

# Material Safety Data Sheet

## Chromium-Nickel-Molybdenum Alloyed Stainless Steel grades

### 1. Product And Company Identification

Outokumpu Plate Products  
549 West State Road 38  
New Castle, IN 47362  
Tel. 1-800 349 0023, 1-765 529 0120

Outokumpu Bar Products  
3043 Crenshaw Parkway  
Richburg, SC 29729  
Tel. 1-888 458 4600, 1-803 789 5383

Outokumpu Pipe Products  
1101 North Main Street  
Wildwood, FL 34785  
Tel. 1-800 731 7473, 1-352 748 1313

Outokumpu Coil Products  
425 North Martingale Road  
Schaumburg, IL 60173  
Tel. 1-800 833 8703, 1-847 517 4050

#### Additional information:

Elisabeth Torsner and Jim Bell, Outokumpu  
Tel. 1-800 349 0023, 1-765 529 0120, (Office hours)  
e-mail: elisabeth.torsner@outokumpu.com  
email: jim.bell@outokumpu.com

**Products:** Solid stainless steel products, various forms, and uses.

#### Grades and Outokumpu Trademarks:

310MoLN, 316, 317, 329, 254 SMO®, 2205, 2205 Code Plus Two®, 2209, Outokumpu 2507, and 1.4439. This includes all listed grades with letter prefixes and suffixes as well as PRODEC® suffix.

### 2. Hazards Identification

**Caution!** Dust and fumes from welding and other processing are eye, skin, and respiratory irritants and sensitizers. May cause metal fume fever.

**Attention!** Cancer hazard. Dust and fumes can cause cancer.

#### OSHA Regulatory status

Solid stainless steel products covered by this MSDS are shipped as non-flammable, non-explosive, non-reactive articles and do not constitute a hazardous material in solid form under the terms of OSHA Hazard Communications Act. However, some metallic elements from which this product is manufactured are listed in OSHA Hazard Standard (29 CFR 1910.1000).

Solid stainless steel does not contain hexavalent chromium. Chromium as Cr(VI) compound can be found in fumes and dust formed by grinding, polishing, abrasive blasting, hot rolling, hot

forging, thermal cutting, or welding of stainless steel. Cr(VI) compounds can also be formed by cleaning stainless steel with strong oxide formers at high pH. Cr(VI) is classified by NTP as "Known to be a human carcinogen" and by ACGIH as AI "Confirmed Human carcinogen."

Manganese as metal and inorganic compound in fumes and dust may cause CNS (manganism).

Nickel in alloys is not listed by NTP and classified by ACGIH as A5 "Not suspected as a Human carcinogen."

#### Potential health effects

No carcinogenic effects resulting from exposure to stainless steel have been reported, either in epidemiological studies or in tests with animals.

**Skin contact:** If an individual is already sensitized to nickel, prolonged skin contact may result in an allergic reaction.

**Inhalation:** Dust and fumes which may be produced as a by-product during grinding, polishing, abrasive blasting, hot rolling, hot forging, welding, brazing, thermal cutting, pickling, and post-fabrication cleaning or similar processes may contain fumes of chromium (VI) oxides and other welding rod components.

Section 11 discusses health effects in more detail.

### 3. Components/ Information On Ingredients

Table 1

Component	CAS No.	% by Weight
Iron	7439-89-6	Balance
Silicon	7440-21-3	0 – 1.0
Manganese	7439-96-5	0 – 2.0
Chromium	7440-47-3	16 – 28
Nickel	7440-02-0	2.5 – 23
Molybdenum	7439-98-7	1.0 – 6.5
Titanium	7440-32-6	0 – 0.7
Copper	7440-50-8	0 – 1
Cobalt	7440-48-4	0 – 0.6

**Trace elements:** All trace elements as cadmium, lead, mercury, hexavalent chromium, antimony, beryllium, and bismuth are below the levels specified in the CPSC, European ELV and RoHS Directives, the Japanese Green Procurement Standardization Initiative, and the U.S. EIA Joint Industry Guide JIG.

