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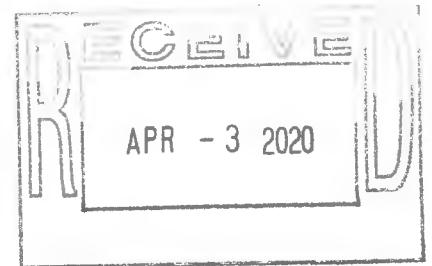
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**NEW SOURCE CONSTRUCTION AIR
PERMIT APPLICATION
ELLISON SURFACE TECHNOLOGIES
NORTH CLARENDON, VERMONT**

Prepared for:

Ellison Surface Technologies, Inc.
106 Innovation Drive
North Clarendon, VT 05759



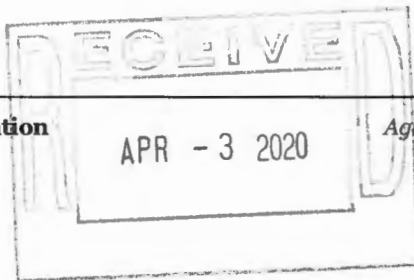
Prepared by:

Project Integration, Inc.
116 Hidden Hill Road
Spartanburg, South Carolina 29301

March 2020

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Vermont Department of Environmental Conservation
 Air Quality and Climate Division
 Davis 4 - 4th Floor
 One National Life Drive
 Montpelier, VT 05620-3802

Agency of Natural Resources

Air Quality & Climate Division
Certification of Information Accuracy

In accordance with §§5-409, 5-501(2) and 5-1006(f) of the Vermont Air Pollution Control Regulations this form must be signed by a responsible official of the facility and submitted with any Air Pollution Permit Application, Request for Transfer of Permit Ownership, Annual Emission Registration Submittal and Annual/Semi-Annual Compliance Reports as well as any other applications, records, reports, plans, designs, statements or documents required to be submitted to the AQCD. Note: all information submitted to the Agency is subject to 10 V.S.A. §563 regarding the confidentiality of records.

Facility Information:

Ellison Surface Technologies, Inc.

Facility Name (as registered with the Secretary of State)

106 Innovation Dr

Facility Street Address

North Clarendon, VT 05759

Facility City/State/Zip

Matthew Calcagni

Facility Contact

802-775-9300

Contact Phone

mcalcagni@ellisonsurfacetech.com

Contact E-mail

I certify that I have personally examined and am familiar with the information submitted herein. Based on information and belief formed after reasonable inquiry, the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment.

Signature

Robert Tibbetts

Print Name

3/19/2020

Date

Site Leader

Title

Vermont Air Pollution Control Regulation §5-1002:

"Responsible official" means one of the following: (1) For a corporation: (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or, (ii) a duly authorized representative of such person if the representative is responsible for the overall operation of one or more manufacturing, production, or operating facilities applying for an operating permit or subject to this subchapter and the Secretary is notified in writing and approves of the delegation of authority to such representative. (2) For a partnership or sole proprietorship: a general partner or the proprietor, respectively; or, (3) For a municipality, State, Federal, or other public agency: either a principal executive officer or ranking elected official. For the purposes of this subchapter, a principal executive officer of a Federal agency includes the chief executive officer having responsibility for the overall operations of a principal geographic unit of the agency.

OFFICIAL NOTICE

Hello Neighbor,

This letter is an official notice that Ellison Surface Technologies, Inc intends to apply for one or more permits from the Agency of Natural Resources, Department of Environmental Conservation (DEC). Because your property borders the location of the activity as described below, Vermont law requires the applicant to provide you with notice of the application(s).

Once each application has been submitted and deemed complete by DEC to begin the review, it will be posted to the DEC Environmental Notice Bulletin (ENB) at ENB.VERMONT.GOV, where you may register to receive notifications to stay informed as each application moves through the review process. Although the application(s) may not yet be received or processed by the DEC upon receipt of this letter from the applicant below, you may register now to receive notifications using a specified mile/distance radius from your address location (see next page for detailed instructions on how to register).

In the meantime, you may also contact the property owner/applicant with questions about the activity using the contact information provided below. For background, the permit process includes a public comment period and an opportunity to request a public meeting, all which can be done through the ENB link above once permit applications are posted. Note that to appeal a final permit decision you must submit comments during the public comment period.

For additional information please visit the following website: DEC.VERMONT.GOV/PERMITS/ENB/GENERAL. For general questions or assistance with registering on the ENB please call DEC's main line at (802) 828-1535 and plan to provide the permit types that are being applied for as listed below.

PROPERTY OWNER(S)/APPLICANT(S) NAME

Ellison Surface Technologies, Inc.

PROPERTY OWNER(S)/APPLICANT(S) CONTACT INFORMATION (MUST PROVIDE TELEPHONE NUMBER AND/OR EMAIL)

802-775-9300

PROPOSED ACTIVITY STREET ADDRESS/ROUTE

106 Innovation Dr

PROPOSED TOWN(S)

North Clarendon, VT

PERMIT TYPE(S) (INDICATE FOR EACH PERMIT TYPE NEW OR RENEWAL)

New Source Construction Air Permit



**NEW SOURCE CONSTRUCTION AIR
PERMIT APPLICATION
ELLISON SURFACE TECHNOLOGIES
NORTH CLARENDON, VERMONT**

Prepared for:

Ellison Surface Technologies, Inc.
106 Innovation Drive
North Clarendon, VT 05759

Prepared by:

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116 Hidden Hill Road
Spartanburg, South Carolina 29301

March 2020

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Project Integration, Inc

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The Ellison Surface Technologies, Inc. (Ellison) plant in North Clarendon, Vermont is a specialty coating facility that prepares and applies performance coatings designed to provide high corrosion, chemical and abrasion resistance, lubrication, and wear resistance for metal parts. The facility provides solid/dry film lubricants and powder coatings for the aerospace, power generation, and industrial markets.

Ellison operates the manufacturing processes in compliance with Air Pollution Permit to Construct #AP-16-013. This permit includes seven metallic powder spray booth (thermal spray booths), seven grit blast units, parts cleaning, five spray booths for manually applying dry lubricant, a nitric acid strip tank, three propane gas ovens, three electric ovens for dry film lube, and two propane space heating units. Currently there are seven thermal spray booths installed and operating.

This Construction Air Permit application is intended to serve two purposes. First, is to add an additional thermal spray booth. Second, Ellison is proposing to increase the operational limitations in the current permit for the thermal spray booths.

As an area source for hazardous air pollutants (HAPs), including metal HAPs, the thermal spray coating booths are subject to regulation at 40 Code of Federal Regulations (CFR) , Part 63, Subpart WWWW—National Emission Standards for Hazardous Air Pollutants (NESHAP), Area Source Standards for Plating and Polishing Operations (Part 63 Subpart 6W). The regulations require control of particulate matter (PM) emissions from the spray booths using technologies specified in the regulations or by an alternative device that achieves equivalent control of PM emissions.

1.1 Purpose and Scope

Ellison retained Project Integration, Inc. (PI) to assist in the preparation of the environmental documentation for the construction permit amendment for the proposed installation of an additional thermal spray booth, to increase the usage rates of the powdered coatings, and to update the PM emission limitations for the existing and new thermal spray booths. The purpose of this document is to satisfy the regulatory requirements to receive an amended permit to construction.

This application package consists of a process and project description, a summary of air emissions, a regulatory review, the Emission Calculations (Appendix A), the Safety Data Sheets

(Appendix B), and California Air Resources Board's (CARB's) Final Regulation Order regarding hexavalent chromium and nickel in thermal spray operations.

1.2 Facility Location and Contact

The facility contact, mailing and street address are:

Matthew Calcagni
EHS Manager
Ellison Surface Technologies
106 Innovation Drive
N. Clarendon, Vermont 05759
Phone: 802-775-9300
Email: mcalcagni@ellisonsurfacetech.com

Project and Process Descriptions

The Ellison plant in North Clarendon specializes in thermal spray coating of various parts primarily for the aerospace and power generation industries.

2.1 Project Description

Due to increased demand Ellison is proposing to install a new thermal spray booth, increase permitted coating usage limits, and update PM emissions limits.

2.1.1 New Thermal Spray Booth

In August 1996 Vermont Department of Environmental Conservation (DEC) issued Ellison a permit to construct (#AP-96-021) for three arc plasma coating lines. DEC issued an amendment (#AP-05-003) in February 2005 to add an additional four arc plasma spray booths. An amended permit (#AP-10-023) was issued in May 2010 and added an eighth thermal spray booth.

Due to several factors, Ellison only added three additional booths in 2005 and did not add an additional booth in 2010. The permits stated that approval to construct is invalid if construction is not commenced within eighteen months after issuance of the permit.

As a result, in 2016, Ellison obtained the current permit (#AP-16-013) in order to construct a seventh thermal spray booth. Due to increased market demand Ellison is proposing to install an additional thermal spray booth that will be the eighth installed booth at the facility.

The new thermal spray booth will utilize plasma spray guns. The new spray booth will be equipped with a high efficiency PM filtration system consisting of a high efficiency cyclone and a cartridge filter.

2.1.2 Coating Usage Increase

Due to installation of the new spray booth and increased market demand, Ellison is proposing an increase in the current limits for overall coating usage and also for coatings containing chromium (Cr) and nickel (Ni).

- The current permit limits the total usage of Cr to 3,100 lb/yr. Ellison is proposing to increase this to 3,875 lb/yr.
- The current permit limits the total usage of Ni to 13,800 lb/yr. Ellison is proposing to increase this to 17,250 lb/yr.

- The current permit limits the total usage of Co to 5,000 lb/yr. Ellison is proposing to increase this to 6,250 lb/yr.

The potential impact of these proposed increases on emissions is detailed in Section 3 and the Hazardous Most Stringent Emission Rate (HMSER) requirements are detailed in Sections 3 and 5 of this application.

2.1.3 PM Emission Limits

The current permit limits the emissions of PM from each thermal spray booth to a minimum PM reduction of 99.999 percent by weight and maximum PM emission of 0.000015 pounds per hour (lb/hr).

This limit was first established based on installing Donaldson Torit Downflo Model DFT3-24 High Efficiency Cartridge filter dust collector with a rated efficiency of 99.999 percent control of particles 0.5 micron (μm) and larger.

The equipment supplier for the new thermal spray booth is Beach Dynamics, Inc. Beach Dynamics is proposing a Beach high efficiency cyclone in series with the MERV 15 cartridge collector and guarantees a removal efficiency of 99.999 percent by weight as stated in the current permit. This efficiency, in conjunction with the transfer efficiency of 70 percent, is used in the current permit to establish the permitted values for PM emissions and metallic HAP emissions for HMSER analysis. Ellison is proposing to continue utilizing this stated removal efficiency and maximum hourly PM emissions rate.

2.2 Process Description - Thermal Spray Booth

The thermal spray process is conducted in spray booths equipped with high efficiency particulate filtration systems. Thermal spraying is a coating process where materials are heated, melted and sprayed onto a substrate. The booth will use plasma spray guns. In the plasma spray system the dry metallic powders are injected into a high velocity inert gas stream that is heated by an arc plasma gas to heat and melt the dry metallic powders to propel the particles onto the metal substrate. Materials applied generally consist of metal alloys such as aluminum bronze powder and nickel chrome powder.

There are ancillary processes to the thermal spray booths that involve grit blasting. The parts are grit blasted to promote adhesion. One type is a completely enclosed walk-in booth grit blasting station and the others are totally enclosed units (i.e. glove boxes) where the parts are put into the unit, the unit is closed and the grit blasting is performed. The grit blasting booths do not contribute to air emissions due to the total enclosure.

2.3 Facility Description

The current permitted sources at the facility (Permit #AP-16-013, issued September 21, 2016) are identified in Table 1:

**Table 1
Existing Sources**

Source Designation	Source Description
01	8 – Thermal Spray Booths ¹
02	8 – Grit Blast Units ¹
03	Parts Cleaning
04	5- Dry Lubricant Spray Booths
05	1 – Nitric acid strip tank
06	3 – Propane gas ovens
07	3 – Electric ovens for Dry Film Lube
08	2 – Propane space heating air make-up units

¹ As described in Section 2.1.1 this includes the existing 7-booths and the proposed new booth

After the parts have been coated they are cleaned with a wire brush and an organic solvent of acetone. Some parts are spray or brush coated with a dry lubricant in one of five dry lubricant spray booths. Off specification parts are dipped into a nitric acid to strip the coating and send the part back for grit blasting and recoating in the thermal spray booth.

Summary of Material Usage and Emissions

The Thermal Spray Booths emit small amounts of particulate matter (PM) and metal Hazardous Air Pollutants (HAPs). PM and metallic HAP emissions from the new thermal spray booth are controlled by a high efficiency cyclone in series with a MERV 15 cartridge collector. The overall control efficiency is 99.999 percent by weight. The Thermal Spray Booth has an ancillary process involving grit blasting stations. The grit blasting booths are totally enclosed units with internal dust collectors. Therefore, grit blasting does not contribute to facility wide air emission estimates.

Potential and Actual emissions from the thermal sprays booths are summarized in Table 2 below. As noted on the table the potential emissions are based on operating all eight thermal spray booths for aggregate total dry metallic alloy coatings (powder) quantities that result in chromium, nickel, and cobalt usages meeting the current and proposed limits. Detailed emission calculations for the proposed permit limits are included in Appendix A.

Table 2
Potential vs. Actual Controlled Emissions

Contaminant	Current Emissions ¹	Current Permit ²		Proposed Permit ³	
	Actual lb/yr	Potential lb/yr	Potential tpy	Potential lb/yr	Potential tpy
PM _{Total} :	0.075	0.106	0.000	0.132	0.000
VOC _{Total} :	0.000	0.000	0.000	0.000	0.000
HAP _{Total} :	0.043	0.066	0.000	0.082	0.000
Nickel:	0.030	0.041	0.000	0.052	0.000
Chromium (Non-Hexavalent)	0.005	0.009	0.000	0.011	0.000
Chromium (VI)	0.0001	0.0001	0.000	0.0001	0.000
Cobalt:	0.008	0.015	0.000	0.019	0.000
Manganese:	0.000	0.000	0.000	0.000	0.000

NOTES:

1. Current Emissions: Assumed to be 2019 and powders used for potential are the same as 2019
2. Current Permit: Assumes powder usages resulting in chromium

usage of 3,100 lbs/yr, nickel usage of 13,800 lbs/yr, and cobalt usage of 5,000 lbs/yr

3. Proposed Permit: Assumes powder usages resulting in chromium usage of 3,875 lbs/yr, nickel usage of 17,250 lbs/yr, and cobalt usage of 6,250 lbs/yr

Section 4 Regulatory Review

In support of this New Source Construction Air Permit Application the following regulatory review is provided to discuss applicable or non-applicable regulations.

4.1 State Regulations

In support of the Ellison Construction Permit Application, the following regulatory review is provided to discuss applicable or non-applicable regulations.

5-201 Open Burning Prohibited

Not Applicable

5-202 Permissible Open Burning

Not Applicable

5-203 Procedures For Local Authorities To Burn Natural Wood

Not Applicable

5-204 Outdoor Wood Fired Boilers

Not Applicable

5-211 Prohibition Of Visible Air Contaminants

Ellison will not allow or permit the emission of any visible air contaminant for more than a period of six (6) minutes in any hour, which has a shade, or density, greater than 20% opacity (No. 1 of the Ringelmann Chart). At no time shall the visible air contaminants have a shade, density, or appearance greater than 60% opacity (No. 3 of the Ringelmann Chart).

5-221 Prohibition Of Potentially Polluting Materials In Fuel

Not Applicable

5-231 Prohibition Of Particulate Matter

This regulation establishes allowable particulate matter emissions as a function of process weight throughput. Facilities are prohibited from emitting particulate matter in excess of the amounts shown in Table 1 of the regulation, or in excess of 0.06 grains/dscf. The Ellison facility

will comply with these limitations through the use of particulate matter filtration (i.e. dust collectors) for all particulate generating processes.

5-241 Prohibition Of Nuisance And Odor

Ellison will not create a nuisance or odor beyond the property line

5-251 Control Of Nitrogen Oxides Emissions

This regulation establishes limitations on the emissions of NO_x from any fuel burning equipment with greater than 250 MMBTU/hr heat input. The Ellison facility will utilize small space heating equipment well below 250 MMBTU/hr heat input. Therefore, this regulation is not applicable.

5-252 Control Of Sulfur Dioxide Emissions

This regulation establishes limitations on the emissions of SO_x from any fuel burning equipment with greater than 250 MMBTU/hr heat input. The Ellison facility will utilize small space heating equipment well below 250 MMBTU/hr heat input. Therefore, this regulation is not applicable.

5-253.1 Petroleum Liquid Storage in Fixed Roof Tanks

Not Applicable

5-253.2 Bulk Gasoline Terminals

Not Applicable

5-253.3 Bulk Gasoline Plants

Not Applicable

5-253.4 Gasoline Tank Trucks

Not Applicable

5-253.5 Stage I Vapor Recovery Controls at Gasoline Dispensing Facilities

Not Applicable

5-253.6 Volatility of Gasoline

Not Applicable

5-253.7 Stage II Vapor Recovery Controls at Gasoline Dispensing Facilities

Not Applicable

5-271 Control Of Air Contaminants From Stationary Reciprocating Internal Combustion Engines

Not Applicable

5-301 Ambient Air Quality Standards

EPA and VT ANR have adopted significant impact levels (SILs) for the contaminants with ambient air quality standards. Due to Ellison's minor source status, the facility will not generate emissions that exceed these levels.

5-501 Non-Attainment New Source Review – Prevention of Significant Deterioration

Ellison has a potential to emit less than 50 tpy of VOC and less than 100 tpy of NO_x, therefore, these regulations are not applicable.

4.2 Federal Air Standards

40 CFR 60 – New Source Performance Standards, Subpart A to Subpart WWW

The operations described in this application are not subject to New Source Performance Standards; therefore this regulation is not applicable.

40 CFR 63 - National Emission Standards for Hazardous Air Pollutants for Source Categories

40 CFR 63 is generally targeted at major sources for HAPs. The Ellison plant is not a major source of HAPs. Therefore, the facility is not subject to 40 CFR 63 regulations unless the regulation specifically states that it includes area sources.

40 CFR 63 Subpart WWWW (6W) - Plating and Polishing Operations

This subpart is applicable to area sources and Ellison does use some of the regulated metal HAPs and is therefore subject to this regulation. Ellison will submit compliance documentation including an Initial Notification (IN) and a Notification of Compliance Status (NOCS upon start-up.

The air pollution capture and control system will comply with the area source standards of 6W. This includes a totally enclosed booth for 100 percent capture and a high efficiency cyclone and cartridge filter for PM control.

Section 5

Hazardous Most Stringent Emission Rate (HMSER) Evaluation

The Vermont Air Pollution Control Regulations (VAPCR), Section 5-261, requires that any stationary source that emits a hazardous air contaminant (HAC) must apply a control technology to achieve the Hazardous Most Stringent Emission Rate (HMSER) for the HAC. If the actual emission of the HAC is below the action level for that HAC then the stationary source is not subject to Section 5-261, Control of Hazardous Air Contaminants.

The three HACs of concern from Appendix B of Section 5-261 of the VAPCR for the thermal spray booth emissions are Chromium (VI) Compounds (Cr⁶⁺), Cobalt Compounds (Co), and Nickel Compounds (Ni). If the Action Level is exceeded one alternative to demonstrate compliance is to perform a dispersion model to show that the ambient air concentration does not exceed the value in Appendix C of Section 5-261. Table 3 summarizes the Action Levels and Ambient Air Standards for the HACs of concern for the thermal spray booths.

**Table 3
Hazardous Ambient Air Standards
Appendix C, VT APC Regulations**

HAC	Ambient Air Standard (annual average) (µg/m ³)	Action Level lbs/8 hr)
Chromium (VI) Compounds	0.000083	0.0000069
Cobalt Compounds	0.01	0.00083
Nickel Compounds	0.0021	0.00017

As with the previous thermal spray booth submitted, Ellison is using the CARB emission factors to determine the Cr⁶⁺ emission rates in Table 4 and Table 5. The CARB documentation is included in Appendix C. Cr⁶⁺ emissions shown in Tables 4 and 5 are calculated by utilizing the current and proposed chromium usage limits, 3,100 lb/yr and 3,875 lb/yr, respectively, an overspray of 30 percent, a control efficiency of 99.999 percent, annual production of 8,760 hr/yr, and Cr⁶⁺ prevalence of 0.0118 lb Cr⁶⁺/lb Cr. The prevalence Cr⁶⁺ relative to non-hexavalent chromium was determined by CARB for plasma spraying applications. These calculations resulted in controlled Cr⁶⁺ emissions rates for the current and proposed operational limits of

0.00000010 lb/8 hr and 0.00000013 lb/8 hr, respectively. Since these were below the HMSER Action Level of 0.0000069 lb/8 hr HMSER was not triggered.

A similar calculation was performed for Co and Ni emissions excluding the ratio of species. Co emissions were calculated based on total Co usages of 5,000 lb/yr and 6,250 lb/yr for current and proposed scenarios, respectively, with resulting controlled emissions of 0.00001370S lb/8-hr and 0.00001712 lb/8-hr which are less than the HMSER Action Level. Ni emissions were calculated based on total Ni usages of 13,800 lb/yr and 17,250 lb/yr for current and proposed scenarios, respectively, with resulting controlled emissions of 0.00003781 lb/8-hr and 0.00004726 lb/8-hr. These results are also less than the HMSER Action level. Therefore, it was determined that HMSER did not apply to the Permit to Construct. The current permitted emission rates are shown in Table 4.

**Table 4
Current HAC Emission Rates for Permitted Cr and Ni Powders Usage**

HAC	Action Level lbs/8 hr)	Uncontrolled Emissions lb/8-hr	Controlled Emissions lb/8-hr	Percent of Limit
Chromium (VI) Compounds	0.0000069	0.010	0.00000010	1.45%
Cobalt Compounds	0.00083	1.370	0.00001370	8.06%
Nickel Compounds	0.00017	3.781	0.00003781	4.56%

As described in Section 2.1.2 of this application, Ellison is proposing to increase the usage limits of total Cr to a maximum of 3,875 lb/yr, total Ni to a maximum of 17,250 lb/yr, and total Co to a maximum of 6,250 lb/yr.

**Table 5
HAC Emission Rates for Proposed Increase in Cr and Ni Powder Usage**

HAC	Action Level lbs/8 hr)	Uncontrolled Emissions lb/8-hr	Controlled Emissions lb/8-hr	Percent of Limit
Chromium (VI) Compounds	0.0000069	0.013	0.00000013	1.82%
Cobalt Compounds	0.00083	1.712	0.00001712	10.07%
Nickel Compounds	0.00017	4.726	0.00004726	5.69%

As shown in Table 5 Cr, Ni, and Co compounds are well below the HMSER Action Level and, therefore, HMSER is not applicable.

As stated in Section 1.1 this permit amendment was prepared to accomplish two objectives:

1. Provide environmental documentation for a construction permit amendment for the installation of an additional thermal spray booth,
2. To increase the usage rates of the powdered coatings, and

6.1 New Thermal Spray Booth

The new booth will utilize plasma spray guns to provide high performance coatings to metal parts. Metallic PM emissions will be controlled by a high efficiency cyclone and a cartridge filter for 99.999 weight percent removal efficiency of the metallic PM. The thermal spray booth is subject to regulation by the NESHAP Part 63, Subpart WWWW - Area Source Standards for Plating and Polishing Operations (Subpart 6W). The new spray booth will be in compliance with all aspects of Subpart 6W including the monitoring, reporting, recordkeeping, and work practices standards.

6.2 Powdered Coating Limits

The current permit includes operational limits on the annual usage of total Cr, Ni, and Co in the metallic powders.

- The impact of increasing the total aggregate metallic powder usage by increasing the maximum usage of Cr, Ni, and Co is a minor increase in the total annual PM emissions. As shown in Table 2 the impact in annual tpy emissions is negligible to the third decimal place.
- The impact of increasing the total usage of Cr from 3,100 to 3,875 lb/yr is related to the HMSER evaluation. As shown in Section 5 the emissions of Cr⁶⁺ at the increased usage rate are below the HMSER Action Level of 0.000069/8-hr and HMSER is not triggered.
- The impact of increasing the total usage of Ni from 13,800 to 17,250 lb/yr is related to the HMSER evaluation. As shown in Section 5 the emissions of Ni at the increased usage rate are below the HMSER Action Level of 0.00017/8-hr and HMSER is not triggered.
- The impact of increasing the total usage of Co from 5,000 to 6,250 lb/yr is related to the HMSER evaluation. As shown in Section 5 the emissions of Co at the increased usage rate are below the HMSER Action Level of 0.00083/8-hr and HMSER is not triggered.
- In all cases the controlled emissions of the HACs in the powders being applied by Ellison are less than their respective Action Level and therefore an air quality impact evaluation to determine compliance with the Hazardous Ambient Air standards is not required.

6.3 PM Removal Efficiency

The current permit requires that the reduction in PM emissions from each thermal spray booth is 99.999 percent by weight and the maximum PM emission of 0.000015 pounds per hour (lb/hr). This limit was first established in 1996 based on a guarantee that the cartridge filter had a rated efficiency of 99.999% control of particles 0.5 micron (μm) and larger. Construction of a new thermal spray booth does not effect the removal efficiency or hourly emission rate per spray booth and Ellison will continue to comply with this requirement.

6.4 Facility Allowable Emissions

The Ellison facility is currently permitted as an area source for HAPs. The proposed increase in powder usage and HAC usage does not impact this determination. The table in the current air permit, #AP-16-013 will not change. This is shown in Table 6.

Table 6
Future Allowable Air Contaminant Emissions (tons/year)

PM/PM10	SO ₂	NO _x	CO	VOCs	Total Criteria	HAPs
1	1	4.6	1	1	<10	<10/25

Appendix A

Emission Calculations

Ellison Surface Technologies
N. Clarendon, VT

Contaminant	Current Emissions ¹		Current Permit ²		Proposed Permit ³	
	Actual	lb/yr	Potential lb/yr	Potential tpy	Potential lb/yr	Potential tpy
PM _{Total} :	0.075		0.106	0.000	0.132	0.000
VOC _{Total} :	0.000		0.000	0.000	0.000	0.000
HAP _{Total} :	0.043		0.066	0.000	0.082	0.000
Nickel:	0.030		0.041	0.000	0.052	0.000
Chromium (Non-Hexavalent)	0.005		0.009	0.000	0.011	0.000
Chromium (VI)	0.0001		0.0001	0.000	0.0001	0.000
Cobalt:	0.008		0.015	0.000	0.019	0.000
Manganese:	0.000		0.000	0.000	0.000	0.000

NOTES:

1. Current Emissions: Assumed to be 2019 and powders used for potential are the same as 2019
Current Permit: Assumes powder usages resulting in chromium usage of 3,100 lbs/yr, nickel usage of 13,800 lbs/yr, and cobalt usage of 5,000 lbs/yr
2. Proposed Permit: Assumes powder usages resulting in chromium usage of 3,875 lbs/yr, nickel usage of 17,250 lbs/yr, and cobalt usage of 6,250 lbs/yr
- 3.

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Ellison - N. Clarendon

Thermal Spray Booths (Powder Materials)
Actual (2019) PM & Metal HAP Emissions

Control Efficiency:	99.999%
Overspray:	30.0%

EST No.	Material Name	Usage (lbs)	Controlled Actual Emissions (lbs)													
			Solids Content %	PM Emis (lbs)	Total VOC Content %	Total VOC Emis (lbs)	Total HAP Content %	Total HAP Emis (lbs)	Nickel Content %	Nickel Emis (lbs)	Chromium Content %	Chromium Emis (lbs)	Cobalt Content %	Cobalt Emis (lbs)	Manganese Content %	Manganese Emis (lbs)
EST001	Nickel Aluminum	820	100.0%	0.00	0.0%	0.00	94.0%	0.00	94.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST003	Tungsten Carbide Cobalt	400	100.0%	0.00	0.0%	0.00	18.0%	0.00	0.0%	0.00	0.0%	0.00	12.0%	0.00	0.0%	0.00
EST009	Copper Nickel Indium	2,097	100.0%	0.01	0.0%	0.00	40.0%	0.00	40.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST012	Nickel Chrome Aluminum 170 Mesh	3,530	100.0%	0.01	0.0%	0.00	92.0%	0.01	75.0%	0.01	17.0%	0.00	0.0%	0.00	0.0%	0.00
EST016	Cobalt Molybdenum Chrome	4,172	100.0%	0.01	0.0%	0.00	75.0%	0.01	0.0%	0.00	15.0%	0.00	60.0%	0.01	0.0%	0.00
EST022	Copper Nickel Indium	991	100.0%	0.00	0.0%	0.00	48.0%	0.00	48.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST023	Yttria Zirconia Stabilized	4	100.0%	0.00	0.0%	0.00	40.0%	0.00	40.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST024	Ni Cr, Alum, Yttria (PAC600AM)	1	100.0%	0.00	0.0%	0.00	78.0%	0.00	80.0%	0.00	28.0%	0.00	0.0%	0.00	0.0%	0.00
EST026	Magnesium Stabilized Zirconia	0	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST028	Nickel Graphite (75%/25%)	5,020	100.0%	0.00	0.0%	0.00	78.0%	0.01	78.0%	0.01	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST029	Aluminum Oxide-Coarse	3,893	100.0%	0.01	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST031	Cobalt Molybdenum Chrome Silicon	48	100.0%	0.00	0.0%	0.00	73.0%	0.00	8.0%	0.00	18.0%	0.00	90.0%	0.00	0.0%	0.00
EST048	Aluminum Bronze	1,050	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST059	Aluminum Oxide	38	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST070	Tungsten Carbide	47	100.0%	0.00	0.0%	0.00	17.0%	0.00	0.0%	0.00	0.0%	0.00	17.0%	0.00	0.0%	0.00
EST113	Tungsten Carbide Cobalt	90	100.0%	0.00	0.0%	0.00	18.0%	0.00	0.0%	0.00	0.0%	0.00	18.0%	0.00	0.0%	0.00
EST384	Nickel Iron Chrome	2,650	100.0%	0.01	0.0%	0.00	77.0%	0.01	61.0%	0.00	16.0%	0.00	0.0%	0.00	0.0%	0.00
Totals (lbs):		24,850		0.075		0.000		0.043		0.030		0.005		0.008		0.000
Totals (tons):		12.425		0.000		0.000		0.000		0.000		0.000		0.000		0.000

Project Integration, Inc.
1116 Hidden Hill Road
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Ellison - N. Clarendon

Thermal Spray Booths (Powder Materials)
Current Potential PM & Metal HAP Emissions

Control Efficiency:	99.999%
Overspray:	30.0%

		2020														
EST No.	Material Name	Usage (lbs)	Current Potential Emissions (lbs)													
			Solids Content %	PM Emis (lbs)	Total VOC Content %	Total VOC Emis (lbs)	Total HAP Content %	Total HAP Emis (lbs)	Nickel Content %	Nickel Emis (lbs)	Chromium Content %	Chromium Emis (lbs)	Cobalt Content %	Cobalt Emis (lbs)	Manganese Content %	Manganese Emis (lbs)
EST001	Nickel Aluminum	927	100.0%	0.00	0.0%	0.00	94.0%	0.00	94.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST003	Tungsten Carbide Cobalt	536	100.0%	0.00	0.0%	0.00	12.0%	0.00	12.0%	0.0%	0.00	12.0%	0.00	0.0%	0.00	
EST006	Copper Nickel Indium	2,362	100.0%	0.01	0.0%	0.00	40.0%	0.00	40.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST012	Nickel Chrome Aluminum 170 Mesh	6,734	100.0%	0.02	0.0%	0.00	30.0%	0.00	78.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST016	Cobalt Molybdenum Chrome	8,119	100.0%	0.02	0.0%	0.00	75.0%	0.02	0.0%	0.00	15.0%	0.00	60.0%	0.01	0.0%	
EST022	Copper Nickel Indium	1,143	100.0%	0.00	0.0%	0.00	30.0%	0.00	45.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST023	Yttria Zirconia Stabilized	5	100.0%	0.00	0.0%	0.00	40.0%	0.00	40.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST024	Ni Chr. Alum. Yttria (HAP/ROAM)	1	100.0%	0.00	0.0%	0.00	30.0%	0.00	30.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST026	Magnesium Stabilized Zirconia	0	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST028	Nickel Graphite (75%/25%)	4,791	100.0%	0.01	0.0%	0.00	75.0%	0.01	75.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST029	Aluminum Oxide-Coarse	4,812	100.0%	0.01	0.0%	0.00	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.00	0.0%	0.00	
EST031	Cobalt Molybdenum Chrome Silicon	61	100.0%	0.00	0.0%	0.00	75.0%	0.00	0.0%	0.00	15.0%	0.00	50.0%	0.00	0.00	
EST046	Aluminum Bronze	1,244	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.0%	0.0%	0.0%	0.00	0.0%	0.00	
EST050	Aluminum Oxide	45	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.0%	0.0%	0.0%	0.00	0.0%	0.00	
EST070	Tungsten Carbide	57	100.0%	0.00	0.0%	0.00	17.0%	0.00	0.0%	0.0%	0.0%	0.0%	17.0%	0.00	0.00	
EST010	Tungsten Carbide Cobalt	111	100.0%	0.00	0.0%	0.00	38.0%	0.00	0.0%	0.0%	0.0%	0.0%	38.0%	0.00	0.00	
EST384	Nickel Iron Chrome	4,549	100.0%	0.01	0.0%	0.00	77.0%	0.01	81.0%	0.0%	0.00	16.0%	0.00	0.0%	0.00	
Totals (lbs):		35,298		0.106		0.000		0.066		0.041		0.009		0.015	0.000	
Totals (tons):		17.649		0.000		0.000		0.000		0.000		0.000		0.000	0.000	

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Thermal Spray Booths (Powder Materials)
Proposed Potential PM & Metal HAP Emissions

Control Efficiency:	99.999%
Overspray:	30.0%

EST No.	Material Name	Usage (lbs)	Proposed Potential Emissions (lbs)													
			Solids Content %	PM Emis (lbs)	Total VOC Content %	Total VOC Emis (lbs)	Total HAP Content %	Total HAP Emis (lbs)	Nickel Content %	Nickel Emis (lbs)	Chromium Content %	Chromium Emis (lbs)	Cobalt Content %	Cobalt Emis (lbs)	Manganese Content %	Manganese Emis (lbs)
EST001	Nickel Aluminum	1,166	100.0%	0.00	0.0%	0.00	94.0%	0.00	94.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST003	Tungsten Carbide Cobalt	591	100.0%	0.00	0.0%	0.00	12.0%	0.00	12.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST006	Copper Nickel Indium	2,972	100.0%	0.01	0.0%	0.00	40.0%	0.00	40.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST011	Nickel Chrome Aluminum 770 Mesh	8,419	100.0%	0.03	0.0%	0.00	82.0%	0.00	75.0%	0.00	17.0%	0.00	0.0%	0.00	0.0%	0.00
EST018	Cobalt Molybdenum Chrome	10,172	100.0%	0.03	0.0%	0.00	75.0%	0.02	0.0%	0.00	15.0%	0.00	80.0%	0.02	0.0%	0.00
EST022	Copper Nickel Indium	1,434	100.0%	0.00	0.0%	0.00	48.0%	0.00	48.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST023	Yttria Zirconia Stabilized	8	100.0%	0.00	0.0%	0.00	40.0%	0.00	40.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST024	Ni Cr Alum Yttria (HVOF/ADAM)	2	99.0%	0.00	0.0%	0.00	79.0%	0.00	80.0%	0.00	19.0%	0.00	0.0%	0.00	0.0%	0.00
EST026	Magnesium Stabilized Zirconia	0	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST028	Nickel Graphite (75%/25%)	5,979	100.0%	0.02	0.0%	0.00	78.0%	0.01	78.0%	0.01	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST029	Aluminum Oxide-Coarse	5,785	100.0%	0.02	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST031	Cobalt Molybdenum Chrome Silicon	71	100.0%	0.00	0.0%	0.00	15.0%	0.00	0.0%	0.00	85.0%	0.00	50.0%	0.00	0.0%	0.00
EST046	Aluminum Bronze	1,554	100.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST056	Aluminum Oxide	56	100.0%	0.00	0.0%	0.00	2.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00
EST070	Tungsten Carbide	70	100.0%	0.00	0.0%	0.00	17.0%	0.00	0.0%	0.00	0.0%	0.00	17.0%	0.00	0.0%	0.00
EST073	Tungsten Carbide Cobalt	134	100.0%	0.00	0.0%	0.00	10.0%	0.00	0.0%	0.00	0.0%	0.00	16.0%	0.00	0.0%	0.00
EST364	Nickel Iron Chrome	5,668	100.0%	0.02	0.0%	0.00	77.0%	0.01	61.0%	0.01	16.0%	0.00	0.0%	0.00	0.0%	0.00
Totals (lbs):		44,061		0.13		0.00		0.08		0.05		0.01		0.02		0.00
Totals (tons):		22		0.00		0.00		0.00		0.00		0.00		0.00		0.00

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Appendix B

Safety Data Sheets

Safety Data Sheet

Metco 450, Metco 450NS, Metco 450P, XPT-459, XPT-460

Section 1. Product and company identification

Product name : Metco 450, Metco 450NS, Metco 450P, XPT-459, XPT-460
Material uses : Metal industry: Suitable for thermal spray coating applications
Supplier : Oerlikon Metco (US) Inc.
1101 Prospect Avenue
Westbury, NY 11590
Telephone no. : (516) 334-1300 (7:30AM - 4:00PM)
In case of emergency : CHEMTREC: 800-424-9300
Calls Outside the United States : +1 703-741-5970: (USA) 24 hour Chemtrec International Emergency Response Service

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture : SKIN SENSITIZATION - Category 1
CARCINOGENICITY - Category 2
SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 1
AQUATIC HAZARD (LONG-TERM) - Category 3

GHS label elements

Hazard pictograms :



Signal word :

Danger

Hazard statements :

May cause an allergic skin reaction.
Suspected of causing cancer.
Causes damage to organs through prolonged or repeated exposure.
Harmful to aquatic life with long lasting effects.

Precautionary statements

Prevention :

Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves. Wear eye or face protection. Wear protective clothing. Avoid release to the environment. Do not breathe fumes. Do not eat, drink or smoke when using this product. Wash hands thoroughly after handling. Contaminated work clothing must not be allowed out of the workplace.

Response :

Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention. IF ON SKIN: Wash with plenty of soap and water. Wash contaminated clothing before reuse. If skin irritation or rash occurs: Get medical attention.

Storage :

Store locked up.

Disposal :

Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Ingredient name	%	CAS number
nickel	94	7440-02-0
Aluminum	4 - 5	7429-90-5
Organic binder	1 - 2	-

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

- Eye contact** : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.
- Inhalation** : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.
- Skin contact** : Wash with plenty of soap and water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water. Continue to rinse for at least 10 minutes. Get medical attention. In the event of any complaints or symptoms, avoid further exposure. Wash clothing before reuse. Clean shoes thoroughly before reuse.
- Ingestion** : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

- Eye contact** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the eyes.
- Inhalation** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.
- Skin contact** : May cause an allergic skin reaction.
- Ingestion** : No known significant effects or critical hazards.

Over-exposure signs/symptoms

- Eye contact** : Adverse symptoms may include the following:
irritation
redness
- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Skin contact** : Adverse symptoms may include the following:
irritation
redness
- Ingestion** : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

- Notes to physician** : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.
- Specific treatments** : No specific treatment.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

- Suitable extinguishing media** : Use approved Class D extinguisher or smother with dry sand, dry clay or dry ground limestone.
- Unsuitable extinguishing media** : Do not use water. Do not use dry chemical, CO₂ or halon.
- Specific hazards arising from the chemical** : This material is harmful to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain. May form explosible dust-air mixture if dispersed.
- Hazardous thermal decomposition products** : Decomposition products may include the following materials:
metal oxide/oxides
- Special protective actions for fire-fighters** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

- For non-emergency personnel** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
- For emergency responders** : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods and materials for containment and cleaning up

- Small spill** : Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Place spilled material in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.
- Large spill** : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

- Protective measures** : Put on appropriate personal protective equipment (see Section 8). Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not breathe dust. Do not ingest. Avoid release to the environment. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene

- : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities

- : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate container to avoid environmental contamination. See Section 10 for incompatible materials before handling or use.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
nickel	<p>ACGIH TLV (United States, 4/2014). Notes: Refers to Appendix A -- Carcinogens. Inhalable fraction. See Appendix C, paragraph A. Inhalable Particulate Mass TLVs (IPM-TLVs) for those materials that are hazardous when deposited anywhere in the respiratory tract. 1998 Adoption.</p> <p>TWA: 1.5 mg/m³ 8 hours. Form: Inhalable fraction</p> <p>OSHA PEL (United States, 2/2013). Notes: as Ni</p> <p>TWA: 1 mg/m³, (as Ni) 8 hours.</p> <p>NIOSH REL (United States, 10/2013).</p> <p>TWA: 0.015 mg/m³, (as Ni) 10 hours.</p>

- Additional information** : A portion of nickel may be converted during the thermal spray process to nickel compounds which are classified as an IARC Group 1 Carcinogen. NTP classifies nickel compounds as Known to be Carcinogenic.
- Appropriate engineering controls** : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.
- Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Contaminated work clothing should not be allowed out of the workplace. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.
- Eye/face protection** : Safety glasses or goggles are recommended when handling this material. During the thermal spray process, safety goggles and dark lenses must be worn.
- Skin protection**
- Hand protection** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated. Rubber or other appropriate gloves should be worn to minimize contact. For hygienic reasons rubber gloves should not be worn for more than 2 hours. During the thermal spray process, heat insulated gloves are recommended.
- Body protection** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory protection** : Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use.
- Hearing Protection** : Hearing protection that meets local standards should be used. During the thermal spray process, the operator and other personnel close to the spray operation must be protected from excessive noise.

