluble compounds, as Ba) LD50: 418 mg/kg, rat, oral <i>EH40 OES 0.5 mg/m³ (soluble compounds, as Ba)</i>	Excessive inhalation can produce a benign pneumoconiosis called Baritosis. Ingestion can cause excessive salivation, vomiting, colic, violent diarrhea, convulsive tremors progressing to muscular paralysis, increased blood pressure, internal hemorrhages in the kidneys and G.I tract, and possible hypokalemia.
BaF ₂	Barium Fluoride		7787-32-8	TLV: 0.5 mg/m ³ (Soluble compounds, as Ba) PEL: 0.5 mg/m ³ (Soluble compounds, as Ba) LD50: 250 mg/kg, rat, oral <i>EH40 OES 0.5 mg/m³ (soluble compounds, as Ba)</i>	Inhalation may cause irritation of the respiratory tract. Ingestion can cause severe gastrointestinal distress with vomiting, diarrhea, and abdominal pain. Barium and fluoride absorption can result in muscle (including cardiac) and nerve irregularities with potassium and calcium deficiencies. Chronic exposures may cause Fluorosis (Chronic fluoride intoxication) with symptoms of digestive disturbances such as vomiting, loss of appetite, diarrhea, or constipation.
C	Carbon		7440-44-0	TLV: 3.5 mg/m ³ (As carbon black) PEL: 3.5 mg/m ³ (As carbon black) LD50: 440 mg/kg, mouse, intravenous	Inhalation that is prolonged and repeated at excessive levels may lead to benign pneumoconiosis. No effects have been found for ingestion.
CaCO ₃	Calcium Carbonate		1317-65-3	TLV: 10 mg/m ³ PEL: 15 mg/m ³ (Total dust); 5 mg/m ³ (Respirable fraction) LD50: 6,450 mg/kg, rat, oral <i>EH40: Total inhalable dust OES 10 mg/m³ (8 hours TWA), Total respirable dust OES 4 mg/m³ (8 hours TWA)</i>	This compound is considered non-toxic. Inhalation of particulates could cause mild irritation of the respiratory tract. Though used as an antacid, ingestion of large amounts could lead to intestinal blockage.

CaF ₂	Calcium Fluoride (Fluorspar)	7789-75-5	TLV: 2.5 mg/m ³ (as F) PEL: 2.5mg/m ³ (as F) LD ₅₀ : 4,250mg/kg, rat, oral	Inhalation of welding fumes containing calcium fluoride can cause irritation of the respiratory tract. Ingestion of soluble fluorides can produce symptoms of vomiting, abdominal pain, diarrhea, convulsions, muscular weakness and other signs of neurological problems. Chronic exposures may cause Fluorosis (Chronic fluoride intoxication) with symptoms of digestive disturbances such as vomiting, loss of appetite, diarrhea, or constipation.
CaO	Calcium Oxide	1305-78-8	TLV: 2 mg/m ³ , as Calcium Oxide PEL: 5 mg/m ³ , as Calcium Oxide LD50: Not Known EH40: Total inhalable dust OES 2 mg/m ³ (8 hours TWA)	May cause skin, eye and mucous membrane irritation. Inhalation of dust or fume may cause respiratory irritation. Repeated exposure can cause damage to the nasal septum, pneumonia and dermatitis.
CaSiO ₃	Calcium Metasilicate	1344-95-2	TLV: 10 mg/m ³ (Dust) PEL: 15 mg/m ³ (Total dust) 5 mg/m ³ (Respirable) LD ₅₀ : Not Available EH40: Total inhalable dust OES 10 mg/m ³ (8 hours TWA), Total respirable dust OES 4 mg/m ³ (8 hours TWA)	Long Term cumulative inhalation of calcium metasilicate may cause restriction of the large airways. May cause minor skin and eye irritation. The International Agency for Research on Cancer (IARC) has concluded that calcium metasilicate is a questionable carcinogen with experimental tumorigenic data in animals. Not classifiable as a human carcinogen according to IARC.