Other elements may be present such as Carbon, Nitrogen, Sulfur, Phosphorous, Boron, Aluminum, Calcium, Columbium, Tantalum, and Tungsten. These are either not hazardous or below 0.1% concentration.

**4. First Aid Measures**

Employ first aid techniques recommended by the American Red Cross.

**Eye Contact:** In case of irritation from particulate, immediately flush with plenty of water for 15 minutes and call for medical assistance.

**Skin contact:** In case of skin irritation or laceration, wash thoroughly with plenty of soap and water.

**Inhalation:** Not applicable to stainless steel in massive form. Inhalation of dust and/or fumes from grinding, cutting, and welding operations—if breathing is difficult remove person from exposed area to fresh air.

**Ingestion:** Accidental ingestion is unlikely. If ingested, call for medical assistance

**5. Fire Fighting Measures**

Stainless steels are not combustible. There are no special hazards or precautions associated with stainless steels if in vicinity of a fire.

**6. Accidental Release Measures**

Not applicable.

**7. Handling And Storage**

There are no special technical measures involved for handling stainless steels. Normal precautions should be taken to avoid physical injury from coiled or bundled products, possibly with sharp edges.

- Do not use straps or bands, used to secure some products, for lifting. Coil and bundled products (e.g. sections, rods, bars) may spring apart when the banding is removed and the banding itself could cause eye or other injury when tension is released.
- Certain products may, as a result of processing, be brittle or have residual stresses that might cause fracture or significant deformation.
- All products are likely to have sharp edges that could cause lacerations and flying particles may be produced when shearing.
- Adopt suitable work procedures to take account of hazards arising from the risk of fracturing or the release of tension when breaking open banding.
- Use suitable racks to ensure stability when stacking narrow coils or bundled material.

**Occupational exposure limits 8-hour TWA mg/m<sup>3</sup>**

Table 2

Component	OSHA PEL	ACGIH TLV	Carcinogenetic listing		
			ACGIH	NTP	IARC
Iron oxide as Fe <sub>2</sub> O <sub>3</sub>	10	5	A4	No	NE
Silicon dust	15 5 (R)	NE	NE	No	NE
Manganese, inorganic compounds as Mn	5	0.2	No	No	NE
Manganese, fume as Mn	5	NE	No	No	NE
Chromium metal and insoluble salts as Cr	1	0.5	A4	No	3
Chromium Cr(II) and Cr(III) compounds as Cr	0.5	0.5	A4	No	3
Cr(VI) compounds, water soluble as Cr	5* µg/m <sup>3</sup>	0.05	A1, BEI	A	1
Cr(VI) compounds, insoluble as Cr	5* µg/m <sup>3</sup>	0.01	A1	A	1
Nickel, in alloys as Ni	1	1.5 (I)	A5	No	2B
Nickel, elemental metallic as Ni	1	1.5 (I)	A5	B	2B
Nickel, soluble inorganic compounds as Ni	1	0.1 (I)	A4	A	1
Nickel, insoluble inorganic compounds as Ni	1	0.2 (I)	A1	A	1
Nickel, subsulfide as Ni	NA	0.1 (I)	A1	A	1
Nickel, carbonyl as Ni	0.007	NE	No	A	1
Molybdenum, soluble compounds as Mo	5	0.5(R)	A3	No	NE
Molybdenum, metal, and insoluble compounds as Mo	15	10(I) 3 (R)	No	No	NE
Titanium in titanium dioxide form	15	10	A4	No	3
Copper, fume as Cu	0.1	0.2	No	No	NE
Copper, dusts, and mists as Cu	1	1	No	No	NE
Cobalt and inorganic compounds as Co	0.1	0.02	A3, BEI	B Cobolt sulfate	2B

TWA=Time Weighted Average, STEL= Short Term Exposure Limit, NE=Not Established, R=Respirable fraction, I=Inhalable fraction, BEI=Biological Exposure Index ACGIH Ratings: A1=Confirmed Human Carcinogen, A2=Suspected Human Carcinogen, A3=Confirmed Animal Carcinogen with Unknown Relevance to Humans, A4=Not classifiable as a Human Carcinogen, A5=Not suspected as a Human Carcinogen. NTP Ratings: A=Known to be a human carcinogen, B=Reasonably anticipated to be a human carcinogen, IARC Groups: 1=Carcinogenic to humans, 2A=Probably carcinogenic to humans, 2B=Possibly carcinogenic to humans, 3=Not classifiable as to carcinogenicity to humans.  
 \*See OSHA 29 CFR 1910.1026(5).