Protective Clothing (Pictograms)



Section 9. Physical and chemical properties

Appearance

Physical state	: Solid. [Metallic powder.]
Color	: Gray.
Odor	: Odorless.
Odor threshold	: Not available.
pH	: Not applicable.
Melting point	: Not available.
Boiling point	: Not available.
Explosive properties	: Fine dust clouds may form explosive mixtures with air.
Flash point	: [Product does not sustain combustion.]
Evaporation rate	: Not applicable.
Flammability (solid)	: Not available.
Lower and upper explosive (flammable) limits	: Not available.
Vapor pressure	: Not applicable.
Vapor density	: Not applicable.
Relative density	: Not available.
Solubility	: Insoluble in the following materials: cold water and hot water.
Partition coefficient: n-octanol/water	: Not applicable.
Auto-ignition temperature	: Not available.
Decomposition temperature	: Not available.
Viscosity	: Not applicable.
Flow time (ISO 2431)	: Not available.

Section 10. Stability and reactivity

Reactivity	: No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	: The product is stable.
Possibility of hazardous reactions	: Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	: No specific data.
Incompatible materials	: No specific data.
Hazardous decomposition products	: Ozone and nitric oxide are formed by plasma flame. This action is independent of material. Some metallic oxides.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Classification

Product/ingredient name	OSHA	IARC	NTP
nickel	-	2B	Reasonably anticipated to be a human carcinogen.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Name	Category	Route of exposure	Target organs
nickel	Category 1	Not determined	Not determined

Aspiration hazard

Not available.

Information on the likely routes of exposure : Routes of entry anticipated: Oral, Dermal, Inhalation.

Potential acute health effects

- Eye contact** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the eyes.
- Inhalation** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.
- Skin contact** : May cause an allergic skin reaction.
- Ingestion** : No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

- Eye contact** : Adverse symptoms may include the following:
irritation
redness

- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Skin contact** : Adverse symptoms may include the following:
irritation
redness
- Ingestion** : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

- Potential immediate effects** : Not available.
- Potential delayed effects** : Not available.

Long term exposure

- Potential immediate effects** : Not available.
- Potential delayed effects** : Not available.

Potential chronic health effects

Not available.

- Conclusion/Summary General** : Not available.

: Causes damage to organs through prolonged or repeated exposure. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.

- Carcinogenicity** : Suspected of causing cancer. Risk of cancer depends on duration and level of exposure.
- Mutagenicity** : No known significant effects or critical hazards.
- Teratogenicity** : No known significant effects or critical hazards.
- Developmental effects** : No known significant effects or critical hazards.
- Fertility effects** : No known significant effects or critical hazards.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Not available.

Mobility in soil

- Soil/water partition coefficient (K_{oc})** : Not available.

- Other adverse effects** : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT Classification	TDG Classification	Mexico Classification	ADR/RID	IMDG	IATA
UN number	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
UN proper shipping name	-	-	-	-	-	-
Transport hazard class(es)	-	-	-	-	-	-
Packing group	-	-	-	-	-	-
Environmental hazards	No.	No.	No.	No.	No.	No.

Additional information

DOT Classification : Reportable quantity 106.38 lbs / 48.298 kg. Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements.

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : TSCA 8(a) CDR Exempt/Partial exemption: Not determined
Clean Water Act (CWA) 307: Nickel

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Immediate (acute) health hazard
Delayed (chronic) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
nickel	≥90	No.	No.	No.	Yes.	Yes.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	Nickel	7440-02-0	≥90
	Aluminum	7429-90-5	≤5
Supplier notification	Nickel	7440-02-0	≥90
	Aluminum	7429-90-5	≤5

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : The following components are listed: NICKEL

New York : The following components are listed: Nickel

New Jersey : The following components are listed: NICKEL

Pennsylvania : The following components are listed: NICKEL

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
Nickel	Yes.	No.	-	-

Inventory list

United States : Not determined.

Section 16. Other information

National Fire Protection Association (U.S.A.)



Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
SKIN SENSITIZATION - Category 1	Calculation method
CARCINOGENICITY - Category 2	Calculation method
SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 1	Calculation method
AQUATIC HAZARD (LONG-TERM) - Category 3	Calculation method

History

Date of issue/Date of revision : 9/20/2017

Version : 3.04

Key to abbreviations : ATE = Acute Toxicity Estimate
 BCF = Bioconcentration Factor
 GHS = Globally Harmonized System of Classification and Labelling of Chemicals
 IATA = International Air Transport Association
 IBC = Intermediate Bulk Container
 IMDG = International Maritime Dangerous Goods
 LogPow = logarithm of the octanol/water partition coefficient
 MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
 UN = United Nations

▣ Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

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SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : AMPERIT® 518.280/768 WC-Co 88/12 AS
 MSDS Number : 000010005325
 Product Use Description : Thermal Metallic Compounds, Surface Treatment and Wear Resistant Coatings

Chemical nature : Mixture

Company : H.C. Starck North American Trading LLC
 45 Industrial Place
 Newton, MA 02461-1951
 USA

Telephone : + 1 617 630 5800

Responsible Department : Sustainability Management
 E-mail address : infoSDS@hcstarck.com
 H.C. Starck Emergency Phone : + 1 617 630 5815 [8:00 a.m - 5:00 p.m EST]
 (Non-Transportation)
 24h-Emergency Phone (US, : + 1-800-535-5053 (GBK/INFOTRAC ID 101020)
 Transportation)
 24h-Emergency Phone : +1 352 3233500 (GBK/INFOTRAC ID 101020)
 (International, Transportation)

SECTION 2. HAZARDS IDENTIFICATION**Emergency Overview**

DANGER!	
Form	powdered form
Colour	grey
Odour	odourless
Hazard Summary	Suspect cancer hazard Harmful if inhaled or ingested. May cause eye, skin, and respiratory tract irritation. May cause reproductive system damage. May cause allergic respiratory reaction. May cause allergic skin reaction. Dust or fumes may be a fire and explosion hazard when exposed to high temperature or ignition. Irritating gases/fumes may be given off during burning or thermal decomposition. May react forming chromium(VI) compounds when processing thermally. Very toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

Potential Health Effects

Primary Routes of Entry : Eye contact.
 Skin contact.
 Inhalation.
 Ingestion.

Inhalation : Inhalation of cobalt may cause respiratory tract irritation with coughing, sore throat, sneezing and inflammation of the mucous membranes.

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- Sensitization reactions may occur in previously exposed individuals.
- Skin** : Direct contact with cobalt may cause skin irritation and skin sensitization.
Skin eruptions may occur in skin areas subjected to friction, such as elbows, ankles and neck.
- Eyes** : Direct eye contact may produce irritation with symptoms of redness, swelling and pain.
- Ingestion** : Ingestion of cobalt may cause vomiting and diarrhea.
- Chronic Exposure** : Prolonged or repeated inhalation of cobalt may cause respiratory irritation with a burning sensation when swallowing, headache, gastrointestinal distress, appetite and weight loss, weakness, irritability and the loss of the sense of smell.
- Repeated or prolonged skin contact with cobalt may cause sensitization and dermatitis.
Cardiomyopathy has been caused by excessive intake of cobalt. Signs and symptoms may include gastrointestinal disturbances with nausea, vomiting, diarrhea, shortness of breath, coughing, cyanosis, lowered blood pressure, rapid heart rate and death.
- If superfine particulates are generated during mechanical handling (particle size < 7 µm), there is a risk of inhalation toxicity (T, toxic on inhalation).
Pulmonary diseases ("hard metal disease") are known to have been observed in the cemented carbide and diamond polishing industries.
- Aggravated Medical Condition** : None known.
Symptoms of Overexposure : No information available.
- IARC** Group 2A: Probably carcinogenic to humans
Cobalt 7440-48-4
Group 2B: Possibly carcinogenic to humans
- OSHA** No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
- NTP** No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
- ACGIH** Confirmed animal carcinogen with unknown relevance to humans
Cobalt 7440-48-4

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous components

Component	CAS-No.	Concentration (%)
Tungsten monocarbide	12079-12-1	87 - 89
Cobalt	7440-48-4	11 - 13

SECTION 4. FIRST AID MEASURES

First aid procedures

If inhaled : Remove to fresh air.

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If symptoms persist, call a physician.

If inhaled, remove to fresh air.
If not breathing, give artificial respiration.
If breathing is difficult, give oxygen.
Call a physician immediately.

In case of skin contact : Wash off with soap and water.
In the case of skin irritation or allergic reactions see a physician.

In case of skin contact, wash affected areas with soap and water.
Wash clothing and shoes before reuse.
Get medical attention if irritation develops or persists.

In case of eye contact : Rinse with plenty of water.
If eye irritation persists, consult a specialist.

In case of contact, flush eyes with plenty of lukewarm water.
Get medical attention if irritation develops or persists.

If swallowed : Clean mouth with water and drink afterwards plenty of water.
Obtain medical attention.

Give two glasses of water for dilution.
Never give anything by mouth to an unconscious person.
Call a physician immediately.

Notes to physician

Symptoms : No information available.

Risks : No information available.

Treatment : No information available.

SECTION 5. FIREFIGHTING MEASURES

Hazardous combustion products : Please refer to specific hazards during fire fighting.

Fire fighting

Suitable extinguishing media : Dry sodium chloride
Special powder against metal fire
Sand

Unsuitable extinguishing media : Water
Carbon dioxide (CO₂)

Further information : None known.

Protective equipment and precautions for firefighters

Specific hazards during firefighting : Carbon monoxide
Carbon Dioxide - Gas is heavier than air. Act as an asphyxiant at high concentrations.
Cobalt oxide

Special protective equipment for firefighters : In the event of fire, wear self-contained breathing apparatus.

SECTION 6. ACCIDENTAL RELEASE MEASURES

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- Personal precautions : Effective exhaust ventilation system
 Avoid breathing dust.
 Avoid contact with skin, eyes and clothing.
 Use personal protective equipment.
 Avoid dust formation.
 Avoid dust accumulation in enclosed space.
- : If dust is generated, use appropriate respiratory protection.
 Avoid generation of dust.
 Avoid dust formation.
- Environmental precautions : No special environmental precautions required.
- Collect wash water for approved disposal.
 Keep from entering water or ground water.
- Methods for containment /
 Methods for cleaning up : Use mechanical handling equipment.
 Avoid dust formation.
 Pick up and transfer to properly labelled containers.
- Vacuum or sweep up material and place in appropriate container.
 After removal, flush contaminated area thoroughly with water.

SECTION 7. HANDLING AND STORAGE**Handling**

- Advice on safe handling : Avoid dust formation.
 Do not breathe dust.
 Do not breathe vapours, aerosols.
 Avoid contact with the skin and the eyes.
 Provide sufficient air exchange and/or exhaust in work rooms.
 Avoid exceeding of the given occupational exposure limits (see section 8).
- Avoid contact with moisture or water.
 Vent storage bins, conveyors, dust collectors, ground handling equipment, etc.
 Reseal containers immediately after use.
- Advice on protection against fire and explosion : During processing, dust may form explosive mixture in air.
 Keep away from heat, sparks and flames.
- Dust explosion class : no data available

Storage

- Requirements for storage areas and containers : No special storage conditions required.
- Keep container closed when not in use.
 Label precautions also apply to this container when empty.
 Do not reuse empty container.
 Recondition or dispose of empty container in accordance with government regulations.
 Store in a dry place away from excessive heat.
- Further information on storage conditions : Store in tightly closed containers in a dry place.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Guidelines**Components with workplace control parameters**

Components	CAS-No.	Value	Control parameters	Form of exposure	Basis
Tungsten carbide	12070-12-1	TWA	5 mg/m ³		ACGIH
		STEL	10 mg/m ³		ACGIH
		TWA	5 mg/m ³		CA AB OEL
		STEL	10 ppm		CA AB OEL
		LMPE-PPT	5 mg/m ³		MX OEL
		LMPE-CT	10 mg/m ³		MX OEL
		TWA	5 mg/m ³		CA BC OEL
		STEL	10 mg/m ³		CA BC OEL
		TWA	5 mg/m ³		OSHA P0
		STEL	10 mg/m ³		OSHA P0
		TWA	5 mg/m ³		NIOSH REL
		ST	10 mg/m ³		NIOSH REL
		TWAEV	5 mg/m ³		CA QC OEL
		STEV	10 mg/m ³		CA QC OEL
Cobalt	7440-48-4	TWA	0.02 mg/m ³		CA BC OEL
		TWA	0.02 mg/m ³		ACGIH
		LMPE-PPT	0.1 mg/m ³		MX OEL
		TWA	0.05 mg/m ³	dust and fume	NIOSH REL
		TWA	0.1 mg/m ³		OSHA Z-1
		TWA	0.05 mg/m ³		OSHA P0
		TWA	0.02 mg/m ³		CA AB OEL
		TWAEV	0.02 mg/m ³		CA QC OEL

Engineering measures

Engineering measures : Dust must be extracted directly at the point of origin.

Personal protective equipment

Eye protection : Safety glasses

Avoid contact with eyes.

Hand protection

Material : Chemical resistant gloves made of butyl rubber or nitrile rubber category III according to EN 374.

Remarks : The data about break through time/strength of material is not valid for undissolved solids/dust.

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Skin and body protection	: Protective suit
Respiratory protection	: Respiratory protective device with particle filter EN 143 - P2 or P3 Avoid breathing dust, vapors or mist. Work ambient concentrations should be monitored and if the recommended exposure limit is exceeded, a NIOSH/MSHA approved respirator should be worn.
Hygiene measures	: Handle in accordance with good industrial hygiene and safety practice. Keep working clothes separately. Wash thoroughly after handling. Store away from food and beverages.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: powdered form
Colour	: grey
Odour	: odourless
Odour Threshold	: no data available
pH	: no data available
Melting point/range	: no data available
Boiling point/boiling range	: no data available
Flash point	: not applicable
Evaporation rate	: not applicable
Flammability (solid, gas)	: negative
Burning rate	: no data available
Lower explosion limit	: no data available
Upper explosion limit	: no data available
Vapour pressure	: not applicable
Relative vapour density	: not applicable
Relative density	: no data available
Density	: no data available
Bulk density	: 3,800 - 4,500 kg/m ³
Water solubility	: no data available
Solubility in other solvents	: no data available
Partition coefficient: n-octanol/water	: not applicable
Ignition temperature	: no data available
Thermal decomposition	: no data available
Viscosity, dynamic	: not applicable
Viscosity, kinematic	: not applicable
Explosive properties	: no data available

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Oxidizing properties : not oxidizing

Burning number : 1

Method: VDI 2263

For risk assessment data of analog ingredients

SECTION 10. STABILITY AND REACTIVITY

Chemical stability : Stable under normal conditions.
Conditions to avoid : Reacts with oxygen at high temperatures to form cobalt oxide.

Materials to avoid : Incompatible with acids.

Hazardous decomposition products : Formation of carbon dioxide (CO₂) and carbon monoxide (CO) during thermal decomposition.

Hazardous reactions : None known.

SECTION 11. TOXICOLOGICAL INFORMATION**Information on toxicological effects****Product**

Acute oral toxicity : no data available

Acute inhalation toxicity : no data available

Acute dermal toxicity : no data available

Skin corrosion/irritation : no data available

Serious eye damage/eye irritation : no data available

Respiratory or skin sensitisation : no data available

Germ cell mutagenicity

Genotoxicity in vitro : no data available

Genotoxicity in vivo : no data available

Carcinogenicity : no data available

STOT - single exposure : Remarks: no data available

Repeated dose toxicity : Remarks: no data available

STOT - repeated exposure : Remarks: no data available

Components:

Tungsten carbide :
Acute oral toxicity : LD50 rat, male and female: > 2,000 mg/kg

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	Method: OECD Test Guideline 401
Acute inhalation toxicity	: LC50 rat, male and female: 5.3 mg/l Exposure time: 4 h Method: OECD Test Guideline 403
Acute dermal toxicity	: LD50 rat, male and female: > 2,000 mg/kg Method: OECD Test Guideline 402
Skin corrosion/irritation	: Species: rabbit Exposure time: 4 h Result: No skin irritation Method: OECD Test Guideline 404
Serious eye damage/eye irritation	: Species: rabbit Result: Mild eye irritation Method: OECD Test Guideline 405
Respiratory or skin sensitisation	: Test Method: Maximisation Test Species: guinea pig Result: Did not cause sensitisation on laboratory animals. Method: OECD Test Guideline 406
Germ cell mutagenicity	
Genotoxicity in vitro	: Type: Ames test Test species: Salmonella typhimurium, E. coli with and without metabolic activation Result: negative Method: OECD Test Guideline 471 GLP: yes In vitro tests did not show mutagenic effects
Genotoxicity in vivo	: no data available
Carcinogenicity	: no data available
Reproductive toxicity	: no data available
Teratogenicity	: Species: rat Application Route: Oral Method: One-generation Reproductive Study (EPA OPPTS 870.3800/870.3650) Test substance: Sodium wolframate (Read across)
STOT - single exposure	: Assessment: The substance or mixture is not classified as specific target organ toxicant, single exposure.
Repeated dose toxicity	: NOEL: rat, female: NOAEL: ≥ 15 mg/m ³ Application Route: Inhalation dust/mist Exposure time: 90-day Method: OECD Test Guideline 413 Target Organs: Lungs
STOT - repeated exposure	: Assessment: The substance or mixture is not classified as specific target organ toxicant, repeated exposure.
Further information	: None known.

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cobalt :

- Acute oral toxicity : LD50 rat, female: 6,171 mg/kg
Method: No information available.
- Acute inhalation toxicity : no data available
- Acute dermal toxicity : LD50 Dermal rat, male and female: > 2,000 mg/kg
Method: OECD Test Guideline 402
Test substance: Read across
Weight of Evidence
- Skin corrosion/irritation : Exposure time: 0.25 h
Result: No skin irritation
Method: OECD Test Guideline 439
in vitro assay
- Serious eye damage/eye irritation : Exposure time: 4 h
Result: Mild eye irritation
Method: OECD Test Guideline 437
in vitro assay
- Respiratory or skin sensitisation : Species: guinea pig
Result: Skin sensitisation
Method: OECD Test Guideline 406
Test substance: CoSO₄ (CAS-No. 10124-43-3)
- Result: Respiratory sensitisation
Method: Evaluation of human information
- Germ cell mutagenicity
- Genotoxicity in vitro : no data available
- Genotoxicity in vivo : no data available
- Carcinogenicity : no data available
- Reproductive toxicity : no data available
- Teratogenicity : no data available
- STOT - single exposure : Remarks: no data available
- Repeated dose toxicity : NOEL:
NOAEL rat, female: 5 mg/kg Application Route: Oral
Exposure time: 28-day
Method: OECD Test Guideline 422
Test substance: Cobalt stearate (Read across)
Remarks: Weight of Evidence
- STOT - repeated exposure : Assessment: The substance or mixture is not classified as specific target organ toxicant, repeated exposure.
- Further information : None known.

SECTION 12. ECOLOGICAL INFORMATION

Toxicity**Product:**

Toxicity to fish	: no data available
Toxicity to daphnia and other aquatic invertebrates	: no data available
Toxicity to algae	: no data available
Toxicity to bacteria	: no data available
Toxicity to fish (Chronic toxicity)	: no data available
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	: no data available
Toxicity to soil dwelling organisms	: no data available
Plant toxicity	: no data available
Toxicity to terrestrial organisms	: no data available

Components:**Tungsten carbide :**

Toxicity to fish	: LC50 (Danio rerio (zebra fish)): > 1,000 mg/l Exposure time: 96 h Test Method: static test Analytical monitoring: yes Method: OECD Test Guideline 203 GLP: yes
Toxicity to daphnia and other aquatic invertebrates	: EC50 (Daphnia magna (Water flea)): > 1,000 mg/l Exposure time: 48 h Test Method: static test Analytical monitoring: yes Method: OECD Test Guideline 202 GLP: yes Immobilization test
Toxicity to algae	: ErC50 (Desmodesmus subspicatus (green algae)): > 1 mg/l Exposure time: 72 h Test Method: static test Analytical monitoring: no Method: OECD Test Guideline 201 GLP: yes
Toxicity to bacteria	: EC50 (activated sludge): > 1,000 mg/l Exposure time: 3 h Analytical monitoring: no Method: OECD Test Guideline 209 GLP: yes
Toxicity to fish (Chronic toxicity)	: NOEC: >= 10 mg/l Exposure time: 38 d Species: Danio rerio (zebra fish) Test Method: flow-through test Test substance: Sodium wolframate (Read across) Method: OECD Test Guideline 210 GLP: No information available.
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	: NOEC: >= 85.1 mg/l Exposure time: 21 d Species: Daphnia magna (Water flea)

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- Test Method: static test
 Test substance: Sodium wolframate (Read across)
 Method: OECD Test Guideline 211
 GLP: No information available.
- Toxicity to soil dwelling organisms : NOEC: $\geq 1,000$ mg/kg
- Exposure duration: 56 d
 Species: Eisenia fetida (earthworms)
 Test substance: Sodium wolframate (Read across)
 Method: OECD Test Guideline 222
 GLP: No information available.
- Plant toxicity : NOEC: $\geq 1,000$ mg/kg
- Growth inhibition
 Species: Avena sativa (oats)
 Test substance: Sodium wolframate (Read across)
 Method: OECD Test Guideline 208
 GLP: No information available.
- Toxicity to terrestrial organisms : NOAEL: $\geq 1,210$ mg/kg
- Exposure duration: 120 d
 Species: Anas platyrhynchos (Mallard duck)
 Test substance: Tungsten (Read across)
 Method: Federal Register 51: 42098-42102
 GLP: No information available.
- cobalt :**
- Toxicity to fish : LC50 (Oncorhynchus mykiss (rainbow trout)): 1.512 mg/l
- Exposure time: 96 h
 Test Method: flow-through test
 Test substance: cobalt dichloride (Read across)
 Method: ASTM Directive
 GLP: no data available
 Fresh water
- LOEC (Oncorhynchus tshawytscha): ≤ 0.024 mg/l
 Exposure time: 0.5 h
 Test Method: flow-through test
 Test substance: cobalt dichloride (Read across)
 Method: no data available
 GLP: no data available
 Fresh water
- Toxicity to daphnia and other aquatic invertebrates : LC50 (Ceriodaphnia Dubia (water flea)): 0.61 mg/l
- Exposure time: 48 h
 Test Method: static test
 Test substance: cobalt dichloride (Read across)
 Method: USEPA 2002
 GLP: no
 Fresh water
- EC50 (Dendroaster excentricus): 2.3 mg/l
 Exposure time: 72 h
 Test Method: static test
 Test substance: cobalt dichloride (Read across)
 Method: ASTM Directive
 GLP: yes
 Marine water
- Toxicity to algae : EC50 (Pseudokirchneriella subcapitata (green algae)): 0.144 mg/l
- Exposure time: 72 h
 Test Method: static test
 Test substance: cobalt dichloride (Read across)

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Method: OECD Test Guideline 201
 GLP: no data available
 Fresh water

EC10 (Lemna minor (duckweed)): 0.005 mg/l
 Exposure time: 168 h
 Test Method: static test
 Test substance: cobalt dichloride (Read across)
 Method: OECD Test Guideline 221
 GLP: no data available
 Fresh water

EC50 (Champia parvula): 0.024 mg/l
 Exposure time: 168 h
 Test Method: static test
 Test substance: cobalt dichloride (Read across)
 Method: EPA 821-R-02-014, Method 1009.0
 GLP: no data available
 Marine water

EC10 (Champia parvula): 0.001 mg/l
 Exposure time: 168 h
 Test Method: static test
 Test substance: cobalt dichloride (Read across)
 Method: EPA 821-R-02-014, Method 1009.0
 GLP: no data available
 Marine water

M-Factor
 Toxicity to bacteria

: 10
 : EC10 (activated sludge): 3.73 mg/l
 Exposure time: 0.5 h
 Test Method: Growth inhibition
 Test substance: cobalt dichloride (Read across)
 Method: OECD Test Guideline 209
 GLP: no data available
 Information refers to the main component.
 Fresh water
 static test

EC50 (activated sludge): 120 mg/l
 Exposure time: 0.5 h
 Test Method: Growth inhibition
 Test substance: cobalt dichloride (Read across)
 Method: OECD Test Guideline 209
 GLP: no data available
 Information refers to the main component.
 Fresh water
 static test

Toxicity to fish (Chronic toxicity) : EC10: 0.35 mg/l
 Exposure time: 34 d
 Species: Pimephales promelas (fathead minnow)
 Test Method: flow-through test
 Test substance: cobalt dichloride (Read across)
 Method: OECD Test Guideline 210
 GLP: no
 Fresh water

EC10: 31.8 mg/l
 Exposure time: 28 d
 Species: Cyprinodon variegatus (sheepshead minnow)
 Test Method: flow-through test
 Test substance: cobalt dichloride (Read across)
 Method: OECD Test Guideline 210
 GLP: no

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- Marine water
- Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity) : EC10: 0.0055 mg/l
Exposure time: 28 d
Species: *Hyalella azteca*
Test Method: semi-static test
Test substance: cobalt dichloride (Read across)
Method: OECD Test Guideline 211
GLP: no data available
Fresh water
- EC10: 0.21 mg/l
Exposure time: 113 d
Species: *Neanthes arenaceodentata*
Test Method: flow-through test
Test substance: cobalt dichloride (Read across)
Method: ASTM E 1562
GLP: yes
Marine water
- Toxicity to soil dwelling organisms : EC10: 86 mg/kg
- Exposure duration: 42 d
Growth rate
Species: *Hyalella azteca*
Test substance: cobalt dichloride (Read across)
Method: OECD Test Guideline
GLP: no data available
Fresh water sediment
EC50: 146 mg/kg
- Exposure duration: 42 d
reproduction rate
Species: *Hyalella azteca*
Test substance: cobalt dichloride (Read across)
Method: OECD Test Guideline
GLP: no data available
Fresh water sediment
EC10: 52 mg/kg
- Exposure duration: 42 d
reproduction rate
Species: *Enchytraeus albidus*
Test substance: cobalt dichloride (Read across)
Method: ISO 11268-2
GLP: no data available
- EC10: 14 mg/kg
- Exposure duration: 28 d
reproduction rate
Species: *Folsomia candida*
Test substance: cobalt dichloride (Read across)
Method: ISO 11267
GLP: no data available
- Plant toxicity : EC10: 2.9 mg/kg
Growth inhibition
Species: *Medicago sativa*
Test substance: cobalt dichloride (Read across)
Method: ASTM E 1963-98
GLP: no data available
- Toxicity to terrestrial organisms : NOEC: 50 mg/kg
Exposure duration: 21 d

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change in weight
 Species: Gallus domesticus
 Test substance: no data available
 Method: no data available
 GLP: no data available
 Weight of Evidence

Persistence and degradability

Product:

Biodegradability : The methods for determining biodegradability are not applicable to inorganic substances.
 Stability in water : no data available

Persistence and degradability

Components:

Tungsten carbide :

Biodegradability : The methods for determining biodegradability are not applicable to inorganic substances.
 Stability in water : no data available

cobalt :

Biodegradability : The methods for determining biodegradability are not applicable to inorganic substances.
 Stability in water : no data available

Bioaccumulative potential

Product:

Bioaccumulation : This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
 Partition coefficient: n-octanol/water : not applicable

Bioaccumulative potential

Components:

Tungsten carbide :

Bioaccumulation : This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).
 Partition coefficient: n-octanol/water : not applicable

cobalt :

Bioaccumulation : no data available
 Partition coefficient: n-octanol/water : not applicable

Mobility in soil

Product:

Mobility : no data available

Mobility in soil

Components:

Tungsten carbide :

Mobility : no data available
cobalt :
 Mobility : no data available

Results of PBT and vPvB assessment

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Product:

Assessment : This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

Results of PBT and vPvB assessment**Components:****Tungsten carbide :**

Assessment : This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

cobalt :

Assessment : This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

Other adverse effects**Product:**

Ozone-Depletion Potential : no data available
Regulation: CAA 602 I
This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).

Additional ecological information : None known.

Other adverse effects**Components:****Tungsten carbide :**

Ozone-Depletion Potential : no data available
Additional ecological information : None known.

cobalt :

Ozone-Depletion Potential : no data available
Additional ecological information : None known.

SECTION 13. DISPOSAL CONSIDERATIONS

Further information : In accordance with local and national regulations.
The hazard and precautionary statements displayed on the label also apply to any residues left in the container.
Disposal should be in accordance with applicable state, federal and local laws and regulations. Local regulations may be more stringent than state or federal requirements.

SECTION 14. TRANSPORT INFORMATION**DOT**

UN number : 3077
Description of the goods : Environmentally hazardous substances, solid, n.o.s.
(COBALT)
Class : 9
Packing group : III
Labels : 9
Emergency Response : 171
Guidebook Number :
Environmentally hazardous : yes

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Reportable Quantity(regulated by PHMSA/DOT)
none

TDG

UN number : 3077
Description of the goods : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S.
(COBALT)
Class : 9
Packing group : III
Labels : 9
Environmentally hazardous : yes

IATA

UN number : 3077
Description of the goods : Environmentally hazardous substance, solid, n.o.s.
(cobalt)
Class : 9
Packing group : III
Labels : 9
Packing instruction (cargo aircraft) : 956
Packing instruction (passenger aircraft) : 956
Packing instruction (LQ) : Y956
Environmentally hazardous : yes

IMDG

UN number : 3077
Description of the goods : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S.
(COBALT)
Class : 9
Packing group : III
Labels : 9
EmS Number 1 : F-A
EmS Number 2 : S-F
Marine pollutant : yes

SECTION 15. REGULATORY INFORMATION

OSHA Hazards : Carcinogen

WHMIS Classification : D2A
D2B

Ingredient Disclosure List (WHMIS) : Cobalt

NPRI Components : Cobalt

CERCLA Reportable Quantity

Product :
none

This material does not contain any components with a CERCLA RQ.

SARA 302 Reportable Quantity

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Product :
This material does not contain any components with a SARA 302 RQ.

SARA 311/312 Hazards : Immediate Health Hazard
Delayed Health Hazard
Chronic Health Hazard

EPCRA - Emergency Planning and Community Right-to-Know Act

SARA 302 : none
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 304 : This material does not contain any components with a section 304 EHS RQ.

SARA 313 : The following components are subject to reporting levels established by SARA Title III, Section 313:

Components : Cobalt 7440-48-4

Clean Air Act

The following chemical(s) are listed as HAP under the U.S. Clean Air Act, Section 12 (40 CFR 61):
Cobalt 15

The following chemical(s) are listed as HAP under the U.S. Clean Air Act, Section 12 (40 CFR 61):
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCM1 Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.
This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

US State Regulations

Massachusetts Right To Know

Components : Cobalt 7440-48-4 10 - 30 %

Pennsylvania Right To Know

Components : Tungsten monocarbide 12070-12-1 60 - 100 %
Cobalt 7440-48-4 10 - 30 %

New Jersey Right To Know

Components : Tungsten monocarbide 12070-12-1 60 - 100 %
Cobalt 7440-48-4 10 - 30 %

California Prop 65 Components

: WARNING! This product contains a chemical known to the State of California to cause cancer.
Cobalt 7440-48-4

The components of this product are reported in the following inventories:

TSCA On TSCA Inventory
DSL All components of this product are on the Canadian DSL.

SECTION 16. OTHER INFORMATION

Further information

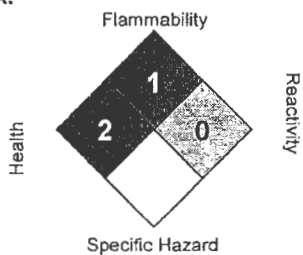
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NFPA:



HMIS III:

HEALTH	2*
FLAMMABILITY	1
PHYSICAL	0

0 = Insignificant, 1 = Slight
 2 = Moderate, 3 = High
 4 = Extreme, * = Chronic

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

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P007

POWDER ALLOY CORPORATION
MATERIAL SAFETY DATA SHEET

CINCINNATI, OHIO 45242
EMERGENCY PHONE 513-984-4016
DATE: MAY 11, 1991

009E

SECTION I MATERIAL IDENTIFICATION
PRODUCT NAME: PAC12, PAC12F, PAC658C, PAC658F

DESCRIPTION: METAL ALLOY POWDER

CHEMICAL FAMILY: COPPER BASE ALLOY

SECTION II HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENT	%	CAS #	OSHA PEL	ACGIH TLY
COPPER	55-65	7440-50-8	1.0 MG/M3	1.0 MG/M3
NICKEL	33-45	7440-02-2	1.0 MG/M3	1.0 MG/M3
INDIUM	0-5.3	7440-74-6	0.1 MG/M3	0.1 MG/M3

SECTION III PHYSICAL DATA

BOILING POINT: N/A

SPECIFIC GRAVITY: N/A

VAPOR PRESSURE: N/A

EVAPORATION RATE: N/A

VAPOR DENSITY: N/A

FREEZING POINT: N/A

SOLUBILITY IN WATER: INSOLUBLE PERCENT VOLATILE: N/A

APPEARANCE AND ODOR: GRAY METALLIC POWDER WITH NO APPRECIABLE ODOR.

SECTION IV FIRE & EXPLOSION HAZARD DATA

FLAMABLE LIMITS: LEL: N/A UEL: N/A
FLASH POINT: N/A

EXTINGUISHING MEDIA: USE CLASS "D" FIRE EXTINGUISHER.

SPECIAL FIREFIGHTING PROCEDURES: SELF CONTAINED BREATHING APPARATUS SHOULD BE WORN. COMPLY WITH NFPA51B STANDARD FOR FIRE PREVENTION IN THE USE OF CUTTING AND WELDING PROCESSES.

UNUSUAL FIRE & EXPLOSION HAZARDS:

PROVIDE ADEQUATE VENTILATION. MODEATE FIRE HAZARD IN THE FORM OF DUST OR ACCUMULATION OF SUCH. IN ADDITION, MINIMIZE AIRBORN POWDER PARTICLES.

SECTION V REACTIVITY DATA:

MATERIAL STABILITY: STABLE

CHEMICAL INCOMPATIBILITY: NONE KNOWN.

HAZARDOUS DECOMPOSITION: OZONE & NITRIC OKIDE ARE FORMED DURING SPRAYING.

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

SECTION VI HEALTH HAZARD DATA:

SKIN CONTACT: MAY CAUSE DERMATITIS. FIRST AID PROCEDURE IS TO THOROUGHLY WITH SOAP AND WATER.

EYE CONTACT: MAY CAUSE IRRITATION AND REDNESS. FIRST AID PROCEDURE IS TO IRRIGATE EYE WITH WATER.

INHALATION: MAY CAUSE IRRIGATION TO UPPER RESPIRATORY TRACT. FIRST AID PROCEDURE IS TO REMOVE TO FRESH AIR.

INGESTION: MAY CAUSE NAUSEA, VOMITING AND DIARRHEA. FIRST AID PROCEDURE IS TO INDUCE VOMITING AND CONSULT A PHYSICIAN.

EFFECTS OF OVEREXPOSURE: CHRONIC SKIN CONTACT MAY LEAD TO LESIONS AND REDNESS. CHRONIC INHALATION MAY CAUSE FIBROTIC DISEASE.

* THIS MATERIAL MAY CONTAIN NICKEL AND/OR CHROMIUM. CHROMIUM IS LISTED AS A HUMAN CARCINOGEN AND NICKEL IS LISTED AS A PROBABLE HUMAN CARCINOGEN.

SECTION VII SPILL AND LEAK PROCEDURES

SPILL/LEAK CLEANUP: USE RESPIRATORY EQUIPMENT DURING CLEANUP. USE EQUIPMENT THAT KEEPS MATERIAL FROM BECOMING AIRBORNE TO MINIMIZE DUST GENERATION I.E. WET MOP, HEPA VACUUM.

WASTE DISPOSAL: DISPOSE IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII SPECIAL PROTECTION DATA

GOGGLES: PER OSHA 1910.3

GLOVES: WEAR IMPERVIOUS GLOVES TO PREVENT SKIN CONTACT.

RESPIRATOR: WEAR RESPIRATOR AS APPROVED BY NIOSH OR OSHA 1910.134 TO PROTECT OPERATOR FROM FUMES.

VENTILATION: DUST PICKUP AND VENTILLATION IS SUGGESTED.

SECTION IX SPECIAL PRECAUTIONS

RECOMMENDATIONS:

1. KEEP MATERIAL CONTAINERS CLOSED AND DRY DURING STORAGE.
2. NO FOOD OR SMOKING IN WORK AREAS.
3. WASH THOROUGHLY AFTER HANDLING.
4. INSTALL EYE WASH STATION.
5. HAVE SAFETY MANAGERS AND OPERATORS REVIEW "RECOMMENDED SAFE PRACTICES FOR THERMAL SPRAY"-AWS PUBLICATION C2.1-73.

THE ABOVE DATA CONTAINED HEREIN IS BELIEVED TO BE ACCURATE BASE ON AVAILABLE TESTS AND INFORMATION. POWDER ALLOY CORPORATION ASSUMES NO LIABILITY IN CONNECTION WITH THE INFORMATION SUPPLIED ON THIS SHEET.

Material Safety Data Sheet

SULZER

Metco 410, Metco 410NS

Sulzer Metco

1. Product and company identification

Product name : Metco 410, Metco 410NS
Material uses : Metal industry: Used by spraying
Supplier : Sulzer Metco (US) Inc.
1101 Prospect Avenue
Westbury, NY 11590
Telephone no. : (516) 334 - 1300 (7:30AM - 4:00PM)
In case of emergency : CHEMTREC 800-424-9300
Calls Outside the United States : +1 703-527-3887 (USA) 24 hour Chemtrec International Emergency Response Service
Product type : Powder.

2. Hazards identification

Emergency overview

Physical state : Solid. [Metallic powder.]
Color : Gray.
Odor : Odorless.
Signal word : WARNING!
Hazard statements : CAUSES RESPIRATORY TRACT, EYE AND SKIN IRRITATION. MAY CAUSE ALLERGIC SKIN REACTION. CONTAINS MATERIAL THAT CAN CAUSE TARGET ORGAN DAMAGE. CANCER HAZARD - CONTAINS MATERIAL WHICH CAN CAUSE CANCER.
DURING THERMAL SPRAY A PORTION OF NICKEL MAY BE CONVERTED TO NICKEL COMPOUNDS WHICH ARE KNOWN TO CAUSE CANCER.

Precautionary measures : Do not handle until all safety precautions have been read and understood. Obtain special instructions before use. Do not breathe dust. Use only with adequate ventilation. Do not eat, drink or smoke when using this product. Avoid contact with eyes, skin and clothing. Keep container tightly closed. Use personal protective equipment as required. Wash thoroughly after handling.

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Routes of entry : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Inhalation : Irritating to respiratory system.
Ingestion : No known significant effects or critical hazards.
Skin : Irritating to skin. May cause sensitization by skin contact.
Eyes : Irritating to eyes.

Potential chronic health effects

Chronic effects : Contains material that can cause target organ damage. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.
Carcinogenicity : Contains material which can cause cancer. Risk of cancer depends on duration and level of exposure.
Mutagenicity : No known significant effects or critical hazards.
Teratogenicity : No known significant effects or critical hazards.
Developmental effects : No known significant effects or critical hazards.
Fertility effects : No known significant effects or critical hazards.

2. Hazards identification

Target organs : Contains material which causes damage to the following organs: eye, lens or cornea.
Contains material which may cause damage to the following organs: kidneys, lungs, the nervous system, upper respiratory tract, skin, nose/sinuses.

Over-exposure signs/symptoms

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Ingestion : No specific data.

Skin : Adverse symptoms may include the following:
irritation
redness

Eyes : Adverse symptoms may include the following:
pain or irritation
watering
redness

Medical conditions aggravated by over-exposure : Pre-existing skin disorders and disorders involving any other target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (Section 11)

3. Composition/information on ingredients

United States

Name	CAS number	%
Aluminium oxide	1344-28-1	66.5
Nickel	7440-02-0	24
Aluminium	7429-90-5	6
titanium dioxide	13463-67-7	2
silicon dioxide	7631-86-9	1
diiron trioxide	1309-37-1	0.5

Canada

Name	CAS number	%
Aluminium oxide	1344-28-1	66.5
Nickel	7440-02-0	24
Aluminium	7429-90-5	6
titanium dioxide	13463-67-7	2
silicon dioxide	7631-86-9	1
diiron trioxide	1309-37-1	0.5

Mexico

Classification

Name	CAS number	UN number	%	IDLH	H	F	R	Special
Aluminium oxide	1344-28-1	Not regulated	66.5	-	0	0	0	-
Nickel	7440-02-0	Not regulated	24	10 mg/m ³	2	0	0	-
Aluminium	7429-90-5	Not regulated	6	-	4	1	0	-
titanium dioxide	13463-67-7	Not regulated	2	5000 mg/m ³	2	0	0	-
silicon dioxide	7631-86-9	Not regulated	1	3000 mg/m ³	1	0	0	-
diiron trioxide	1309-37-1	Not regulated	0.5	2500 mg/m ³	2	0	0	-

3. Composition/information on ingredients

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

4. First aid measures

- Eye contact** : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- Skin contact** : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.
- Inhalation** : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- Ingestion** : Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water.
- Notes to physician** : No specific treatment. Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

5. Fire-fighting measures

- Flammability of the product** : Fine dust clouds may form explosive mixtures with air.
- Extinguishing media**
- Suitable** : Use approved Class D extinguisher or smother with dry sand, dry clay or dry ground limestone.
- Not suitable** : Do not use water. Do not use dry chemical, CO₂ or halon.
- Special exposure hazards** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.
- Hazardous thermal decomposition products** : Decomposition products may include the following materials:
metal oxide/oxides
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

6. Accidental release measures

- Personal precautions** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see Section 8).
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods for cleaning up

- Small spill** : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.