Co	Cobalt	231-158-0	7440-48-4 TLV: 0.02 mg/m ³ (Dust & fume as Co) PEL: 0.1 mg/m ³ (As Co metal) LD ₅₀ : 6,170 mg/kg, rat, oral EH40 OES 0.1 mg/m ³ (8 hours TWA)	Asthmatic symptoms and pulmonary fibrosis occurring in the tungsten carbide industry may be related to the inhalation of metallic cobalt dust. Evidence of polycythemia (an increase in the total red cell mass of the blood in the body) and altered thyroid, kidney and liver function have also been found. Excessive inhalation of metallic cobalt has produced cardiac changes in miniature swine. Eye contact may cause conjunctivitis. Symptoms of excessive ingestion may be a sensation of hotness with vomiting, diarrhea and nausea along with the potential for causing damage to blood, heart, thyroid and pancreas. Repeated skin contact can cause sensitivity and allergic skin rashes. Cobalt powders have caused tumors at the site of injection in rodents. However, studies of cobalt-containing prostheses do not suggest a significant risk for humans.
Cr	Chromium	231-157-5	7440-47-3 TLV: 0.5 mg/m ³ PEL: 1.0 mg/m ³ (Metal as Cr) LD ₅₀ : Not Available EH40: Chromium VI compounds (as Cr) OES 0.05 mg/m ³ (8 hours TWA) Chromium II compounds (as Cr) OES 0.5 mg/m ³ (8 hours TWA) Chromium III compounds (as Cr) OES 0.5 mg/m ³ (8 hours TWA) Chromium OES 0.5 mg/m ³ (8 hours TWA)	Chromium metal is relatively nontoxic. Chromium metal and insoluble salts are said to be involved in fibrosis of the lungs. When the metal is heated to a high temperature, fumes produced may be damaging to the lungs if inhaled. The International Agency for Research on Cancer has concluded that the evidence for carcinogenicity in humans and animals is inadequate for chromium metal and trivalent chromium compounds, but sufficient for hexavalent chromium compounds. Fumes from welding chromium-containing stainless steel or certain chromium-containing rods can trigger eczematous eruptions on the palms of the hands of chromium-sensitized individuals.
Cr ₂ O ₃	Chromic Oxide	1308-38-9	TLV: 0.5 mg/m ³ , as Cr PEL: 0.5 mg/m ³ (Metal as Cr) LD50: Not Available	Trivalent chromium compounds (such as Cr ₂ O ₃) are considered to exhibit a low degree of toxicity. Excessive concentrations of airborne dust may irritate the nose, throat, and respiratory tract. Prolonged overexposure may result in pulmonary changes. Skin and eye contact may cause irritation. The U.S. National Toxicology Program (NTP) has concluded that there is sufficient evidence that certain chromium compounds were carcinogenic to humans. However, the International Agency for Research on Cancer (IARC) has stated that there is inadequate evidence for carcinogenicity to humans or animals for trivalent chromium compounds.