## 8. Exposure Controls/ Personal Protection

### Exposure guidelines

There are no occupational exposure limits for stainless steels. Occupational exposure limits apply to some components and certain of their compounds. Table 2 shows limits according to current U.S. legislation.

### Engineering controls

Employ appropriate control measures when welding, brazing, thermal cutting, burning, sawing, grinding, or post fabrication cleaning of stainless steel. Use local exhaust and dilution ventilation to control dust and/or fumes.

**Welding and related processes:** Read and understand the MSDS, manufacturers instruction, and precautionary labels for welding consumables. See American National Standard Z49.1, Safety in Welding and Cutting, published by the American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126, and OSHA Publication 2206 (29 CFR 1910), U.S. Government Printing Office, Washington, D.C. 20402, for more details on exposure controls.

### Pickling, acid cleaning, and neutralization of cleaning wastes:

Read and understand the cleaning product MSDS, manufacturers instruction and precautionary labels for cleaning agents. Unintended use of strong oxidizers (high pH) on stainless steel may cause Cr(VI) compounds to form at ambient temperatures.

**Eye/face protection:** Wear ANSI Z87.1 approved safety glasses with side shields or goggles where metal dust or fume is present. Use appropriate eye protection, including welding helmets and/or face shields with protective filter lenses when welding, brazing, or thermal cutting. Select welding lens shades from the American Welding Society (AWS) publication F2.2. Use appropriate eye/face protection when cleaning and pickling stainless steel.

**Skin protection:** Wear protective gloves while handling stainless steel to prevent cuts and skin abrasions, and to reduce the risk of sensitization from skin contact. Wear appropriate hand protection when welding, brazing, and thermal cutting. Wear acid proof gloves when cleaning and pickling stainless steels.

**Respiratory protection:** Use a NIOSH-approved respirator for dust and fumes or an air supplied respirator where local exhaust or general dilution ventilation does not keep exposures below the PEL or TLV for air contaminants. See OSHA 29 CFR 1910.134.

**Protective clothing:** Wear suitable protective clothing and equipment, such as hand and eye protection to take account of hazards arising from the risk of fracturing or the release of tension when breaking open banding. Safety shoes are recommended. Wear appropriate hand and body protection during welding, brazing, and thermal cutting on stainless steel. Refer to ANSI Z49.1 for more information. Wear appropriate hand and body protection when cleaning and pickling stainless steel.

**General Hygiene Considerations:** Do not eat, smoke, or drink in areas where metal dust or fume is present. Utilize good personal hygiene including washing hands and face prior to eating or drinking.

## 9. Physical And Chemical Properties

**Color:** Varying from dull very light grey, to shiny metallic light grey to bright mirror-finish

<b>Odor:</b>	Odorless
<b>Odor threshold:</b>	Not applicable
<b>Physical state:</b>	Solid
<b>pH:</b>	Not applicable
<b>Melting point:</b>	2500 – 2760 °F (1370 – 1520°C)
<b>Boiling point:</b>	Not applicable
<b>Flash point:</b>	Not applicable
<b>Evaporation rate:</b>	Not applicable
<b>Flammability:</b>	Not applicable
<b>Explosive limits:</b>	Not applicable
<b>Vapor pressure:</b>	Not applicable
<b>Vapor density:</b>	Not applicable
<b>Specific gravity:</b>	0.27 - 0.30 lbs./in <sup>3</sup> (7.7 – 8.1 kg/dm <sup>3</sup> )
<b>Solubility (water):</b>	Insoluble
<b>Partition coefficient:</b>	Not applicable
<b>Auto-ignition temperature:</b>	Not applicable
<b>Decomposition temperature:</b>	Not applicable
<b>Thermal expansion (ambient to 100°C):</b>	10 – 16 x10 <sup>6</sup> m/m°C
<b>Thermal conductivity (ambient temperature):</b>	12 – 30 W/m°C

**Magnetic:** Austenitic stainless steels are non-magnetic in most supply conditions, but may be para-magnetic in some supply conditions. Duplex, ferritic and martensitic stainless steels are magnetic.