6. Accidental release measures

Large spill : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

7. Handling and storage

Handling : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Avoid exposure - obtain special instructions before use. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing dust. Avoid the creation of dust when handling and avoid all possible sources of ignition (spark or flame). Prevent dust accumulation. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Electrical equipment and lighting should be protected to appropriate standards to prevent dust coming into contact with hot surfaces, sparks or other ignition sources. Empty containers retain product residue and can be hazardous. Do not reuse container.

Storage : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see section 10) and food and drink. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate container to avoid environmental contamination.

8. Exposure controls/personal protection

United States

Ingredient	Exposure limits
Aluminium oxide	OSHA PEL (United States, 6/2010). TWA: 5 mg/m ³ 8 hour(s). Form: Respirable fraction
Nickel	TWA: 15 mg/m ³ 8 hour(s). Form: Total dust ACGIH TLV (United States, 2/2010). TWA: 1.5 mg/m ³ 8 hour(s). Form: Inhalable fraction
Aluminium	OSHA PEL (United States, 6/2010). TWA: 1 mg/m ³ , (as Ni) 8 hour(s). OSHA PEL (United States, 6/2010). TWA: 5 mg/m ³ , (as Al) 8 hour(s). Form: Respirable fraction TWA: 15 mg/m ³ , (as Al) 8 hour(s). Form: Total dust
titanium dioxide	ACGIH TLV (United States, 2/2010). TWA: 1 mg/m ³ 8 hour(s). Form: Respirable fraction OSHA PEL (United States, 6/2010). TWA: 15 mg/m ³ 8 hour(s). Form: Total dust ACGIH TLV (United States, 2/2010). TWA: 10 mg/m ³ 8 hour(s).

Canada

Occupational exposure limits		TWA (8 hours)			STEL (15 mins)			Ceiling			
Ingredient	List name	ppm	mg/m ³	Other	ppm	mg/m ³	Other	ppm	mg/m ³	Other	Notations

8. Exposure controls/personal protection

Aluminium oxide	AB 4/2009	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[a]
Aluminium oxide, as Al	QC 6/2008	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[b]
Nickel	US ACGIH 2/2010	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[c]
Nickel, as Ni	AB 4/2009	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[d]
Nickel	BC 9/2010	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[e]
Nickel	ON 7/2010	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[f]
Nickel	QC 6/2008	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[g]
Aluminium	US ACGIH 2/2010	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[h]
Aluminium	AB 4/2009	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[i]
Aluminium	BC 9/2010	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[j]
Aluminium	ON 7/2010	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[k]
Aluminium, as Al	QC 6/2008	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[l]
titanium dioxide	US ACGIH 2/2010	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[m]
titanium dioxide	AB 4/2009	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[n]
titanium dioxide	BC 9/2010	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[o]
titanium dioxide	ON 7/2010	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[p]
titanium dioxide	QC 6/2008	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[q]

Mexico

Occupational exposure limits

Ingredient	Exposure limits
Aluminium oxide	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 10 mg/m ³ 8 hour(s).
Nickel	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 1 mg/m ³ 8 hour(s).
Aluminium	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 5 mg/m ³ 8 hour(s).
titanium dioxide	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 5 mg/m ³ 8 hour(s). Form: powder
silicon dioxide	NOM-010-STPS (Mexico, 9/2000). LMPE-CT: 20 mg/m ³ , (as Ti) 15 minute(s). LMPE-PPT: 10 mg/m ³ , (as Ti) 8 hour(s).
	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 3 mg/m ³ 8 hour(s). Form: breathable particulates LMPE-PPT: 10 mg/m ³ 8 hour(s). Form: inhalable particulates


Consult local authorities for acceptable exposure limits.

- Additional information** : A portion of nickel may be converted during the thermal spray process to nickel compounds which are classified as an IARC Group 1 Carcinogen. NTP classifies nickel compounds as Known to be Carcinogenic.
- Recommended monitoring procedures** : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.
- Engineering measures** : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits.
- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Contaminated work clothing should not be allowed out of the workplace. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal protection

- Eyes** : Safety glasses or goggles are recommended when handling this material. During the thermal spray process, safety goggles and dark lenses must be worn.

8. Exposure controls/personal protection

- Skin** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory** : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
- Hands** : Rubber or other appropriate gloves should be worn to minimize contact. For hygienic reasons rubber gloves should not be worn for more than 2 hours. During the thermal spray process, heat insulated gloves are recommended.
- Hearing Protection** : Hearing protection that meets local standards should be used.
- Protective Clothing (Pictograms)** :
- 
- Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

9. Physical and chemical properties

- Physical state** : Solid. [Metallic powder.]
- Flash point** : Not applicable.
- Color** : Gray.
- Odor** : Odorless.
- Explosive properties** : Fine dust clouds may form explosive mixtures with air.
- Relative density** : 2.5
- Solubility** : Insoluble in the following materials: cold water.
- Physical/chemical properties comments** : Insoluble.

10. Stability and reactivity

- Chemical stability** : The product is stable under normal storage conditions.
- Conditions to avoid** : Store and use away from heat, sparks, open flame or any other ignition source.
- Incompatible materials** : Avoid contact with combustible materials, acids, oxidizing agents, halogenated hydrocarbons.
- Hazardous decomposition products** : Ozone and nitric oxide are formed by plasma flame. This action is independent of material. Some metallic oxides.
- Possibility of hazardous reactions** : Under normal conditions of storage and use, hazardous reactions will not occur.

11. Toxicological information

United States Canada Mexico

Acute toxicity

Conclusion/Summary : Not available.

Chronic toxicity

Conclusion/Summary : Not available.

Irritation/Corrosion

11. Toxicological information

Product/ingredient name	Result	Species	Score	Exposure	Observation
titanium dioxide	Skin - Mild irritant	Human	-	72 hours 300 Micrograms Intermittent	-
silicon dioxide	Eyes - Mild irritant	Rabbit	-	24 hours 25 milligrams	-

Conclusion/Summary : Not available.

Sensitizer

Conclusion/Summary : Not available.

Carcinogenicity

Conclusion/Summary : Contains material which can cause cancer. Risk of cancer depends on duration and level of exposure.

Classification

Product/ingredient name	ACGIH	IARC	EPA	NIOSH	NTP	OSHA
Aluminium oxide	A4	-	-	None.	-	-
Nickel	A5	2B	-	+	Possible	-
Aluminium	A4	-	-	None.	-	-
titanium dioxide	A4	2B	-	+	-	-
silicon dioxide	-	3	-	-	-	-

Mutagenicity

Conclusion/Summary : Not available.

Teratogenicity

Conclusion/Summary : Not available.

Reproductive toxicity

Conclusion/Summary : Not available.

12. Ecological information

Ecotoxicity : No known significant effects or critical hazards.

United States**Aquatic ecotoxicity**

Product/ingredient name	Result	Species	Exposure
Nickel	Acute LC50 2.3 ppm Fresh water	Fish - Cyprinus carpio - Juvenile (Fledgling, Hatchling, Weanling) - 6 cm	96 hours
	Chronic NOEC 3.5 ug/L Fresh water	Fish - Cyprinus carpio - 13 months - 10.5 cm - 27.8 g	4 weeks
titanium dioxide	Acute EC50 5.83 mg/L Fresh water	Algae - Pseudokirchneriella subcapitata - Exponential growth phase	72 hours
	Acute LC50 >10 mg/L Fresh water	Crustaceans - Ceriodaphnia dubia - Neonate - <24 hours	48 hours
	Acute LC50 5.5 ppm Fresh water	Daphnia - Daphnia magna - Juvenile (Fledgling, Hatchling, Weanling) - <24 hours	48 hours
	Acute LC50 >1000000 ug/L Marine water	Fish - Fundulus heteroclitus	96 hours

Conclusion/Summary : Not available.

Persistence/degradability

Conclusion/Summary : Not available.

Other adverse effects : No known significant effects or critical hazards.

13. Disposal considerations

Waste disposal

: The generation of waste should be avoided or minimized wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Disposal should be in accordance with applicable regional, national and local laws and regulations.

Refer to Section 7: **HANDLING AND STORAGE** and Section 8: **EXPOSURE CONTROLS/PERSONAL PROTECTION** for additional handling information and protection of employees.

14. Transport information

Regulatory information	UN number	Proper shipping name	Classes	PG*	Label	Additional information
DOT Classification	Not regulated	-	-	-		-
TDG Classification	Not regulated	-	-	-		-
Mexico Classification	Not regulated	-	-	-		-
ADR/RID Class	Not regulated	-	-	-		-
IMDG Class	Not regulated	-	-	-		-
IATA-DGR Class	Not regulated	-	-	-		-

PG* : Packing group

15. Regulatory information

United States

HCS Classification : Irritating material
Sensitizing material
Carcinogen
Target organ effects

U.S. Federal regulations : TSCA 8(a) IUR: Partial exemption

United States inventory (TSCA 8b): All components are listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.

SARA 302/304 emergency planning and notification: No products were found.

SARA 302/304/311/312 hazardous chemicals: Aluminium oxide; Nickel; Aluminium ; titanium dioxide

SARA 311/312 MSDS distribution - chemical inventory - hazard identification:

Aluminium oxide: Immediate (acute) health hazard; Nickel: Fire hazard, Immediate (acute) health hazard, Delayed (chronic) health hazard; Aluminium : Fire hazard, reactive; titanium dioxide: Immediate (acute) health hazard

Clean Water Act (CWA) 307: Nickel

15. Regulatory information

- Clean Air Act Section 112(b) Hazardous Air Pollutants (HAPs) : Not listed
- Clean Air Act Section 602 Class I Substances : Not listed
- Clean Air Act Section 602 Class II Substances : Not listed
- DEA List I Chemicals (Precursor Chemicals) : Not listed
- DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 313

	Product name	CAS number	Concentration
Form R - Reporting requirements	Aluminium oxide	1344-28-1	66.5
	Nickel	7440-02-0	24
	Aluminium	7429-90-5	6
Supplier notification	Aluminium oxide	1344-28-1	66.5
	Nickel	7440-02-0	24
	Aluminium	7429-90-5	6

SARA 313 notifications must not be detached from the MSDS and any copying and redistribution of the MSDS shall include copying and redistribution of the notice attached to copies of the MSDS subsequently redistributed.

State regulations

- Massachusetts** : The following components are listed: ALUMINUM OXIDE; NICKEL; ALUMINUM; TITANIUM DIOXIDE; AMORPHOUS SILICA
- New York** : The following components are listed: Nickel
- New Jersey** : The following components are listed: ALUMINUM OXIDE; alpha-ALUMINA; NICKEL; ALUMINUM; TITANIUM DIOXIDE; TITANIUM OXIDE (TiO₂)
- Pennsylvania** : The following components are listed: ALUMINUM OXIDE (AL₂O₃); NICKEL; ALUMINUM; TITANIUM OXIDE (TiO₂); SILICA

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
Nickel titanium dioxide	Yes. Yes.	No. No.	No. No.	No. No.

United States inventory (TSCA 8b) : All components are listed or exempted.

Canada

- WHMIS (Canada)** : Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

Canadian lists

- Canadian NPRI** : The following components are listed: Aluminum oxide; Nickel; Aluminum
- CEPA Toxic substances** : None of the components are listed.
- Canada inventory** : All components are listed or exempted.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Mexico

Classification :

15. Regulatory information



Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

16. Other information

Label requirements : WARNING!
CAUSES RESPIRATORY TRACT, EYE AND SKIN IRRITATION. MAY CAUSE ALLERGIC SKIN REACTION. CONTAINS MATERIAL THAT CAN CAUSE TARGET ORGAN DAMAGE. CANCER HAZARD - CONTAINS MATERIAL WHICH CAN CAUSE CANCER.
DURING THERMAL SPRAY A PORTION OF NICKEL MAY BE CONVERTED TO NICKEL COMPOUNDS WHICH ARE KNOWN TO CAUSE CANCER.

National Fire Protection Association (U.S.A.) :



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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Date of issue : 6/8/2012.
Version : 1.5

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

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Material Safety Data Sheet - Tribaloy T-800

SECTION 1 - PRODUCT IDENTIFICATION

Product Name:	Tribaloy T-800		
Other Product Name(s):	Metal Alloy No. 1738		
Product Type and Use:	Cobalt Based Alloy Powder - Surface Coating Alloy		
Manufacturer:	Kennametal Stellite 1201 Eisenhower Drive N Goshen, Indiana 46526 USA	Phone: 574-534-2585 Fax: 574-534-3417 www.stellite.com	
MSDS Issued Date:	May 2011	Previous Issue Date:	April 2008

SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS No.	Weight %
Carbon	7440-44-0	.1 - 1.0
Chromium	7440-47-3	10 - 30
Cobalt	7440-48-4	30 - 60
Iron	1309-37-1	.5 - 1.5
Molybdenum	7439-98-7	15 - 40
Nickel	7440-02-0	.5 - 1.5
Silicon	7440-21-3	1 - 5

Material Safety Data Sheet - Tribaloy T-800

SECTION 3 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: A grey, odorless metallic powder. Contact with the eyes may be irritating and contact with the skin may cause allergic reactions to some individuals. Inhalation of dusts is harmful and should be avoided.

POTENTIAL HEALTH HAZARDS

Welding Operations	Electric arc or oxy-fuel welding may produce intense arc rays and/or infrared heat rays which are hazardous to the eyes and skin. In addition, such operations may produce noise at levels damaging to hearing. Use of electric arc equipment can present a potential electrocution hazard.
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The potential health effects described as chronic effects and in the OSHA carcinogen table in this section cover all potential ingredients in this family of products: Refer to Section 2 (above) for ingredients found in this specific product:

Skin Contact	May cause an allergic skin reaction in some individuals. Handling with bare skin may cause irritation due to the abrasive nature of the metal powder.
Eye Contact	May cause irritation due to the abrasive nature of the metal powder.
Ingestion	Harmful if swallowed. Effects can include a burning sensation, nausea, abdominal pain, vomiting, diarrhea and central nervous system depression.
Inhalation	Inhalation of dusts and welding-generated fumes can cause irritation, chills, cough, fever, nausea, vomiting, weakness and flu-like symptoms. Products containing cobalt may cause an allergic respiratory reaction in sensitized individuals. Excessive inhalation can lead to severe toxic effects up to and including death.
Chronic Effects	<p>Chromium: While insoluble hexavalent chromium compounds are associated with lung damage and lung cancer, however, the chromium metal found in this product is not considered a suspect carcinogen.</p> <p>Cobalt: Cobalt has caused cancer in laboratory animals and is associated with lung injury and effects upon the circulatory system.</p> <p>Nickel metal is considered to be possibly carcinogenic to humans. Long-term overexposure to nickel compounds may cause lung damage (fibrosis or pneumoconiosis). Soreness and itchiness of the nose and change in skin color and/or appearance may also result.</p> <p>Manganese: Repeated inhalation of manganese dust or fume can cause irreversible damage to the central nervous system resulting in symptoms similar to Parkinson's disease. Manganese is also associated with chronic lung disease and potential reproductive effects.</p> <p>Molybdenum: Molybdenum is considered an animal carcinogen based on laboratory test.</p>

Potential ingredients found on one of the OSHA designated Carcinogen Lists are listed below:

Ingredient Name	NTP Status	IARC Status	OSHA Status
Cobalt metal	-----	2B - Possibly carcinogenic	-----
Nickel metal	Suspect carcinogen	2B - Possibly carcinogenic	-----

SECTION 4 - FIRST AID MEASURES

Skin Contact	Wash with soap and water. Get medical assistance if irritation persists.
Eye Contact	Wash eyes in running water. Get medical assistance if irritation persists.
Ingestion	Do not induce vomiting unless directed to do so by a physician. Get immediate medical assistance.
Inhalation	Remove to fresh air. Get immediate medical assistance if breathing is difficult or has stopped. Get medical assistance for persistent irritation.
Advice to Physician	Treat symptomatically.
Extinguishing Media to Avoid	None (see below)

Material Safety Data Sheet - Tribaloy T-800

SECTION 5 - FIRE FIGHTING MEASURES

Flash Point and Method	None
Autoignition Temperature	Not determined
Upper/Lower/Flame Limits	Not applicable
Extinguishing Media to Use	Use media suitable for surrounding structural fire.
Extinguishing Media to Avoid	None (see below)
Special Fire Fighting Procedures	Avoid skin contact and wear self-contained breathing apparatus to avoid inhalation of dusts or fumes. If material has been mechanically reduced in size, it may burn if involved in a fire. Use dry sand to smother burning metal powder.
Unusual Fire and Explosion Hazards	None normally present.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

In case of spill	Wear appropriate personal protective equipment. Sweep or vacuum up spilled materials and place into containers for use and/or disposal. Dispose of materials contaminated with dirt or any other foreign substance.
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Spills may be reportable to the National Response Center or other agencies. See section 15 for 'reportable quantities' (RQs) that may exist.

SECTION 7 - HANDLING AND STORAGE

Use this product in accordance with ANSI Z49.1 "Safety in Welding, Cutting and Allied Processes" and in compliance with OSHA welding regulations, 29CFR1910.252-255 (as appropriate).

Normal Handling	Avoid contact with skin and eyes. Do not breathe product dusts.
Storage	Keep containers closed and store in a dry area. Do not store where contamination with foreign materials may occur. Avoid storage next to acids. If powder particles are reduced in size, they may oxidize or burn if involved in a fire. Avoid storage near sources of combustion.

Material Safety Data Sheet - Tribaloy T-800

SECTION 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits for possible ingredients:

Ingredient	ACGIH TLV	OSHA PEL	Other Limit
Aluminum metal	None	15 mg/m ³ TWA (total dust) 5 mg/m ³ TWA (respirable dust)	* 5 mg/m ³ TWA (as welding fumes) * 10 mg/m ³ TWA (Total dust)
Boron Metal	None	None	None
Carbon	None established	None established	None established
Chromium metal	0.5 mg/m ³ TWA	1 mg/m ³ TWA	* 0.5 mg/m ³ TWA
Cobalt metal	0.02 mg/m ³ TWA	0.1 mg/m ³ TWA (dust and fume)	* 0.05 mg/m ³ TWA (dust and fume)
Copper metal	0.2 mg/m ³ TWA (fume) 1 mg/m ³ TWA (dusts and mists)	0.1 mg/m ³ TWA (fume) 1 mg/m ³ TWA (dusts and mists)	* 0.1 mg/m ³ TWA (fume R) 1 mg/m ³ TWA (dusts and mists)
Iron (as iron oxide)	5 mg/m ³ TWA (dust and fume)(R)	10 mg/m ³ TWA (Fume)	* 5 mg/m ³ TWA (dust and fume)
Manganese metal	0.2 mg/m ³ TWA	5 mg/m ³ Ceiling (fume)	* 1 mg/m ³ (fume) * 3 mg/m ³ (STEL)
Molybdenum metal	10 mg/m ³ TWA (I) 3 mg/m ³ TWA (R)	None	None
Nickel metal	1.5 mg/m ³ TWA (I)	1 mg/m ³ TWA	* 0.015 mg/m ³ TWA
Niobium Metal	None	None	None
Silicon metal	TLV Withdrawn	15 mg/m ³ TWA (total dust) 5 mg/m ³ (respirable)	* 10 mg/m ³ TWA (total dust) * 5 mg/m ³ TWA (respirable)
Titanium Metal	None	None	None
Tungsten metal	5 mg/m ³ TWA 10 mg/m ³ STEL	None	5 mg/m ³ TWA 10 mg/m ³ STEL
Vanadium (as vanadium pentoxide)	0.05 mg/m ³ TWA (respirable fraction)	0.5 mg/m ³ Ceiling (respirable dust) 0.1 mg/m ³ Ceiling (fume)	* 0.05 mg/m ³ TWA ceiling 15 min, Total dust, As V
Welding Fumes (produced during use)	5 mg/m ³ TWA	None established	* Keep exposures as low as possible

*=NIOSH NIOSH TWA's are based upon a 10 hour day (vs. 8 hrs for OSHA and ACGIH)

R = Measured as respirable fraction of the aerosol. I = Measured as Inhalable fraction of the aerosol.

Engineering Controls	Provide local exhaust ventilation at transfer points and at areas where material is being used in welding operations. Ventilation should maintain exposure levels below the exposure levels listed above.
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Personal Protective Equipment

Skin Protection	Wear head, hand, and body protection which help to prevent injury from radiation, sparks, and electrical shock. See ANSI Z49.1. At a minimum this includes welder's gloves and a protective face shield, and may include arm protectors, aprons, hats, shoulder protection, as well as dark substantial clothing. Train the welder not touch live electrical parts and to insulate himself from work and ground.
Eye Protection	Wear helmet or use face shield with filter lens. As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to the next lighter shade which gives sufficient view of the weld zone. Provide protective screens and flash goggles, if necessary, to shield others.
Respiratory Protection	Use NIOSH approved air-purifying fume respirator or air supplied respirator when welding in confined space or where local exhaust or ventilation does not keep exposure below TLV. Pulmonary Function tests are recommended for users of negative pressure respirators.

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SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Physical State	Gray Powder
Odor	None
Specific Gravity	8.78
Melting Point	2465 °F
Freezing Point	2350 °F
Vapor Pressure	Negligible
pH	Not applicable
Flash Point and Method	None
Autoignition Temperature	Not applicable
Lower/ Flame Limits	Not applicable

SECTION 10 - STABILITY AND REACTIVITY

Chemical Stability	Material is normally stable.
Conditions to Avoid	Do not allow contact with inorganic acids. Flammable hydrogen gas may be released.
Hazardous Decomposition Products	Oxides of metal components and oxides of organic fluxes used in the welding process may be formed. Inhalation should be avoided.
Possibility of Hazardous Reactions	Material will not polymerize or undergo self-reactions.

SECTION 11 - TOXICOLOGICAL INFORMATION

Acute Toxicity	<p>Boron: LD₅₀ (oral, rat) – 650 mg/kg Carbon: LD₅₀ (oral, rat) –> 5g/kg Cobalt: LD₅₀ (oral, rat) – 6171 mg/kg Manganese: LD₅₀ (oral, rat) – 9g/kg Silicon: LD₅₀ (oral, rat) – 3160 mg/kg Vanadium Pentoxide (oxidation product of vanadium metal) LD₅₀ (oral, rat) – 10 mg/kg</p>
Chronic Toxicity	<p>Chromium: Although hexavalent forms of insoluble chromium are considered to be lung carcinogens, trivalent compounds and chromium metal are not associated with cancer. IARC - 3 (Unclassifiable as to Carcinogenicity to Humans). Cobalt: Cobalt has caused cancer in laboratory animals and is associated with lung injury and effects upon the circulatory system (myocardial effects). IARC - 2A (with Tungsten Carbide) (Probably Carcinogenic to Humans), IARC-2B (All other forms) (Possibly Carcinogenic to Humans). Iron Oxide: IARC-3 (Unclassifiable as to Carcinogenicity to Humans). Manganese: Repeated inhalation of manganese dust or fume can cause irreversible damage to the central nervous system resulting in symptoms similar to Parkinson's disease. Manganese is also associated with chronic lung disease and reduced reproductive vitality in males (based on studies of male workers in manganese production). Molybdenum: An animal carcinogen. (Lung cancer - rats) Relevance to human health is uncertain. Nickel: Classified as a suspect carcinogen by NTP (NTP-R) and as an animal carcinogen by IARC (IARC-2B) (Possibly Carcinogenic to Humans). NIOSH-Ca (Potential occupational carcinogen. Chronic exposure is associated with lung damage (fibrosis or pneumoconiosis). Soreness and itchiness of the nose and change in skin color and/or appearance may also result. Nickel can also cause allergic sensitization via contact. Vanadium Pentoxide (Oxidation product of Vanadium Metal): IARC-2B (Possibly Carcinogenic to Humans). Welding Fumes (NOS) - IARC-2B (Possibly Carcinogenic to Humans).</p>

SECTION 12 - ECOLOGICAL INFORMATION

Chromium content classifies this product as hazardous to the environment if discharged. Both chromium and nickel may be persistent in the environment.

Material Safety Data Sheet - Tribaloy T-800

SECTION 13 - DISPOSAL CONSIDERATIONS

Is unused product a RCRA Hazardous Waste if discarded?	No
If yes, the RCRA waste identification number is:	-----

Always dispose of in accordance with Federal, State and Local regulations.

SECTION 14 - TRANSPORT INFORMATION

DOT Classification	Not regulated
UN Identification Number	Not applicable
DOT Shipping Description	Not applicable

SECTION 15 - REGULATORY INFORMATION

Toxic Substances Control Act	All ingredients are listed on the Toxic Substances Control Act Inventory of Chemical Substances.
SARA 311 Hazard Class	Immediate, delayed
SARA 313 This product may contain certain toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning Community Right-To-Know Act of 1988 and 40 CFR 372:	

Ingredient	C.A.S. No.	Maximum Wt % in this Product
Chromium	7440-47-3	30
Cobalt	7440-48-4	60
Copper	7440-50-8	None
Manganese	7439-96-5	None
Nickel	7440-02-0	1.5

Reportable Quantities and Threshold Planning Quantities: The following possible ingredients have CERCLA/SARA Reportable Quantities (RQs) and/or Threshold Planning Quantities (TPQs).

Ingredient	RQ	TPQ
Chromium	5000 lbs (for particles whose diameter is less than 0.004")	None
Copper	5000 lbs (for particles whose diameter is less than 0.004")	None
Cobalt	1 lb (compounds of cobalt only) Cobalt metal has no RQ	None
Manganese	1 lb (compounds of manganese only) Manganese metal has no RQ	None
Nickel	100 lbs (for particles whose diameter is less than 0.004")	None

State Right to Know Lists: In addition to ingredients listed in section 2, the following information is presented for state right to know purposes.

Ingredient	Comment
Cobalt	Listed on the California Proposition 65 carcinogen list.
Nickel	Listed on the California Proposition 65 carcinogen list.

Foreign Inventory Status:	The ingredients of this product are on the following chemical control inventories: Australia, Canada (DSL), China, European Union, Korea, Philippines
WHMIS Classification:	D2A - This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

SECTION 16 - OTHER INFORMATION

Changes to this datasheet from previous version:	Updated Hazard information Based upon 2007 edition of "Guide to Occupational Exposure Values" published by ACGIH.
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NFPA Ratings	Health: 1	Fire: 1	Reactivity: 0
HMIS (III) Ratings	Health: 1	Fire: 1	Physical Hazard: 0

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022E

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POWDER ALLOY CORPORATION
MATERIAL SAFETY DATA SHEET

CINCINNATI, OHIO 45242
EMERGENCY PHONE 513-984-4016
DATE: MAY 11, 1991

SECTION I MATERIAL IDENTIFICATION

PRODUCT NAME: PAC12, PAC12F, PAC658C, PAC658F

DESCRIPTION: METAL ALLOY POWDER
CHEMICAL FAMILY: COPPER BASE ALLOY

SECTION II HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENT	%	CAS #	OSHA PEL	ACGIH TLV
COPPER	55-65	7440-50-8	1.0 MG/M3	1.0 MG/M3
NICKEL	33-45	7440-02-2	1.0 MG/M3	1.0 MG/M3
INDIUM	0-5.3	7440-74-6	0.1 MG/M3	0.1 MG/M3

SECTION III PHYSICAL DATA

BOILING POINT: N/A
VAPOR PRESSURE: N/A
VAPOR DENSITY: N/A
SOLUBILITY IN WATER: INSOLUBLE
APPEARANCE AND ODOR: GRAY METALLIC POWDER WITH NO APPRECIABLE ODOR.
SPECIFIC GRAVITY: N/A
EVAPORATION RATE: N/A
FREEZING POINT: N/A
PERCENT VOLATILE: N/A

SECTION IV FIRE & EXPLOSION HAZARD DATA

FLAMABLE LIMITS: LEL: N/A UEL: N/A

FLASH POINT: N/A

EXTINGUISHING MEDIA: USE CLASS "D" FIRE EXTINGUISHER.

SPECIAL FIREFIGHTING PROCEDURES: SELF CONTAINED BREATHING APPARATUS SHOULD BE WORN. COMPLY WITH NFPA51B STANDARD FOR FIRE PREVENTION IN THE USE OF CUTTING AND WELDING PROCESSES.

UNUSUAL FIRE & EXPLOSION HAZARDS:

PROVIDE ADEQUATE VENTILATION. MODEATE FIRE HAZARD IN THE FORM OF DUST OR ACCUMULATION OF SUCH. IN ADDITION, MINIMIZE AIRBORN POWDER PARTICLES.

SECTION V REACTIVITY DATA:

MATERIAL STABILITY: STABLE

CHEMICAL INCOMPATIBILITY: NONE KNOWN.

HAZARDOUS DECOMPOSITION: OZONE & NITRIC OKIDE ARE FORMED DURING SPRAYING.

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

SECTION VI HEALTH HAZARD DATA:

SKIN CONTACT: MAY CAUSE DERMATITIS. FIRST AID PROCEDURE IS TO THOROUGHLY WITH SOAP AND WATER.

EYE CONTACT: MAY CAUSE IRRITATION AND REDNESS. FIRST AID PROCEDURE IS TO IRRIGATE EYE WITH WATER.

INHALATION: MAY CAUSE IRRIGATION TO UPPER RESPIRATORY TRACT. FIRST AID PROCEDURE IS TO REMOVE TO FRESH AIR.

INGESTION: MAY CAUSE NAUSEA, VOMITING AND DIARRHEA. FIRST AID PROCEDURE IS TO INDUCE VOMITING AND CONSULT A PHYSICIAN.

EFFECTS OF OVEREXPOSURE: CHRONIC SKIN CONTACT MAY LEAD TO LESIONS AND REDNESS. CHRONIC INHALATION MAY CAUSE FIBROTIC DISEASE.

*** THIS MATERIAL MAY CONTAIN NICKEL AND/OR CHROMIUM. CHROMIUM IS LISTED AS A HUMAN CARCINOGEN AND NICKEL IS LISTED AS A PROBABLE HUMAN CARCINOGEN.**

SECTION VII SPILL AND LEAK PROCEDURES

SPILL/LEAK CLEANUP: USE RESPIRATORY EQUIPMENT DURING CLEANUP. USE EQUIPMENT THAT KEEPS MATERIAL FROM BECOMING AIRBORN TO MINIMIZE DUST GENERATION I.E. WET MOP, HEPA VACUUM.

WASTE DISPOSAL: DISPOSE IN ACCORDANC WITH LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII SPECIAL PROTECTION DATA

GOGGLES: PER OSHA 1910.3

GLOVES: WEAR IMPERVIOUS GLOVES TO PREVENT SKIN CONTACT.

RESPIRATOR: WEAR RESPIRATOR AS APPROVED BY NIOSH OR OSHA 1910.134 TO PROTECT OPERATOR FROM FUMES.

VENTILATION: DUST PICKUP AND VENTILLATION IS SUGGESTED.

SECTION IX SPECIAL PRECAUTIONS

RECOMMENDATIONS:

1. KEEP MATERIAL CONTAINERS CLOSED AND DRY DURING STORAGE.
2. NO FOOD OR SMOKING IN WORK AREAS.
3. WASH THOROUGHLY AFTER HANDLING.
4. INSTALL EYE WASH STATION.
5. HAVE SAFETY MANAGERS AND OPERATORS REVIEW "RECOMMENDED SAFE PRACTICES FOR THERMAL SPRAY"-AWS PUBLICATION C2.1-73.

THE ABOVE DATA CONTAINED HEREIN IS BELIEVED TO BE ACCURATE BASE ON AVAILABLE TESTS AND INFORMATION. POWDER ALLOY CORPORATION ASSUMES NO LIABILITY IN CONNECTION WITH THE INFORMATION SUPPLIED ON THIS SHEET.

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Material Safety Data Sheet



AMPERIT® 831.936 ZrO2-Y2O3 93-7 plasma densified

Version 0.1

Revision Date 09/27/2012

Print Date 02/28/2013

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : AMPERIT® 831.936 ZrO2-Y2O3 93-7 plasma densified
MSDS Number : 000010009182
Product Use Description : Thermal Metallic Compounds, Surface Treatment and Wear Resistant Coatings

Chemical nature : Mixture

Company : H.C. Starck North American Trading LLC
45 Industrial Place
Newton, MA 02461-1951
USA

Telephone : + 1 617 630 5800

Responsible Department : Sustainability Management / Chemical Control Legislation
E-mail address : infoSDS@hcstarck.com
H.C. Starck Emergency Phone : + 1 617 630 5815 [8:00 a.m - 5:00 p.m EST]
(Non-Transportation)
24h-Emergency Phone (US, : + 1-800-535-5053 (GBK/INFOTRAC ID 101020)
Transportation)
24h-Emergency Phone : +1 352 3233500 (GBK/INFOTRAC ID 101020)
(International, Transportation)

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Table with 2 columns: Hazard Category, Description. Includes CAUTION!, Form (powdered form), Odour (odourless), and Hazard Summary (May cause mechanical irritation to the eyes, skin and respiratory tract).

Potential Health Effects

Primary Routes of Entry : Inhalation, Skin contact, Eye contact, Ingestion.
Inhalation : May cause mechanical irritation to the respiratory tract.
Skin : May cause mechanical irritation to the skin.
Eyes : May cause mechanical irritation to eyes.
Ingestion : None known.
Chronic Exposure : None known.
Aggravated Medical Condition : None known.
Symptoms of Overexposure : No information available.

IARC : No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen

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	by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
ACGIH	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS**Hazardous components**

Component	CAS-No.	Concentration (%)
Zirconium dioxide	1314-23-4	90 - 91
Yttrium oxide (Y ₂ O ₃)	1314-36-9	7 - 9
Hafnium(IV) oxide	12055-23-1	2.5

SECTION 4. FIRST AID MEASURES**First aid procedures**

If inhaled	: Remove to fresh air. If symptoms persist, call a physician.
	If inhaled, remove to fresh air.
In case of skin contact	: Wash off with soap and water. If skin irritation occurs, seek medical advice/attention.
	In case of skin contact, wash affected areas with soap and water.
In case of eye contact	: Rinse with plenty of water. If eye irritation persists, consult a specialist.
	In case of contact, flush eyes with plenty of lukewarm water. Get medical attention if irritation develops or persists.
If swallowed	: Clean mouth with water and drink afterwards plenty of water. Obtain medical attention.
	Call a physician immediately.

Notes to physician

Symptoms	: No information available.
Risks	: No information available.
Treatment	: No information available.

SECTION 5. FIREFIGHTING MEASURES

Hazardous combustion products	: None known.
Fire fighting	
Suitable extinguishing media	: Extinguishing methods depends upon fire in vicinity poses. The product itself does not burn.

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Unsuitable extinguishing media : None known.

Further information : Prevent fire extinguishing water from contaminating surface water or the ground water system.

Protective equipment and precautions for firefighters

Specific hazards during firefighting : None known.

Special protective equipment for firefighters : In the event of fire, wear self-contained breathing apparatus.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions : If dust is generated, use appropriate respiratory protection.
Avoid generation of dust.

: Avoid formation and deposition of dust.
Use personal protective equipment.

Environmental precautions : Keep from entering water or ground water.
Collect wash water for approved disposal.

: Do not flush into surface water or sanitary sewer system.

Methods for containment /
Methods for cleaning up : Vacuum or sweep up material and place in appropriate container.
After removal, flush contaminated area thoroughly with water.

: Use mechanical handling equipment.
Avoid dust formation.
Fill into labelled, sealable containers.

SECTION 7. HANDLING AND STORAGE**Handling**

Advice on safe handling : Avoid contact with moisture or water.
Reseal containers immediately after use.
Vent storage bins, conveyors, dust collectors, ground handling equipment, etc.

: Avoid dust formation.
Ensure adequate ventilation and, if necessary, exhaust ventilation when handling or transferring the product.
Ensure that the occupational exposure limit value/s (OEL) and/or other limit values are complied with.

Advice on protection against fire and explosion : No special precautions required.

Storage

Requirements for storage areas and containers : Comply with the directives governing water law

: Keep container closed when not in use.
Label precautions also apply to this container when empty.
Do not reuse empty container.
Recondition or dispose of empty container in accordance with government regulations.

Further information on storage : Store in tightly closed containers in a dry place.

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conditions

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Guidelines

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Form of exposure	Basis
zirconium dioxide	1314-23-4	PEL	5 mg/m3		
		TWA	5 mg/m3		OSHA P1
		TWA	5 mg/m3		ACGIH
		STEL	10 mg/m3		ACGIH
		TWA	5 mg/m3		CA AB OEL
		TLV	5 mg/m3		
		STEL	10 mg/m3		CA AB OEL
		LMPE-PPT	5 mg/m3		MX OEL
			10 mg/m3		
		LMPE-CT	10 mg/m3		MX OEL
		TWAEV	5 mg/m3		CA QC OEL
		STEV	10 mg/m3		CA QC OEL
		TWA	5 mg/m3		CA BC OEL
		STEL	10 mg/m3		CA BC OEL
		TWA	5 mg/m3		OSHA P0
STEL	10 mg/m3		OSHA P0		
TWA	5 mg/m3		NIOSH REL		
ST	10 mg/m3		NIOSH REL		
yttrium oxide (Y ₂ O ₃)	1314-36-9	TWA	1 mg/m3		ACGIH
		TWA	1 mg/m3		CA AB OEL
		TLV	1 mg/m3		
		TWAEV	1 mg/m3		CA QC OEL
		TWA	1 mg/m3		CA BC OEL
TWA	1 mg/m3		NIOSH REL		
hafnium dioxide	12056-23-1	TWA	0.5 mg/m3		ACGIH
		TWA	0.5 mg/m3		CA AB OEL
		TLV	0.5 mg/m3		
		TWA	0.5 mg/m3		CA BC OEL
TWA	0.5 mg/m3		NIOSH REL		

Engineering measures

Personal protective equipment

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<u>Eye protection</u>	: Safety glasses
<u>Hand protection</u>	
Material	: Butyl-rubber, Natural rubber, Nitrile rubber
Remarks	: The data about break through time/strength of material is not valid for undissolved solids/dust.
Skin and body protection	: Protective suit
Respiratory protection	: Avoid breathing dust, vapors or mist. Work ambient concentrations should be monitored and if the recommended exposure limit is exceeded, a NIOSH/MSHA approved respirator should be worn. Respiratory protective device with particle filter EN 143
Hygiene measures	: Wash thoroughly after handling. Store away from food and beverages. Handle in accordance with good industrial hygiene and safety practice. Keep working clothes separately.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: powdered form
Colour	: no data available
Odour	: odourless
Odour Threshold	: no data available
pH	: no data available
Melting point/range	: > 3,632 °F (2,000 °C)
Boiling point/boiling range	: no data available
Flash point	: no data available
Evaporation rate	: no data available
Flammability (solid, gas)	: not highly flammable
Burning rate	: no data available
Lower explosion limit	: no data available
Upper explosion limit	: no data available
Vapour pressure	: no data available
Relative vapor density	: no data available
Relative density	: no data available
Density	: no data available
Water solubility	: no data available
Solubility in other solvents	: no data available
Partition coefficient: n-octanol/water	: no data available
Ignition temperature	: no data available

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Thermal decomposition	:	not applicable
Viscosity, dynamic	:	no data available
Viscosity, kinematic	:	no data available
Explosive properties	:	no data available
Oxidizing properties	:	no data available
Burning number	:	1

SECTION 10. STABILITY AND REACTIVITY

Chemical stability	:	Stable under normal conditions.
Conditions to avoid	:	None known.
Materials to avoid	:	None known.
Hazardous decomposition products	:	not applicable
Hazardous reactions	:	None known.

SECTION 11. TOXICOLOGICAL INFORMATION**Information on toxicological effects****Product**

Acute oral toxicity	:	no data available
Skin corrosion/irritation	:	no data available
Serious eye damage/eye irritation	:	no data available

Components:**yttrium oxide :**

Acute oral toxicity	:	LD50 rat: > 5.000 mg/kg Method: No information available.
Skin corrosion/irritation	:	Species: rabbit Exposure time: 24 h Result: No skin irritation Method: No information available.
Serious eye damage/eye irritation	:	Result: Mild eye irritation Method: No information available.

SECTION 12. ECOLOGICAL INFORMATION**Toxicity****Product:**

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Toxicity to fish	:	no data available
Toxicity to daphnia and other aquatic invertebrates	:	no data available
Toxicity to algae	:	no data available
Toxicity to bacteria	:	no data available
Toxicity to fish (Chronic toxicity)	:	no data available

Persistence and degradabilityProduct:

Biodegradability : The methods for determining biodegradability are not applicable to inorganic substances.

Bioaccumulative potentialProduct:

Bioaccumulation : This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

Mobility in soilProduct:

Mobility : Soil
no data available

Results of PBT and vPvB assessmentProduct:

Assessment : This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

Other adverse effectsProduct:

Ozone-Depletion Potential : Regulation: CAA 602 I
This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).

Additional ecological information : No information on ecology is available.
This product has no known eco-toxicological effects.