Cu	Copper	231-159-6	7440-50-8	<p>TLV: 1 mg/m³ (Dusts & mists, as Cu), 0.2 mg/m³ (Fume)</p> <p>PEL: 1 mg/m³ (Dusts & mists, as Cu), 0.1 mg/m³ (Fume as Cu)</p> <p>LD₅₀: 35 mg/kg, mouse, intraperitoneal</p> <p><i>EH40: Fume OES 0.2 mg/m³ (8 hours TWA) Dusts & mists (as Cu) OES 1.0 mg/m³ (8 hours TWA), 2.0 mg/m³ (15 minute reference period)</i></p>	<p>Copper metal dust and fume may be irritating to the respiratory tract. In user operations where copper fume is generated, inhalation of the fume can result in symptoms of "Metal Fume Fever" such as chills, fever and sweating. A few instances of allergic skin rashes have been reported in workers with skin exposure to metallic copper. In the eyes, copper metal as a foreign body can provoke an inflammatory reaction resulting in pus formation in the conjunctiva, cornea or sclera. Ingestion of copper metal may cause gastrointestinal upset. Wilson's disease can occur in certain individuals with a rare, inherited metabolic disorder characterized by retention of excessive amounts of copper in the liver, brain, kidneys and corneas. These deposits eventually lead to tissue necrosis and fibrosis, causing a variety of clinical effects, especially liver disease and neurological changes. Wilson's disease is progressive and, if untreated, leads to fatal liver failure.</p>
Fe/ Fe ₂ O ₃	Iron	231-096-4	7439-89-6	<p>TLV: No limit set (For Fe₂O₃ fume the TLV is 5 mg/m³ as Fe)</p> <p>PEL: No limit set (For Fe₂O₃ dust & fume the PEL is 10 mg/m³ as Fe)</p> <p>LD₅₀: Not Available</p> <p><i>EH40 Iron Oxide, fume (as Fe) OES 5.0 mg/m³ (8 hours TWA), 10 mg/m³ (15 minute reference period)</i></p>	<p>Inhalation of the excessive oxide fumes or dusts can lead to irritation of the respiratory tract. Prolonged inhalation of iron oxide for periods of 6 to 10 years is known to cause siderosis which appears to be a benign pneumoconiosis. Prolonged eye contact with the metal dust could cause rust brown colored spots forming around the particles and if left for several years, permanent damage could result.</p>
Fe ₃ O ₄	Ferrosferriic Oxide		1317-61-9	<p>TLV: No limit set (For Fe₂O₃ fume, 5 mg/m³ as Fe)</p> <p>PEL: No limit set (For Fe₂O₃ dust and fume, 5 mg/m³ as Fe)</p> <p>LD₅₀: Not Available</p>	<p>Inhalation of excessive amounts can lead to irritation of the respiratory tract. Chronic inhalation of iron oxide for periods of 6 - 10 years is known to cause siderosis which seems to be a benign pneumoconiosis. No data found on ingestion.</p>
K ₂ O	Potassium Oxide		12136-45-7	<p>TLV: 2 mg/m³ Ceiling value as KOH</p> <p>PEL: 2 mg/m³ Ceiling value as KOH</p> <p>LD₅₀: Not Available</p>	<p>No toxicity data was found on potassium oxide, but it is expected to have effects similar to sodium peroxide which is highly irritating to the skin, eyes and the mucous membranes of the respiratory tract.</p>
K ₂ SiO ₃	Potassium Silicate		1312-76-1	<p>TLV: Not Established</p> <p>PEL: Not Established</p> <p>LD₅₀: >1000 mg/kg, oral, rat</p>	<p>Silicates are generally considered to have low systemic toxicity, however due to their alkaline nature they may cause corrosive effects on mucous membranes. Eye exposure can cause irritation, redness, tearing and blurred vision. Prolonged eye exposure may lead to chronic conjunctivitis. Skin exposure may cause local slight irritation. Repeated contact may lead to dermatitis. Inhalation of mist or fume can cause irritation of the nasal and respiratory passages. Ingestion can produce gastrointestinal irritation, nausea, vomiting, diarrhea, accompanied by potentially severe tissue damage. No known chronic effects have been noted.</p>