## 10. Stability And Reactivity

**Chemical stability:** Stable and non-reactive under normal ambient atmospheric conditions.

**Conditions to avoid:** None known

**Incompatible materials:** May react in contact with strong acids to release gaseous acid decomposition products, e.g. hydrogen, oxides of nitrogen. Use of strong oxidizers (high pH) on stainless steel may cause Cr(VI) compounds to form at ambient temperatures.

### Possibility of hazardous by-products—Welding fumes:

Various fumes and gases may be produced when stainless steel is subjected to welding, brazing, thermal cutting, and similar processes at high temperature. Such fumes and gases cannot be simply classified. The composition and quantity of both are dependent upon the composition of the base metal and the process, procedures, and consumables being used. Other conditions which also influence the composition and quantity of the fumes and gases to which workers may be exposed include; coatings on the base metal (such as paint, plating, galvanizing, and phosphate coatings), the number of workers performing welding, brazing, thermal cutting, or other related operations, the volume of the work area, the quantity of consumables used, the

design and amount of ventilation delivered, the position of the worker's head with respect to the fume plume, and the presence of contaminants in the atmosphere (such as chlorinated hydrocarbon vapors from solvent, cleaning, or painting activities) which may decompose by the arc into toxic gases such as phosgene.

Decomposition products from welding, brazing, thermal cutting operations will include those originating from the volatilization, reaction, or oxidation of ingredients in welding rods, fluxes, and fillers, plus those from the base metal and coatings, etc. Possible decomposition products that may be generated during welding, brazing, or thermal cutting include complex oxides of the ingredients listed in Section 3. Fumes generated during welding, brazing, or thermal cutting may contain: chromium compounds, including hexavalent chromium Cr(VI); nickel; manganese; iron; molybdenum; and silicon compounds.

The employer is required by OSHA to limit the worker's level of exposure to chemicals for which OSHA has established a PEL in 29 CFR 1910 Subpart Z. The only way to determine a worker's exposure to welding, brazing, or thermal cutting decomposition products is by sampling and analyses using accepted industrial hygiene techniques. The composition and quantity of the fumes and gases to which a worker is exposed can be established from an air sample(s) obtained from inside the welder's helmet, if worn, or in the worker's breathing zone. Review ANSI/AWS F1.1 and F1.3 standards for further information on air sampling for welding decomposition products.

## **11. Toxicology Information**

### **Acute effects**

In its solid form stainless steel does not present an inhalation, absorption, or ingestion hazard.

Short-term over-exposure to the fumes generated by hot rolling, hot forging, welding, brazing, or thermal cutting on stainless steel may result in dizziness; nausea; and irritation of the eyes, skin, lungs, nose, and throat. Metal fume fever, a flu-like illness lasting about 24 hours with chills, ache, cough, and fever can be caused by overexposure to metal fumes, including iron, chromium, manganese, and copper.

Metal dust particles may cause eye, skin and/or respiratory system irritation. Acute asthma attacks may be experienced by asthmatics when metal dust or fume is inhaled.

### **Chronic effects, inhalation, or ingestion**

#### **Dust and fumes**

Grinding, polishing, abrasive blasting, hot rolling, hot forging, thermal cutting, or welding may produce stainless steel dust or fumes containing complex or mixed oxides (spinels) of its components. Over long periods, inhalation of excessive airborne levels may have long term health effects, primarily affecting the lungs, e.g. lung fibrosis, or pneumoconiosis. Overexposure to iron oxide can cause siderosis (deposits of iron in the lungs) which may affect pulmonary function. However, studies of workers

exposed to nickel powder and dust and fumes generated in the production of nickel alloys and stainless steels have not indicated a respiratory cancer hazard.