SECTION 13. DISPOSAL CONSIDERATIONS

Further information : The Federal, regional and local rules and regulations governing disposal must be complied with.
Packaging that is not contaminated and has been cleaned can be recycled.
Disposal should be in accordance with applicable state, federal and local laws and regulations. Local regulations may be more stringent than state or federal requirements.

SECTION 14. TRANSPORT INFORMATIONDOT

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Not dangerous goods

Reportable Quantity (regulated by PHMSA/DOT)
none**TDG**

Not dangerous goods

IATA

Not dangerous goods

IMDG

Not dangerous goods

SECTION 15. REGULATORY INFORMATION**OSHA Hazards** : hazardous**WHMIS Classification** : Uncontrolled product according to WHMIS classification criteria.**Ingredient Disclosure List (WHMIS)** : Zirconium dioxide
Yttrium oxide (Y2O3)**CERCLA Reportable Quantity**

Product :

This material does not contain any components with a CERCLA RQ.

SARA 302 Reportable Quantity

Product :

This material does not contain any components with a SARA 302 RQ.

SARA 311/312 Hazards : Delayed Health Hazard**SARA 302** : SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.**SARA 304** : This material does not contain any components with a section 304 EHS RQ.**SARA 313** : SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.**Clean Air Act**

This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 12 (40 CFR 61).

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCM1 Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.

This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

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US State Regulations

Massachusetts Right To Know

Components	:	Zirconium dioxide	1314-23-4	60 - 100 %
		Yttrium oxide (Y2O3)	1314-36-9	5 - 10 %

Pennsylvania Right To Know

Components	:	Zirconium dioxide	1314-23-4	60 - 100 %
		Yttrium oxide (Y2O3)	1314-36-9	5 - 10 %

New Jersey Right To Know

Components	:	Zirconium dioxide	1314-23-4	60 - 100 %
		Yttrium oxide (Y2O3)	1314-36-9	5 - 10 %
		Hafnium(IV) oxide	12055-23-1	1 - 5 %

California Prop 65

Components : This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

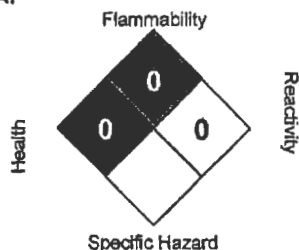
The components of this product are reported in the following inventories:

DSL All components of this product are on the Canadian DSL.
 US.TSCA Listed on TSCA

SECTION 16. OTHER INFORMATION

Further Information

NFPA:



HMIS III:

HEALTH	0
FLAMMABILITY	0
PHYSICAL	0

0 = Insignificant, 1 = Slight
 2 = Moderate, 3 = High
 4 = Extreme, * = Chronic

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Prepared by: : H.C. Starck GmbH
 Sustainability Management
 Telephone: 01149 5321 7510
 E-Mail: infoSDS@hcstarck.com

Safety Data Sheet

Amdry: 962, 9620-B, 9621, 9622, 9624, 9625, 9626, XPT 492, XPT 510, XPT 527, SP 10864, AE 9798, AE 9851 (Amdry 962X), Amdry 510, AE 11330, AE 11695, AE 11755

Section 1. Product and company identification

Product name : Amdry: 962, 9620-B, 9621, 9622, 9624, 9625, 9626, XPT 492, XPT 510, XPT 527, SP 10864, AE 9798, AE 9851 (Amdry 962X), Amdry 510, AE 11330, AE 11695, AE 11755

Material uses : Metal industry: Suitable for thermal spray coating applications

Supplier : Oerlikon Metco (US) Inc.
1101 Prospect Avenue
Westbury, NY 11590

Telephone no. : (516) 334-1300 (7:30AM - 4:00PM)

In case of emergency : CHEMTREC: 800-424-9300

Calls Outside the United States : **+1 703-741-5970: (USA) 24 hour Chemtrec International Emergency Response Service**

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : SKIN SENSITIZATION - Category 1
CARCINOGENICITY - Category 2
SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 1
AQUATIC HAZARD (LONG-TERM) - Category 3

GHS label elements

Hazard pictograms :



Signal word : Danger

Hazard statements : May cause an allergic skin reaction.
Suspected of causing cancer.
Causes damage to organs through prolonged or repeated exposure.
Harmful to aquatic life with long lasting effects.

Precautionary statements

Prevention : Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Use personal protective equipment as required. Wear protective gloves. Avoid release to the environment. Do not breathe fumes. Do not eat, drink or smoke when using this product. Wash hands thoroughly after handling. Contaminated work clothing should not be allowed out of the workplace.

Response : Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention.

Storage : Store locked up.

Disposal : Not applicable.

Section 2. Hazards identification

Hazards not otherwise classified : Fine dust clouds may form explosive mixtures with air. Handling and/or processing of this material may generate a dust which can cause mechanical irritation of the eyes, skin, nose and throat.

Section 3. Composition/information on ingredients

United States

Name	CAS number	%
Nickel	7440-02-0	67
chromium	7440-47-3	22
Aluminum	7429-90-5	10
yttrium	7440-65-5	1

Canada

Name	CAS number	%
Nickel	7440-02-0	67
chromium	7440-47-3	22
Aluminum	7429-90-5	10
yttrium	7440-65-5	1

Mexico

Classification

Name	CAS number	UN number	%	IDLH	H	F	R	Special
Nickel	7440-02-0	Not regulated	67	10 mg/m ³	2	0	0	-
chromium	7440-47-3	Not regulated	22	250 mg/m ³	0	0	0	-
Aluminum	7429-90-5	Not available.	10	-	4	0	0	-
yttrium	7440-65-5	Not regulated	1	500 mg/m ³	2	0	0	-

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

- Eye contact** : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.
- Inhalation** : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Section 4. First aid measures

- Skin contact** : Wash with plenty of soap and water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water. Continue to rinse for at least 10 minutes. Get medical attention. In the event of any complaints or symptoms, avoid further exposure. Wash clothing before reuse. Clean shoes thoroughly before reuse.
- Ingestion** : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

- Eye contact** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the eyes.
- Inhalation** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.
- Skin contact** : May cause an allergic skin reaction.
- Ingestion** : No known significant effects or critical hazards.

Over-exposure signs/symptoms

- Eye contact** : Adverse symptoms may include the following:
irritation
redness
- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Skin contact** : Adverse symptoms may include the following:
irritation
redness
- Ingestion** : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

- Notes to physician** : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.
- Specific treatments** : No specific treatment.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

- Suitable extinguishing media** : Use approved Class D extinguisher or smother with dry sand, dry clay or dry ground limestone.
- Unsuitable extinguishing media** : Do not use water. Do not use dry chemical, CO₂ or halon.
- Specific hazards arising from the chemical** : Fine dust clouds may form explosive mixtures with air. This material is harmful to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.
- Hazardous thermal decomposition products** : Decomposition products may include the following materials:
metal oxide/oxides
- Special protective actions for fire-fighters** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

- For non-emergency personnel** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
- For emergency responders** : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods and materials for containment and cleaning up

- Small spill** : Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Place spilled material in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.
- Large spill** : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

- Protective measures** : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Avoid exposure - obtain special instructions before use. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing dust. Avoid the creation of dust when handling and avoid all possible sources of ignition (spark or flame). Prevent dust accumulation. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Electrical equipment and lighting should be protected to appropriate standards to prevent dust coming into contact with hot surfaces, sparks or other ignition sources. Empty containers retain product residue and can be hazardous. Do not reuse container.
- Advice on general occupational hygiene** : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
- Conditions for safe storage, including any incompatibilities** : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate container to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

United States

Occupational exposure limits

Ingredient name	Exposure limits
nickel	ACGIH TLV (United States, 4/2014). TWA: 1.5 mg/m ³ 8 hours. Form: Inhalable fraction OSHA PEL (United States, 2/2013). TWA: 1 mg/m ³ , (as Ni) 8 hours.
chromium	ACGIH TLV (United States, 4/2014). TWA: 0.5 mg/m ³ , (measured as Cr) 8 hours. Form: Inorganic OSHA PEL (United States, 2/2013). TWA: 1 mg/m ³ , (as Cr) 8 hours.
Aluminum	ACGIH TLV (United States, 4/2014). TWA: 1 mg/m ³ 8 hours. Form: Respirable fraction OSHA PEL (United States, 2/2013). TWA: 5 mg/m ³ , (as Al) 8 hours. Form: Respirable fraction TWA: 15 mg/m ³ , (as Al) 8 hours. Form: Total dust
yttrium	ACGIH TLV (United States, 4/2014). TWA: 1 mg/m ³ , (as Y) 8 hours. OSHA PEL (United States, 2/2013). TWA: 1 mg/m ³ 8 hours.

Canada

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient	List name	TWA (8 hours)			STEL (15 mins)			Ceiling			Notations
		ppm	mg/m ³	Other	ppm	mg/m ³	Other	ppm	mg/m ³	Other	
Nickel	US ACGIH 4/2014	-	1.5	-	-	-	-	-	-	-	[a]
	AB 4/2009	-	1.5	-	-	-	-	-	-	-	
Nickel, as Ni	BC 2/2015	-	0.05	-	-	-	-	-	-	-	
	ON 1/2013	-	1	-	-	-	-	-	-	-	[b]
Nickel	QC 1/2014	-	1	-	-	-	-	-	-	-	
	US ACGIH 4/2014	-	0.5	-	-	-	-	-	-	-	[c]
chromium, measured as Cr	AB 4/2009	-	0.5	-	-	-	-	-	-	-	[3]
	BC 2/2015	-	0.5	-	-	-	-	-	-	-	
chromium, as Cr	ON 1/2013	-	0.5	-	-	-	-	-	-	-	[c]
	QC 1/2014	-	0.5	-	-	-	-	-	-	-	
Aluminum	US ACGIH 4/2014	-	1	-	-	-	-	-	-	-	[d]
	AB 4/2009	-	10	-	-	-	-	-	-	-	[3] [e]
Aluminum, as Al	BC 2/2015	-	1	-	-	-	-	-	-	-	[f]
	ON 1/2013	-	1	-	-	-	-	-	-	-	[d]
yttrium, as Y	QC 1/2014	-	10	-	-	-	-	-	-	-	
	US ACGIH 4/2014	-	1	-	-	-	-	-	-	-	
yttrium	AB 4/2009	-	1	-	-	-	-	-	-	-	
	BC 2/2015	-	1	-	-	-	-	-	-	-	
yttrium, as Y	ON 1/2013	-	1	-	-	-	-	-	-	-	
	QC 1/2014	-	1	-	-	-	-	-	-	-	

Mexico

Occupational exposure limits

Ingredient name	Exposure limits
Nickel	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 1 mg/m ³ 8 hours.
chromium	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 0.5 mg/m ³ 8 hours.
Aluminum	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 5 mg/m ³ 8 hours.
yttrium	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 5 mg/m ³ 8 hours. Form: powder LMPE-CT: 3 mg/m ³ 15 minutes. LMPE-PPT: 1 mg/m ³ 8 hours.

Additional information : A portion of nickel may be converted during the thermal spray process to nickel compounds which are classified as an IARC Group 1 Carcinogen. NTP classifies nickel compounds as Known to be Carcinogenic.

A portion of metallic chromium may be converted during the thermal spray process to hexavalent chromium. Hexavalent chromium is classified as an IARC group 1 carcinogen. NTP classifies hexavalent chromium as Known to be Carcinogenic.

OSHA PEL (United States, 5/2006)

PEL: 0.005 mg/m³ 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Section 8. Exposure controls/personal protection

- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Contaminated work clothing should not be allowed out of the workplace. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.
- Eye/face protection** : Safety glasses or goggles are recommended when handling this material. During the thermal spray process, safety goggles and dark lenses must be worn.
- Skin protection**
- Hand protection** : Rubber or other appropriate gloves should be worn to minimize contact. For hygienic reasons rubber gloves should not be worn for more than 2 hours. During the thermal spray process, heat insulated gloves are recommended.
- Body protection** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory protection** : Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
- Hearing Protection** : Hearing protection that meets local standards should be used. During the thermal spray process, the operator and other personnel close to the spray operation must be protected from excessive noise.

Protective Clothing (Pictograms) :



Section 9. Physical and chemical properties

Appearance

- Physical state** : Solid. [Metallic powder.]
- Color** : Gray.
- Odor** : Odorless.
- Odor threshold** : Not available.
- pH** : Not applicable.
- Melting point** : Not available.
- Boiling point** : Not available.
- Explosive properties** : Fine dust clouds may form explosive mixtures with air.
- Flash point** : [Product does not sustain combustion.]
- Evaporation rate** : Not applicable.
- Flammability (solid)** : Not applicable
- Lower and upper explosive (flammable) limits** : Not available.
- Vapor pressure** : Not applicable.
- Vapor density** : Not applicable.
- Relative density** : Not applicable

Section 9. Physical and chemical properties

Solubility : Insoluble in the following materials: cold water and hot water.
 Partition coefficient: n-octanol/water : Not applicable.
 Auto-ignition temperature : Not available.
 Decomposition temperature : Not available.
 Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.
 Chemical stability : The product is stable.
 Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.
 Conditions to avoid : Store and use away from heat, sparks, open flame or any other ignition source.
 Incompatible materials : Avoid contact with combustible materials, acids, oxidizing agents, halogenated hydrocarbons.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity
 Not available.

Irritation/Corrosion
 Not available.

Sensitization
 Not available.

Mutagenicity
 Not available.

Carcinogenicity
 Not available.

Classification

Product/ingredient name	OSHA	IARC	NTP
nickel	-	2B	Reasonably anticipated to be a human carcinogen.

Reproductive toxicity
 Not available.

Teratogenicity
 Not available.

Specific target organ toxicity (single exposure)
 Not available.

Specific target organ toxicity (repeated exposure)

Name	Category	Route of exposure	Target organs
nickel	Category 1	Not determined	Not determined

Section 11. Toxicological information

Aspiration hazard

Not available.

Information on the likely routes of exposure : Routes of entry anticipated: Oral, Dermal, Inhalation.

Potential acute health effects

Eye contact : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the eyes.

Inhalation : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.

Skin contact : May cause an allergic skin reaction.

Ingestion : No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
irritation
redness

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Skin contact : Adverse symptoms may include the following:
irritation
redness

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

Conclusion/Summary : Not available.

General : Causes damage to organs through prolonged or repeated exposure. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.

Carcinogenicity : Suspected of causing cancer. Risk of cancer depends on duration and level of exposure.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{oc}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT Classification	TDG Classification	Mexico Classification	ADR/RID	IMDG	IATA
UN number	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
UN proper shipping name	-	-	-	-	-	-
Transport hazard class(es)	-	-	-	-	-	-
Packing group	-	-	-	-	-	-
Environmental hazards	No.	No.	No.	No.	No.	No.
Additional information	Not available.	-	-	-	-	-

Section 14. Transport information

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Section 15. Regulatory information

U.S. Federal regulations : TSCA 8(a) CDR Exempt/Partial exemption: Not determined
 United States inventory (TSCA 8b): All components are listed or exempted.
 Clean Water Act (CWA) 307: Nickel; chromium

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Immediate (acute) health hazard
 Delayed (chronic) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
nickel	67	No.	No.	No.	Yes.	Yes.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	Nickel	7440-02-0	67
	chromium	7440-47-3	22
	Aluminum	7429-90-5	10
Supplier notification	Nickel	7440-02-0	67
	chromium	7440-47-3	22
	Aluminum	7429-90-5	10

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Section 15. Regulatory information

Massachusetts : The following components are listed: NICKEL; CHROMIUM; YTTRIUM
New York : The following components are listed: Nickel; Chromium
New Jersey : The following components are listed: NICKEL; CHROMIUM; YTTRIUM
Pennsylvania : The following components are listed: NICKEL; CHROMIUM; YTTRIUM

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
Nickel	Yes.	No.	No.	No.

Canada

Canadian lists

CEPA Toxic substances : None of the components are listed.
CANADA INVENTORY (DSL) : Not determined.

This product has been classified in accordance with the hazard criteria of the Hazardous Products Regulations and the SDS contains all the information required by the Hazardous Products Regulations.

Section 16. Other information

National Fire Protection Association (U.S.A.)



Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of issue/Date of revision : 5/10/2017.
Version : 1.02
Key to abbreviations : ATE = Acute Toxicity Estimate
 BCF = Bioconcentration Factor
 GHS = Globally Harmonized System of Classification and Labelling of Chemicals
 IATA = International Air Transport Association
 IBC = Intermediate Bulk Container
 IMDG = International Maritime Dangerous Goods
 LogPow = logarithm of the octanol/water partition coefficient
 MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
 UN = United Nations

▀ Indicates information that has changed from previously issued version.

Notice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

026

SULZER METCO

Material Safety Data Sheet

SULZER METCO (US) INC.

1101 Prospect Avenue
 PO Box 1006
 Westbury, NY 11590-0201
 Phone: (516) 334-1300

Product:

METCO 210, 210NS, 210NS-1
 210NS-1-G, AMDRY 333

MSDS No.:

50-150

Revision No.:

6

Revision Date:

May 9, 1996

Original Date of Issue:

September 7, 1987

EMERGENCY CONTACT: CHEMTREC 800-424-9300
 CALLS OUTSIDE THE UNITED STATES: 202-483-7616

SECTION I MATERIAL IDENTIFICATION

Trade/Material Name: METCO 210, 210NS, 210NS-1, 210NS-1-G, AMDRY 333

Description: Ceramic Powder

Other Designation: MAGNESIUM OXIDE / ZIRCONIUM OXIDE POWDER

SECTION II COMPOSITION AND TOXICITY

Composition	%	CAS#	OSHA PEL	ACGIH TLV	Toxicity
Zirconium Oxide	76.0	1314-23-4	5 mg/m ³ TWA 10 mg/m ³ STEL as Zr	5 mg/m ³ TWA 10 mg/m ³ STEL as Zr	
Magnesium Oxide	22.0	1309-48-4	10 mg/m ³ TWA total particulate 5 mg/m ³ TWA respirable dust as MgO fume	10 mg/m ³ TWA as MgO fume	
Hafnium Oxide	1.5	12055-23-1	0.5mg/m ³ TWA as Hf	0.5 mg/m ³ TWA as Hf	
Calcium Oxide	0.5	1305-78-8	5 mg/m ³ TWA	2 mg/m ³ TWA	

* Indicates toxic chemical(s) subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments & Reauthorization Act (SARA) & supplier notification requirements (40CFR Part 372).

□ Contains no asbestos and <1% crystalline silica.

+ Indicates on the list of Hazardous Air Pollutants that are regulated under Section 112 of the EPA Clean Air Act, 1990.

N/A - Not Available, Not Applicable. NE - Not Established.

SECTION III**PHYSICAL DATA**

Boiling Point:	N/A	Specific Gravity (H₂O = 1):	1.8 - 2.1
Vapor Pressure (mmHg):	N/A	Melting Point:	3500 - 4000° F
Vapor Density (Air=1):	N/A	Percentage Volatiles:	N/A
Solubility in water (%):	Insoluble	Evaporation Rate:	N/A
Appearance and Odor:	Powder, no odor	pH of Solution:	N/A

SECTION IV**FIRE AND EXPLOSION HAZARD DATA**

Flash Point (Method Used):	N/A	Flammable Limits:	
		LEL %: N/A	UEL%: N/A
		(% BY VOLUME)	(% BY VOLUME)

- Extinguishing Media:** Use Dry Chemical Extinguisher.
- Special Fire Fighting Procedures:** Use NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing if involved in a fire.
- Unusual Fire and Explosive Hazards:** Fine airborne ceramic dust can be a fire hazard when exposed to heat, flame or oxidizers. Finely divided dusts of zirconium oxide may ignite spontaneously. Finely divided dusts of hafnium oxide may ignite.

SECTION V**REACTIVITY DATA**

Material is stable. Hazardous polymerization will not occur.

Incompatibility (Materials to Avoid): Zirconium oxide is incompatible with oxidizers and potassium nitrate. Magnesium oxide is incompatible with chlorine trifluoride and phosphorus pentachloride. Hafnium oxide is incompatible with oxidizers and chlorine. Calcium oxide is incompatible with water and fluorine.

Hazardous Decomposition Products: Ozone and nitric acid are formed by the plasma flame (similar to welding fumes). This action is independent of ceramic powder. The hazardous decomposition product of calcium oxide is calcium hydroxide.

SECTION VI**HEALTH HAZARD DATA****COMPONENTS****SUMMARY OF RISKS**

- ZIRCONIUM OXIDE:** Hazard by inhalation and skin contact. Inhalation may cause irritation to the respiratory system. Skin contact may cause irritation and skin granulomas.
- Target Organ(s): Respiratory system, skin.
- MAGNESIUM OXIDE:** Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause metal fume fever, respiratory distress and mucous membrane irritation. Ingestion may cause irritation to the gastrointestinal tract. Skin contact may cause blisters, sores and ulcers. Eye contact may cause irritation.
- Target Organ(s): Respiratory system, gastrointestinal tract, skin, eyes.

SECTION VI**HEALTH HAZARD DATA****CONTINUED**

HAFNIUM OXIDE: Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause irritation to the respiratory system. Ingestion may cause irritation to the gastrointestinal tract. Skin and eye contact may cause irritation.

Target Organ(s): Respiratory system, gastrointestinal tract, skin, eyes.

CALCIUM OXIDE: Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause irritation to the respiratory system. Ingestion may cause irritation to the respiratory system and stomach, bloody diarrhea, shallow respirations, confusion, delirium, collapse, convulsions and coma. Skin contact may cause dermatitis or burns to the skin. Eye contact may cause burns to the eyes.

Target Organ(s): Respiratory system, gastrointestinal tract, skin, eyes.

Medical Conditions Which May be Aggravated by Contact: Consult a physician.

Primary Entry Route(s): Inhalation, ingestion, skin and eye contact.

SIGNS AND SYMPTOMS OF OVEREXPOSURE

Eye Contact: Possible irritation and burns.

Skin Contact: Possible irritation, skin granulomas, blisters, sores, ulcers, dermatitis and burns.

Inhalation: Possible irritation to the respiratory system, mucous membrane irritation.

Ingestion: Possible irritation to the respiratory system, gastrointestinal tract and stomach, bloody diarrhea, shallow respirations, confusion, delirium, collapse, convulsions and coma.

FIRST AID

Eye Contact: Flush eye with water for at least 15-20 minutes while holding eyelid open. If irritation persists, consult a physician.

Skin Contact: Wash with soap and water. If irritation persists consult a physician.

Inhalation: Expose to fresh air. Consult a physician if irritation or respiratory distress persists.

Ingestion: Consult a physician.

SECTION VII**SPILL, LEAK AND DISPOSAL PROCEDURES**

Spill/Leak Procedures: Vacuum loose powder only with vacuums equipped with HEPA filtration. Vacuums appropriate for use with metallic dusts should be used. Wet wipe area clean. Do not use water for clean up operations. Do not dry sweep, avoid generating airborne dust.

Waste Management and Disposal:

Empty product containers, product waste, and cleaning media should be stored and disposed of according to the appropriate local, state and federal regulatory guidelines.

SECTION VIII

SPECIAL PROTECTION INFORMATION

PERSONAL PROTECTIVE EQUIPMENT

- Goggles:** The following lens shades are recommended for the process indicated. Combustion spraying shaded #5, plasma spraying up to 40 kW shade #9, 40-60 kW shade #10 and greater than 60 kW shade #11. Goggles may be appropriate during other phases of product handling.
- Gloves:** Aluminized gloves are to be worn during the plasma spray process. Rubber or other appropriate gloves may be worn as necessary during other phases of product handling to avoid excessive skin contact.
- Respirator:** A respirator approved by NIOSH with filter cartridges approved for dust/fume/mists should be worn at all times during the thermal spray process to protect the operator from exposure to dust and fumes. Respirators may also be worn when product handling generates dust.
- Clothing/Equipment:** Ear protection must be worn when the operator is subjected to excessive noise levels. (Refer to the appropriate regulatory guidelines). An aluminized apron is to be worn during the plasma spray process. Other appropriate protective clothing may be worn as necessary during product handling to avoid excessive contact with the skin.

WORKPLACE CONSIDERATIONS

- Ventilation:** Product should be used with the appropriate local exhaust ventilation provided.
- Safety Stations:** Eye wash station(s) is/are recommended.
- Other:** Wash facilities are recommended.

SECTION IX

HANDLING AND STORAGE PRECAUTIONS

- Storage/Handling:** Store away from incompatibles. Store product containers in a well-ventilated, clean, cool and dry area. Store in a manner to minimize punctures and breakage of containers.
- Other Precautions:** Avoid ingestion, inhalation and excessive skin contact.

While this information is furnished in good faith, no guaranty is made as to accuracy. This material is for the Thermal Spraying Process, and relevant instructions should be consulted before use. The user assumes all risk in connection with the use of this material. SULZER METCO (US) INC. shall in no event be liable for special, incidental or consequential damages in connection with this information, or for any damage or injury caused by this material if used for any other purpose than the Thermal Spray Process, or if proper safety and health practices are not followed.

OL8

H.C. Starck

**AMPERIT® 205.276/415/575 Ni-C- 75-25 dense coated**

Version 2.0

Revision Date 01/04/2011

Print Date 05/05/2011

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : AMPERIT® 205.276/415/575 Ni-C- 75-25 dense coated
 MSDS Number : 000010005820
 Product Use Description : Thermal Metallic Compounds, Surface Treatment and Wear Resistant Coatings
 Chemical nature : Substance

Company : H.C. Starck North American Trading LLC
 45 Industrial Place
 Newton, MA 02461-1951
 USA

Telephone : + 1 617 630 5800

Responsible Department : Product Safety/Regulatory Affairs
 E-mail address : infoSDS@hccstarck.com
 H.C. Starck Emergency Phone (Non-Transportation) : + 1 617 630 5815 (8:00 a.m - 3:00 p.m EST)
 24h Emergency Phone (US, Transportation) : + 1-800-535-5063 (GBK/INFOTRAC ID 101020)
 24h Emergency Phone (International, Transportation) : +1 352 3233500 (GBK/INFOTRAC ID 101020)

SECTION 2. HAZARDS IDENTIFICATION**Emergency Overview**

Form : powdered form
 Colour : grey
 Odour : odourless

WARNING!

May cause eye, skin, and respiratory tract irritation. May be harmful if inhaled. May cause allergic skin reaction. May cause lung damage. May cause cancer.

Potential Health Effects

See Section 11 for more information

Primary Routes of Entry : Eye contact. Skin contact. Inhalation.
Eyes : Direct eye contact may produce irritation with symptoms of redness, swelling and pain.
Skin : Direct skin contact may cause irritation and sensitization reactions ("nickel itch"). Symptoms may include a burning sensation, itching, and hives which may be followed by ulcers which discharge and become crusted. The skin eruptions may be delayed up to 7 days. In chronic stages, pigmented and unpigmented areas of the skin may be formed.
Ingestion : None known.
Inhalation : Inhalation of nickel compounds may cause respiratory tract irritation, cough, pneumonitis and fever. Symptoms may also include headache, dizziness and difficult breathing. Inhalation may also cause asthma, pulmonary fibrosis (increase in interstitial fibrous tissue in the lungs) and pulmonary edema (fluid in the lungs).
Chronic Exposure : Repeated or prolonged inhalation of nickel compounds may cause

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hypertrophic rhinitis (inflammation of the mucous membrane lining of the nasal passages) and nasal sinusitis.
Repeated or prolonged contact with nickel compounds may cause sensitization and dermatitis.

Carcinogenicity:

IARC:

Components
Nickel

CAS-No.
7440-02-0

Classification
Group 2B: Possibly carcinogenic to humans.

NTP:

Components
Nickel

CAS-No.
7440-02-0

Classification
Reasonably anticipated to be a human carcinogen.

OSHA:

Components
Nickel

CAS-No.
7440-02-0

Classification
Regulated by OSHA as a carcinogen in 29 CFR 1910.

This material is hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29CFR 1910.1200.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous components

Component	CAS-No.	Weight percent
Nickel	7440-02-0	74 - 76
Graphite	7782-42-5	24 - 26

SECTION 4. FIRST AID MEASURES

First aid procedures

Inhalation

: If inhaled, remove to fresh air.
If not breathing, give artificial respiration.
If breathing is difficult, give oxygen.
Call a physician immediately.

Skin contact

: In case of skin contact, wash affected areas with soap and water.
Wash clothing and shoes before reuse.
Get medical attention if irritation develops or persists.

Eye contact

: In case of contact, flush eyes with plenty of lukewarm water.
Get medical attention if irritation develops or persists.

Ingestion

: Call a physician immediately.

SECTION 5. FIRE-FIGHTING MEASURES

Fire fighting

Suitable extinguishing media

: Special powder against metal fire
dry sand
sodium chloride

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Unsuitable extinguishing media : Water
Carbon dioxide (CO2)

Further information : Prevent fire extinguishing water from contaminating surface water or the ground water system.

Protective equipment and precautions for firefighters

Specific hazards during fire fighting : Nickel monoxide -Toxic, Carcinogenic, Sensitizing, Dangerous for the environment
Carbon monoxide - Extremely flammable, Toxic
Carbon Dioxide - Gas is heavier than air. Act as an asphyxiant at high concentrations.

Special protective equipment for fire-fighters : In the event of fire, wear self-contained breathing apparatus.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions : Avoid generation of dust.
If dust is generated, use appropriate respiratory protection.

Environmental precautions : Collect wash water for approved disposal.
Keep from entering water or ground water.

Methods for cleaning up : Vacuum or sweep up material and place in appropriate container.
After removal, flush contaminated area thoroughly with water.

SECTION 7. HANDLING AND STORAGE

Handling

Handling : Vent storage bins, conveyors, dust collectors, ground handling equipment, etc.
Avoid contact with moisture or water.
Reseal containers immediately after use.

Advice on protection against fire and explosion : Keep away from heat, sparks and flames.

Storage

Requirements for storage areas and containers : Store in a dry place away from excessive heat.
Keep container closed when not in use.
Label precautions also apply to this container when empty.
Do not reuse empty container.
Recondition or dispose of empty container in accordance with government regulations.

Further information on storage conditions : Store in tightly closed containers in a dry place.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limit Values

Nickel, metal; CAS-No.: 7440-02-0

Basis	Threshold limits	Note

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OSHA	PEL	1 mg/m3	TWA	
ACGIH	TLV	1.5 mg/m3 Inhalable fraction	TWA	

GRAPHITE; CAS-No.: 7782-42-5

Basis		Threshold limits		Note
OSHA	PEL	5 mg/m3 Respirable fraction	TWA	
	PEL	10 mg/m3 Total dust	TWA	
ACGIH	TLV	2 mg/m3	TWA	

Personal protective equipment

- Respiratory protection** : Avoid breathing dust, vapors or mist. Work ambient concentrations should be monitored and if the recommended exposure limit is exceeded, a NIOSH/MSHA approved respirator should be worn.
- Hand protection** : Glove material: Butyl-rubber, Natural rubber, Nitrile rubber
The data about break through time/strength of material is not valid for undissolved solids/dust.
- Eye protection** : Avoid contact with eyes.
- Body Protection** : Protective suit
- Hygiene measures** : Store away from food and beverages. Wash thoroughly after handling.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

- Form** : powdered form
- Colour** : grey
- Odour** : odourless

Safety data

- pH** : no data available

Change in physical state

- **Melting point/range** : Note: no data available

- Burning number** : 1
Method: VDI 2263

- Flammability (solid, gas)** : not highly flammable
Method: Directive 67/548/EEC Annex V, A.10.

- Flammability (contact with water)** : not highly flammable

- Dust explosibility** : no data available

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Explosion limits

- Lower explosion limit : no data available

Autoignition temperature

: not auto-flammable
Method: Directive 67/548/EEC Annex V, A.16.

Density

: no data available

Solubility

- Water solubility : no data available

SECTION 10. STABILITY AND REACTIVITY

Conditions to avoid : Reacts with oxygen at high temperatures to form nickel monoxide.

Materials to avoid : Evolves hydrogen on contact with acids. Risk of formation of explosive hydrogen-air mixtures.

Thermal decomposition : not applicable

Hazardous decomposition products : not applicable

SECTION 11. TOXICOLOGICAL INFORMATION**Acute oral toxicity**

Nickel : LD50 rat > 9,000 mg/kg
Method: No information available.

Graphite : LD50 rat > 2,000 mg/kg
Method: OECD Test Guideline 401

Skin Irritation

Graphite : rabbit
No skin irritation
Method: OECD Test Guideline 404

Eye Irritation

Graphite : rabbit
Mild eye irritation
Method: OECD Test Guideline 405

SECTION 12. ECOLOGICAL INFORMATION

No information on ecology is available.

SECTION 13. DISPOSAL CONSIDERATIONS

Product : Disposal should be in accordance with applicable state, federal and local laws and regulations. Local regulations may be more stringent than state or federal requirements.

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SECTION 14. TRANSPORT INFORMATION**DOT**

Not dangerous goods

Reportable Quantity (regulated by PHMSA/DOT)

Components

CAS-No.

Reportable Quantity

Nickel

7440-02-0

100 lbs

The Reportable Quantity (RQ) for this hazardous substance applies only to those pieces of the metal having a diameter smaller than 100 micrometers (0.004 inches).

TDG

Not dangerous goods

Air transport ICAO-TI/IATA-DGR

Not dangerous goods

Sea transport IMDG

Not dangerous goods

SECTION 15. REGULATORY INFORMATION**OSHA Hazards** : hazardous**WHMIS Classification** : D2A, D2B**TSCA** : On TSCA Inventory**DSL** : All components of this product are on the Canadian DSL list.**CERCLA**

Components

CAS-No.

Reportable Quantity

Nickel

7440-02-0

100 lbs

No reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is equal to or exceeds 100 micrometers (0.004 inches).

SARA Title III**SARA Section 302 Extremely hazardous Substances**

Components

CAS-No.

none

SARA Section 311/312 Hazard categories

Immediate Health Hazard, Delayed Health Hazard

SARA Section 313 Toxic chemicals

Components

CAS-No.

Weight percent

Nickel

7440-02-0

US State Regulations

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Massachusetts Right To Know

Components	CAS-No.
Nickel	7440-02-0
Graphite	7782-42-5

Pennsylvania Right To Know

Components	CAS-No.
Nickel	7440-02-0
Graphite	7782-42-5

New Jersey Right To Know

Components	CAS-No.
Nickel	7440-02-0

Rhode Island Right To Know

Components	CAS-No.
Nickel	7440-02-0
Graphite	7782-42-5

WHMIS Ingredient Disclosure List

Components	CAS-No.	Weight percent
Nickel	7440-02-0	74 - 76
Graphite	7782-42-5	24 - 26

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)

Components	CAS-No.	Type of toxicity
Nickel	7440-02-0	Carcinogen

SECTION 16. OTHER INFORMATION

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

The above details do not imply any guarantee concerning composition, properties or performance.

Changes since the last version are highlighted in the margin. This version replaces all previous versions.

Prepared by: : H.C. Starck GmbH
Corporate HSEQ
Telephone: 01149 5321 75 1-0
E-Mail: infoSDS@hcstarck.com

Material Safety Data Sheet

SULZER

Metco 101, 101NS, 101BNS, 101SF, 101FP, Metcolite 14, C, F, F36, VF, AMDRY 187, 6200, 6202, 6203, 6204, 6208, PEM 10-231, Sulzer Metco 6203, XPT-D 705, 644, PT 1100, AMDRY XPT W631, GRIT BLAST MATERIAL 0.4-0.8MM, GRIT BLASTING MATERIAL G-24, PT-1100, XPT DH 1079, AE 9503, AE 9795

Sulzer Metco

1. Product and company identification

Product name : Metco 101, 101NS, 101BNS, 101SF, 101FP, Metcolite 14, C, F, F36, VF, AMDRY 187, 6200, 6202, 6203, 6204, 6208, PEM 10-231, Sulzer Metco 6203, XPT-D 705, 644, PT 1100, AMDRY XPT W631, GRIT BLAST MATERIAL 0.4-0.8MM, GRIT BLASTING MATERIAL G-24, PT-1100, XPT DH 1079, AE 9503, AE 9795

Material uses : Metal industry: Used by spraying

Supplier : Sulzer Metco (US) Inc.
1101 Prospect Avenue
Westbury, NY 11590

Telephone no. : (516) 334 - 1300 (7:30AM - 4:00PM)

In case of emergency : CHEMTREC 800-424-9300

Calls Outside the United States : +1 703-527-3887 (USA) 24 hour Chemtrec International Emergency Response Service

Product type : Powder.

2. Hazards identification

Emergency overview

Physical state : Solid. [Powder.]

Color : Gray.

Odor : Odorless.

Signal word : WARNING!

Hazard statements : CAUSES RESPIRATORY TRACT, EYE AND SKIN IRRITATION. CONTAINS MATERIAL THAT MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. POSSIBLE CANCER HAZARD - CONTAINS MATERIAL WHICH MAY CAUSE CANCER, BASED ON ANIMAL DATA.

Precautionary measures : Do not handle until all safety precautions have been read and understood. Obtain special instructions before use. Do not breathe dust. Use only with adequate ventilation. Do not eat, drink or smoke when using this product. Avoid contact with eyes, skin and clothing. Keep container tightly closed. Use personal protective equipment as required. Wash thoroughly after handling.

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Routes of entry : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Inhalation : Irritating to respiratory system.

Ingestion : No known significant effects or critical hazards.

Skin : Irritating to skin.

Eyes : Irritating to eyes.

Potential chronic health effects

Chronic effects : Contains material that may cause target organ damage, based on animal data. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation.

Carcinogenicity : Contains material which may cause cancer, based on animal data. Risk of cancer depends on duration and level of exposure.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Date of issue
6/7/2012

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50-134

Prepared by
Sulzer Metco

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2. Hazards identification

- Fertility effects** : No known significant effects or critical hazards.
- Target organs** : Contains material which may cause damage to the following organs: lungs, upper respiratory tract, skin, eye, lens or cornea, testes.

Over-exposure signs/symptoms

- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Ingestion** : No specific data.
- Skin** : Adverse symptoms may include the following:
irritation
redness
- Eyes** : Adverse symptoms may include the following:
pain or irritation
watering
redness
- Medical conditions aggravated by over-exposure** : Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (Section 11)

3. Composition/information on ingredients

United States

Name	CAS number	%
Aluminium oxide	1344-28-1	95
titanium dioxide	13463-67-7	3
diiron trioxide	1309-37-1	1
silicon dioxide	7631-86-9	1

Canada

Name	CAS number	%
Aluminium oxide	1344-28-1	95
titanium dioxide	13463-67-7	3
diiron trioxide	1309-37-1	1
silicon dioxide	7631-86-9	1

Mexico

Classification

Name	CAS number	UN number	%	IDLH	H	F	R	Special
Aluminium oxide	1344-28-1	Not regulated	95	-	0	0	0	-
titanium dioxide	13463-67-7	Not regulated	3	5000 mg/m ³	2	0	0	-
diiron trioxide	1309-37-1	Not regulated	1	2500 mg/m ³	2	0	0	-
silicon dioxide	7631-86-9	Not regulated	1	3000 mg/m ³	1	0	0	-

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

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4. First aid measures

- Eye contact** : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- Skin contact** : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.
- Inhalation** : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- Ingestion** : Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.
- Notes to physician** : No specific treatment. Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

5. Fire-fighting measures

Flammability of the product : No specific fire or explosion hazard.

Extinguishing media

- Suitable** : Use extinguishing media suitable for surrounding materials.
- Not suitable** : None known.
- Special exposure hazards** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.
- Hazardous thermal decomposition products** : None known.
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

6. Accidental release measures

- Personal precautions** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see Section 8).
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods for cleaning up

- Small spill** : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.
- Large spill** : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

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7. Handling and storage

- Handling** : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing dust. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.
- Storage** : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see section 10) and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate container to avoid environmental contamination.

8. Exposure controls/personal protection

United States

Ingredient	Exposure limits
Aluminium oxide	OSHA PEL (United States, 6/2010). TWA: 5 mg/m ³ 8 hour(s). Form: Respirable fraction
titanium dioxide	TWA: 15 mg/m ³ 8 hour(s). Form: Total dust OSHA PEL (United States, 6/2010). TWA: 15 mg/m ³ 8 hour(s). Form: Total dust
diiron trioxide	ACGIH TLV (United States, 2/2010). TWA: 10 mg/m ³ 8 hour(s). ACGIH TLV (United States, 2/2010). TWA: 5 mg/m ³ 8 hour(s). Form: Respirable fraction OSHA PEL (United States, 6/2010). TWA: 10 mg/m ³ 8 hour(s).