K ₂ ZrF ₆	Potassium Fluorizirconate		16923-95-8	<p>TLV: 2.5 mg/m³ (Fluorides, as F)</p> <p>PEL: 2.5 mg/m³ (Fluorides, as F)</p> <p>LD₅₀: 98 mg/kg, mouse, oral</p>	<p>Inhalation of welding fumes containing fluorides can cause irritation of the respiratory tract. Ingestion of soluble fluorides can produce symptoms of vomiting, abdominal pain, diarrhea, convulsions, muscular weakness and other signs of neurological problems. Nose bleeds, skin irritation, tissue damage and slow healing scars can result if exposure is excessive. Chronic exposures may cause Fluorosis (Chronic fluoride intoxication) with symptoms of digestive disturbances such as vomiting, loss of appetite, diarrhea, or constipation.</p>

LiCO ₃ Li ₂ CO ₃	Lithium Carbonate	554-13-2	TLV: No limit set PEL: No limit set LD50: Oral 525 mg/kg, rat Dermal LD 50, > 2000 mg/kg, rat	Contact with skin or eyes may cause irritation. Ingestion may cause acute local tissue damage. Some studies of pregnant mice and rats indicated an association between lithium ingestion and birth defects but only at dose levels large enough to produce signs of severe maternal toxicity. Although data for the 1970's and early 1980's suggested an increase in cardiovascular defects in babies born to women on lithium carbonate therapy, more recent studies have not found any association between lithium exposure and birth defects. Exposure to lithium in industrial settings is not considered to pose a risk to human health. NIOSH studied 25 workers exposed to lithium-containing dust at air concentrations exceeding 10 Mg/M3 (nuisance dust limit) and found that typical industrial exposure to lithium will not result in blood levels sufficiently high to produce toxicity in either adults or their offspring.
MgO	Magnesium Oxide	1309-48-4	TLV: 10 mg/m ³ (As fume) PEL: 15 mg/m ³ (Total dust or fume) LD50: Not Available EH40 Total inhalable dust OES 10 mg/m ³ (8 hours TWA), Total fume and respirable dust OES 4 mg/m ³ (8 hours TWA)	Inhalation of fumes can irritate the nose and throat. Excessive inhalation can cause metal fume fever with flu-like symptoms such as fever, body aches, vomiting, etc. Fumes of magnesium may irritate the eyes and skin. On ingestion the oxide will act as an antacid and laxative.
Mn	Manganese	231-105-1 7439-96-5	TLV: 0.2 mg/m ³ elemental and inorganic compounds, as Mn PEL: 5 mg/m ³ (Ceiling, as Mn compounds); 5 mg/m ³ (Fume, as Mn) LD ₅₀ : 9,000 mg/kg, rat, oral EH40 Manganese and its inorganic compounds (as Mn) OES 0.5 mg/m ³ (8 hours TWA)	Excessive inhalation or ingestion of manganese can produce manganese poisoning. Chronic exposures can lead to neurological problems such as apathy, drowsiness, weakness, spastic gait, paralysis, and other neurological problems resembling Parkinsonism. These symptoms can become progressive and permanent if not treated. Excessive inhalation of fumes may cause "Metal Fume Fever" with its flu-like symptoms, such as chills, fever, body aches, vomiting, sweating, etc.
MnO	Manganous Oxide	1344-43-0	TLV: 0.2 mg/m ³ (as Mn) PEL: 1mg/m ³ (fume) 5mg/m ³ (Stel, Ceiling) LD ₅₀ : >50mg/kg, intratracheal rat.	Excessive inhalation or ingestion of manganese and manganese compounds can produce manganese poisoning. Chronic exposures can lead to neurological problems such as apathy, drowsiness, weakness, spastic gait, paralysis, and other neurological problems resembling Parkinsonism. These symptoms can become progressive and permanent if not treated. Inhalation of fumes may bring about "metal fume fever" with symptoms such as chills and fever, upset stomach, vomiting, dryness of throat, cough, weakness, and aching of the head and body.
Mo	Molybdenum	231-107-2 7439-96-7	TLV: 10 mg/m ³ (Insoluble and metal compounds, as Mo) PEL: 15 mg/m ³ (Insoluble compounds, total dust as Mo) LD ₅₀ : Not Available EH40 - Molybdenum compounds (as Mo): Soluble - OES 5.0 mg/m ³ (8 hours TWA), 10 mg/m ³ (15 minute reference period) Insoluble - OES 10 mg/m ³ (8 hours TWA), 20 mg/m ³ (15 minute reference period)	Molybdenum and its insoluble compounds are reported to have a low toxicity. High dietary intake may produce a gout-like disease and high blood uric acid. Inhalation of fumes has caused kidney damage, respiratory irritation and liver damage in animals. Skin and eye contact may cause irritation.