### **Nickel**

For stainless steels there is no direct evidence of carcinogenic effects in man, nor indirect evidence from animals tested by relevant routes, i.e. inhalation or ingestion. In other studies, using non-relevant routes in animals, alloys with up to 40% nickel caused no significant increase in cancer.

The National Toxicology Program modified its classification of nickel in the 10<sup>th</sup> Report on Carcinogens, 2002. Nickel alloys, e.g. stainless steels were reviewed but were excluded due to inadequate human data and insufficient rodent cancer data to list. NTP regards metallic nickel as "Reasonably anticipated to be a carcinogen" and nickel compounds are "Known human carcinogens."

California Proposition 65 has adopted the same distinctions as NTP.

ACGIH is now classifying elemental nickel as A5 "Not suspected as a Human carcinogen."

OSHA has not made a distinction and lists "nickel metal and insoluble compounds" in 29 CFR 1910.1000.

### **Chromium**

Grinding, polishing, abrasive blasting, hot rolling and hot forging dust, welding fumes, and thermal cutting fumes may contain Cr(VI) hexavalent chromium compounds. Studies have shown that some hexavalent chromium compounds can cause cancer.

Chromium as Cr(VI) hexavalent compound in fumes and dust is classified by NTP as "Known to be a human carcinogen" and by ACGIH as A1 "Confirmed Human carcinogen."

Chromium as metal or Cr(II) and Cr(III) oxides is not listed by NTP and is classified by ACGIH as A4 "Not classifiable as a human carcinogen." However, epidemiological studies amongst welders indicate no extra risk of cancer when welding stainless steels, compared to the slightly increased risk when welding steels that do not contain chromium.

### **Manganese**

Overexposure to manganese can result in central nervous system effects referred to as manganism, including symptoms of muscular weakness, impaired speech, and tremors similar to Parkinson's disease. However, a new study of 49,488 male welders compared to 489,572 men from the general Swedish population did not reveal any statistically significantly increased risks for Parkinson's disease or other basal ganglia and movement disorders for welders compared with an age and geographically matched general population comparison cohort.

### **Molybdenum and Copper**

Both molybdenum and copper are necessary nutritional elements.

**5 Material Safety Data Sheet  
Chromium-Nickel-Molybdenum Alloyed  
Stainless Steel grades**

In accordance with ANSI Z400.1-2004  
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High doses of molybdenum may antagonize absorption of copper. Likewise, high doses of copper may antagonize absorption of molybdenum.

Overexposure to molybdenum causes anemia, gout-like syndrome, and increases uric acid levels. In experimental animals molybdenum toxicity causes weight loss, harmful changes of the liver, kidneys, and bones and impaired reflexes.

**Cobalt**

Cobalt in stainless steel is an alloy. None of the classifications of cobalt is valid for alloys. Cobalt dust may cause an asthma-like disease. Based on hard-metal workers, IARC has made a difference between cobalt metal with (2A) and without (2B) tungsten. NTP's 11<sup>th</sup> report on Carcinogens classifies cobalt sulfate as "Reasonably anticipated to be carcinogen." ACGIH classifies cobalt as A3 Confirmed Animal Carcinogen with Unknown Relevance to Humans.

**Dermatological effects**

Stainless steels do not cause nickel sensitization by prolonged skin contact in human. However, nickel is classified as a skin sensitizer. It causes skin sensitization in susceptible individuals through prolonged intimate contact with the skin (e.g. wearing jewelry).

Numerous patch tests have established that most stainless steels do not cause sensitization. However, studies have shown that, in some individuals already sensitized to nickel, close and prolonged skin contact with the re-sulfurized free-machining types of stainless steels with 0.15 – 0.35% S (416, 430F, 303, 303Cu) may cause an allergic reaction.

**Other observations**

Long-term experience of stainless steels in the most varied applications has demonstrated that these very resistant materials are eminently suitable where hygiene is of paramount importance

(e.g. food processing and food preparation). NIOSH lists Welding exposure as the 10<sup>th</sup> largest cause of work-related asthma, but makes no distinction between stainless and carbon steel welding.