Canada

Occupational exposure limits		TWA (8 hours)			STEL (15 mins)			Ceiling			Notations
Ingredient	List name	ppm	mg/m ³	Other	ppm	mg/m ³	Other	ppm	mg/m ³	Other	
Aluminium oxide	AB 4/2009	-	10	-	-	-	-	-	-	-	
	QC 6/2008	-	10	-	-	-	-	-	-	-	[a]
Aluminium oxide, as Al	US ACGIH 2/2010	-	10	-	-	-	-	-	-	-	
	AB 4/2009	-	10	-	-	-	-	-	-	-	[3]
	BC 9/2010	-	3	-	-	-	-	-	-	-	[b]
titanium dioxide	ON 7/2010	-	10	-	-	-	-	-	-	-	[c]
	QC 6/2008	-	10	-	-	-	-	-	-	-	[d]
	US ACGIH 2/2010	-	5	-	-	-	-	-	-	-	[a]
diiron trioxide	AB 4/2009	-	5	-	-	-	-	-	-	-	[e]
	BC 9/2010	-	5	-	-	-	-	-	-	-	[f]
diiron trioxide, as Fe	-	-	5	-	-	10	-	-	-	-	[g]
	-	-	3	-	-	-	-	-	-	-	[h]
	-	-	10	-	-	-	-	-	-	-	[b]
diiron trioxide	ON 7/2010	-	5	-	-	-	-	-	-	-	[c]
	QC 6/2008	-	5	-	-	-	-	-	-	-	[e]
diiron trioxide, as Fe	-	-	5	-	-	-	-	-	-	-	[i]

Mexico

Occupational exposure limits

Ingredient	Exposure limits


8. Exposure controls/personal protection

Aluminium oxide	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 10 mg/m ³ 8 hour(s).
titanium dioxide	NOM-010-STPS (Mexico, 9/2000). LMPE-CT: 20 mg/m ³ , (as Ti) 15 minute(s). LMPE-PPT: 10 mg/m ³ , (as Ti) 8 hour(s).
diiron trioxide	NOM-010-STPS (Mexico, 9/2000). LMPE-CT: 10 mg/m ³ , (as Fe) 15 minute(s). LMPE-PPT: 5 mg/m ³ , (as Fe) 8 hour(s).
silicon dioxide	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 3 mg/m ³ 8 hour(s). Form: breathable particulates LMPE-PPT: 10 mg/m ³ 8 hour(s). Form: inhalable particulates

Consult local authorities for acceptable exposure limits.

- Recommended monitoring procedures** : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.
- Engineering measures** : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.
- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal protection

- Eyes** : Safety glasses or goggles are recommended when handling this material. During the thermal spray process, safety goggles and dark lenses must be worn.
- Skin** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory** : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
- Hands** : Rubber or other appropriate gloves should be worn to minimize contact. For hygienic reasons rubber gloves should not be worn for more than 2 hours. During the thermal spray process, heat insulated gloves are recommended.
- Hearing Protection** : Hearing protection that meets local standards should be used.
- Protective Clothing (Pictograms)** :
- 
- Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

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9. Physical and chemical properties

Physical state : Solid. [Powder.]
 Flash point : Not available.
 Color : Gray.
 Odor : Odorless.
 Explosive properties : No specific hazard.
 Solubility : Insoluble in the following materials: cold water.
 Physical/chemical properties comments : Insoluble.

10. Stability and reactivity

Chemical stability : The product is stable under normal storage conditions.
 Conditions to avoid : Store in a cool dry place away from incompatible materials.
 Incompatible materials : Strong acids.
 Hazardous decomposition products : Ozone and nitric oxide are formed by plasma flame. This action is independent of material.
 Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

11. Toxicological information

United States Canada Mexico

Acute toxicity

Conclusion/Summary : Not available.

Chronic toxicity

Conclusion/Summary : Not available.

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
titanium dioxide	Skin - Mild irritant	Human	-	72 hours 300 Micrograms Intermittent	-
silicon dioxide	Eyes - Mild irritant	Rabbit	-	24 hours 25 milligrams	-

Conclusion/Summary : Not available.

Sensitizer

Conclusion/Summary : Not available.

Carcinogenicity

Conclusion/Summary : Contains material which may cause cancer, based on animal data. Risk of cancer depends on duration and level of exposure.

Classification

Product/ingredient name	ACGIH	IARC	EPA	NIOSH	NTP	OSHA
Aluminium oxide	A4	-	-	None.	-	-
titanium dioxide	A4	2B	-	+	-	-
diiron trioxide	A4	3	-	None.	-	-
silicon dioxide	-	3	-	-	-	-

Mutagenicity

Conclusion/Summary : Not available.

Teratogenicity

Conclusion/Summary : Not available.

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11. Toxicological information

Reproductive toxicity

Conclusion/Summary : Not available.

12. Ecological information

Ecotoxicity : No known significant effects or critical hazards.

United States

Aquatic ecotoxicity

Product/ingredient name	Result	Species	Exposure
titanium dioxide	Acute EC50 5.83 mg/L Fresh water	Algae - Pseudokirchneriella subcapitata - Exponential growth phase	72 hours
	Acute LC50 >10 mg/L Fresh water	Crustaceans - Ceriodaphnia dubia - Neonate - <24 hours	48 hours
	Acute LC50 5.5 ppm Fresh water	Daphnia - Daphnia magna - Juvenile (Fledgling, Hatchling, Weanling) - <24 hours	48 hours
	Acute LC50 >1000000 ug/L Marine water	Fish - Fundulus heteroclitus	96 hours

Conclusion/Summary : Not available.

Persistence/degradability

Conclusion/Summary : Not available.

Other adverse effects : No known significant effects or critical hazards.

13. Disposal considerations

Waste disposal : The generation of waste should be avoided or minimized wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Disposal should be in accordance with applicable regional, national and local laws and regulations.

Refer to Section 7: HANDLING AND STORAGE and Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION for additional handling information and protection of employees.

14. Transport information

Regulatory information	UN number	Proper shipping name	Classes	PG*	Label	Additional information
DOT Classification	Not regulated	-	-	-		-
TDG Classification	Not regulated	-	-	-		-
Mexico Classification	Not regulated	-	-	-		-

Metco 101, 101NS, 101BNS, 101SF, 101FP, Metcolite 14, C, F, F36, VF, AMDRY 187, 6200, 6202, 6203, 6204, 6208, PEM 10-231, Sulzer Metco 6203, XPT-D 705, 644, PT 1100, AMDRY XPT W631, GRIT BLAST MATERIAL 0.4-0.8MM, GRIT BLASTING MATERIAL G-24, PT-1100, XPT DH 1079, AE 9503, AE 9795

14. Transport information

ADR/RID Class	Not regulated	-	-	-	-
IMDG Class	Not regulated	-	-	-	-
IATA-DGR Class	Not regulated	-	-	-	-

PG* : Packing group

15. Regulatory information

United States

HCS Classification : Irritating material
Carcinogen
Target organ effects

U.S. Federal regulations : **TSCA 8(a) IUR**: Partial exemption

United States inventory (TSCA 8b): All components are listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.

SARA 302/304 emergency planning and notification: No products were found.

SARA 302/304/311/312 hazardous chemicals: Aluminium oxide; titanium dioxide; diiron trioxide

SARA 311/312 MSDS distribution - chemical inventory - hazard identification:

Aluminium oxide: Immediate (acute) health hazard; titanium dioxide: Immediate (acute) health hazard; diiron trioxide: Delayed (chronic) health hazard

Clean Air Act Section 112(b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 313

	Product name	CAS number	Concentration
Form R - Reporting requirements	Aluminium oxide	1344-28-1	95
Supplier notification	Aluminium oxide	1344-28-1	95

SARA 313 notifications must not be detached from the MSDS and any copying and redistribution of the MSDS shall include copying and redistribution of the notice attached to copies of the MSDS subsequently redistributed.

State regulations

Massachusetts : The following components are listed: ALUMINUM OXIDE; TITANIUM DIOXIDE; IRON OXIDE DUST; AMORPHOUS SILICA

New York : None of the components are listed.

New Jersey : The following components are listed: ALUMINUM OXIDE; alpha-ALUMINA; TITANIUM DIOXIDE; TITANIUM OXIDE (TiO₂); IRON OXIDE; FERRIC OXIDE

Metco 101, 101NS, 101BNS, 101SF, 101FP, Metcolite 14, C, F, F36, VF, AMDRY 187, 6200, 6202, 6203, 6204, 6208, PEM 10-231, Sulzer Metco 6203, XPT-D 705, 644, PT 1100, AMDRY XPT W631, GRIT BLAST MATERIAL 0.4-0.8MM, GRIT BLASTING MATERIAL G-24, PT-1100, XPT DH 1079, AE 9503, AE 9795

15. Regulatory information

Pennsylvania : The following components are listed: ALUMINUM OXIDE (AL₂O₃); TITANIUM OXIDE (TiO₂); IRON OXIDE (Fe₂O₃); SILICA

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
titanium dioxide	Yes.	No.	No.	No.

United States inventory (TSCA 8b) : All components are listed or exempted.

Canada

WHMIS (Canada) : Class D-2A: Material causing other toxic effects (Very toxic).

Canadian lists

Canadian NPRI : The following components are listed: Aluminum oxide

CEPA Toxic substances : None of the components are listed.

Canada inventory : All components are listed or exempted.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Mexico

Classification :



Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

16. Other information

Label requirements : **WARNING!**
CAUSES RESPIRATORY TRACT, EYE AND SKIN IRRITATION. CONTAINS MATERIAL THAT MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. POSSIBLE CANCER HAZARD - CONTAINS MATERIAL WHICH MAY CAUSE CANCER, BASED ON ANIMAL DATA.

National Fire Protection Association (U.S.A.) :



Metco 101, 101NS, 101BNS, 101SF, 101FP, Metcolite 14, C, F, F36, VF, AMDRY 187, 6200, 6202, 6203, 6204, 6208, PEM 10-231, Sulzer Metco 6203, XPT-D 705, 644, PT 1100, AMDRY XPT W631, GRIT BLAST MATERIAL 0.4-0.8MM, GRIT BLASTING MATERIAL G-24, PT-1100, XPT DH 1079, AE 9503, AE 9795

16. Other information

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Date of issue : 6/7/2012.

Version : 1.5

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.



031
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Safety Data Sheet

Issuing Date 2013-11-28

Revision Date 2014-01-16

Revision Number 1

1. Identification of the substance/preparation and of the Company/undertaking

Product Identifier

Product Type	Stellite - Welding powder
Product name	TRIBALLOY® T400 - POWDER
Product code	KSPC400 41 - POWDER

Other means of identification

UN-No	UN3077
Synonyms	No information available

Recommended use of the chemical and restrictions on use

Recommended Use Wear and Corrosion Resistant Welding Consumable. For use in industrial installations only.

Details of the Supplier of the Safety Data Sheet

Emergency Telephone Number

Prepared by	Kennametal Inc. 1600 Technology Way Latrobe, PA 15650, USA
E-mail	k-corp-product.safety@kennametal.com
Emergency Telephone Number	CHEMTREC: +1-703-527-3887 (INTERNATIONAL) 1-800-424-9300 (NORTH AMERICA)

2. Hazards Identification

Classification

Acute toxicity - Oral	Category 4
Acute toxicity - Inhalation (Dusts/Mists)	Category 1
Serious eye damage/eye irritation	Category 2
Respiratory sensitization	Category 1B
Skin sensitization	Category 1
Carcinogenicity	Category 1B
Reproductive Toxicity	Category 1B
Specific target organ toxicity (repeated exposure)	Category 1


Label Elements

Emergency Overview

DANGER

Hazard Statements

- Harmful if swallowed
 - Fatal if inhaled
- Causes serious eye irritation
- May cause allergy or asthma symptoms or breathing difficulties if inhaled
 - May cause cancer by inhalation
 - May cause an allergic skin reaction
- May damage fertility or the unborn child
- Causes damage to organs through prolonged or repeated exposure
 - Very toxic to aquatic life
- Very toxic to aquatic life with long lasting effects
 - Heating may cause a fire



- Avoid breathing dust/fume/gas/mist/vapors/spray
- Use only with adequate ventilation/personal protection
- Keep container tightly closed in a cool, well-ventilated place
- Wash thoroughly after handling and before eating or drinking
 - Keep away from heat, sparks and flame

Appearance metallic Powder **Physical State** solid **Odor** none

Precautionary Statements - Prevention

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Use personal protective equipment as required
 Wash face, hands and any exposed skin thoroughly after handling
 Do not eat, drink or smoke when using this product
 Do not breathe dust/fume/gas/mist/vapors/spray
 Use only outdoors or in a well-ventilated area
 Wear respiratory protection
 In case of inadequate ventilation wear respiratory protection
 Contaminated work clothing should not be allowed out of the workplace
 Wear protective gloves/protective clothing/eye protection/face protection

Precautionary Statements - Response

IF exposed or concerned: Get medical advice/attention
 Specific treatment is urgent (see supplemental first aid instructions on this label)

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
 If eye irritation persists: Get medical advice/attention

Skin

IF ON SKIN: Wash with plenty of soap and water
 If skin irritation or rash occurs: Get medical advice/attention
 Wash contaminated clothing before reuse

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
 Immediately call a POISON CENTER or doctor/physician

Ingestion

IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
 Rinse mouth

Precautionary Statements - Storage Store locked up. Store in a well-ventilated place. Keep container tightly closed.

Precautionary Statements - Disposal Dispose of contents/container to an approved waste disposal plant.

Hazards not otherwise classified (HNOC)

Welding Hazards

CAUTION. Welding will create fumes which may be toxic. If welding is performed on plated or coated materials such as galvanized or painted steel, excessive fume may be produced which contains additional hazardous components, and may result in metal fume fever or other health effects. Radiation from the welding arc can cause burns to the skin and damage to the eyes. The product and work surface will be hot during and after welding. Electric shock can kill. Arc Rays can injure eyes and burn skin.

OTHER INFORMATION

May be harmful if swallowed. Causes mild skin irritation. Very toxic to aquatic life with long lasting effects. Very toxic to aquatic life.

Unknown Aquatic Toxicity

37.65% of the mixture consists of ingredient(s) of unknown toxicity

3. Composition/Information on Ingredients

Chemical name	Formula	CAS-No.	Weight-%	GHS Classification
Cobalt	Co	7440-48-4	> 50	Acute oral 4 (H302) Acute dust/mist 1 (H330) Eye damage 2 (H319) Resp. Sens. 1B (H334) Skin Sens. 1 (H317) Carc. 1B (H350i) Repro. tox. 2 (H361f) Aquatic Acute 1 M=10 (H400) Aquatic Chronic 1 (H410) M=1
Molybdenum	Mo	7439-98-7	25 - 50	
Chromium	Cr	7440-47-3	5 - 10	
Silicon Metal	Si	7440-21-3	2.5 - 3	
Nickel	Ni	7440-02-0	1 - 2.5	STOT RE 1 (H372) S,7 Carc. 2 (H351) S,7 Skin Sens. 1 (H317) S,7 Aquatic Chronic 3 (H412)
Iron	Fe	7439-89-6	1 - 2.5	

Full text of H-Statements referred to under sections 2 and 3

H302 - Harmful if swallowed
H317 - May cause an allergic skin reaction
H319 - Causes serious eye irritation
H330 - Fatal if inhaled
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H350i - May cause cancer if inhaled
H351 - Suspected of causing cancer if inhaled
H361f - Suspected of damaging fertility
H372 - Causes damage to the following organs through prolonged or repeated exposure if inhaled:
Lungs
H400 - Very toxic to aquatic life
H410 - Very toxic to aquatic life with long lasting effects
H412 - Harmful to aquatic life with long lasting effects

4. First aid measures

FIRST AID MEASURES

General advice

If symptoms persist, call a physician. Do not breathe dust/fume/gas/mist/vapors/spray. Do not get in eyes, on skin, or on clothing. In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).

Eye Contact	Keep eye wide open while rinsing. If symptoms persist, call a physician. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
Skin contact	Consult a physician if necessary. Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Wash off immediately with soap and plenty of water.
Inhalation	Move to fresh air. If breathing is irregular or stopped, administer artificial respiration. Oxygen or artificial respiration if needed. Get medical attention. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation.
Ingestion	Do NOT induce vomiting. Drink plenty of water. If symptoms persist, call a physician. Rinse mouth.
Self-protection of the first aider	Self-protection of the first aider. Wear suitable gloves.

Most important symptoms and effects, both acute and delayed

Most important symptoms and effects, both acute and delayed	May cause allergy or asthma symptoms or breathing difficulties if inhaled. CNS and psychiatric effects, Parkinson-like symptoms. Languor, sleepiness and weakness in legs. A stolid masklike appearance of face, emotional disturbances such as uncontrollable laughter and spastic gait with tendency to fall in walking and findings in more advanced cases. Persons with a history of asthma, allergies, chronic or recurrent respiratory disease should not be exposed to any process in which this product is used.
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Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically. May cause sensitization by inhalation and skin contact. May cause sensitization of susceptible persons.
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5. Fire fighting measures

Suitable extinguishing media	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Extinguishing media which must not be used for safety reasons	none.
Specific hazards arising from the chemical	Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes Thermal decomposition can lead to release of irritating and toxic gases and vapors May cause sensitization by inhalation and skin contact Carbon oxides
Protective equipment and precautions for firefighters	Use personal protective equipment as required In the event of fire, wear self-contained breathing apparatus

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions	Avoid contact with skin and eyes. Ensure adequate ventilation. Use personal protective equipment as required. Avoid dust accumulation in enclosed space.
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OTHER INFORMATION	See Section 12 for additional Ecological Information.
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Environmental precautions	Avoid release to the environment.
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Methods and material for containment and cleaning up	Pick up and transfer to properly labeled containers. Avoid generation of dust. Do not dry sweep dust. Wet dust with water before sweeping or use a vacuum to collect dust.
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7. Handling and Storage

Precautions for safe handling Do not eat, drink or smoke when using this product. Use personal protective equipment as required. Avoid contact with eyes, skin and clothing. Wash contaminated clothing before reuse. Do not breathe dust/fume/gas/mist/vapors/spray.

Conditions for safe storage, including any incompatibilities

Storage Keep out of the reach of children. Keep container tightly closed in a dry and well-ventilated place. Keep containers tightly closed in a cool, well-ventilated place.

Incompatible products

Specific use(s) Welding.

8. Exposure Controls/Personal Protection

Control parameters

Exposure Guidelines

Exposure Guidelines

Chemical name	USA - ACGIH TLV	USA - OSHA PEL	USA - NIOSH IDLH	Argentina	Brazil
Cobalt	0.02 mg/m ³ TWA	0.1 mg/m ³ TWA (dust and fume)	20 mg/m ³ IDLH (dust and fume)	TWA: 0.02 mg/m ³	
Molybdenum	10 mg/m ³ TWA (Inhalable fraction); 3 mg/m ³ TWA (respirable fraction)	Not Listed	5000 mg/m ³ IDLH	TWA: 10 mg/m ³ TWA: 3 mg/m ³	
Chromium	0.5 mg/m ³ TWA	1 mg/m ³ TWA	250 mg/m ³ IDLH	TWA: 0.5 mg/m ³	
Silicon Metal	-	15 mg/m ³ TWA (total dust); 5 mg/m ³ TWA (respirable fraction)	Not Listed	TWA: 10 mg/m ³	
Nickel	1.5 mg/m ³ TWA (inhalable fraction)	1 mg/m ³ TWA	10 mg/m ³ IDLH	TWA: 1.5 mg/m ³	
Chemical name	Canada - Alberta	Canada - British Columbia	Canada - Ontario	Canada - Quebec	Canada - Manitoba
Cobalt	0.02 mg/m ³ TWA	0.02 mg/m ³ TWA	0.02 mg/m ³ TWA	0.02 mg/m ³ TWA EV	0.02 mg/m ³ TWA 0.02 mg/m ³ TWA (as Co)
Molybdenum	10 mg/m ³ TWA (total); 3 mg/m ³ TWA (respirable)	3 mg/m ³ TWA (respirable); 10 mg/m ³ TWA (inhalable)	10 mg/m ³ TWA (metal, inhalable); 3 mg/m ³ TWA (metal, respirable)		10 mg/m ³ TWA (inhalable fraction); 3 mg/m ³ TWA (respirable fraction)
Chromium	0.5 mg/m ³ TWA	0.5 mg/m ³ TWA	0.5 mg/m ³ TWA	0.5 mg/m ³ TWA EV	0.5 mg/m ³ TWA
Silicon Metal		10 mg/m ³ TWA (total dust); 3 mg/m ³ TWA (respirable fraction)	10 mg/m ³ TWA (total dust)	10 mg/m ³ TWA EV (containing no Asbestos and <1% Crystalline silica, total dust)	
Nickel	1.5 mg/m ³ TWA	0.05 mg/m ³ TWA	1 mg/m ³ TWA (inhalable)	1 mg/m ³ TWA EV	1.5 mg/m ³ TWA (Inhalable fraction)
Chemical name	Chile	Mexico - OEL (TWA)	Peru	Uruguay	Venezuela
Cobalt	TWA: 0.016 mg/m ³	0.1 mg/m ³ TWA LMPE-PPT (dust and fume, as Co)	0.02 mg/m ³ TWA	0.02 mg/m ³ TWA	TWA: 0.02 mg/m ³
Molybdenum				10 mg/m ³ TWA (inhalable fraction); 3 mg/m ³ TWA (respirable fraction)	TWA: 10 mg/m ³ TWA: 3 mg/m ³
Chromium	TWA: 0.4 mg/m ³	0.5 mg/m ³ TWA LMPE-PPT		0.5 mg/m ³ TWA	TWA: 0.5 mg/m ³

Silicon Metal		10 mg/m ³ TWA LMPE-PPT (inhalable fraction)	10 mg/m ³ TWA (Inhalable fraction); 4 mg/m ³ TWA (respirable fraction); 5 mg/m ³ TWA (welding fumes)		TWA: 10 mg/m ³
Nickel	TWA: 0.8 mg/m ³	1 mg/m ³ TWA LMPE-PPT	1.5 mg/m ³ TWA	1.5 mg/m ³ TWA (inhalable fraction)	TWA: 1.5 mg/m ³

Other Exposure Guidelines Hexavalent Chrome may be formed during welding.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye Protection Use suitable eye protection to guard against the effects of welding. Wear safety glasses with side shields (or goggles). Eye-irrigation bottle with pure water.

Skin Protection Long sleeved clothing. Wear fire/flame resistant/retardant clothing. Apron. Wear suitable protective clothing. Wear suitable gloves.

Hand Protection Protective gloves. The product and work surface will be hot during and after welding. Ensure adequate protection is in place to stop Individuals from burning themselves.

Respiratory protection Use only with adequate ventilation. If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice. Do not eat, drink or smoke when using this product. Regular cleaning of equipment, work area and clothing is recommended.

Biological standards

Chemical name	MSA/ACGIH/BEI
Cobalt - 7440-48-4	15 µg/L Medium: urine Time: end of shift at end of workweek Parameter: Cobalt (background); 1 µg/L Medium: blood Time: end of shift at end of workweek Parameter: Cobalt (background, semi-quantitative)

9. Physical and Chemical Properties

Information on basic physical and chemical properties

Physical State	solid	Appearance	metallic Powder
Odor	none	pH	
Melting point/freezing point	1285-1395 °C / 2340-2540 °F	Boiling temperature / boiling range	No information available
Flash Point	No information available	Evaporation Rate	
Flammability (solid, gas)		Flammability Limits in Air	
Upper flammability limits		Lower Flammability Limit	
Vapor Pressure		Vapor Density	
Specific gravity		Water solubility	Insoluble in water
Solubility in other solvents		Partition coefficient	
Autoignition temperature		Decomposition Temperature	
Kinematic viscosity		Dynamic viscosity	

OTHER INFORMATION

VOC Content (%) Not Applicable
 Density 8.44 g/cm³

10. Stability and Reactivity

Reactivity Stable under normal conditions

No data available

Chemical stability Stable under normal conditions.

Stable under normal conditions.

Possibility of Hazardous Reactions None under normal processing.

Conditions to avoid Keep away from sources of heat (e.g. hot surfaces), sparks and open flames.

incompatible materials Acids. Strong oxidizing agents.

Hazardous decomposition products Thermal decomposition can lead to release of toxic/corrosive gases and vapors.

11. Toxicological Information

Information on likely routes of exposure

Product Information

- Inhalation** May cause allergy or asthma symptoms or breathing difficulties if inhaled.
- Eye Contact** May cause eye irritation with susceptible persons.
- Skin contact** Repeated or prolonged skin contact may cause allergic reactions with susceptible persons. Prolonged contact may cause redness and irritation. Prolonged skin contact may defat the skin and produce dermatitis. May cause sensitization by skin contact.
- Ingestion** Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea. Ingestion may cause irritation to mucous membranes.

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Cobalt - 7440-48-4	550 mg/kg bw	>2000 mg/kg bw	0.05 mg/L
Molybdenum - 7439-98-7	LD50 >2000 mg/kg bw	Not Classified	LC50 >3.92 mg/L air
Chromium - 7440-47-3	LD50 >5000 mg/kg bw	Data waiving - Study Scientifically Unjustified	LC50 >5.41 mg/L air (analytical)
Silicon Metal - 7440-21-3	LD50 >3160 mg/kg bw	LD50 >5000 mg/kg bw	Acutely Non Toxic
Nickel - 7440-02-0	>9000 mg/kg bw	Data waiving - Other Justification	NOAEC >=10.2 mg/L air
Iron - 7439-89-6	= 984 mg/kg (Rat)		Inhalation LC50 (4 hrs)

Information on toxicological effects

Chemical name	US ACGIH Critical effects
Cobalt - 7440-48-4	asthma; myocardial effects; pulmonary function
Chromium - 7440-47-3	skin and upper respiratory tract irritation
Nickel - 7440-02-0	dermatitis; pneumoconiosis

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Repeated exposure may cause skin dryness or cracking.

Sensitization May cause sensitization of susceptible persons.

MUTAGENIC EFFECTS None known.

Carcinogenicity This product contains one or more substances which are classified by IARC as carcinogenic to humans (Group I), probably carcinogenic to humans (Group 2A) or possibly carcinogenic to humans (Group 2B).

Chemical name	ACGIH	IARC	NTP	OSHA
Cobalt - 7440-48-4	A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans	Group 2B - Possible Human Carcinogen	Not Listed	Not Listed
Chromium - 7440-47-3	A4 - Not Classifiable as a Human Carcinogen	Group 3 - Not Classified as a Human Carcinogen	Not Listed	Not Listed
Nickel - 7440-02-0	A5 - Not Suspected as a Human Carcinogen	Nickel Compounds: Group 1 - Known Human Carcinogen - Nickel, Metallic & Alloy: Group 2B - Possible Human Carcinogen	Reasonably anticipated to be a Human Carcinogen	Not Listed
Chemical name	Chile	Argentina	Venezuela	Peru
Cobalt - 7440-48-4	A3 - Animal Carcinogen	A3 - Confirmed animal carcinogen with unknown relevance to humans	A3 - Animal Carcinogen	
Chromium - 7440-47-3	A4 - Not Classifiable as a Human Carcinogen	A4 - Not classifiable as a human carcinogen	A4 - Not Classified as a Carcinogen in Humans	
Nickel - 7440-02-0	A1 - Confirmed Human Carcinogen	A5 - Not Suspected as a human carcinogen	A5 - Not an Alleged Carcinogen in Humans	A1 - Confirmed Human Carcinogen

Reproductive toxicity

Chronic toxicity

Contains a known or suspected reproductive toxin.
Prolonged exposure may cause chronic effects. CNS and psychiatric effects, Parkinson-like symptoms. Languor, sleepiness and weakness in legs. A stolid masklike appearance of face, emotional disturbances such as uncontrollable laughter and spastic gait with tendency to fall in walking and findings in more advanced cases. Repeated contact may cause allergic reactions in very susceptible persons. Avoid repeated exposure. Repeated or prolonged skin contact may cause skin irritation and/or dermatitis and sensitization of susceptible persons. Repeated or prolonged exposure may cause central nervous system damage. Contains a known or suspected reproductive toxin. This product contains one or more substances which are classified by IARC as carcinogenic to humans (Group I), probably carcinogenic to humans (Group 2A) or possibly carcinogenic to humans (Group 2B).

Target organ effects

blood, central nervous system (CNS), Central Vascular System (CVS), Eyes, kidney, liver, Lungs, Nasal Cavities, respiratory system, Skin.

Neurological effects

Repeated or prolonged exposure may cause central nervous system damage. Prolonged or excessive exposure to manganese in dust or fume may cause irreversible central nervous system damage (Manganism). Symptoms resemble Parkinson's disease and include tremors, impaired speech, mask like face and impaired movement.

Numerical measures of toxicity - Product Information

Unknown Aquatic Toxicity 37.65% of the mixture consists of ingredient(s) of unknown toxicity
The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)	508 mg/kg
ATEmix (dermal)	5 mg/kg
ATEmix (inhalation-gas)	10 mg/l

12. Ecological Information

This product contains a chemical which is listed as a marine pollutant according to DOT.

12.1. Ecotoxicity 96% of the mixture consists of component(s) of unknown hazards to the aquatic environment

Chemical name	Algae toxicity	Acute/Fish toxicity	Toxicity to Microorganisms	Daphnia magna
Cobalt 7440-48-4	EC50 - 270ug/L	NOEC - 100 mg/L - Cobalt Powder	Not available	LOEC - 5.6 mg/L, LC50 > 100 mg/L
Molybdenum 7439-98-7	EC10 - 150 mg/L, NOEL - 169.9 ,h/L	LC50 - 609 mg/L	Not available	EC50 - 2847.5 mg/L
Chromium 7440-47-3	Data Waiving - Study Scientifically Unjustified	Data Waiving - Study Scientifically Unjustified	Not available	Data Waiving - Study Scientifically Unjustified
Silicon Metal 7440-21-3	Data Waiving - Study Scientifically Unjustified	Data Waiving - Other Justification	Not available	Data Waiving - Study Scientifically Unjustified
Nickel 7440-02-0	EC10 - 316.5 ug/L	LC50 - 15.3 mg/L	Not available	LC50 >200ug/L (@6-6.5 pH), 13ug/L (@8-8.5pH)
Iron 7439-89-6	NOEC - 1.4 mg/L	Data Waiving - Study Scientifically Unjustified	Not available	Data Waiving - Study Scientifically Unjustified

12.2 Persistence and degradability Product/Substance is inorganic. not applicable.

Bioaccumulation/Accumulation No information available.

13. Disposal Considerations

Waste treatment methods It must undergo special treatment, e.g. at suitable disposal site, to comply with local regulations.

Waste from residues/unused products Reuse or recycle Recover or recycle if possible Dispose of in accordance with local regulations

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal.

California Waste Status This product contains one or more substances that are listed with the State of California as a hazardous waste.

Chemical name	California Hazardous Waste Status
Cobalt - 7440-48-4	Toxic Ignitable
Molybdenum - 7439-98-7	Ignitable
Chromium - 7440-47-3	Toxic Corrosive Ignitable
Nickel - 7440-02-0	Toxic Ignitable

14. Transport Information

DOT UN3077, Environmentally hazardous substance, solid, n.o.s (Cobalt), 9, III
UN-No UN3077
Proper shipping name Environmentally hazardous substances, solid, n.o.s.
Hazard Class 9
Packing group III
Marine pollutant This product contains a chemical which is listed as a marine pollutant according to DOT.
Emergency Response Guide Number 171

TDG UN3077, Environmentally hazardous substance, solid, n.o.s (Cobalt), 9, III

UN-No	UN3077
Proper shipping name	Environmentally hazardous substance, solid, n.o.s.
Hazard Class	9
Packing group	III
MEX	
	Not regulated UN3077, Environmentally hazardous substance, solid, n.o.s (Cobalt), 9, III
UN-No	UN3077
Proper shipping name	Environmentally hazardous substance, solid, n.o.s.
Hazard Class	9
Packing group	III
ICAO / IATA-DGR	
	UN3077, Environmentally hazardous substance, solid, n.o.s (Cobalt), 9, III
14.1 UN number	UN3077
14.2. UN proper shipping name	Environmentally hazardous substance, solid, n.o.s.
14.3. Transport hazard class(es)	9
14.4 Packing group	III
IMO / IMDG	
	UN3077, Environmentally hazardous substance, solid, n.o.s (Cobalt), 9, III
14.1 UN number	UN3077
14.2. UN proper shipping name	Environmentally hazardous substance, solid, n.o.s.
14.3. Transport hazard class(es)	9
14.4 Packing group	III
EmS No.	F-A, S-F

15. Regulatory Information		
Chemical name	Bollvia hazardous substance regulated under Bolivia Environmental Regulations for the Industrial Manufacturing Sector	
Cobalt - 7440-48-4		Present
Nickel - 7440-02-0		Present

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
 DSL/NDL - Canadian Domestic Substances List/Non-Domestic Substances List

U.S. Federal Regulations
SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

Chemical name	CAS No	Weight %	SARA 313 Threshold Values %
Cobalt - 7440-48-4	7440-48-4	> 50	Present
Chromium - 7440-47-3	7440-47-3	5 - 10	Present

SARA 311/312 Hazard Categories

Acute health hazard	yes
Chronic Health Hazard	yes
Fire Hazard	no
Sudden release of pressure hazard	no
Reactive Hazard	no

Clean Water Act

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

Chemical name	CWA Reportable Quantities	CWA Toxic Pollutants	CWA Priority Pollutants	CWA Hazardous Substances
Chromium - 7440-47-3	Not Applicable	Present	Present	Not Applicable
Nickel - 7440-02-0	Not Applicable	Present	Present	Not Applicable

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material

Chemical name	Hazardous Substances RQs	Extremely Hazardous Substances RQs	RQ
Chromium - 7440-47-3	5000 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 2270 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)		5000 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 2270 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)
Nickel - 7440-02-0	100 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 45.4 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)		100 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 45.4 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)

U.S. State Regulations

California Proposition 65

This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Cobalt - 7440-48-4	sn 0520	Present	Environmental hazard (fume) Present
Molybdenum - 7439-98-7	sn 1309	Present	Present
Chromium - 7440-47-3	sn 0432	Carcinogen; Extraordinarily hazardous	Environmental hazard; Special hazardous substance Present
Silicon Metal - 7440-21-3	sn 3125 (powder)	Present (dust, exempt when encapsulated or if particulates are not present and cannot be substantially generated through use of the product)	Present
Nickel - 7440-02-0	sn 1341 (dust and fume)	Carcinogen; Extraordinarily hazardous	Environmental hazard; Special hazardous substance Present

U.S. EPA Label information

CANADA

Chemical name	WHMIS classification of Component
Cobalt - 7440-48-4	D2A, D2B
Molybdenum - 7439-98-7	Uncontrolled product according to WHMIS classification criteria
Chromium - 7440-47-3	Uncontrolled product according to WHMIS classification criteria
Silicon Metal - 7440-21-3	B4
Nickel - 7440-02-0	D2A, D2B; B6, D2A (Raney)
Iron - 7439-89-6	Uncontrolled product according to WHMIS classification criteria

16. Other Information

<u>NFPA</u>	Health hazard 2	Flammability 0	Instability 0	Physical and Chemical Hazards -
<u>HMIS</u>	Health hazard 2	Flammability 0	Physical hazards 0	Personal precautions -

Issuing Date 2013-11-28

Revision Date 2014-01-16

Revision Note No information available

Disclaimer

Kennametal urges each customer or recipient of this SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Due to the proliferation of sources for information such as manufacturer-specific SDSs, we are not and cannot be responsible for SDS's obtained from any source other than ourselves. If you have obtained an SDS from another source or if you are not sure that the SDS you have is current, please contact us for the most current version.

End of Safety Data Sheet



Safety Data Sheet

Metco: 51, 51NS, 51FNS, 51FNS-1, 51VF, Diamalloy 1004, Amdry 331, Amdry 332, XPT 834

Section 1. Product and company identification

Product name : Metco: 51, 51NS, 51FNS, 51FNS-1, 51VF, Diamalloy 1004, Amdry 331, Amdry 332, XPT 834

Material uses : Metal industry: Suitable for thermal spray coating applications

Supplier : Oerlikon Metco (US) Inc.
1101 Prospect Avenue
Westbury, NY 11590

Telephone no. : (516) 334-1300 (7:30AM - 4:00PM)

In case of emergency : CHEMTREC: 800-424-9300

Calls Outside the United States : +1 703-741-5970: (USA) 24 hour Chemtrec International Emergency Response Service

Section 2. Hazards identification

OSHA/HCS status : While this material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200), this SDS contains valuable information critical to the safe handling and proper use of the product. This SDS should be retained and available for employees and other users of this product.

Classification of the substance or mixture : Not classified.

GHS label elements

Signal word : No signal word.

Hazard statements : No known significant effects or critical hazards.

Precautionary statements

Prevention : Not applicable.

Response : IF exposed or concerned: Get medical attention.

Storage : Not applicable.

Disposal : Not applicable.

Hazards not otherwise classified : Fine dust clouds may form explosive mixtures with air. Handling and/or processing of this material may generate a dust which can cause mechanical irritation of the eyes, skin, nose and throat.

Section 3. Composition/information on ingredients

United States

Name	CAS number	%
copper	7440-50-8	89
Aluminum	7429-90-5	10
iron	7439-89-6	1

Canada

Name	CAS number	%
copper	7440-50-8	89
Aluminum	7429-90-5	10
iron	7439-89-6	1

Mexico

Classification

Name	CAS number	UN number	%	IDLH	H	F	R	Special
copper	7440-50-8	Not regulated	89	100 mg/m ³	0	0	0	-
Aluminum	7429-90-5	Not available.	10	-	4	0	0	-
iron	7439-89-6	Not regulated	1	-	2	0	0	-

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

- Eye contact** : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Get medical attention if irritation occurs.
- Inhalation** : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.
- Skin contact** : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.
- Ingestion** : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Most important symptoms/effects, acute and delayed

Potential acute health effects

- Eye contact** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the eyes.
- Inhalation** : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.
- Skin contact** : No known significant effects or critical hazards.
- Ingestion** : No known significant effects or critical hazards.

Over-exposure signs/symptoms

- Eye contact** : Adverse symptoms may include the following:
irritation
redness
- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Skin contact** : No specific data.

Section 4. First aid measures

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use approved Class D extinguisher or smother with dry sand, dry clay or dry ground limestone.

Unsuitable extinguishing media : Do not use water. Do not use dry chemical, CO₂ or halon.

Specific hazards arising from the chemical : Fine dust clouds may form explosive mixtures with air.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
metal oxide/oxides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing dust. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

- Protective measures** : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Do not ingest. Avoid contact with eyes, skin and clothing. Avoid breathing dust. Avoid the creation of dust when handling and avoid all possible sources of ignition (spark or flame). Prevent dust accumulation. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Electrical equipment and lighting should be protected to appropriate standards to prevent dust coming into contact with hot surfaces, sparks or other ignition sources. Empty containers retain product residue and can be hazardous. Do not reuse container.
- Advice on general occupational hygiene** : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
- Conditions for safe storage, including any incompatibilities** : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate container to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

United States

Occupational exposure limits

Ingredient name	Exposure limits
copper	ACGIH TLV (United States, 4/2014). TWA: 1 mg/m ³ , (as Cu) 8 hours. Form: Dust and mist TWA: 0.2 mg/m ³ 8 hours. Form: Fume OSHA PEL (United States, 2/2013). TWA: 1 mg/m ³ 8 hours. Form: Dusts and Mists TWA: 0.1 mg/m ³ 8 hours. Form: Fume
Aluminum	ACGIH TLV (United States, 4/2014). TWA: 1 mg/m ³ 8 hours. Form: Respirable fraction OSHA PEL (United States, 2/2013). TWA: 5 mg/m ³ , (as Al) 8 hours. Form: Respirable fraction TWA: 15 mg/m ³ , (as Al) 8 hours. Form: Total dust
iron	-

Canada

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient	List name	TWA (8 hours)			STEL (15 mins)			Ceiling			Notations
		ppm	mg/m³	Other	ppm	mg/m³	Other	ppm	mg/m³	Other	
copper, as Cu	US ACGIH 4/2014	-	1	-	-	-	-	-	-	-	[a]
		-	0.2	-	-	-	-	-	-	-	[b]
	AB 4/2009	-	1	-	-	-	-	-	-	-	[c]
		-	0.2	-	-	-	-	-	-	-	[b]
	BC 2/2015	-	1	-	-	-	-	-	-	-	[d]
copper		-	0.2	-	-	-	-	-	-	-	[b]
	ON 1/2013	-	1	-	-	-	-	-	-	-	[e]
copper, as Cu	QC 1/2014	-	1	-	-	-	-	-	-	-	[f]
	QC 1/2014	-	0.2	-	-	-	-	-	-	-	[g]
Aluminum	US ACGIH 4/2014	-	1	-	-	-	-	-	-	-	[h]
	AB 4/2009	-	10	-	-	-	-	-	-	-	[3] [i]
	BC 2/2015	-	1	-	-	-	-	-	-	-	[j]
	ON 1/2013	-	1	-	-	-	-	-	-	-	[h]
Aluminum, as Al	QC 1/2014	-	10	-	-	-	-	-	-	-	

Mexico

Occupational exposure limits

Ingredient name	Exposure limits
copper	NOM-010-STPS (Mexico, 9/2000). LMPE-CT: 2 mg/m³, (as Cu) 15 minutes. Form: powder and fog LMPE-PPT: 1 mg/m³, (as Cu) 8 hours. Form: powder and fog LMPE-CT: 2 mg/m³, (as Cu) 15 minutes. Form: smoke LMPE-PPT: 0.2 mg/m³, (as Cu) 8 hours. Form: smoke
Aluminum	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 5 mg/m³ 8 hours. LMPE-PPT: 5 mg/m³ 8 hours. Form: powder

Appropriate engineering controls : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety glasses or goggles are recommended when handling this material. During the thermal spray process, safety goggles and dark lenses must be worn.

Skin protection

Hand protection : Rubber or other appropriate gloves should be worn to minimize contact. For hygienic reasons rubber gloves should not be worn for more than 2 hours. During the thermal spray process, heat insulated gloves are recommended.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Section 8. Exposure controls/personal protection

- Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory protection** : Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
- Hearing Protection** : Hearing protection that meets local standards should be used. During the thermal spray process, the operator and other personnel close to the spray operation must be protected from excessive noise.