Na ₂ O	Sodium Oxide	1313-59-3	TLV: 2 mg/m ³ (ceiling level as NaOH) PEL: 2mg/m ³ (as NaOH) LD ₅₀ : Not Available	Sodium oxide, in powder form, is highly corrosive to moist skin, eyes, and the mucous membranes of the digestive and respiratory tracts due to its reaction with water to form sodium hydroxide. Inhalation of dusts may cause symptoms that vary from mild irritation to destructive burns depending on exposure. Ingestion can cause immediate burning of the mouth, esophagus, and stomach; swelling of surround tissues, vomiting; and rapid, faint pulse with cold, clammy skin. Death can result. Skin contact causes slippery, soapy feeling that may not be immediately painful even though skin damage begins at contact. This contact can lead to chemical burns, tissue corrosion, ulceration, loss of nails and hair, and permanent scarring if not immediately washed off. The cornea of the eye will begin corroding on contact and can lead to temporary or permanent corneal opacification producing blindness. Chronic low level skin exposures to sodium hydroxide may result in dermatitis. Sodium hydroxide is reported to have caused carcinoma of the esophagus 12 to 42 years after ingestion.
Na ₂ Si ₄ O ₉ / Na ₂ SiO ₃	Sodium Silicate	1344-09-8	TLV: Not Established PEL: Not Established LD ₅₀ : 1153 mg/kg, oral, rat	Silicates are generally considered to have low systemic toxicity, however due to their alkaline nature they may cause corrosive effects on mucous membranes. Eye exposure can cause severe irritation, redness, tearing and blurred vision. Skin exposure may cause slight irritation. Inhalation of mist or fume can cause irritation of the nasal and respiratory passages. Ingestion may produce gastrointestinal irritation, nausea, vomiting, diarrhea and abnormal kidney function. No known chronic effects have been noted.
Na ₂ AlF ₆	Sodium Aluminum Fluoride (Sodium Fluoaluminate)	15096-52-3	TLV: No limit set PEL: No limit set LD ₅₀ : 200 mg/kg, rat, oral	Excessive inhalation of dust may cause irritation of the nose, throat and respiratory tract. Ingestion causes severe gastrointestinal distress with salivation, nausea, vomiting, diarrhea, and pain. Also may cause muscular weakness, tremors, convulsions, loss of consciousness, and death. Prolonged exposure to fluorides can cause skeletal abnormalities and digestive tract disturbances. Prolonged or repeated skin contact can produce dermatitis.
NaF	Sodium Flouride	7681-49-4	TLV: 2.5 mg/m ³ (as F) PEL: 2.5 mg/m ³ (as F) LD ₅₀ : 0.18g/kg, rat, oral	Sodium fluoride is very poisonous. Ingestion of less than 1 gram can cause nausea and vomiting, salivation, diarrhea, weakness, spasms of limbs, and stupor. Ingestion of 5 to 10 grams has proven fatal. Symptoms of possible lethal exposure include muscular weakness, tremors, convulsions, collapse, and difficulty breathing to respiratory and cardiac failure. This chemical is irritating to the eyes, nose and respiratory system. Long-term exposure can cause skeletal abnormalities (Fluorosis) to develop. This can include bone densification and calcification of certain ligaments along with stiffness of the spinal column. Mottling of tooth enamel is also possible.
Nb	Niobium	231-113-5 7440-03-1	TLV: No limit set PEL: No limit set LD ₅₀ : Not Available	Also known as Columbium (Cb), there is almost no information on the toxicity of this metal or its fumes. Russian medical literature has described early chest x-ray changes in welders and chemical workers handling niobium and tantalum, but no specific data has been found. It is expected that the metal dust and fumes could cause irritation to the skin, eyes and respiratory tract upon acute exposure.