There are some reports indicating that there is a risk of developing asthma from chromium (VI) compounds and nickel in welding fumes. In the European Union, stainless steel welding fume did not meet the classification criteria required to be listed as a "substance causing asthma."

**12. Ecological Information**

No known harmful effects. No special precautions are required.

**13. Disposal Considerations**

If discarded, the material is classified as RCRA Hazardous waste due to the chromium, manganese, and nickel contents.

Recycle if possible. Surplus and scrap (waste) stainless steel is valuable and in demand for the production of prime stainless steel. Recycling routes are well established, and recycling is therefore the preferred disposal route.

**14. Transport Information**

Stainless steel products in the solid form are not classified as HAZMAT. No label is required during transport.

**15. Regulatory Information**

See Table 3 for EPCRA/SARA information. For solid stainless steel products the required label may be transmitted to the customer at the time of the initial shipment, see 29 CFR 1910.1200 (f)(2)(i).

**Inventories**

OSHA	United States	Included
TSCA	United States	Included
DSL	Canada	Included

**EPCRA / SARA Section 302, 304, 311/312 and 313**

Table 3

Component	CAS #	Section 302 EHS	Section 304 Spill	Section 311/312 Hazard classes	Section 312 SARA Tier II	Section 313 Form R
			Reporting Quantity, lbs.		Threshold Planning Quantity, lbs.	By weight %
Chromium	7440-47-3	Not applicable	5,000	Chronic health hazard	10,000	16 – 28
Nickel	7440-02-0	Not applicable	100	Chronic health hazard	10,000	2.5 – 23
Manganese compounds	N450	Not applicable	No RQ established	Chronic health hazard	10,000	0 – 2.0

**California Safe Drinking Water and Toxic Enforcement Act (Proposition 65)**

**WARNING:** This product contains or produces chemicals known to the State of California to cause cancer. (California Health and Safety Code §25249.5 et seq.)

## 16. Other Information

### Food contact materials:

Stainless steel grade 316L is approved by NSF for food, 3-A dairy, and drinking water applications. 2205 Code Plus Two® is approved by NSF for drinking water applications and by the Department of Agriculture for 3-A dairy applications.

### Basic information used to draw up this information

#### References to key data:

OSHA, Standards 29 CFR 1910.1000–1200  
OSHA, Standards 29 CFR 1910.134 Respiratory Protection  
ANSI Z49.1:2005, Safety in Welding and Cutting  
EPA Consolidated List of Chemicals Subject to the Emergency Planning and Community-Right-to-Know Act (EPCRA) and section 112(r) of the Clean Air Act 2006.  
DOT, Standards 49 CFR.172.101-102  
National Toxicology Program, 11<sup>th</sup> Report on Carcinogens, 2005  
ACGIH, TLVs and BEIs, 2009 edition  
International Agency for Research on Cancer. 'IARC Monographs on the Evaluation of Carcinogenic Risks to Humans', vol. 1-88  
N. Becker: Cancer mortality among arc welders exposed to fumes containing chromium and nickel. Results of a third follow-up: 1989-1995  
IMOA, International Molybdenum Institute  
Outokumpu MSDS, European version, 1005EN:2, March 2004.  
C.M. Ford: Parkinson's Disease and other Basal Ganglia or Movement disorders in a large nationwide cohort of Swedish welders, Occupational and Environmental Medicine, February 2006.

### This MSDS replaces:

Outokumpu MSDS 120.3 dated 12.18.2008.

### Prepared by:

Elisabeth Torsner  
Vice President Technology  
Outokumpu  
Elisabeth.Torsner@outokumpu.com

### Disclaimer

The information contained in this document is based on the present level of our knowledge and experience. The information applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other material or in any other product form.

### Availability

All Outokumpu U.S. MSDS are available at the Outokumpu web site. To find them go to <http://www.outokumpu.com/stainless/na> and click on Material Safety Data Sheets on the sidebar menu.