**Protective Clothing
(Pictograms)** :



Section 9. Physical and chemical properties

Appearance

- Physical state** : Solid. [Metallic powder.]
- Color** : Gray.
- Odor** : Odorless.
- Odor threshold** : Not available.
- pH** : Not available.
- Melting point** : 1080 to 1460°C (1976 to 2660°F)
- Boiling point** : 2330 to 2600°C (4226 to 4712°F)
- Explosive properties** : Fine dust clouds may form explosive mixtures with air.
- Flash point** : Not applicable.
- Evaporation rate** : Not applicable.
- Flammability (solid)** : This material has been tested under UN criteria and found not to be flammable and therefore, not to meet the definition of a hazard class 4 for transport.
- Lower and upper explosive (flammable) limits** : Not available.
- Vapor pressure** : Not applicable.
- Vapor density** : Not applicable.
- Relative density** : Not available.
- Solubility** : Insoluble in the following materials: cold water.
- Partition coefficient: n-octanol/water** : Not applicable.
- Auto-ignition temperature** : Not available.
- Decomposition temperature** : Not available.
- Viscosity** : Not applicable.

Section 10. Stability and reactivity

- Reactivity** : No specific test data related to reactivity available for this product or its ingredients.
- Chemical stability** : The product is stable.
- Possibility of hazardous reactions** : Under normal conditions of storage and use, hazardous reactions will not occur.
- Conditions to avoid** : Store and use away from heat, sparks, open flame or any other ignition source.
- Incompatible materials** : Avoid contact with combustible materials, acids, oxidizing agents, halogenated hydrocarbons.
- Hazardous decomposition products** : Ozone and nitric oxide are formed by plasma flame. This action is independent of material. Some metallic oxides.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Routes of entry anticipated: Oral, Dermal, Inhalation.

Potential acute health effects

Eye contact : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the eyes.

Inhalation : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.

Skin contact : No known significant effects or critical hazards.

Ingestion : No known significant effects or critical hazards.

Section 11. Toxicological information

Symptoms related to the physical, chemical and toxicological characteristics

- Eye contact** : Adverse symptoms may include the following:
irritation
redness
- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Skin contact** : No specific data.
- Ingestion** : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

- Potential immediate effects** : Not available.
- Potential delayed effects** : Not available.

Long term exposure

- Potential immediate effects** : Not available.
- Potential delayed effects** : Not available.

Potential chronic health effects

Not available.

- Conclusion/Summary** : Not available.

General : Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
Copper	Acute EC50 1100 µg/l Fresh water	Aquatic plants - Lemna minor	4 days
	Acute IC50 5.4 mg/l Marine water	Aquatic plants - Plantae - Exponential growth phase	72 hours
	Chronic NOEC 0.013 mg/l Marine water	Algae - Ulva pertusa	96 hours
	Chronic NOEC 7 mg/l Fresh water	Aquatic plants - Ceratophyllum demersum	3 days
	Chronic NOEC 2 µg/l Fresh water	Daphnia - Daphnia magna	21 days
	Chronic NOEC 0.8 µg/l Fresh water	Fish - Oreochromis niloticus - Juvenile (Fledgling, Hatchling, Weanling)	6 weeks

Persistence and degradability

Not available.

Section 12. Ecological information

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{oc}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT Classification	TDG Classification	Mexico Classification	ADR/RID	IMDG	IATA
UN number	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
UN proper shipping name	-	-	-	-	-	-
Transport hazard class(es)	-	-	-	-	-	-
Packing group	-	-	-	-	-	-
Environmental hazards	No.	No.	No.	No.	No.	No.
Additional information	Not available.	-	-	-	-	-

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Section 15. Regulatory information

U.S. Federal regulations : TSCA 8(a) CDR Exempt/Partial exemption: Not determined
 United States inventory (TSCA 8b): Not determined.
 Clean Water Act (CWA) 307: copper

Clean Air Act Section 112 : Listed
 (b) Hazardous Air
 Pollutants (HAPs)

Clean Air Act Section 602 : Not listed
 Class I Substances

Clean Air Act Section 602 : Not listed
 Class II Substances

DEA List I Chemicals : Not listed
 (Precursor Chemicals)

DEA List II Chemicals : Not listed
 (Essential Chemicals)

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Not applicable.

Composition/information on ingredients

No products were found.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	copper	7440-50-8	89
	Aluminum	7429-90-5	10
Supplier notification	copper	7440-50-8	89
	Aluminum	7429-90-5	10

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : The following components are listed: COPPER
 New York : The following components are listed: Copper
 New Jersey : The following components are listed: COPPER
 Pennsylvania : The following components are listed: COPPER FUME

Canada

Canadian lists

CEPA Toxic substances : None of the components are listed.
 CANADA INVENTORY (DSL) : Not determined.

This product has been classified in accordance with the hazard criteria of the Hazardous Products Regulations and the SDS contains all the information required by the Hazardous Products Regulations.

Section 16. Other information

National Fire Protection Association (U.S.A.)



Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of issue/Date of revision : 08/15/2016.

Version : 3

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

▼ Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SULZER METCO

Material Safety Data Sheet

059A

SULZER METCO (US) NC.

1101 Prospect Avenue
 PO Box 1006
 Westbury, NY 11590-0201
 Phone: (516) 334-1300

Product:

METCO 410, 410NS

MSDS No.:

50-162

Revision No.:

5

Revision Date:

October 14, 1996

Original Date of Issue:

September 7, 1987

EMERGENCY CONTACT: CHEMTREC 800-424-9300
 CALLS OUTSIDE THE UNITED STATES: 202-483-7616

SECTION I	MATERIAL IDENTIFICATION
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Trade/Material Name: METCO 410, 410NS

Description: Fused Ceramic and Composite Metal Powder Blend

Other Designation: ALUMINUM OXIDE / "NICKEL ALUMINIDE" POWDER

SECTION II	COMPOSITION AND TOXICITY
-------------------	---------------------------------

Composition	%	CAS#	OSHA PEL	ACGIH TLV	Toxicity
Titanium Dioxide	2	13463-67-7	10 mg/m ³ TWA	10 mg/m ³ TWA	
Silicon Dioxide	1	7631-86-9	0.05 mg/m ³ TWA	0.05 mg/m ³ TWA	
Iron Oxide	0.5	1309-37-1	10 mg/m ³ TWA total particulate Fe ₂ O ₃ fume, as Fe	5 mg/m ³ TWA Fe ₂ O ₃ fume, as Fe	
Aluminum Oxide	66.5	1344-28-1	5 mg/m ³ TWA Welding fumes	10 mg/m ³ TWA as Al	
Nickel * +	24	7440-02-0	1 mg/m ³ TWA	1 mg/m ³ TWA	
Aluminum *	6	7429-90-5	15 mg/m ³ TWA total dust 5 mg/m ³ TWA respirable 5 mg/m ³ TWA fume	10 mg/m ³ TWA metal dust 5 mg/m ³ TWA fume	

* Indicates toxic chemical(s) subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments & Reauthorization Act (SARA) & supplier notification requirements (40CFR Part 372).
 □ Contains no asbestos and <1% crystalline silica.
 + Indicates on the list of Hazardous Air Pollutants that are regulated under Section 112 of the EPA Clean Air Act, 1990.
 N/A - Not Available, Not Applicable. NE - Not Established.

SECTION III**PHYSICAL DATA**

Boiling Point:	N/A	Specific Gravity (H ₂ O = 1):	2.46
Vapor Pressure (mmHg):	N/A	Melting Point:	N/A
Vapor Density (Air=1):	N/A	Percentage Volatiles:	N/A
Solubility in water (%):	Insoluble	Evaporation Rate:	N/A
Appearance and Odor:	Powder, no odor	pH of Solution:	N/A

SECTION IV**FIRE AND EXPLOSION HAZARD DATA**

Flash Point (Method Used):	N/A	Flammable Limits:	
		LEL %: N/A	UEL%: N/A
		(% by VOLUME)	(% by VOLUME)

Extinguishing Media: Use Class D Fire Extinguisher.

Special Fire Fighting Procedures: Treat as a metallic fire. Use NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing if involved in a fire.

Unusual Fire and Explosive Hazards: Fine metal dusts are flammable and may explode when exposed to heat, flame or oxidizers. Aluminum is a flammable solid, do not expose to water or moisture.

SECTION V**REACTIVITY DATA**

Material is stable. Hazardous polymerization will not occur.

Incompatibility (Materials to Avoid): Titanium dioxide may have a violent or incandescent reaction with other metals such as aluminum, calcium, magnesium, potassium, zinc and lithium. Iron oxide is incompatible with calcium hypochlorite. Aluminum oxide is incompatible with chlorine trifluoride, hot chlorinated rubber, acids and oxidizers. Hydrogen gas may be formed when finely divided iron contacts moisture during crushing and milling operations. Nickel is incompatible with acids, sulfur, selenium, wood, other combustibles and nickel nitrate. Aluminum is incompatible with strong oxidizers, acids and halogenated hydrocarbons.

Hazardous Decomposition Products: Ozone and nitric oxide are formed by plasma flame (similar to welding fumes). This action is independent of powder.

SECTION VI**HEALTH HAZARD DATA****COMPONENTS****SUMMARY OF RISKS****TITANIUM DIOXIDE:**

Hazard by inhalation, skin and eye contact as a nuisance particulate. Inhalation may cause irritation to the respiratory system and mucous membranes. Skin contact may have a defatting effect, causing drying and irritation. Eye contact may cause irritation.

Target Organ(s): Respiratory system, skin, eyes.

SILICON DIOXIDE:

Hazard by inhalation and eye contact. Inhalation may cause irritation to the respiratory system. Eye contact may cause irritation. Prolonged inhalation may cause silicosis, a pulmonary fibrosis characterized by generalized fibrotic changes on X-ray examination, shortness of breath, cough, decreased chest expansion, lessened capacity for work and increased susceptibility to tuberculosis.

Target Organ(s): Respiratory system, eyes.

IRON OXIDE: Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause Siderosis (benign pneumoconiosis). Ingestion may cause irritation to the gastrointestinal tract. Skin and eye contact may cause irritation.

Target Organ(s): Respiratory system, gastrointestinal tract, skin, eyes.

ALUMINUM OXIDE: Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause pneumoconiosis. Ingestion may cause irritation to the gastrointestinal tract. Pulmonary, skin and eye irritant due to abrasive action.

Target Organ(s): Respiratory system, gastrointestinal tract, skin, eyes.

NICKEL: Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause irritation to the respiratory system, Central Nervous System depression, cancers of the lung and nasal sinuses. Ingestion may cause irritation to the gastrointestinal tract, loss of muscular coordination, confusion and convulsions. Skin contact may cause dermatitis. Eye contact may cause irritation. ACGIH classified A1 Confirmed Human Carcinogen. IARC classification Group 1 Carcinogenic to Humans. NTP classifies nickel as Reasonably Anticipated to be Carcinogens.

Target Organ(s): Respiratory system, Central Nervous System, gastrointestinal tract, skin, eyes.

ALUMINUM: Hazard by inhalation, ingestion, skin and eye contact. Inhalation may cause pneumoconiosis. Ingestion may cause irritation to the gastrointestinal tract. Pulmonary, skin and eye irritant due to abrasive action. Under normal use/conditions, aluminum oxide may be formed.

Target Organ(s): Respiratory system, gastrointestinal tract, skin, eyes.

Medical Conditions Which May be Aggravated by Contact: Consult a physician.

Primary Entry Route(s): Inhalation, ingestion, skin and eye contact.

SIGNS AND SYMPTOMS OF OVEREXPOSURE

Eye Contact: Possible irritation.

Skin Contact: Possible defatting effect, causing dryness and irritation, dermatitis.

Inhalation: Possible irritation to the respiratory system and mucous membranes, shortness of breath, cough, decreased chest expansion, lessened capacity for work.

Ingestion: Possible irritation to the respiratory system and gastrointestinal tract, loss of muscular coordination, confusion and convulsions.

FIRST AID

Eye Contact: Flush eye with water for at least 15-20 minutes while holding eyelid open. If irritation persists, consult a physician.

Skin Contact: Wash with soap and water. If irritation persists, consult a physician.

Inhalation: Expose to fresh air. Consult a physician if irritation or respiratory distress persists.

Ingestion: Consult a physician.

SECTION VII

SPILL, LEAK AND DISPOSAL PROCEDURES

Spill/Leak Procedures: Vacuum loose powder only with vacuums equipped with HEPA filtration. Vacuums appropriate for use with metallic dusts should be utilized. Wipe the area clean. Do not use water for clean up operations. Do not sweep. Avoid generating airborne dust.

Waste Management and Disposal:

Empty product containers, product waste and cleaning media should be stored and disposed of according to the appropriate local, state, and federal regulatory guidelines.

SECTION VIII

SPECIAL PROTECTION INFORMATION

PERSONAL PROTECTIVE EQUIPMENT

Goggles: The following lens shades are recommended for the process indicated. Combustion spraying shade #5, plasma spraying up to 40 kW shade #9, 40-60 kW shade #10 and greater than 60 kW shade #11. Goggles may be appropriate during other phases of product handling.

Gloves: Aluminized gloves are to be worn during the plasma spray process. Rubber or other appropriate gloves may be worn as necessary during other phases of product handling to avoid excessive skin contact.

Respirator: A respirator approved by NIOSH with filter cartridges approved for dust/fumes/mists should be worn at all times during the thermal spray process to protect the operator from exposure to dust and fumes. Respirators may also be worn when product handling generates dust.

Clothing/Equipment: Ear protection must be worn when the operator is subjected to excessive noise levels. (Refer to the appropriate regulatory guidelines.) An aluminized apron is to be worn during the plasma spray process. Other appropriate protective clothing may be worn as necessary during product handling to avoid excessive contact with the skin.

WORKPLACE CONSIDERATIONS

Ventilation: Product should be used with the appropriate local exhaust ventilation provided.

Safety Stations: Eye wash station(s) is/are recommended.

Other: Wash facilities are recommended.

SECTION IX

HANDLING AND STORAGE PRECAUTIONS

Storage/Handling: Store away from incompatibles. Store product containers in a well-ventilated, clean, cool and dry area. Store in a manner to minimize punctures and breakage of containers.

Other Precautions: Avoid ingestion, inhalation and excessive skin contact.

While this information is furnished in good faith, no guaranty is made as to accuracy. This material is for the Thermal Spraying Process, and relevant instructions should be consulted before use. The user assumes all risk in connection with the use of this material. SULZER METCO (US) Inc. shall in no event be liable for special, incidental or consequential damages in connection with this information, or for any damage or injury caused by this material if used for any other purpose than the Thermal Spray Process, or if proper safety and health practices are not followed.

Material Safety Data Sheet



WC-559

1. Product and company identification

Product name : WC-559
Supplier : Praxair Surface Technologies, Inc.
1555 Main Street
Indianapolis, IN 46224
USA
317-240-2650
Manufacturer : Praxair Surface Technologies
1555 Main St.
Indianapolis, IN 46224
Code : 011078-10
MSDS # : 011078-10
Validation date : 4/20/2012.
Print date : 4/20/2012.
Responsible name : **Sarah Behling**
In case of emergency : 317-240-2484
Chemtrec: 1-800-424-9300
Product type : Powder.

2. Hazards identification

Emergency overview

Physical state : Solid. [Powder.]
Color : Gray.
Odor : Odorless
Hazard statements : MAY CAUSE EYE AND SKIN IRRITATION. CONTAINS MATERIAL THAT MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. POSSIBLE CANCER HAZARD - CONTAINS MATERIAL WHICH MAY CAUSE CANCER, BASED ON ANIMAL DATA.
Precautionary measures : Do not handle until all safety precautions have been read and understood. Obtain special instructions before use. Do not breathe dust. Do not eat, drink or smoke when using this product. Avoid contact with eyes, skin and clothing. Use personal protective equipment as required. Wash thoroughly after handling.
OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Potential acute health effects

Inhalation : Exposure to airborne concentrations above statutory or recommended exposure limits may cause irritation of the nose, throat and lungs.
Ingestion : No known significant effects or critical hazards.
Skin : Slightly irritating to the skin.
Eyes : Slightly irritating to the eyes.

Potential chronic health effects

Chronic effects : Contains material that may cause target organ damage, based on animal data. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation.
Carcinogenicity : Contains material which may cause cancer, based on animal data. Risk of cancer depends on duration and level of exposure.
Mutagenicity : No known significant effects or critical hazards.
Teratogenicity : No known significant effects or critical hazards.
Developmental effects : No known significant effects or critical hazards.
Fertility effects : No known significant effects or critical hazards.
Target organs : Contains material which may cause damage to the following organs: blood, cardiovascular system, upper respiratory tract, skin, eye, lens or cornea.

2. Hazards identification

Over-exposure signs/symptoms

- Inhalation** : Adverse symptoms may include the following:
respiratory tract irritation
coughing
- Ingestion** : No specific data.
- Skin** : Adverse symptoms may include the following:
irritation
redness
- Eyes** : Adverse symptoms may include the following:
irritation
watering
redness
- Medical conditions aggravated by over-exposure** : Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (Section 11)

3. Composition/information on ingredients

Name	CAS number	%
Tungsten	7440-33-7	>75
Cobalt	7440-48-4	5 - 20
Carbon	7440-44-0	1 - 5

There are no ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

4. First aid measures

- Eye contact** : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- Skin contact** : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.
- Inhalation** : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- Ingestion** : Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.
- Notes to physician** : No specific treatment. Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

5. Fire-fighting measures

Flammability of the product : No specific fire or explosion hazard.

Extinguishing media

- Suitable** : Use an extinguishing agent suitable for the surrounding fire.
- Not suitable** : None known.
- Special exposure hazards** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

5. Fire-fighting measures

- Hazardous thermal decomposition products** : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
metal oxide/oxides
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

6. Accidental release measures

- Personal precautions** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see Section 8).
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods for cleaning up

- Small spill** : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.
- Large spill** : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

7. Handling and storage

- Handling** : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing dust. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.
- Storage** : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see section 10) and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

8. Exposure controls/personal protection

Ingredient	Exposure limits
Tungsten	ACGIH TLV (United States, 2/2010). TWA: 5 mg/m ³ , (as W) 8 hour(s). Form: Insoluble STEL: 10 mg/m ³ , (as W) 15 minute(s). Form: Insoluble NIOSH REL (United States, 6/2009). Notes: Note: The REL also applies to other insoluble tungsten compounds (as W). STEL: 10 mg/m ³ , (as W) 15 minute(s). TWA: 5 mg/m ³ , (as W) 10 hour(s).
Cobalt	NIOSH REL (United States, 6/2009). Notes: as Co TWA: 0.05 mg/m ³ , (as Co) 10 hour(s). Form: Dust and fumes ACGIH TLV (United States, 2/2010). Notes: as Co

8. Exposure controls/personal protection

TWA: 0.02 mg/m³, (as Co) 8 hour(s). Form: Inorganic
OSHA PEL (United States, 6/2010). Notes: as Co
 TWA: 0.1 mg/m³, (as Co) 8 hour(s).
OSHA PEL 1989 (United States, 3/1989). Notes: as Co
 TWA: 0.05 mg/m³, (as Co) 8 hour(s).

- Recommended monitoring procedures** : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.
- Engineering measures** : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.
- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.
- Personal protection**
- Respiratory** : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
- Hands** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products.
- Eyes** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts. If operating conditions cause high dust concentrations to be produced, use dust goggles.
- Skin** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

9. Physical and chemical properties

- Physical state** : Solid. [Powder.]
- Color** : Gray.
- Odor** : Odorless
- Distribution** : -53/+10u
- Melting/freezing point** : 3410°C (6170°F)
- VOC content** : 0 lbs/gal (0 g/l)
- Solubility** : Insoluble in the following materials: cold water and hot water.

10. Stability and reactivity

- Chemical stability** : The product is stable.
- Conditions to avoid** : No specific data.
- Incompatible materials** : No specific data.
- Hazardous decomposition products** : Under normal conditions of storage and use, hazardous decomposition products should not be produced.
- Possibility of hazardous reactions** : Under normal conditions of storage and use, hazardous reactions will not occur.

11. Toxicological information

Acute toxicity

Conclusion/Summary : Not available.

Chronic toxicity

Conclusion/Summary : Not available.

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
Tungsten	Eyes - Mild irritant	Rabbit	-	24 hours 500 milligrams	-
	Skin - Mild irritant	Rabbit	-	24 hours 500 milligrams	-

Conclusion/Summary : Not available.

Sensitizer

Conclusion/Summary : Not available.

Carcinogenicity

Conclusion/Summary : Not available.

Classification

Product/ingredient name	ACGIH	IARC	EPA	NIOSH	NTP	OSHA
Cobalt	A3	2B	-	-	-	-

Mutagenicity

Conclusion/Summary : Not available.

Teratogenicity

Conclusion/Summary : Not available.

Reproductive toxicity

Conclusion/Summary : Not available.

12. Ecological information

Ecotoxicity : No known significant effects or critical hazards.

Aquatic ecotoxicity

Conclusion/Summary : Not available.

Persistence/degradability

Conclusion/Summary : Not available.

Other adverse effects : No known significant effects or critical hazards.

13. Disposal considerations

Waste disposal : The generation of waste should be avoided or minimized wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Disposal should be in accordance with applicable regional, national and local laws and regulations.

Refer to Section 7: HANDLING AND STORAGE and Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION for additional handling information and protection of employees.

14. Transport information

Regulatory information	UN number	Proper shipping name	Classes	PG*	Label	Additional information
DOT Classification	Not regulated.	-	-	-		-
TDG Classification	Not regulated.	-	-	-		-
Mexico Classification	Not regulated.	-	-	-		-
ADR/RID Class	Not regulated.	-	-	-		-
IMDG Class	Not regulated.	-	-	-		-
IATA-DGR Class	Not regulated.	-	-	-		-

PG* : Packing group

15. Regulatory information

HCS Classification : Carcinogen
Target organ effects

U.S. Federal regulations : TSCA 8(a) PAIR: Tungsten

TSCA 8(a) IUR Exempt/Partial exemption: Not determined

United States inventory (TSCA 8b): All components are listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.

SARA 302/304 emergency planning and notification: No products were found.

SARA 302/304/311/312 hazardous chemicals: Tungsten; Cobalt; Carbon

SARA 311/312 MSDS distribution - chemical inventory - hazard identification:

Tungsten: Immediate (acute) health hazard, Delayed (chronic) health hazard; Cobalt: Delayed (chronic) health hazard; Carbon: Fire hazard, Immediate (acute) health hazard, Delayed (chronic) health hazard

Clean Air Act Section 112(b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 313

	Product name	CAS number	Concentration
Form R - Reporting requirements	Cobalt	7440-48-4	5 - 20
Supplier notification	Cobalt	7440-48-4	5 - 20

SARA 313 notifications must not be detached from the MSDS and any copying and redistribution of the MSDS shall include copying and redistribution of the notice attached to copies of the MSDS subsequently redistributed.

State regulations

15. Regulatory information

- Massachusetts** : The following components are listed: TUNGSTEN; COBALT
- New York** : None of the components are listed.
- New Jersey** : The following components are listed: TUNGSTEN; COBALT
- Pennsylvania** : The following components are listed: TUNGSTEN; COBALT FUME
- California Prop. 65**

WARNING: This product contains a chemical known to the State of California to cause cancer.

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
Cobalt	Yes.	No.	No.	No.

Canada inventory : All components are listed or exempted.

International regulations

- International lists** :
 - Australia inventory (AICS):** All components are listed or exempted.
 - China inventory (IECSC):** All components are listed or exempted.
 - Japan inventory:** Not determined.
 - Korea inventory:** All components are listed or exempted.
 - New Zealand Inventory of Chemicals (NZIoC):** All components are listed or exempted.
 - Philippines inventory (PICCS):** All components are listed or exempted.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

16. Other information

Label requirements : MAY CAUSE EYE AND SKIN IRRITATION. CONTAINS MATERIAL THAT MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. POSSIBLE CANCER HAZARD - CONTAINS MATERIAL WHICH MAY CAUSE CANCER, BASED ON ANIMAL DATA.

Hazardous Material Information System (U.S.A.) :

Health	1
Flammability	0
Physical hazards	0

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings are not required on MSDSs under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.) :



16. Other information

Reprinted with permission from NFPA 704-2001, Identification of the Hazards of Materials for Emergency Response Copyright ©1997, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Date of printing : 4/20/2012.
Date of issue : 4/20/2012.
Date of previous issue : No previous validation.
Version : 3
Prepared by : Not available.

▀ Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Material Safety Data Sheet

SULZER

Sulzer Metco 4538

Sulzer Metco

1. Product and company identification

Product name : Sulzer Metco 4538
Material uses : Metal industry: Used by spraying
Supplier : Sulzer Metco (US) Inc.
1101 Prospect Avenue
Westbury, NY 11590
Telephone no. : (516) 334 - 1300 (7:30AM - 4:00PM)
In case of emergency : CHEMTREC 800-424-9300
Calls Outside the United States : +1 703-527-3887 (USA) 24 hour Chemtrec International Emergency Response Service
Product type : Powder.

2. Hazards identification

Emergency overview

Physical state : Solid. [Metallic powder.]
Color : Gray.
Odor : Odorless.
Signal word : WARNING!
Hazard statements : CAUSES RESPIRATORY TRACT, EYE AND SKIN IRRITATION. MAY CAUSE ALLERGIC SKIN REACTION. CONTAINS MATERIAL THAT CAN CAUSE TARGET ORGAN DAMAGE. CANCER HAZARD - CONTAINS MATERIAL WHICH CAN CAUSE CANCER.
DURING THERMAL SPRAY A PORTION OF CHROMIUM AND NICKEL MAY BE CONVERTED TO HEXAVALENT CHROMIUM AND NICKEL COMPOUNDS WHICH ARE KNOWN TO CAUSE CANCER.

Precautionary measures : Do not handle until all safety precautions have been read and understood. Obtain special instructions before use. Do not breathe dust. Use only with adequate ventilation. Do not eat, drink or smoke when using this product. Avoid contact with eyes, skin and clothing. Keep container tightly closed. Use personal protective equipment as required. Wash thoroughly after handling.

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Routes of entry : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Inhalation : Irritating to respiratory system.
Ingestion : No known significant effects or critical hazards.
Skin : Irritating to skin. May cause sensitization by skin contact.
Eyes : Irritating to eyes.

Potential chronic health effects

Chronic effects : Contains material that can cause target organ damage. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.
Carcinogenicity : Contains material which can cause cancer. Risk of cancer depends on duration and level of exposure.
Mutagenicity : No known significant effects or critical hazards.
Teratogenicity : No known significant effects or critical hazards.
Developmental effects : No known significant effects or critical hazards.
Fertility effects : No known significant effects or critical hazards.

2. Hazards identification

Target organs : Contains material which may cause damage to the following organs: kidneys, lungs, upper respiratory tract, skin, eye, lens or cornea, nose/sinuses.

Over-exposure signs/symptoms

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Ingestion : No specific data.

Skin : Adverse symptoms may include the following:
irritation
redness

Eyes : Adverse symptoms may include the following:
pain or irritation
watering
redness

Medical conditions aggravated by over-exposure : Pre-existing skin disorders and disorders involving any other target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (Section 11)

3. Composition/information on ingredients

United States

Name	CAS number	%
Nickel	7440-02-0	60
iron	7439-89-6	22.5
chromium	7440-47-3	16
silicon	7440-21-3	1.5

Canada

Name	CAS number	%
Nickel	7440-02-0	60
iron	7439-89-6	22.5
chromium	7440-47-3	16
silicon	7440-21-3	1.5

Mexico

Name	CAS number	UN number	%	IDLH	Classification			
					H	F	R	Special
Nickel	7440-02-0	Not regulated	60	10 mg/m ³	2	0	0	-
iron	7439-89-6	Not regulated	22.5	-	2	0	0	-
chromium	7440-47-3	Not regulated	16	250 mg/m ³	0	0	0	-
silicon	7440-21-3	Not regulated	1.5	-	2	0	0	-

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

4. First aid measures

- Eye contact** : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- Skin contact** : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.
- Inhalation** : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- Ingestion** : Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water.
- Notes to physician** : No specific treatment. Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

5. Fire-fighting measures

- Flammability of the product** : Fine dust clouds may form explosive mixtures with air.
- Extinguishing media**
- Suitable** : Use approved Class D extinguisher or smother with dry sand, dry clay or dry ground limestone.
- Not suitable** : Do not use water. Do not use dry chemical, CO₂ or halon.
- Special exposure hazards** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.
- Hazardous thermal decomposition products** : Decomposition products may include the following materials:
metal oxide/oxides
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

6. Accidental release measures

- Personal precautions** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see Section 8).
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).
- Methods for cleaning up**
- Small spill** : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.

6. Accidental release measures

- Large spill** : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

7. Handling and storage

- Handling** : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Avoid exposure - obtain special instructions before use. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing dust. Avoid the creation of dust when handling and avoid all possible sources of ignition (spark or flame). Prevent dust accumulation. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Electrical equipment and lighting should be protected to appropriate standards to prevent dust coming into contact with hot surfaces, sparks or other ignition sources. Empty containers retain product residue and can be hazardous. Do not reuse container.
- Storage** : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see section 10) and food and drink. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate container to avoid environmental contamination.

8. Exposure controls/personal protection

United States

Ingredient	Exposure limits
Nickel	ACGIH TLV (United States, 2/2010). TWA: 1.5 mg/m ³ 8 hour(s). Form: Inhalable fraction
chromium	OSHA PEL (United States, 6/2010). TWA: 1 mg/m ³ , (as Ni) 8 hour(s).
	ACGIH TLV (United States, 2/2010). TWA: 0.5 mg/m ³ , (measured as Cr) 8 hour(s). Form: Inorganic
	OSHA PEL (United States, 6/2010). TWA: 1 mg/m ³ , (as Cr) 8 hour(s).
silicon	OSHA PEL (United States, 6/2010). TWA: 5 mg/m ³ 8 hour(s). Form: Respirable fraction TWA: 15 mg/m ³ 8 hour(s). Form: Total dust

Canada

Occupational exposure limits		TWA (8 hours)			STEL (15 mins)			Ceiling			Notations
Ingredient	List name	ppm	mg/m ³	Other	ppm	mg/m ³	Other	ppm	mg/m ³	Other	
Nickel	US ACGIH 2/2010	-	1.5	-	-	-	-	-	-	-	[a]
	AB 4/2009	-	1.5	-	-	-	-	-	-	-	
Nickel, as Ni	BC 9/2010	-	0.05	-	-	-	-	-	-	-	
Nickel	ON 7/2010	-	1	-	-	-	-	-	-	-	[b]
	QC 6/2008	-	1	-	-	-	-	-	-	-	
chromium, measured as Cr	US ACGIH 2/2010	-	0.5	-	-	-	-	-	-	-	[c]
chromium, as Cr	AB 4/2009	-	0.5	-	-	-	-	-	-	-	[3]
chromium	BC 9/2010	-	0.5	-	-	-	-	-	-	-	
chromium, as Cr	ON 7/2010	-	0.5	-	-	-	-	-	-	-	[c]
chromium	QC 6/2008	-	0.5	-	-	-	-	-	-	-	
silicon	BC 9/2010	-	3	-	-	-	-	-	-	-	[d]

8. Exposure controls/personal protection

	ON 7/2010	-	10	-	-	-	-	-	-	-	[e]
	QC 6/2008	-	10	-	-	-	-	-	-	-	[e]
		-	10	-	-	-	-	-	-	-	[f]

Mexico

Occupational exposure limits

Ingredient	Exposure limits
Nickel	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 1 mg/m ³ 8 hour(s).
chromium	NOM-010-STPS (Mexico, 9/2000). LMPE-PPT: 0.5 mg/m ³ 8 hour(s).
silicon	NOM-010-STPS (Mexico, 9/2000). LMPE-CT: 20 mg/m ³ 15 minute(s). LMPE-PPT: 10 mg/m ³ 8 hour(s).

Consult local authorities for acceptable exposure limits.

Additional information : A portion of nickel may be converted during the thermal spray process to nickel compounds which are classified as an IARC Group 1 Carcinogen. NTP classifies nickel compounds as Known to be Carcinogenic.

A portion of metallic chromium may be converted during the thermal spray process to hexavalent chromium. Hexavalent chromium is classified as an IARC group 1 carcinogen. NTP classifies hexavalent chromium as Known to be Carcinogenic.

OSHA PEL (United States, 5/2006)
PEL: 0.005 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.

Engineering measures : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits.

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Contaminated work clothing should not be allowed out of the workplace. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal protection

Eyes : Safety glasses or goggles are recommended when handling this material. During the thermal spray process, safety goggles and dark lenses must be worn.

Skin : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Hands : Rubber or other appropriate gloves should be worn to minimize contact. For hygienic reasons rubber gloves should not be worn for more than 2 hours. During the thermal spray process, heat insulated gloves are recommended.

Hearing Protection : Hearing protection that meets local standards should be used.

Protective Clothing (Pictograms) :



8. Exposure controls/personal protection

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

9. Physical and chemical properties

Physical state : Solid. [Metallic powder.]
Flash point : Not applicable.
Color : Gray.
Odor : Odorless.
Explosive properties : Fine dust clouds may form explosive mixtures with air.

10. Stability and reactivity

Chemical stability : The product is stable under normal storage conditions.
Conditions to avoid : Store and use away from heat, sparks, open flame or any other ignition source.
Incompatible materials : Avoid contact with combustible materials, acids, oxidizing agents, halogenated hydrocarbons.
Hazardous decomposition products : Ozone and nitric oxide are formed by plasma flame. This action is independent of material. Some metallic oxides.
Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

11. Toxicological information

United States Canada Mexico

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
silicon	LD50 Oral	Rat	3160 mg/kg	-

Conclusion/Summary : Not available.

Chronic toxicity

Conclusion/Summary : Not available.

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
silicon	Eyes - Mild irritant	Rabbit	-	3 milligrams	-

Conclusion/Summary : Not available.

Sensitizer

Conclusion/Summary : Not available.

Carcinogenicity

Conclusion/Summary : Contains material which can cause cancer. Risk of cancer depends on duration and level of exposure.

Classification

Product/ingredient name	ACGIH	IARC	EPA	NIOSH	NTP	OSHA
Nickel	A5	2B	-	+	Possible	-
iron	-	-	-	None.	-	-
chromium	A4	3	-	None.	-	-
silicon	-	-	-	None.	-	-

Mutagenicity

Conclusion/Summary : Not available.

11. Toxicological information

Teratogenicity

Conclusion/Summary : Not available.

Reproductive toxicity

Conclusion/Summary : Not available.

12. Ecological information

Ecotoxicity : No known significant effects or critical hazards.

United States

Aquatic ecotoxicity

Product/ingredient name	Result	Species	Exposure
Nickel	Acute LC50 2.3 ppm Fresh water	Fish - Cyprinus carpio - Juvenile (Fledgling, Hatchling, Weanling) - 6 cm	96 hours
	Chronic NOEC 3.5 ug/L Fresh water	Fish - Cyprinus carpio - 13 months - 10.5 cm - 27.8 g	4 weeks
iron chromium	Acute EC50 3700 ug/L Fresh water	Aquatic plants - Lemna minor	4 days
	Acute LC50 13.9 ppm Fresh water	Fish - Anguilla rostrata	96 hours
	Chronic NOEC 0.19 ug/L Fresh water	Fish - Cyprinus carpio - 13 months - 10.5 cm - 27.8 g	4 weeks

Conclusion/Summary : Not available.

Persistence/degradability

Conclusion/Summary : Not available.

Other adverse effects : No known significant effects or critical hazards.

13. Disposal considerations

Waste disposal : The generation of waste should be avoided or minimized wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Disposal should be in accordance with applicable regional, national and local laws and regulations.

Refer to Section 7: HANDLING AND STORAGE and Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION for additional handling information and protection of employees.

14. Transport information

Regulatory information	UN number	Proper shipping name	Classes	PG*	Label	Additional information
DOT Classification	Not regulated	-	-	-	-	-
TDG Classification	Not regulated	-	-	-	-	-
Mexico Classification	Not regulated	-	-	-	-	-

14. Transport information

ADR/RID Class	Not regulated	-	-	-	-	-
IMDG Class	Not regulated	-	-	-	-	-
IATA-DGR Class	Not regulated	-	-	-	-	-

PG* : Packing group

15. Regulatory informationUnited States

HCS Classification : Irritating material
Sensitizing material
Carcinogen
Target organ effects

U.S. Federal regulations : **TSCA 8(a) IUR**: Partial exemption

United States inventory (TSCA 8b): All components are listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.

SARA 302/304 emergency planning and notification: No products were found.

SARA 302/304/311/312 hazardous chemicals: Nickel; silicon

SARA 311/312 MSDS distribution - chemical inventory - hazard identification:

Nickel: Fire hazard, Immediate (acute) health hazard, Delayed (chronic) health hazard;
iron: Fire hazard; silicon: Fire hazard, Immediate (acute) health hazard

Clean Water Act (CWA) 307: Nickel; chromium

Clean Air Act Section 112(b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 313

	Product name	CAS number	Concentration
Form R - Reporting requirements	Nickel	7440-02-0	60
	chromium	7440-47-3	16
Supplier notification	Nickel	7440-02-0	60
	chromium	7440-47-3	16

SARA 313 notifications must not be detached from the MSDS and any copying and redistribution of the MSDS shall include copying and redistribution of the notice attached to copies of the MSDS subsequently redistributed.

State regulations

Massachusetts : The following components are listed: NICKEL; CHROMIUM; SILICON DUST

New York : The following components are listed: Nickel; Chromium

New Jersey : The following components are listed: NICKEL; CHROMIUM; SILICON

Pennsylvania : The following components are listed: NICKEL; CHROMIUM; SILICON

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

15. Regulatory information

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
Nickel	Yes.	No.	No.	No.

United States inventory (TSCA 8b) : All components are listed or exempted.

Canada

WHMIS (Canada) : Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

Canadian lists

Canadian NPRI : The following components are listed: Nickel; Chromium

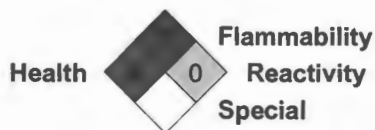
CEPA Toxic substances : None of the components are listed.

Canada inventory : All components are listed or exempted.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Mexico

Classification :



Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

16. Other information

Label requirements : WARNING!
CAUSES RESPIRATORY TRACT, EYE AND SKIN IRRITATION. MAY CAUSE ALLERGIC SKIN REACTION. CONTAINS MATERIAL THAT CAN CAUSE TARGET ORGAN DAMAGE. CANCER HAZARD - CONTAINS MATERIAL WHICH CAN CAUSE CANCER.
DURING THERMAL SPRAY A PORTION OF CHROMIUM AND NICKEL MAY BE CONVERTED TO HEXAVALENT CHROMIUM AND NICKEL COMPOUNDS WHICH ARE KNOWN TO CAUSE CANCER.

National Fire Protection Association (U.S.A.) :



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16. Other information

Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Date of issue : 6/20/2012.

Version : 1.2

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Appendix C
California Air Resources Board (CARB) Final
Regulation Order

Final Regulation Order

AIRBORNE TOXIC CONTROL MEASURE TO REDUCE EMISSIONS OF HEXAVALENT CHROMIUM AND NICKEL FROM THERMAL SPRAYING

Renumber title 17, CCR, section 93102.5 to section 93101.5:

93402.5 93101.5. Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying.

(a) Applicability

This Airborne Toxic Control Measure (ATCM) shall apply to each thermal spraying operation at a stationary source that uses materials containing chromium, chromium compounds, nickel, or nickel compounds. This ATCM does not apply to portable thermal spraying operations.

(b) Definitions

For the purposes of this section, the following definitions shall apply:

- (1) "*Air Pollution Control System*" means equipment that is installed for the purpose of collecting and containing emissions of airborne particles from thermal spraying processes. "Air Pollution Control System" includes, but is not limited to, enclosures, exhaust hoods, ductwork, fans/blowers, particulate control devices, and exhaust stacks/vents.
- (2) "*Control Device*" means a device that reduces emissions of particulate matter. "Control Device" includes, but is not limited to, dry filter cartridges, HEPA filters, water curtains, cyclones, baghouses, and scrubbers.
- (3) "*Detonation Gun Spraying*" means a thermal spraying process in which the coating material is heated and accelerated to the workpiece by a series of detonations or explosions from oxygen-fuel gas mixtures.
- (4) "*Dry Filter System*" means a dry particulate filter control system that uses filter media to remove particulate emissions from the exhaust air stream.
- (5) "*Enclosure*" means a structure, such as a booth, that surrounds a thermal spraying process and captures and contains particulate emissions and vents them to a control device. Enclosures may have permanent or temporary coverings on open faces.
- (6) "*Existing Thermal Spraying Operation*" means a thermal spraying operation that is in operation before January 1, 2005.

- (7) *"Flame Spraying"* means a thermal spraying process in which an oxygen/fuel gas flame is the source of heat for melting the surfacing material.
- (8) *"High Efficiency Particulate Air (HEPA) Filter"* means a disposable, dry filter that has a minimum particle collection efficiency of 99.97 percent when tested with a mono-disperse 0.3 um test aerosol.
- (9) *"Hexavalent chromium"* means the form of chromium with a valence state of +6.
- (10) *"High-Velocity Oxy-Fuel (HVOF) Spraying"* means a thermal spray process in which particles are injected into a high-velocity jet formed by the combustion of oxygen and fuel.
- (11) *"Independent Tester"* means a person who engages in the testing of stationary sources to determine compliance with air pollution laws or regulations and who meets all of the following criteria:
- (A) The independent tester is not owned in whole or in part by the owner/operator of the thermal spraying operation; and
 - (B) The independent tester has not received gross income from the owner/operator of the thermal spraying operation in excess of \$100,000 or in excess of 10% of the tester's annual revenues, other than as a result of source test contracts; and
 - (C) The independent tester has not manufactured or installed any emission control device or monitor used in connection with the specific source to be tested; and
 - (D) When conducting the compliance test, the independent tester does not use any employee or agent who:
 - 1. holds a direct or indirect investment of \$1,000 or more in the owner/operator of the thermal spraying operation; or
 - 2. has directly received income in excess of \$250 from the owner/operator of the thermal spraying operation in the previous 12 months; or
 - 3. is a director, officer, partner, employee, trustee, or holds any position of management in the owner/operator of the thermal spraying operation.
- (12) *"Initial Startup"* means the first time a new thermal spraying operation begins production or the first time additional or modified thermal spraying operations begin operating at a modified source. If such production or operation occurs prior to the operative date of this section, "Initial Startup" means the operative date of this section. "Initial Startup" does not include operation solely for testing of equipment or subsequent startup of permit units following malfunction or shutdown.
- (13) *"Intake Area"* means the area of the opening(s) in an enclosure from which make-up air is drawn from outside the enclosure during normal operations.