Ni	Nickel R43	231-111-4	7440-02-0	<p>TLV: 1.5 mg/m³ as metal (Inhalable Fraction) PEL: 1 mg/m³ for metal and insoluble compounds as Ni LD₅₀: >9,000 mg/kg, rat, oral</p> <p><i>EH40 - Nickel and its inorganic compounds (except nickel carbonyl): Water soluble nickel compounds (as nickel) OES 0.1 mg/m³ (8hours TWA). Nickel & water in-soluble nickel compounds (as Ni) OES 0.5 mg/m³ (8-hour TWA)</i></p>	<p>The U.S. National Toxicology Program (NTP) 10th Report on Carcinogens has listed "metallic nickel" as "reasonably anticipated to be a human carcinogen" and "nickel compounds" as "known human carcinogens". "Nickel Alloys" were reviewed but not listed. The International Agency for Research on Cancer (IARC) concluded that nickel compounds were carcinogenic to humans and that metallic nickel is possibly carcinogenic to humans. Epidemiological studies of workers exposed to nickel powder and to dust and fume generated in the production of nickel alloys and of stainless steel have not indicated the presence of a significant respiratory cancer hazard.</p> <p>The inhalation of nickel powder has not resulted in an increased incidence of malignant tumors in rodents. Repeated intratracheal instillation of nickel powder produced an increased incidence of malignant lung tumors in rats, but did not produce an increased incidence in hamsters when administered at the maximum tolerated dose. However, single intratracheal instillations of nickel powder in hamsters at doses near the LD₅₀ have produced an increased incidence of fibrosarcomas, mesotheliomas and rhabdomyosarcomas. Inhalation of nickel powder at concentrations 15 times the PEL irritated the respiratory tract in rodents. Nickel is a known sensitizer and may produce allergic reactions.</p>
Si	Silicon	231-130-8	7440-21-3	<p>TLV: 10 mg/m³ PEL: 10 mg/m³ Total dust; 5 mg/m³ Respirable fraction LD₅₀: 3,160 mg/kg, rat, oral in amorphous form</p> <p><i>EH40 Total inhalable dust OES 10 mg/m³ (8 hours TWA). Total respirable dust OES 4 mg/m³ (8 hours TWA).</i></p>	<p>Silicon in dust form is considered a nuisance dust with no toxic effects when exposures are kept under control. However, like all dusts, high concentrations of silicon dust will cause some irritation to the nose and throat. Inhalation of crystalline silica (SiO₂) over a long period of time can cause silicosis. In 1997, the International Agency for Research on Cancer (IARC) concluded that crystalline silica is a class I carcinogen. IARC states that a number of studies have shown that persons diagnosed as having silicosis have an increased risk of dying from lung cancer.</p>
SiO ₂	Silicon Dioxide Silica	60676-86-0		<p>TLV: 10 mg/m³ (Metal dust); 5 mg/m³ (Welding fumes) PEL: 15 mg/m³ (Total metal dust); 5 mg/m³ (Metal dust - respirable fraction) LD₅₀: Not Available</p> <p><i>EH40: Silica, fused respirable dust, OES 0.08 mg/m³ (8-hour TWA)</i></p>	<p>No information was found on the hazards of ingestion of crystalline silica as the material seems to be relatively inert. Acute exposures to this material will irritate the respiratory tract. Chronic inhalation (after 10 - 20 years) can produce silicosis pneumoconiosis of the lungs) with symptoms of dyspnea, cough, wheezing and repeated, non-specific chest illnesses. Impairment of pulmonary function may be progressive. In 1997, the International Agency for Research on Cancer (IARC) concluded that crystalline silica is a class 1 carcinogen. IARC states that a number of studies have shown that persons diagnosed as having silicosis have an increased risk of dying from lung cancer.</p>