- (14) *"Inward Face Velocity"* means the airflow into an enclosure that prevents escape of contaminated air from the enclosure. Inward face velocity is measured in feet per minute, in accordance with Appendix 2.
- (15) *"Leak"* means the release of any particulate matter from any opening in the emission collection system/device other than the intended exhaust or emission point of that emission control system/device.
- (16) *"Location"* means one or more contiguous or adjacent properties. Contiguous or adjacent properties are properties with two or more parcels of land in actual physical contact, or separated solely by a public roadway or other public right-of-way.
- (17) *"Modification"* means:
- (A) any existing thermal spraying operation that did not use materials containing chromium, chromium compounds, nickel or nickel compounds before January 1, 2005, but begins using any of these materials on or after January 1, 2005; or
 - (B) any physical change in, change in the method of operation of, or addition to an existing permit unit that requires an application for an authority to construct and/or a permit to operate issued by the permitting agency. Routine maintenance and/or repair is not considered a physical change. A "change in the method of operation" of equipment, unless previously limited by an enforceable permit condition, shall not include:
 1. an increase in the production rate, unless such increase will result in an increase in emissions that causes a move from a lower tier to a higher tier in subsection (c)(1)(A) Table 1 or Table 2 of this regulation; or
 2. an increase in the hours of operation; or
 3. a change in ownership of a source; or
 - (C) the replacement of components for which the fixed capital cost exceeds 50 percent of the fixed capital cost that would be required to construct a comparable new source.
- (18) *"Modified Thermal Spraying Operation"* means any thermal spraying operation which has undergone a modification.
- (19) *"New Thermal Spraying Operation"* means any thermal spraying operation that begins initial operations on or after January 1, 2005. "New Thermal Spraying Operation" does not include the installation of a new permit unit at an existing thermal spraying operation or the modification of an existing thermal spraying operation.
- (20) *"Operating Parameter"* means a parameter established for a control device or process parameter which, if achieved by itself or in combination with one or more

other operating parameter values, determines that an owner or operator is in compliance with the applicable emission limitation or standard.

(21) *"Permit Unit"* means any article, machine, piece of equipment, device, process, or combination thereof, which may cause or control the release of air emissions of hexavalent chromium or nickel from a thermal spraying operation and which requires a permit to operate issued by a permitting agency.

(22) *"Permitting Agency"* means the local air pollution control or air quality management district.

(23) *"Plasma Spraying"* means a thermal spraying process in which an electric arc is used to ionize a gas and produce a plasma jet that melts and propels the coating material to the workpiece.

(24) *"Point Source"* means a permit unit that releases air pollutants through an intended opening such as, but not limited to, a stack, chimney, or vent.

(25) *"Portable Thermal Spraying Operation"* means a thermal spraying operation that is temporarily used for field applications at offsite locations. A thermal spraying operation is not a "Portable Thermal Spraying Operation" if the thermal spraying operation or its replacement resides at the same location for more than 30 consecutive days.

(26) *"Potential to Emit"* means the maximum capacity of a stationary source to emit a regulated air pollutant based on its physical and operational design. Any physical or operational limitation on the capacity of the stationary source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design only if the limitations are listed as enforceable conditions in an air permit issued by the permitting agency.

(27) *"Sensitive Receptor"* means any residence including private homes, condominiums, apartments, and living quarters; education resources such as preschools and kindergarten through grade twelve (k-12) schools; daycare centers; and health care facilities such as hospitals or retirement and nursing homes. A sensitive receptor includes individuals housed in long term care hospitals, prisons, and dormitories or similar live-in housing.

(28) *"Stationary Source"* means any building, structure, facility or installation which emits any affected pollutant directly or as a fugitive emission. "Building, structure, facility, or installation" includes all pollutant emitting activities which meet all of the following criteria:

(A) are under the same ownership or operation, or which are owned or operated by entities which are under common control; and

- (B) belong to the same industrial grouping either by virtue of falling within the same two-digit standard industrial classification code or by virtue of being part of a common industrial process, manufacturing process, or connected process involving a common raw material; and
- (C) are located on one or more contiguous or adjacent properties.

(29) "*Substantial Use*" of an Authority to Construct means one or more of the following: (A) the equipment that constitutes the source has been purchased or acquired; (B) construction activities, other than grading or installation of utilities or foundations, have begun and are continuing; or (C) a contract to complete construction of the source within one year has been entered into.

(30) "*Thermal Spraying Operation*" means one or more of several processes in which metallic or nonmetallic surfacing materials are deposited in a molten or semi-molten condition on a substrate to form a coating. The surfacing material may originate in the form of powder, rod, or wire before it is heated, prior to spraying and deposition. Thermal spraying processes include: detonation gun spraying, flame spraying, high-velocity oxy-fuel spraying, plasma spraying, and twin-wire electric arc spraying. For the purposes of this section, "Thermal Spraying Operation" includes only those operations that are conducted at stationary sources and use materials containing chromium, chromium compounds, nickel, or nickel compounds. "Thermal Spraying Operation" does not include portable thermal spraying operations.

(31) "*Twin-Wire Electric Arc Spraying*" means a thermal spraying process where two electrically conducting wires are brought close together to create an electric arc. The molten material formed in the arc is then projected by a compressed gas stream towards a work piece on which it forms a coating.

(32) "*Volume Source*" means a permit unit, either controlled or uncontrolled, from which air pollutants undergo initial dispersion within a building or structure prior to their release into the outdoor ambient air. "Volume Source" also includes a thermal spraying process that is conducted outside of a building or structure and releases pollutants directly into the outdoor ambient air.

(33) "*Water Curtain*" means a particulate control system that utilizes flowing water (i.e., a conventional water curtain) or a pumpless system to remove particulate emissions from the exhaust air stream.

(c) Standards

(1) Standards for Existing Thermal Spraying Operations

Effective January 1, 2006, each owner or operator of an existing thermal spraying operation must control hexavalent chromium and nickel emissions by complying with the control efficiency requirements specified in subsection (c)(1)(A), the enclosure standards specified in subsection (c)(1)(B), and the

ventilation system standards specified in subsection (c)(1)(C). Annual hexavalent chromium and nickel emissions and maximum hourly nickel emissions must be determined in accordance with the emission calculation methods in Appendix 1 or may be based on the results of an emissions source test. The use of data from an emissions source test must be approved by the permitting agency and the test must be conducted by an independent tester.

(A) Control Efficiency Requirements for Existing Thermal Spraying Operations

All existing thermal spraying operations must control hexavalent chromium and nickel emissions as follows:

1. All hexavalent chromium and nickel emissions from thermal spraying operations must be routed through an air pollution control system that meets the enclosure and ventilation standards in subsections (c)(1)(B) and (c)(1)(C).
2. For point sources, maximum hourly emissions of nickel from all thermal spraying operations at a stationary source must not exceed 0.1 lb. For volume sources, maximum hourly emissions of nickel from all thermal spraying operations must not exceed 0.01 lb.
3. For point sources, the air pollution control system must include a control device that is certified by its manufacturer to meet the minimum control efficiency requirements specified in Table 1 of this subsection (c)(1)(A). For volume sources, the air pollution control system must include a control device that is certified by its manufacturer to meet the minimum control efficiency requirements specified in Table 2 of subsection (c)(1)(A). Emissions of hexavalent chromium and/or nickel from all thermal spraying operations at a stationary source must be included when determining the annual emissions from thermal spraying under subsection (c)(1)(A). If an existing control device meets the minimum control efficiency requirements specified in subsection (c)(1)(A), no additional controls are required by this regulation, but the owner or operator must still comply with the enclosure standards in subsection (c)(1)(B), and the ventilation system standards in subsection (c)(1)(C). If a thermal spraying operation has an air permit that limits the use of chromium and nickel to specific thermal spraying permit units, the control efficiency requirements, enclosure standards, and ventilation system standards only apply to those specific thermal spraying permit units.
4. All thermal spraying operations that are subject to more than one minimum control efficiency requirement under subsection (c)(1)(A) must comply with the most stringent applicable requirement.

**Table 1: Point Sources -
Control Efficiency Requirements for Existing Thermal Spraying Operations**

Tier	Annual Hexavalent Chromium Emissions from Thermal Spraying ¹	Annual Nickel Emissions from Thermal Spraying ¹	Minimum Control Efficiency Requirements ²
1	≥ 0.004 lbs/yr and ≤ 0.04 lbs/yr	≥ 2.1 lbs/yr and ≤ 20.8 lbs/yr	90% by weight (e.g., a water curtain)
2	> 0.04 lbs/yr and ≤ 0.4 lbs/yr	> 20.8 lbs/yr and ≤ 208 lbs/yr	99.999% @ 0.5 microns (e.g., a high-efficiency dry filter)
3	> 0.4 lbs/yr	> 208 lbs/yr	99.97% @ 0.3 microns (e.g., a HEPA filter)

1. Emissions are controlled emissions from all thermal spraying operations at a stationary source, if the thermal spraying operation is already equipped with a control device.
 - a. For non-permitted sources, annual emissions must be determined in accordance with the emission calculation methods specified in Appendix 1 or based on the results of an emissions source test that has been reviewed and approved by the permitting agency.
 - b. For permitted sources, annual emissions must be calculated based on the potential to emit or in accordance with the allowable limits set forth in the permit conditions. Emissions must be determined in accordance with the emission calculation methods specified in Appendix 1 or based on the results of an emissions source test that has been reviewed and approved by the permitting agency.
2. Control efficiency requirements must be certified by the manufacturer/supplier of the control device and/or filter media. Thermal spraying operations are not required to conduct an emissions source test to verify the control efficiency at the listed particle sizes.

**Table 2: Volume Sources -
Control Efficiency Requirements for Existing Thermal Spraying Operations**

Tier	Annual Hexavalent Chromium Emissions from Thermal Spraying ¹	Annual Nickel Emissions from Thermal Spraying ¹	Minimum Control Efficiency Requirements ²
1	≥ 0.001 lbs/yr and ≤ 0.01 lbs/yr	≥ 0.3 lbs/yr and ≤ 3.1 lbs/yr	99% by weight (e.g., a dry filter)
2	> 0.01 lbs/yr and ≤ 0.1 lbs/yr	> 3.1 lbs/yr and ≤ 31 lbs/yr	99.999% @ 0.5 microns (e.g., a high-efficiency dry filter)
3	> 0.1 lbs/yr	> 31 lbs/yr	99.97% @ 0.3 microns (e.g., a HEPA filter)

1. Emissions are controlled emissions from all thermal spraying operations at a stationary source, if the thermal spraying operation is already equipped with a control device.
 - a. For non-permitted sources, annual emissions must be determined in accordance with the emission calculation methods specified in Appendix 1 or based on the results of an emissions source test that has been reviewed and approved by the permitting agency.
 - b. For permitted sources, annual emissions must be calculated based on the potential to emit or in accordance with the allowable limits set forth in the permit conditions. Emissions must be determined in accordance with the emission calculation methods specified in Appendix 1 or based on the results of an emissions source test that has been reviewed and approved by the permitting agency.
2. Control efficiency requirements must be certified by the manufacturer/supplier of the control device and/or filter media. Thermal spraying operations are not required to conduct an emissions source test to verify the control efficiency at the listed particle sizes.

(B) Enclosure Standards

All existing thermal spraying operations that are subject to subsection (c)(1)(A) must use air pollution control systems that meet the following criteria by January 1, 2006. All modified or new thermal spraying operations that are

subject to subsection (c)(2)(A)2. or (c)(3)(A)1., respectively, must use air pollution control systems that meet the following criteria upon initial startup.

1. Enclosures must be exhaust ventilated such that a continuous inward flow of air is maintained from all designed make-up air openings during thermal spraying operations.
2. To ensure good capture of airborne pollutants, the average inward face velocity of air through the enclosure must either be:
 - a. a minimum of 100 feet per minute; or
 - b. the minimum velocity for metal spraying facilities as established in "Industrial Ventilation, A Manual of Recommended Practice", 25th Edition, published by the American Conference of Governmental Industrial Hygienists, which is incorporated by reference herein.

The inward face velocity must be confirmed by a velocity measuring device approved by the permitting agency (e.g., a pitot tube or anemometer.) Measurement of inward face velocity must be performed in accordance with the methods set forth in Appendix 2 or an alternative method approved by the permitting agency. This subsection does not require the use of an independent tester to measure inward face velocity.

3. When thermal spraying is being performed, all air inlets and access openings must be covered to prevent the escape of dust or mist contaminants into areas outside the enclosure. This requirement does not apply to any designed or intended make-up air vents or openings. Coverings can be permanent (e.g., a door) or temporary (e.g., plastic flaps). Temporary coverings must be approved by the permitting agency.
4. Before the enclosure is opened, thermal spraying must cease and the exhaust system must be run for a sufficient period of time, as determined by the permitting agency, to remove contaminated air within the enclosure. A minimum of three air exchanges must be exhausted from the booth after thermal spraying ceases.
5. For the purposes of thermal spraying equipment calibration or research and development activities, permitting agencies may allow operators to open the enclosure door during thermal spraying operations, if all of the following conditions are met:
 - a. The enclosure must be a four-sided booth equipped with a permanent door.
 - b. The enclosure must be under negative pressure, as demonstrated in accordance with subsection (d)(1)(C).
 - c. The owner or operator must verify that the average inward face velocity of air through the enclosure is at least 100 feet per minute while the door is open, in accordance with Appendix 2.
 - d. The owner or operator must obtain approval from the permitting agency before beginning operations pursuant to this subsection.

(C) Ventilation System Standards

1. *Installation of Ventilation System for Existing, New, and Modified Thermal Spraying Operations*

For existing thermal spraying operations, the exhaust gas stream from the air pollution control system required by subsection (c)(1)(B) must be ducted to a particulate matter control device meeting the applicable control efficiency requirements of subsection (c)(1)(A) by January 1, 2006.

For modified or new thermal spraying operations, the exhaust gas stream from the air pollution control collection system required by subsection (c)(1)(B) must be ducted to a particulate matter control device meeting the applicable control efficiency requirements of subsection (c)(2)(A)2. or (c)(3)(A)1., respectively, upon initial startup.

2. *Operating Requirements for Ventilation Systems at Existing, New, and Modified Thermal Spraying Operations*

- a. The ventilation system and control device must be properly maintained and kept in good operating condition at all times. Any leak, as determined by a visual leak inspection conducted in accordance with Appendix 3, is a violation of this section.
- b. Material collected by a particulate matter control system must be discharged into closed containers or an enclosed system that is completely sealed to prevent dust emissions.
- c. Dust collectors for control devices must be maintained in a manner that prevents emissions of particulate matter into the ambient air.

(D) Permit Requirements for Existing Thermal Spraying Operations

All unpermitted existing thermal spraying operations must submit a permit application to the permitting agency no later than October 1, 2005. This permitting requirement applies only to existing thermal spraying operations that use materials containing chromium, chromium compounds, nickel, or nickel compounds.

(E) Standards for Remotely Located Existing Thermal Spraying Operations

1. The requirements of subsections (c)(1)(A), (c)(1)(B), and (c)(1)(C) do not apply to existing thermal spraying operations that meet all of the following criteria:
 - a. The thermal spraying operation is located at least 1,640 feet from a sensitive receptor, as determined by the permitting agency; and
 - b. Annual emissions of hexavalent chromium from all thermal spraying operations do not exceed 0.5 lb; and
 - c. The thermal spraying operation uses an air pollution control system that achieves a minimum control efficiency of 90 percent; and

- d. The thermal spraying operation complies with the permitting requirements of subsection (c)(1)(D); and
 - e. The owner or operator of the thermal spraying operation has submitted an annual report to the permitting agency by March 1st of each calendar year, that quantifies emissions of hexavalent chromium and nickel from all thermal spraying operations during the previous calendar year; and
 - f. The thermal spraying operation has undergone a site specific analysis from the permitting agency to ensure public health protection.
2. Thermal spraying operations that qualify for this standard must undergo an annual evaluation by the permitting agency to ensure that the thermal spraying operation still complies with the conditions of this standard. This standard shall cease to apply if the permitting agency determines that the thermal spraying operation no longer meets all of the criteria in subsection (c)(1)(E)1. If the permitting agency determines that the standard ceases to apply, the owner or operator of the thermal spraying operation must submit a permit application to the permitting agency within 3 months of receipt of the permitting agency's determination. The owner or operator must achieve compliance with the requirements of this section within 9 months of receipt of the permitting agency's determination.

(F) Exemption for Existing Thermal Spraying Operations with Low Emission Levels

1. The requirements in subsections (c)(1)(A), (c)(1)(B), and (c)(1)(C) shall not apply to existing thermal spraying operations that meet all of the following criteria:
 - a. For point sources, annual emissions of hexavalent chromium are less than 0.004 lb and annual emissions of nickel are less than 2.1 lbs. For volume sources, annual emissions of hexavalent chromium are less than 0.001 lb and annual emissions of nickel are less than 0.3 lb; and
 - b. For point sources, maximum hourly emissions of nickel from all thermal spraying operations at a stationary source do not exceed 0.1 lb. For volume sources, maximum hourly emissions of nickel from all thermal spraying operations at a stationary source do not exceed 0.01 lb; and
 - c. The thermal spraying operation complies with the permitting requirements of subsection (c)(1)(D); and
 - d. The owner or operator of the thermal spraying operation has submitted an annual report to the permitting agency by March 1st of each calendar year, that quantifies emissions of hexavalent chromium and nickel from all thermal spraying operations during the previous calendar year.

(2) *Standards for Modified Thermal Spraying Operations*

(A) Upon initial startup, each owner or operator of a modified thermal spraying operation must comply with all of the following requirements:

1. Modified thermal spraying operations must control hexavalent chromium and nickel emissions by complying with the control efficiency requirements specified in subsection (c)(2)(A)2.
2. All thermal spraying operations that undergo a modification on or after January 1, 2005, must use a control device that is certified by the manufacturer to achieve 99.97 percent control efficiency for particles that are 0.3 micron in diameter. These thermal spraying operations must also comply with the enclosure standards specified in subsection (c)(1)(B) and the ventilation standards specified in subsection (c)(1)(C).
3. For point sources, the maximum hourly emissions of nickel from all thermal spraying operations at a stationary source must not exceed 0.1 lb. For volume sources, the maximum hourly emissions of nickel from all thermal spraying operations at a stationary source must not exceed 0.01 lb. Maximum hourly nickel emissions must be determined in accordance with the emission calculation methods specified in Appendix 1 or may be based on the results of an emissions source test. The use of source test data must be approved by the permitting agency and the test must be conducted by an independent tester.
4. All thermal spraying operations that undergo a modification on or after January 1, 2005, must submit a permit modification application to the permitting agency, in accordance with permitting agency requirements. This permitting requirement only applies to thermal spraying operations that use materials containing chromium, chromium compounds, nickel, or nickel compounds.

(3) *Standards for New Thermal Spraying Operations*

- (A) 1. No person may operate a new thermal spraying operation unless it is located outside of an area that is zoned for residential or mixed use and is located at least 500 feet from the boundary of any area that is zoned for residential or mixed use.
2. A new thermal spraying operation shall be deemed to meet the standard specified above in subsection (c)(3)(A)1. if one of the following criteria are met, even if the operation does not meet the standard at the time of initial startup (e.g., because of a zoning change that occurs after the authority to construct is issued):

a. A new thermal spraying operation shall be deemed to meet the standard specified above if it meets the standard at the time it is issued an authority to construct by the permitting agency, and substantial use of the authority to construct takes place within one year after it is issued, or

b. A new thermal spraying operation shall be deemed to meet the standard specified above if it meets the standard at the time it is issued an authority to construct by the permitting agency, and substantial use of the authority to construct takes place before any zoning change occurs that affects the operation's ability to meet the standard at the time of initial start-up.

3. Prior to initial startup of a new thermal spraying operation, the owner or operator must demonstrate to the permitting agency that the operation either meets the standard specified above in subsection (c)(3)(A)1., or meets one of the criteria specified above in subsection (c)(3)(A)2.

(B) On and after initial startup, the new thermal spraying operation must use a control device that is certified by the manufacturer to achieve 99.97 percent control efficiency for particles that are 0.3 micron in diameter. These operations must also comply with the enclosure standards specified in subsection (c)(1)(B) and the ventilation standards specified in subsection (c)(1)(C).

(C) The maximum hourly emissions of nickel from all thermal spraying operations at a stationary source must not exceed 0.1 lb. Maximum hourly nickel emissions must be determined in accordance with the emission calculation methods specified in Appendix 1 or may be based on the results of an emissions source test. The use of source test data must be approved by the permitting agency and the test must be conducted by an independent tester.

(D) Prior to initial startup, the thermal spraying operation must undergo a site specific analysis from the permitting agency to ensure public health protection.

(E) *Permit Requirements for New Thermal Spraying Operations*

All new thermal spraying operations must submit a permit application to the permitting agency prior to initial startup, in accordance with permitting agency requirements. This permitting requirement only applies to new thermal spraying operations that use materials containing chromium, chromium compounds, nickel, or nickel compounds.

(d) Test Requirements and Test Methods

(1) *Testing to Demonstrate Compliance with Enclosure and Ventilation Standards*

(A) The owner or operator of an existing thermal spraying operation subject to the control efficiency requirements in subsection (c)(1)(A), must conduct a test to demonstrate compliance with the enclosure and ventilation standards specified in subsections (c)(1)(B) and (c)(1)(C). The test must include

measurement of the inward face velocity (in accordance with Appendix 2) and a visual leak inspection (in accordance with Appendix 3.) This test must be conducted within 60 days of the operative date of this section. The owner or operator must notify the permitting agency at least 30 days prior to conducting a test. Although 60 days are allowed to conduct the test, all thermal spraying operations must comply with specified control efficiency requirements, enclosure standards, and ventilation standards by January 1, 2006, as specified in subsection (c)(1).

(B) The owner or operator of a modified or new thermal spraying operation subject to the control efficiency requirements in subsections (c)(2)(A)2. or (c)(3)(A)1., respectively, must conduct a test to demonstrate compliance with the enclosure and ventilation standards in subsections (c)(1)(B) and (c)(1)(C). The test must include measurement of the inward face velocity (in accordance with Appendix 2) and a visual leak inspection (in accordance with Appendix 3.) This test must be conducted within 60 days after initial startup. The owner or operator must notify the permitting agency at least 30 days prior to conducting a test. Although 60 days are allowed to conduct the test, all thermal spraying operations must comply with specified control efficiency requirements, enclosure standards, and ventilation standards upon initial startup.

(C) Before beginning operations pursuant to subsection (c)(1)(B)5., the owner or operator must verify that negative pressure is maintained while the enclosure door is open, using one of the following procedures:

1. Measuring with an anemometer at the door opening to demonstrate flow into the enclosure door, or
2. Measuring the static pressure across the enclosure door, or
3. Using smoke tubes to demonstrate flow into the enclosure door.

As specified in subsection (e)(5), this negative pressure verification must have been performed at least once during the 12-month period immediately before operations begin, and at least once after the enclosure is changed in any way that may impact air flow.

(2) *Verification of Control Efficiency*

Existing thermal spraying operations that are subject to Tier 2 or Tier 3 control efficiency requirements specified in subsection (c)(1)(A), modified thermal spraying operations that are subject to the requirements of subsection (c)(2)(A)2., and new thermal spraying operations that are subject to the requirements of subsection (c)(3)(A)1., must use control devices with a control efficiency verified by the manufacturer. This verification must be provided to the permitting agency upon request. The control device manufacturer must verify the control efficiency using one of the following test methods, which are incorporated by reference herein:

- (A) ASHRAE Standard 52.2-1999, "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size", American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329. 1999.
- (B) MIL-PRF-51526A(EA), "Filter, Particulate, 340 CMH (200 CFM), 13 March 2000, U.S. Army.
- (C) ASME AG-1-2003, "Code on Nuclear Air and Gas Treatment", American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017. 2003.
- (D) IEST-RP-CC001.3, "HEPA and ULPA Filters", Institute of Environmental Sciences and Technology, 5005 Newport Drive, Suite 506, Rolling Meadows, IL 60008-3841. 1993.

(3) *Source Tests to Determine Emissions of Hexavalent Chromium and Nickel*
 Owners or operators of thermal spraying operations may choose to quantify hexavalent chromium and/or nickel emissions using data from a source test rather than using the calculation methods specified in Appendix 1. In addition, a permitting agency may require that a source test be performed to quantify hexavalent chromium and/or nickel emissions from thermal spraying operations. The use of source test data must comply with the requirements specified in this subsection (d)(3).

(A) *Use of Existing Source Tests*

A source test conducted prior to January 1, 2006, may be used to quantify emissions or demonstrate compliance with the standards in subsection (c)(1)(A), if the permitting agency approves the use of that test. The test must be conducted by an independent tester, in accordance with a test protocol that was reviewed and approved by the permitting agency.

(B) *Test Methods*

If the owner or operator of a thermal spraying operation conducts a source test to quantify emissions of hexavalent chromium and/or nickel, the testing must be conducted in accordance with the following listed test methods, which are incorporated by reference herein, or in accordance with alternative test methods approved by the permitting agency.

1. Testing to determine emissions of hexavalent chromium must be conducted in accordance with one of the following test methods, which are incorporated by reference herein:

ARB Test Method 425, "Determination of Total Chromium and Hexavalent Chromium Emissions from Stationary Sources", last amended July 28, 1997, section 94135, title 17, California Code of Regulations (CCR).

EPA Test Method 306, "Determination of Chromium Emissions From Decorative and Hard Chromium Electroplating and Chromium Anodizing

Operations – Isokinetic Method”, 40 CFR 63, Appendix A, as promulgated on January 25, 1995.

South Coast Air Quality Management District (SCAQMD) Test Method 205.1, “Determination of Hexavalent and Total Chromium from Plating”, August 1991.

2. Testing to determine emissions of nickel must be conducted in accordance with one of the following test methods, which are incorporated by reference herein:

ARB Test Method 433, “Determination of Total Nickel Emissions from Stationary Sources”, last amended September 12, 1989, section 94145, title 17, California Code of Regulations (CCR).

ARB Test Method 436, “Determination of Multiple Metals Emissions from Stationary Sources” (for nickel only), adopted July 28, 1997, section 94161, title 17, California Code of Regulations (CCR).

- (C) The owner or operator of a thermal spraying operation that is conducting a source test must submit a pre-test protocol to the permitting agency, in accordance with permitting agency procedures, at least 60 days prior to conducting a source test. The pre-test protocol must include source test methods, planned sampling parameters, preliminary pollutant analytical data, calculated targets for testing the pollutant, and any proposed modifications to standardized methods. In addition, the pre-test protocol must include information on equipment, logistics, personnel, and any other information required by the permitting agency.

(e) Monitoring, Inspection, and Maintenance Requirements

(1) Monitoring Requirements

All thermal spraying operations with air pollution control systems must comply with the applicable monitoring requirements listed in Table 3 of this subsection (e)(1). In addition, any other operating parameters designated by the permitting agency must be monitored while conducting thermal spraying to ensure compliance with the requirements set forth in subsection (c).

Table 3 – Summary of Monitoring Requirements for Thermal Spraying Operations Using Add-on Air Pollution Control Devices

	Control Equipment	Monitoring Requirements
(A)	Dry particulate filter system (e.g., dry filter cartridge, HEPA filter)	<ol style="list-style-type: none"> 1. Ensure that the pressure differential gauge continuously monitors pressure drop across the control device while conducting thermal spraying. 2. Record pressure drop once per week while conducting thermal spraying.
(B)	Conventional Water Curtain	<ol style="list-style-type: none"> 1. Ensure that the flow meter continuously monitors the water flow rate while conducting thermal spraying. 2. Monitor the water curtain continuity by visual observation to ensure that there are no gaps while conducting thermal spraying. 3. Record water flow rate and water curtain continuity once per week while conducting thermal spraying.
(C)	Pumpless Water Curtain	<ol style="list-style-type: none"> 1. Monitor parameters that indicate booth performance, per manufacturer's recommendations, while conducting thermal spraying. 2. Visually inspect the water curtain for continuity to ensure that there are no gaps while conducting thermal spraying. 3. Record recommended parameters and water curtain continuity once per week while conducting thermal spraying.

(2) Pressure Drop Monitoring Requirements

All dry particulate control devices (e.g., dry filter cartridges or HEPA filters) must have gauges that continuously monitor the pressure drop across each control device when thermal spraying is occurring. The gauge must have a high and low setting for the pressure drop and must trigger an alarm system when the high or low set points are exceeded. The gauge must be designed to accurately measure pressure drops within the expected range and have an accuracy of at least $\pm 5\%$ of full scale. The gauge must be located so that it can be easily visible and in clear sight of the operation or maintenance personnel. The pressure drop must be maintained per manufacturer's specifications. If the pressure drop is outside of the acceptable limits, the owner or operator must shut down the thermal spraying operation immediately and take corrective action. The thermal spraying operation must not be resumed until the pressure drop is within the specified limit(s).

(3) Water Curtain Monitoring Requirements

For thermal spraying operations that are conducted in water curtain booths, the owner or operator must monitor booth operating parameters during thermal spraying to ensure compliance with the requirements specified in subsection (c). Water curtain booths must provide a continuous sheet of water down the rear wall of the booth. For all water curtain booths, the owner or operator must visually monitor the water curtain during thermal spraying to ensure that the sheet is continuous without any gaps or dry spots. The owner or operator of a

conventional water curtain booth must continuously monitor the water flow rate with a flow meter during thermal spraying to ensure the water flow meets or exceeds the minimum flow rate recommended by the manufacturer. The owner or operator of a pumpless water curtain booth must monitor the parameters recommended by the booth manufacturer to ensure that these parameters meet or exceed the manufacturer's recommendations. If the water curtain fails the continuity and/or flow requirements, the owner or operator must shut down the thermal spraying operation immediately to take corrective action. The thermal spraying operation must not be resumed until the monitored parameters meet or exceed the manufacturer's recommendations.

(4) Inspection and Maintenance Requirements

All thermal spraying operations with air pollution control systems must comply with the applicable inspection and maintenance requirements listed in Table 4.

Table 4 - Summary of Inspection and Maintenance Requirements for Thermal Spraying Operations Using Add-on Air Pollution Control Devices

	Control Equipment	Inspection & Maintenance Requirements	Frequency
(A)	Dry particulate filter system	1. Conduct a visual inspection to ensure there are no leaks in accordance with Appendix 3.	At least once every 90 days.
	(e.g., dry filter cartridge, HEPA filter)	2. Visually inspect ductwork from work area to the control device to ensure there are no leaks in accordance with Appendix 3.	At least once every 90 days.
		3. Replace filter.	Per manufacturer's specifications or permitting agency's requirement.
(B)	Water Curtain	1. Visually inspect ductwork from booth to the exhaust stack to ensure there are no leaks in accordance with Appendix 3.	At least once every 90 days.
(C)	All	1. Measure inward face velocity at each opening in accordance with Appendix 2. This requirement does not apply to existing thermal spraying operations that are remotely located and comply with the standards in section (c)(1)(E).	At least once per calendar year and whenever the air pollution control system is changed in any way that may impact air flow.

(5) Negative Pressure Measurements

Thermal spraying operations that are operating pursuant to subsection (c)(1)(B)5. (i.e., operating with the enclosure door open), must demonstrate negative pressure at least once every 12 months and whenever the enclosure is changed in any way that may impact air flow.

(f) Recordkeeping Requirements

(1) Monitoring Data Records

The owner or operator must maintain records of monitoring data required by subsection (e), including the date and time the data are collected.

Recordkeeping logs must include the applicable acceptable limit(s) for: pressure drop (dry particulate control); water flow rate (conventional water curtain); or manufacturer's recommended parameter limits (pumpless water curtain).

(2) Inspection Records

The owner or operator must maintain inspection records that clearly document all inspections and maintenance activities to enable the permitting agency to determine whether the requirements of subsection (e)(4) have been met. The records may take the form of a checklist and must identify:

- (A) the name of the device inspected;
- (B) the date and time of inspection;
- (C) a brief description of the working condition of the device during the inspection;
- (D) all maintenance activities performed on the components of the air pollution control system (e.g., duct work replacement, filter replacement, fan replacement, leak repairs, etc.);
- (E) the actions taken to correct deficiencies found during the inspection; and
- (F) the person that conducted the inspection.

(3) Material Usage Records

For thermal spraying materials that contain chromium, chromium compounds, nickel, or nickel compounds, the owner or operator must record the name and quantity of material used during each month of the annual reporting period, and the total usage to date for that calendar year.

(4) Source Test Records

The owner or operator must maintain test reports documenting the conditions and results of all source tests.

(5) Equipment Malfunctions and Failures

The owner or operator must maintain records of the occurrence, duration, cause (if known), and action taken for each equipment malfunction and/or failure. This recordkeeping requirement applies only to equipment malfunctions or failures that cause or may cause uncontrolled emissions to be released.

(6) Records Maintenance and Retention

All records required by this subsection (f) must be readily accessible for inspection and review at the thermal spraying operation for at least five years. If so requested by the permitting agency, the owner or operator must provide copies of the records to the permitting agency.

(g) Reporting Requirements

(1) Initial Emission Inventory for Existing Thermal Spraying Operations

All existing thermal spraying operations must submit an emission inventory for hexavalent chromium and nickel to the permitting agency no later than October 1, 2005. This inventory must quantify the emissions from thermal spraying operations conducted during the 12-month period between July 1, 2004 and July 1, 2005. The emission inventory must be prepared in accordance with Appendix 1 or must be based on an emissions source test approved by the permitting agency.

(2) Annual Emission Inventory for Existing Thermal Spraying Operations Qualifying for the Standards for Remotely Located Operations or the Exemption for Operations with Low Emission Levels

Existing thermal spraying operations that qualify for the standards specified in subsection (c)(1)(E) or the exemption specified in subsection (c)(1)(F) must submit an annual report to the permitting agency by March 1st of each calendar year that quantifies emissions of hexavalent chromium and nickel from thermal spraying operations during the previous calendar year.

(3) Initial Notification

Existing thermal spraying operations that intend to begin using materials containing chromium, chromium compounds, nickel, or nickel compounds on or after January 1, 2005, must notify the permitting agency at least 45 days prior to using any of these materials. If the use of these materials begins before the operative date of this section, this notification may be delayed until the operative date of this section.

(4) Reports of Breakdowns, Equipment Malfunctions, and Failures

The owner or operator of a thermal spraying operation must report breakdowns, equipment malfunctions, and failures as required by the permitting agency. This reporting requirement only applies to equipment malfunctions or failures that cause or may cause uncontrolled emissions to be released.

(5) Source Test Documentation

(A) Notification of Source Test

The owner or operator of a thermal spraying operation must notify the permitting agency of his or her intention to conduct a source test to measure emissions of hexavalent chromium and/or nickel. The owner or operator must provide this notification to the permitting agency at least 60 days before the source test is scheduled. The notification must include a pre-test protocol and any other documentation required by the permitting agency.

(B) Reports of Source Test Results

The owner or operator of a thermal spraying operation must provide the source test results to the permitting agency no later than 60 days following completion of the testing.

(6) Adjustments to the Timeline for Submittal and Format of Reports

A permitting agency may change the timeline for submittal of periodic reports, allow consolidation of multiple reports into a single report, establish a common schedule for submittal of reports, or accept reports prepared to comply with other State or local requirements. Prior to allowing any of these changes, the permitting agency must determine that the change will provide the same information and will not reduce the overall frequency of reporting.

(h) Severability

Each part of this section is deemed severable, and in the event that any part of this section is held to be invalid, the remainder of this section shall continue in full force and effect.

Appendix 1 – Emission Calculation Method

Emissions of hexavalent chromium (Cr⁺⁶) and nickel (Ni) from thermal spraying operations must be calculated in accordance with the procedures specified in this Appendix 1.

Step 1: Identify all thermal spraying materials that contain chromium (Cr) or nickel (Ni) at a concentration of at least 0.1% by weight (or less than 0.1%, if listed on the Material Safety Data Sheet.) Include materials that contain chromium or nickel in the form of a metallic compound or alloy. Examples of compounds and alloys include, but are not limited to, stainless steel; chromium carbide (Cr₃C₂); nichrome alloys (NiCr); and chromium oxide (Cr₂O₃).

Step 2: Determine the total percentage of chromium and/or nickel contained in each thermal spraying material. These data can be obtained from the material safety data sheet (MSDS) or by contacting the manufacturer. If the MSDS contains a range of percentages, use the upper value of the range. If the material contains a compound (e.g., Cr₃C₂), include only the portion that is chromium or nickel.

Step 3: For each thermal spraying operation, compile the annual usage for each thermal spraying material that contains chromium or nickel. For thermal spraying operations that have air permits, the annual usage is the maximum allowable under the permit.

Step 4: For each thermal spraying operation, calculate the annual usage quantities for chromium and nickel using the following equations:

$$\text{Eqn. 1: [Annual Usage, lbs Cr/yr]} = [\text{Material Usage, lbs material used/yr}] * [\text{weight \% Cr in Material}]$$

$$\text{Eqn. 2: [Annual Usage, lbs Ni/yr]} = [\text{Material Usage, lbs material used/yr}] * [\text{weight \% Ni in Material}]$$

Step 5. Identify the applicable emission factor(s) for each thermal spraying operation, based on the applicable control efficiency level. If a material is used for multiple thermal spraying operations and material usage records document the quantity of material used for each operation, use the applicable emission factors for each operation. If material usage records do not document the quantity of material used for each operation, use the highest emission factor.

Table 1-1 specifies the applicable emission factors for thermal spraying operations using materials that contain chromium, chromium compounds, or chromium alloys.

Table 1-2 specifies the applicable emission factors for thermal spraying operations using materials that contain nickel, nickel compounds, or nickel alloys.

Table 1-1: Thermal Spraying Emission Factors for Hexavalent Chromium

Operation	Emission Factors (lbs Cr ⁺⁶ /lb Cr sprayed)*			
	0% Control Efficiency (Uncontrolled)	90% Control Efficiency (e.g. Water Curtain)	99% Control Efficiency (e.g. Dry Filter)	99.97% Control Efficiency (e.g., HEPA Filter)
Single-Wire Flame Spray	4.68E-03	4.68E-04	4.68E-05	1.40E-06
Twin-Wire Electric Arc Spray	6.96E-03	6.96E-04	6.96E-05	2.09E-06
Flame Spray	6.20E-03	1.17E-03	6.20E-05	1.86E-06
HVOF	6.20E-03	1.17E-03	6.20E-05	1.86E-06
Plasma Spray	1.18E-02	6.73E-03	2.61E-03	2.86E-06
Other Thermal Spraying	7.17E-03	2.05E-03	5.70E-04	2.01E-06

*Some emission factors are based directly on stack test results while others are calculated values, derived from stack test results and control efficiencies.

Table 1-2: Thermal Spraying Emission Factors for Nickel

Operation	Emission Factors (lbs Ni/lb Ni sprayed)*			
	0% Control Efficiency (Uncontrolled)	90% Control Efficiency (e.g. Water Curtain)	99% Control Efficiency (e.g. Dry Filter)	99.97% Control Efficiency (e.g., HEPA Filter)
Twin-Wire Electric Arc Spray	6.0E-03	6.0E-04	6.0E-05	1.8E-06
Flame Spray	1.10E-01	4.64E-02	1.10E-03	3.30E-05
HVOF	1.10E-01	4.64E-02	1.10E-03	3.30E-05
Plasma Spray	1.5E-01	3.67E-02	1.5E-03	1.72E-05
Other Thermal Spraying	9.4E-02	3.25E-02	9.4E-04	2.13E-05

*Some emission factors are based directly on stack test results while others are calculated values, derived from stack test results and control efficiencies.

Step 6 – Annual Emissions. For each thermal spraying operation, calculate the annual emissions by multiplying the applicable emission factors by the annual usage rates, using the following equations:

Eqn. 3: $[Annual\ Emissions, lbs\ Cr^{+6}/yr] = [Emission\ Factor, lbs\ Cr^{+6}/lb\ Cr\ sprayed] * [Annual\ Usage, lbs\ Cr\ sprayed/yr]$

Eqn. 4: $[Annual\ Emissions, lbs\ Ni/yr] = [Emission\ Factor, lbs\ Ni/lb\ Ni\ sprayed] * [Annual\ Usage, lbs\ Ni\ sprayed/yr]$

Step 7 – Maximum Hourly Nickel Emissions: For each thermal spraying operation that uses nickel, calculate the maximum hourly emissions by multiplying the applicable emission factors by the maximum hourly usage rates, using the following equations:

Eqn. 5:

[Max. Hourly Emissions, lbs Ni/hr] = [Emission Factor, lbs Ni/lb Ni sprayed][Max. Hourly Usage, lbs Ni sprayed/hr]*

Eqn. 6:

[Max. Hourly Usage, lbs Ni sprayed/hr] = [Max. Gun Spray Rate, lbs material sprayed/hr][Max. wt.% Ni in material]*

where

“Maximum Gun Spray Rate” is the highest material throughput rate that a thermal spraying gun can achieve, based on manufacturer specifications or actual user experience, whichever is greater. If multiple guns have the potential to be operated at the same time (e.g., in two separate booths), the maximum gun spray rate must include the total throughput from all guns.