SrCO ₃	Strontium Carbonate	1633-05-2		<p>TLV: No limit set PEL: No limit set LD₅₀: Not Available</p>	<p>There is very little toxicity and health data on this material. Excessive overexposure to the dust may ulcerate mucous membranes in the nose and may cause sneezing and coughing. No data found on ingestion problems.</p>
Ti	Titanium	231-142-3	7440-32-6	<p>TLV: No limit set PEL: No limit set LD₅₀: Not Available</p> <p><i>EH40 - As Titanium dioxide: Total inhalable dust OES 10 mg/m³ (8 hours TWA), Total respirable dust OES 4 mg/m³ (8 hours TWA)</i></p>	<p>Inhalation of titanium could cause mild irritation to the respiratory tract. Inhalation of titanium dioxide dust or fume could produce lung fibrosis and chronic bronchitis.</p>

Ta	Tantalum	7440-25-7	TLV: 5 mg/m ³ (Metal & oxide dusts) PEL: 5 mg/m ³ (Metal & oxide dusts) LD ₅₀ : Not Available <i>EH40 OES 5.0 mg/m³ (8 hours TWA), 10 mg/m³ (15 minute reference period)</i>	There are no reports of adverse health effects in industrially exposed workers. Massive doses of tantalum given by the intratracheal route to rats have produced respiratory tract lesions. In contact with tissue, metallic tantalum is inert. Tantalum pentoxide has an LD ₅₀ of >8 g/kg, orally in rats.
TiO ₂	Titanium Dioxide	13463-67-7	TLV: 10 mg/m ³ (Dust); PEL: 5 mg/m ³ (Respirable) LD ₅₀ : Not Available <i>EH40: Total inhalable dust OES 10.0 mg/m³(8-hour TWA), total respirable OES 4 mg/m³</i>	Is considered a nuisance dust that is inert, practically non-toxic and chemically non-irritating. Skin contact has shown no problems other than possible drying and mechanical abrasion. Eye contact can produce particulate irritation. Does not seem to be absorbed by the body through ingestion. Excessive inhalation can produce mild pulmonary irritation and possible non-disabling slight fibrosis of the lungs.
W	Tungsten	231-143-9	7440-33-7 TLV: 5 mg/m ³ insoluble compounds, as W STEL: 10 mg/m ³ for soluble compounds, as W PEL: No limit set LD ₅₀ : 2,000mg/kg, rat, unreported route <i>EH40: Soluble compounds, OES 1.0 mg/m³ (8-hour TWA) and 3 mg/m³ (15 minute reference period). In-soluble compounds, OES 5 mg/m³(8-hour TWA) and 10.0 mg/m³ (15 minutes reference period)</i>	Inhalation of tungsten dust may cause irritation of the respiratory tract. Skin or eye contact could cause abrasion or irritation of the respective surfaces. No hazards have been identified for tungsten fume except that it may aggravate an existing chronic respiratory disease.
ZrO ₂	Zirconium Dioxide	1314-23-4	TLV: 5 mg/m ³ (as Zr) 10 mg/m ³ (STEL) PEL: 5 mg/m ³ (as Zr) 10 mg/m ³ (STEL) LD ₅₀ : Not Available <i>EH40 Zirconium compounds (as Zr), OES 5mg/m³ (8-hour TWA), 10 mg/m³ (15-minute reference period)</i>	Though this material has a low order of toxicity on inhalation some lung granulomas have been reported. Excessive inhalation may cause irritation of the nose and respiratory tract. Eye contact may cause irritation. Skin contact may cause irritation and sensitization dermatitis characterized by dusty red-brown papules. No information found on effects of ingestion.

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

Trace impurities and additional material names not listed above may also appear in Appendix 1 toward the end of the MSDS. These materials may be listed for local "Right-To-Know" compliance and for other reasons.

Weight percentages for each grade of product are listed in Table 2.x