“Maximum Weight % Nickel in Material” is the highest weight percentage of nickel for all of the thermal spraying materials that are used in thermal spraying operations at a facility.

Point Source Example:

Thermal Spraying Inc. operates two thermal spraying booths. One booth is used for plasma spraying and the other booth is used for flame spraying and twin-wire electric arc spraying. Listed below is information on the facility's operations:

Booth	Control Device	Operation	Materials Used	Quantity Used	% Total Chromium	% Nickel
Booth #1	HEPA Filter	Plasma Spray	Powder ABC	25 lbs/yr	25%	0%
			Powder XYZ	50 lbs/yr	20%	75%
Booth #2	Dry Filter (99% effic.)	Flame Spray	Powder 123	10 lbs/yr	0%	95%
			Powder XYZ	75 lbs/yr	20%	75%
		Twin-Wire	Wire #1	80 lbs/yr	20%	5%

An example calculation is provided below for Thermal Spraying Inc.:

Step 1: Identify all thermal spraying materials that contain at least 0.1% by weight of chromium (Cr), chromium compounds, nickel (Ni), or nickel compounds.

The following four products contain chromium or nickel: Powder 123; Powder ABC; Powder XYZ; Wire #1.

Step 2: Determine the total percentage of chromium and/or nickel.

Materials Used	% Total Chromium	% Nickel
Powder 123	0%	95%
Powder ABC	25%	0%
Powder XYZ	20%	75%
Wire #1	20%	5%

If a thermal spraying material contains a compound, include only the portion that is chromium or nickel. For example, if the material contains 95% chromium oxide (Cr₂O₃), the weight percent of chromium would be calculated as follows:

$$[\text{Chromium Weight \%}] = [\text{Weight \% Cr}_2\text{O}_3] * \frac{[\text{Molecular Weight of Chromium (Cr}_2\text{)}]}{[\text{Molecular Weight of Chromium Oxide (Cr}_2\text{O}_3\text{)}]}$$

$$\text{Molecular Weight of Chromium (Cr}_2\text{)} = (52 \text{ g/g-mol}) * (2) = 104 \text{ g/g-mol}$$

$$\text{Molecular Weight of Chromium Oxide (Cr}_2\text{O}_3\text{)} = (52 \text{ g/g-mol}) * (2) + (16) * (3) = 152 \text{ g/g-mol}$$

$$[\text{Chromium Weight \%}] = [95 \% \text{ Cr}_2\text{O}_3] * \frac{[104 \text{ g/g-mol}]}{[152 \text{ g/g-mol}]} = 65\%$$

Step 3: Compile the annual material usage.

Operation	Materials Used	Quantity Used
Plasma Spray	Powder ABC	25 lbs/yr
	Powder XYZ	50 lbs/yr
Flame Spray	Powder 123	10 lbs/yr
	Powder XYZ	75 lbs/yr
Twin-Wire	Wire #1	80 lbs/yr

Step 4: Calculate the annual usage quantities for chromium and nickel.

Materials Used	Quantity Used	% Total Chromium	% Nickel	Qty. of Total Chromium Used	Qty. of Nickel Used
Powder ABC	25 lbs/yr	25%	0%	$[25 \text{ lbs/yr}] \times [25\% \text{ Cr}] = 6.25 \text{ lbs Cr/yr}$	$[25 \text{ lbs/yr}] \times [0\% \text{ Ni}] = 0 \text{ lbs Ni/yr}$
Powder XYZ	50 lbs/yr	20%	75%	$[50 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 10.0 \text{ lbs Cr/yr}$	$[50 \text{ lbs/yr}] \times [75\% \text{ Ni}] = 37.5 \text{ lbs Ni/yr}$
Powder 123	10 lbs/yr	0%	95%	$[10 \text{ lbs/yr}] \times [0\% \text{ Cr}] = 0 \text{ lbs Cr/yr}$	$[10 \text{ lbs/yr}] \times [95\% \text{ Ni}] = 9.5 \text{ lbs Ni/yr}$
Powder XYZ	75 lbs/yr	20%	75%	$[75 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 15.0 \text{ lbs Cr/yr}$	$[75 \text{ lbs/yr}] \times [75\% \text{ Ni}] = 56.25 \text{ lbs Ni/yr}$
Wire #1	80 lbs/yr	20%	5%	$[80 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 16.0 \text{ lbs Cr/yr}$	$[80 \text{ lbs/yr}] \times [5\% \text{ Ni}] = 4.0 \text{ lbs Ni/yr}$

Step 5: Identify the applicable emission factors.

Control Device	Operation	Emission Factor - Hexavalent Chromium (lb Cr ⁺⁶ /lb Cr sprayed)	Emission Factor – Nickel (lb Ni/lb Ni sprayed)
HEPA Filter	Plasma Spray	2.86E-06	1.72E-05
Dry Filter (99% effic.)	Flame Spray	6.20E-05	1.10E-03
	Twin-Wire	6.96E-05	6.0E-05

Step 6: Calculate annual emissions ($[Annual\ Emissions] = [Emission\ Factor] * [Annual\ Usage].$)

For hexavalent chromium, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Total Chromium Used (lbs Cr sprayed/yr)	Emission Factor (lb Cr ⁺⁶ /lb Cr sprayed)	Annual Emissions (lb Cr ⁺⁶ /yr)
#1	HEPA Filter	Plasma Spray	Powder ABC	6.25	2.86E-06	$[6.25] \times [2.86E-06] = 1.79E-05$
			Powder XYZ	10.0	2.86E-06	$[10.0] \times [2.86E-06] = 2.86E-05$
#2	Dry Filter (99% effic.)	Flame Spray	Powder 123	0	6.20E-05	$[0] \times [6.20E-05] = 0$
			Powder XYZ	15.0	6.20E-05	$[15.0] \times [6.20E-05] = 9.30E-04$
		Twin-Wire	Wire #1	16.0	6.96E-05	$[16.0] \times [6.96E-05] = 1.11E-03$
					Total =	0.002

Based on this emission level, Thermal Spraying Inc. is below the Tier 1 threshold for hexavalent chromium. Therefore, no new control efficiency requirements would be imposed by this ATCM because of hexavalent chromium emissions. However, Thermal Spraying Inc. will still need to comply with the permitting, monitoring, and recordkeeping requirements of the ATCM. In addition, if the workload increased and emissions exceeded Tier 1 thresholds, it would be necessary to upgrade the dry filter system or limit the usage of all chromium materials to the booth that has the HEPA filter.

For nickel, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Nickel Used (lbs Ni sprayed/yr)	Emission Factor (lb Ni/lb Ni sprayed)	Annual Emissions (lb Ni/yr)
#1	HEPA Filter	Plasma Spray	Powder ABC	0	1.72E-05	$[0] \times [1.72E-05] = 0$
			Powder XYZ	37.5	1.72E-05	$[37.5] \times [1.72E-05] = 6.45E-04$
#2	Dry Filter (99% effic.)	Flame Spray	Powder 123	9.5	1.10E-03	$[9.5] \times [1.10E-03] = 1.05E-02$
			Powder XYZ	56.25	1.10E-03	$[56.25] \times [1.10E-03] = 6.19E-02$
		Twin-Wire	Wire #1	4.0	6.0E-05	$[4.0] \times [6.0E-05] = 2.40E-04$
					Total =	0.073

Based on this emission level, Thermal Spraying Inc. is below the Tier 1 threshold for nickel. Therefore, no new control efficiency requirements would be imposed by this ATCM because of nickel emissions. However, Thermal Spraying Inc. will still need to comply with the permitting, monitoring, and recordkeeping requirements of the ATCM. In addition, if the workload increased and emissions exceeded Tier 1 thresholds, it would be necessary to upgrade the dry filter system or limit the usage of all nickel materials to the booth that has the HEPA filter.

Step 7: Calculate the maximum hourly emissions for nickel.

Powder 123 is the material that has the highest weight percentage of nickel (95%).
The maximum spray rate for the flame spraying gun is 10 lbs/hr.
The emission factor for flame spraying is 1.10E-03 lb Ni/lb Ni sprayed.

[Maximum Hourly Usage] = [Maximum Gun Spray Rate]*[Maximum Wt.% Nickel]
[Maximum Hourly Usage] = [10 lbs/hr]*[95% Ni] = 9.5 lbs Ni sprayed/hr

[Maximum Hourly Emissions] = [Emission Factor]*[Maximum Hourly Usage]
Maximum Hourly Emissions = [1.10E-03 lb Ni/lb Ni sprayed]*[9.5 lbs Ni sprayed/hr] = 0.01 lb Ni/hr

The maximum hourly emissions for nickel are 0.01 lbs Ni/hr, which is well below the compliance limit of 0.1 lb Ni/hr for point sources. Therefore, this thermal spraying operation complies with the maximum hourly limit for nickel.

Volume Source Example:

Machine Shop Inc. conducts flame spraying with powder on small parts. The parts are turned on a lathe while spraying is being performed. Since the lathe is not located in a booth, the shop uses a portable local exhaust fan to remove fumes from the worker's breathing area. This type of operation would be considered a volume source with 0% control efficiency. Listed below is information on the facility's operations:

Booth	Control Device	Operation	Materials Used	Quantity Used	% Total Chromium	% Nickel
None	None (uncontrolled)	Flame Spray	Powder 123	20 lbs/yr	0%	95%
			Powder XYZ	5 lbs/yr	20%	75%

An example calculation is provided below for Machine Shop Inc.:

Step 1: Identify all thermal spraying materials that contain at least 0.1% by weight of chromium (Cr), chromium compounds, nickel (Ni), or nickel compounds.

The following two products contain chromium or nickel: Powder 123 and Powder XYZ.

Step 2: Determine the total percentage of chromium and/or nickel.

Materials Used	% Total Chromium	% Nickel
Powder 123	0%	95%
Powder XYZ	20%	75%

Step 3: Compile the annual material usage.

Operation	Materials Used	Quantity Used
Flame Spray	Powder 123	20 lbs/yr
	Powder XYZ	5 lbs/yr

Step 4: Calculate the annual usage quantities for chromium and nickel.

Materials Used	Quantity Used	% Total Chromium	% Nickel	Qty. of Total Chromium Used	Qty. of Nickel Used
Powder 123	20 lbs/yr	0%	95%	$[20 \text{ lbs/yr}] \times [0\% \text{ Cr}] = 0 \text{ lbs Cr/yr}$	$[20 \text{ lbs/yr}] \times [95\% \text{ Ni}] = 19.0 \text{ lbs Ni/yr}$
Powder XYZ	5 lbs/yr	20%	75%	$[5 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 1.0 \text{ lbs Cr/yr}$	$[5 \text{ lbs/yr}] \times [75\% \text{ Ni}] = 3.75 \text{ lbs Ni/yr}$

Step 5: Identify the applicable emission factors.

Control Device	Operation	Emission Factor - Hexavalent Chromium (lb Cr ⁺⁶ /lb Cr sprayed)	Emission Factor – Nickel (lb Ni/lb Ni sprayed)
Uncontrolled	Flame Spray	6.20E-03	1.10E-01

Step 6: Calculate annual emissions ($[Annual\ Emissions] = [Emission\ Factor] \times [Annual\ Usage]$).

For hexavalent chromium, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Total Chromium Used (lbs Cr sprayed/yr)	Emission Factor (lb Cr ⁺⁶ /lb Cr sprayed)	Annual Emissions (lb Cr ⁺⁶ /yr)
None	None	Flame Spray	Powder 123	0	6.20E-03	$[0] \times [6.20E-03] = 0$
			Powder XYZ	1.0	6.20E-03	$[1.0] \times [6.20E-03] = 6.20E-03$
					Total =	0.006

Based on this emission level, Machine Shop Inc. is classified as Tier 1 for hexavalent chromium. Therefore, the thermal spraying operation would need to install a new booth with a control device that met the Tier 1 minimum efficiency requirement of 99%. In addition, Machine Shop Inc. would need to comply with the permitting, monitoring, and recordkeeping requirements of the ATCM. Machine Shop Inc. could avoid having to install a new booth and control device, if they eliminated the use of chromium-containing materials.

For nickel, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Nickel Used (lbs Ni sprayed/yr)	Emission Factor (lb Ni/lb Ni sprayed)	Annual Emissions (lb Ni/yr)
None	None	Flame Spray	Powder 123	19.0	1.10E-01	$[19.0] \times [1.10E-01] = 2.09$
			Powder XYZ	3.75	1.10E-01	$[3.75] \times [1.10E-01] = 4.13E-01$
					Total =	2.50

Based on this emission level, Machine Shop Inc. is below the Tier 1 threshold for nickel. Therefore, no new control efficiency requirements would be imposed by this ATCM because of nickel emissions. However, this ATCM requires thermal spraying operations to comply with the most stringent control efficiency. Since the control efficiency requirement based on hexavalent chromium is the most stringent, they must comply with the 99% control efficiency.

Step 7: Calculate the maximum hourly emissions for nickel.

Powder 123 is the material that has the highest weight percentage of nickel (95%).
The maximum spray rate for the flame spraying gun is 10 lbs/hr.
The emission factor for flame spraying is 1.10E-01 lb Ni/lb Ni sprayed.

[Maximum Hourly Usage] = [Maximum Gun Spray Rate]*[Maximum Wt. % Nickel]
[Maximum Hourly Usage] = [10 lbs/hr]*[95 % Ni] = 9.5 lbs Ni sprayed/hr

[Maximum Hourly Emissions] = [Emission Factor]*[Maximum Hourly Usage]
Maximum Hourly Emissions = [1.10E-01 lb Ni/lb Ni sprayed]*[9.5 lbs Ni sprayed/hr] = 1.1 lb Ni/hr

The maximum hourly emissions for nickel are 1.1 lbs Ni/hr, which exceeds the compliance limit of 0.01 lb Ni/hr for volume sources. Therefore, this thermal spraying operation does not comply with the maximum hourly limit for nickel and it would be necessary to reduce emissions (e.g., install a control device, limit usage, etc.)

Appendix 2 – Method for Measuring Inward Face Velocity

Inward face velocity must be measured at least once every calendar year and whenever the air pollution control system is changed in any way that may impact air flow to ensure that the ventilation system is working properly. Measurements must be conducted in accordance with the procedures specified in this Appendix 2 or an alternative method approved by the permitting agency.

1. Hood Measurement:

Divide the face of the hood, the slot area, or the normal plane, at the capture velocity measurement point into equal area rectangles (see Figure 1). The side of each rectangular area should be no longer than 12 inches. Measure the air velocity (fpm) at the center of each rectangle using a calibrated anemometer or other measuring device approved by the permitting agency. The velocity measuring device must have an accuracy of at least $\pm 10\%$ of full scale. The measuring device must be in good condition, of proper velocity range, and operated according to the manufacturer's instructions. The measuring device must be calibrated in accordance with the manufacturer's recommendations. Do not block or disturb the airflow while taking the readings.

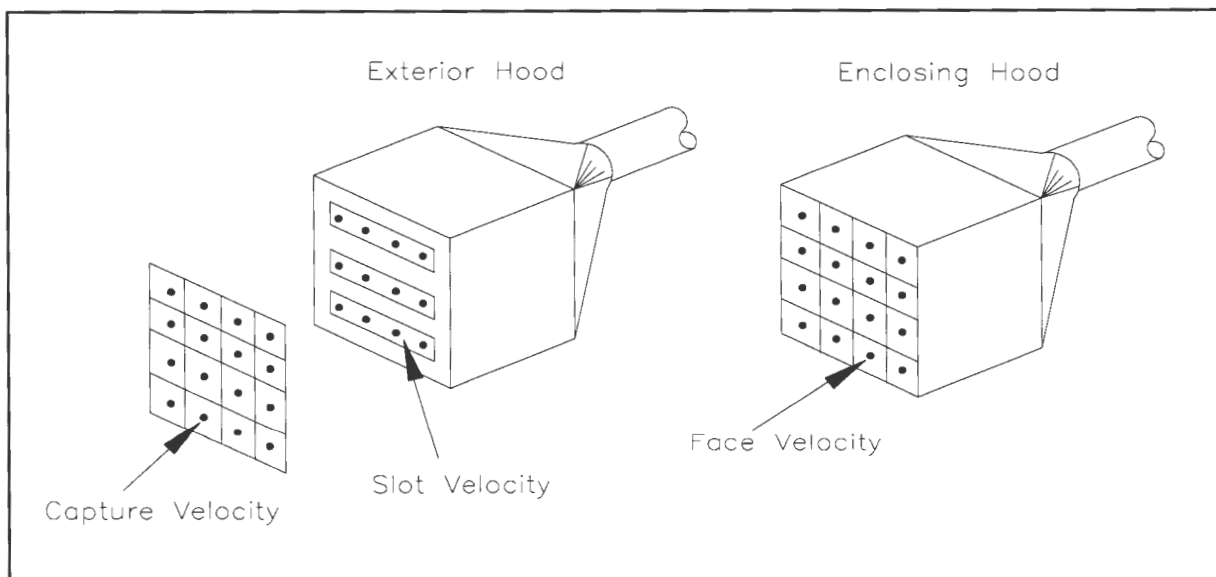


Figure 1: Airflow distribution measurement for an exterior hood and an enclosing hood

Measure the volumetric airflow rate through the hood by measuring the velocity at the center of each equal-sized rectangular area (i.e., by performing pitot traverses.) If no suitable location exists for performing complete pitot traverses, measure the slot velocity and use this data to estimate the volumetric airflow rate through a hood.

2. Walk-in Booth Measurement:

For a cross-draft walk-in booth (i.e., air enters through filters in the front of the booth and leaves through filters in the back of the booth):

Divide the **length** of the booth into at least three cross-sectional areas to obtain the velocity profile in the booth. One cross-sectional area must be located near the exhaust plenum, one close to the supply plenum, and the other in the middle of the booth. Figure 2 illustrates the location of cross-sectional areas. Record the distance between each cross-sectional area and the exhaust or supply plenums. The distance between each cross-sectional area must not exceed ten feet.

Lay out imaginary grid lines through each cross sectional area. Use the intersections of the grid lines as locations to measure velocities inside the booth. The intersection points must be no more than six feet apart. Record the location of each point on the grid. Measure the air velocity (fpm) at each intersection point on the grid using a calibrated anemometer or other measuring device approved by the permitting agency. The velocity measuring device must have an accuracy of at least $\pm 10\%$ of full scale. The measuring device must be in good condition, of proper velocity range, and operated according to the manufacturer's instructions. The measuring device must be calibrated in accordance with the manufacturer's recommendations.

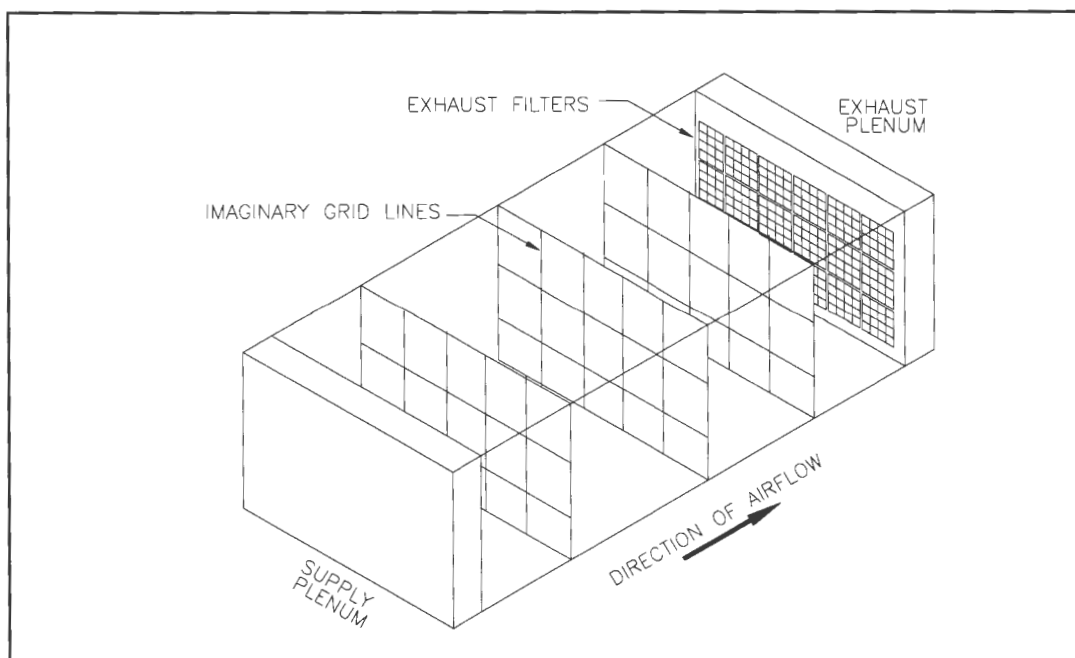


Figure 2: Airflow distribution measurement inside a cross-draft walk-in booth

For a down-draft walk-in booth (i.e., air enters through filters in the ceiling of the booth and leaves through filters that cover trenches under a metal grate floor):

Divide the **height** of the booth into at least three cross-sectional areas to obtain the velocity profile in the booth. One cross-sectional area must be located near the exhaust plenum, one close to the supply plenum, and the other in the middle of the booth. Record the distance between each cross-sectional area and the exhaust or supply plenums. The distance between each cross-sectional area must not exceed ten feet.

Lay out imaginary grid lines through each cross sectional area. Use the intersections of the grid lines as locations to measure velocities inside the booth. The intersection points must be no more than six feet apart. Record the location of each point on the grid. Measure the air velocity (fpm) at each intersection point on the grid using a calibrated anemometer or other measuring device approved by the permitting agency. The velocity measuring device must have an accuracy of at least $\pm 10\%$ of full scale. The measuring device must be in good condition, of proper velocity range, and operated according to the manufacturer's instructions. The measuring device must be calibrated in accordance with the manufacturer's recommendations.

3. Average Value of Readings

Calculate the average value for all velocity readings, if all individual readings are within $\pm 20\%$ of the average value. Do not include turbulent readings when calculating the average (turbulent airflow may be indicated by negative or zero velocity readings.) Record and make available for inspection by the permitting agency the entire velocity profile to show the airflow distribution.

Examples:

Hood A – Velocity Readings (fpm)		
100	90	110
85	115	100
105	95	100
Average Velocity = $900 \text{ fpm} / 9 = 100 \text{ fpm}$		

Hood B – Velocity Readings (fpm)		
200	200	0
200	50	0
100	-5 *	-45 *
Average velocity = $750 \text{ fpm} / 7 = 107 \text{ fpm}^{**}$		

* Negative values indicate airflow in reverse direction and are not included in the average.

** This is not a valid average, because individual readings are not within $\pm 20\%$ of the average. The booth airflow needs to be adjusted and balanced before the velocity is measured again.

Appendix 3 – Leak Check Visual Inspection Checklist

Visual inspections must be conducted at least once every 90 days to ensure that no leaks are present in the control device or ventilation system. At a minimum, the inspection must include the items listed in the following checklist that are applicable. In addition to the items on this checklist, thermal spraying operations must inspect items in accordance with manufacturers' recommendations.

✓ Acceptable
✗ Unacceptable

Item to be Inspected	Look For -	Dates of Inspection:			
1. Hoods	Dents, holes, corrosion				
2. Ductwork	Dents, holes, corrosion				
	Blockages, plugging				
3. Dampers	Deterioration of seals/gaskets				
	Settings				
4. Access doors	Deterioration of seals/gaskets				
	Gaps when door is closed				
5. Fan housing	Deterioration of seals/gaskets				
	Gaps in connection to ductwork				
6. Dry filter media	Holes, gaps, abrasions				
	Does filter need to be changed?				
	Dust on clean side of filter?				
7. Dry filter mounting frame	Deterioration of seals/gaskets				
8. Other items inspected (provide descriptions):					
9. Corrective actions (provide descriptions & dates):					
10. Initials of person doing inspection:					

NOTE: Authority Cited: Sections 39600, 39601, 39650, 39658, 39659, 39666, and 41511, Health and Safety Code. Reference: Sections 39650, 39658, 39659, 39666, and 41511, Health and Safety Code

Appendix C

Methodology for Estimating Hexavalent Chromium Emissions from Thermal Spraying

C.1. Introduction

Hexavalent chromium emissions from thermal spraying can be estimated by direct measurement of facility exhaust gases or by performing calculations based on material usage. Measurement of exhaust gases is generally the preferred method for individual facilities, but conducting stack exhaust tests can be costly. Therefore, we have developed calculation methods that can be used to estimate hexavalent chromium emissions for different types of thermal spraying processes and the associated air pollution control devices. The following sections describe the process that was used to develop emission estimation methods for thermal spraying.

C.2. Hexavalent Chromium Fumes from Thermal Spraying

Hexavalent chromium and hexavalent chromium compounds are classified as toxic air contaminants, but hexavalent chromium compounds are not generally present in thermal spraying materials as a raw ingredient. The types of chromium that are listed as ingredients include:

- Chromium CAS # 7440-47-3
- Chromium +3 (trivalent) CAS # 16065-83-1
- Chromium Oxide CAS # 1308-38-9

Even though hexavalent chromium compounds are not originally present in thermal spraying materials, numerous stack tests have measured emissions of hexavalent chromium from thermal spraying facilities. This indicates that a conversion occurs during the thermal spraying process to change chromium from an elemental or trivalent state to a hexavalent state. A supplier of thermal spraying materials has found that hexavalent chromium may be produced when materials are exposed to the high temperatures that are involved in many thermal spraying processes (Praxair, 2002). In addition, a thermal spraying industry report states that vaporized metallic chromium can cause a small fraction of the chromium to oxidize and form chromates that contain a hexavalent form of chromium (Smith, 1994). This conversion to hexavalent chromium was measured during Sawatari's study of a plasma metal spraying process with chromium metal (Sawatari, 1986). Researchers used a METCO 7MC plasma metal sprayer and 99.9% chromium powder to generate fumes that were then analyzed to determine the hexavalent chromium content. Total chromium was determined with an atomic absorption spectrometer. Hexavalent chromium was determined by the colorimetric method, using an ultraviolet-visible (UV-Vis) spectrophotometer. Results indicated that metallic chromium was undetectable in the fumes (less than 0.5% of the total), but the fumes did contain 30% hexavalent chromium compounds as shown in Table C-1.

Table C-1:
Chromium Compounds in Plasma Spraying Fumes

Name of Compound	CAS #	MW*	% of Total
Dichromium Trioxide (Cr ₂ O ₃) [corundum structure]	1308-38-9	152	25%
Chromium (VI) Trioxide (CrO₃)	1333-82-0	100	3%
Mixed Oxide Fraction Containing:			
Dichromium (III) Trioxide (Cr ₂ O ₃)	1308-38-9	152	45%
Chromium (VI) Trioxide (CrO₃)	1333-82-0	100	27%
		Total =	100%

*MW = Molecular Weight, grams/mole

In another study, researchers used a plasma spraying gun to generate metal fumes from chromium powder. Total chromium was determined with an atomic absorption spectrometer. Hexavalent chromium was determined by the colorimetric method, using an ultraviolet-visible (UV-Vis) spectrophotometer. Chemical analysis determined that 26.4% of the total chromium was hexavalent and the residue was trivalent (Serita, 1990). These results are consistent with the values obtained from Sawatari's study.

The California Occupational Safety and Health Administration (Cal/OSHA) conducted additional research on plasma spraying activities (Gold, 2000). They conducted personal air sampling during two days of plasma spraying activities and measured the concentrations of hexavalent chromium, total chromium, and nickel. Hexavalent chromium was measured using the following analytical methods: NIOSH 7600 (visible absorption spectrophotometry), NIOSH 7604 (ion chromatography conductivity detection), and OSHA 215 (ion chromatography with UV-Vis detector). For the first day, the hexavalent chromium concentration was 0.074 mg/m³ for two different samples, while the total chromium concentration was 0.110 mg/m³ for one sample and 0.230 mg/m³ for the other sample. On the second day, hexavalent chromium levels were much higher, measuring 0.646 mg/m³ for one sample and 7.230 mg/m³ for the other sample, while total chromium was 10.172 mg/m³ and 27.258 mg/m³, respectively. Based on these results, it is possible to estimate the percentage of total chromium that is in the hexavalent form (e.g., 0.074 / 0.110 mg/m³ = 67%). The average percentage of hexavalent chromium is 33%, which is consistent with the results from the Sawatari and Serita studies.

Hexavalent chromium emissions were also measured during a NIOSH Health Hazard Evaluation at a thermal spraying facility (NIOSH, 1989). Air samples were collected while workers conducted electric arc spraying with wires made of stainless steel, bronze, and alcro (aluminum, chromium, and iron). These samples were analyzed for a variety of metals, including hexavalent chromium, total chromium, and nickel. Hexavalent chromium was measured using the analytical method of NIOSH 7600 (visible absorption spectrophotometry.) During twelve sampling events, hexavalent chromium was detected in concentrations ranging from 0.12 to 0.34 mg/m³ at the face of the ventilation hood. Total chromium concentrations ranged from 1.82 to 2.22 mg/m³ and the average percentage of hexavalent chromium was 11%. These results confirm that hexavalent chromium is generated during electric arc spraying, but the percentage of hexavalent chromium in the fumes is lower than has been measured for plasma

spraying. This may be because plasma spraying generates much higher temperatures and particle velocities than electric arc spraying.

As these studies demonstrate, the formation of hexavalent chromium during thermal spraying has been documented for a variety of sources, but the quantities that are emitted can vary widely, depending on the type of process and the type of control device. Some stack tests have found that more than 90% of the total chromium being measured consists of hexavalent chromium, while other tests have found less than 5%. The most conservative approach for estimating statewide emissions would be to assume maximum conversion to hexavalent chromium and complete consumption of all materials sold in California during 2002. However, ARB staff has developed a method that involves estimating emissions by compiling data from a variety of sources and a range of control devices. The following sections describe the different sources that were used to develop emission factors and estimate hexavalent chromium emissions on an annual basis and an hourly (average and maximum) basis.

C.2.1. Particle Sizes

Emissions and control device efficiencies are dependent on the size of the particles that are generated by thermal spraying processes. Some research has been done to measure particle sizes for thermal spraying processes and the results indicate that particle diameters can range from less than one micron to more than 100 microns. In Serita's study, fume particles from a plasma spraying gun were examined with a scanning electron microscope. The mass median aerodynamic diameter and the geometric standard deviation of the chromium fumes were 2.1 μm and 2.00, respectively. Those of the nickel fumes were 3.7 μm and 1.74, respectively (Serita, 1990). Chadwick's study also used a scanning electron microscope to examine fume particulate generated by electric arc, plasma and detonation gun spraying. This study found that particles were of two distinct types: crystalline/angular particles with diameters from 5 μm to 20 μm and smaller spherical particles ranging from <1 μm to 10 μm . Both plasma and detonation gun spraying produced a high proportion of particles with a diameter <2 μm (Chadwick, 1997.) Both Chadwick's and Serita's studies indicate that metal fumes from thermal spraying contain a large portion of particles that are less than 5 μm . We also found data on the "dust" that is generated by thermal spraying. Table C-2 contains particle size distributions for a variety of thermal spraying processes and the results indicate that 90% of the dust particles are larger than 5 microns (Smith, 1994). The analytical method that was used to measure these particles was not provided.

Table C-2:
Typical Particle Size Distributions in Dust of Thermal Spray Processes

Process	1 um	>1-5 um	5-10 um	10-50 um	50-100 um	>100 um
Flame/Wire Metallizing	2	8	10	20	40	20
Wire-Arc (Zinc)	-	1	2	21	-	76
Wire-Arc (Aluminum)	10	-	3	-	87	-
Powder/Flame	1	9	20	30	30	10
HVOF	1	9	30	55	5	-
Plasma	3	7	30	40	20	-

(Smith, 1994)

C.3. Hexavalent Chromium Emission Factors - Summary

The general approach for estimating emissions involves multiplying emission factors by usage rates. Emission factors were obtained from a variety of sources, based on the type of process, the form of material being used (i.e., powder or wire), and the type of control device. In some cases, emission factors were taken directly from stack test results, while other factors were derived from a combination of stack test results, research data, and data on control efficiencies. Table C-3 summarizes the emission factors that were used and Section C.4 describes how these factors were derived.

Table C-3:
Emission Factor Summary – Hexavalent Chromium

Process	Emission Factors (lbs Cr ⁺⁶ /lb Cr sprayed)			
	0% Ctl. Eff. (Uncontrolled)	90% Ctl. Eff. ¹ (e.g. Water Curtain)	99% Ctl. Eff. (e.g. Dry Filter)	99.97% Ctl. Eff. (e.g., HEPA Filter)
Single-Wire Flame Spray ²	4.68E-03	4.68E-04	4.68E-05	1.40E-06
Twin-Wire Electric Arc Spray ²	6.96E-03	6.96E-04	6.96E-05	2.09E-06
Flame Spray ³	6.20E-03	1.17E-03	6.20E-05	1.86E-06
HVOF ³	6.20E-03	1.17E-03	6.20E-05	1.86E-06
Plasma Spray ⁴	1.18E-02	6.73E-03	2.61E-03	2.86E-06
Other Thermal Spraying ⁵	7.17E-03	2.05E-03	5.70E-04	2.01E-06

1. Listed below the control efficiencies are examples of control devices that may meet the control efficiency.
2. Emission factors based on Battelle study.
3. Emission factors based on SDAPCD stack test data for flame spraying.
4. Emission factors based on stack test results compiled by CATEF, SCAQMD, and SDAPCD.
5. For "Other Thermal Spraying" processes, we used an average of the emission factors for the listed thermal spraying processes.

C.4. Emission Factor Development

The following sections describe how emission factors are derived from various sources for different types of thermal spraying processes and control devices. In each case, emission factors are developed for operations that had no air pollution control devices (i.e., uncontrolled) and for operations that had control devices (i.e., controlled).

C.4.1. Emission Factors: Flame Spraying & Electric Arc Spraying with Wire

Emission factors for wire spraying are based on a study that was conducted by Battelle for the American Welding Society. The study was primarily focused on measuring fumes from welding, but it also included using an enclosed fume collection chamber to measure the quantities of fumes generated by combustion flame spraying with stainless steel wire, and twin-wire electric arc spraying with stainless steel wire (AWS, 1979.) Results of the study are summarized in Table C-4.

Table C-4:

Fume Generation Rates - Flame Spraying & Electric Arc Spraying with Wire

Process	$\frac{\text{wt. of fumes}}{\text{wt. of metal sprayed}}$ (grams/kg)	Total Chromium Content in Fumes (weight %)	Type of Wire
Single-Wire Flame Spray	16.6	8-15	316 Stainless Steel (16-18 % Cr)
Twin-Wire Electric Arc Spray (AWS, 1979)	19.75	10-20	Proprietary Stainless Steel (17-18 % Cr)

The results of this study can be used to determine the maximum pounds of total chromium fumes that are generated for each pound of chromium sprayed.

$$\begin{aligned} [\text{max. wt. of total chromium in fumes}] &= [\text{wt. of fumes}] * [\text{max. total chromium content in fumes}] \\ [\text{min. wt. of total chromium sprayed}] &= [\text{wt. of metal sprayed}] * [\text{min. chromium content of metal}] \end{aligned}$$

Flame Spray (wire):

$$\begin{aligned} [\text{max. wt. of total chromium in fumes}] &= [16.6 \text{ grams}] * [15\%] = 2.49 \text{ grams} \\ [\text{min. wt. of total chromium sprayed}] &= [1 \text{ kg metal}] * [16\%] = 0.16 \text{ kg} = 160 \text{ grams} \\ \text{max. wt. of total Cr in fumes per lb. of total Cr sprayed} &= [2.49 \text{ g}] / [160 \text{ g}] = 1.56\text{E-}02 \text{ g Cr/g Cr sprayed} \\ &= 1.56\text{E-}02 \text{ lb Cr/lb Cr sprayed} \end{aligned}$$

Electric Arc:

$$\begin{aligned} [\text{max. wt. of total chromium in fumes}] &= [19.75 \text{ grams}] * [20\%] = 3.95 \text{ grams} \\ [\text{min. wt. of total chromium sprayed}] &= [1 \text{ kg metal}] * [17\%] = 0.170 \text{ kg} = 170 \text{ grams} \\ \text{max. wt. of total Cr in fumes per lb. of total Cr sprayed} &= [3.95 \text{ g}] / [170 \text{ g}] = 2.32\text{E-}02 \text{ g Cr/g Cr sprayed} \\ &= 2.32\text{E-}02 \text{ lb Cr/lb Cr sprayed} \end{aligned}$$

Since the study only measured total chromium, we used the conclusions of the Sawatari study and other studies to estimate that 30% of the total chromium consists of hexavalent chromium. Listed below are the uncontrolled emission factors for wire spraying processes.

$$\text{Flame Spray (wire): } [1.56\text{E-}02] * [30\%] = \mathbf{4.68\text{E-}03} \text{ lb Cr}^{+6} / \text{lb chromium sprayed}$$

$$\text{Electric Arc: } [2.32\text{E-}02] * [30\%] = \mathbf{6.96\text{E-}03} \text{ lb Cr}^{+6} / \text{lb chromium sprayed}$$

To determine controlled emission factors, we used the following equation:

$$\text{Eqn. 1: } [\text{Controlled Emission Factor}] = [\text{Uncontrolled Emission Factor}] * [1 - \text{Control Efficiency}]$$

Controlled emission factors for wire were developed for the following levels of control:

<u>Control Efficiency Levels</u>	
90%	(e.g., a water curtain)
99%	(e.g., dry filter)
99.97%	(e.g., a HEPA filter)

The actual control efficiency for a control device at a particular facility can depend on specific parameters (e.g., particle size, filter media, etc.), but the control efficiencies listed above are consistent with general industry estimates. Calculations for controlled emission factors are provided below:

Flame (wire) –

90% (e.g., water curtain): $[4.68\text{E-}03 \text{ lb Cr}^{+6}/\text{lb wire}] * [1 - 0.90] = 4.68\text{E-}04 \text{ lb Cr}^{+6}/\text{lb Cr}$

99% (e.g., dry filter): $[4.68\text{E-}03 \text{ lb Cr}^{+6}/\text{lb wire}] * [1 - 0.99] = 4.68\text{E-}05 \text{ lb Cr}^{+6}/\text{lb Cr}$

99.97% (e.g., HEPA filter): $[4.68\text{E-}03 \text{ lb Cr}^{+6}/\text{lb wire}] * [1 - 0.9997] = 1.40\text{E-}06 \text{ lb Cr}^{+6}/\text{lb Cr}$

Electric Arc –

90% (e.g., water curtain): $[6.96\text{E-}03 \text{ lb Cr}^{+6}/\text{lb wire}] * [1 - 0.90] = 6.96\text{E-}04 \text{ lb Cr}^{+6}/\text{lb Cr}$

99% (e.g., dry filter): $[6.96\text{E-}03 \text{ lb Cr}^{+6}/\text{lb wire}] * [1 - 0.99] = 6.96\text{E-}05 \text{ lb Cr}^{+6}/\text{lb Cr}$

99.97% (e.g., HEPA filter): $[6.96\text{E-}03 \text{ lb Cr}^{+6}/\text{lb wire}] * [1 - 0.9997] = 2.09\text{E-}06 \text{ lb Cr}^{+6}/\text{lb Cr}$

C.4.2. California Air Toxic Emission Factors – Thermal Spraying

ARB has developed a database of California Air Toxic Emission Factors (CATEF), based on source test data that were compiled for the Air Toxics Hot Spots Program. Source test reports were reviewed to verify the validity of the test methods and results. The validated report data were then used to develop the CATEF emission factors. The CATEF II database can be accessed on the ARB website (<http://www.arb.ca.gov/emisinv/catef/catef.htm>) and it includes a search function that enables users to identify emission factors for specific Source Classification Codes (SCCs). For thermal spraying, the CATEF II database contains emission factors for general thermal spraying of powdered metal (SCC 30904010) and plasma spraying of powdered metal (SCC 30904020).

CATEF contains thermal spraying emission factors for hexavalent chromium and total chromium, as shown in Table C-5. The factors are based on the quantity of material sprayed. To determine the emission factor based on the quantity of chromium metal sprayed, we used the following equation:

$$\text{Eqn. 2: Emission Factor, } \frac{\text{lbs Cr}^{+6}}{\text{lb chromium}} = \text{Emission Factor, } \frac{\text{lbs Cr}^{+6}}{\text{lb material}} \times \frac{1}{\text{wt\% chromium in material}}$$

Different factors are provided based on the type of material that was sprayed and the air pollution control device (APC Device). In some cases, the APC Device is listed as an air filter, but no data were provided regarding control efficiency. Therefore, we have

assumed that the air filters have a control efficiency of 99%, which is a low-end, conservative assumption for the efficiency of a dry filter system.

Table C-5:
Emission Factors – CATEF: Thermal Spraying Processes

Process*	APC Device	Material Type		Hexavalent Chromium Emission Factors		Total Chromium Emission Factors	
		Description	Wt % Cr	(lbs Cr ⁺⁶ /lb matl used)	(lbs Cr ⁺⁶ /lb Cr used)	(lbs total Cr/lb matl used)	(lbs total Cr/lb Cr used)
General Thermal Spray	None	8.5% Cr	8.5%	3.34E-05	3.93E-04	3.82E-03	4.49E-02
Plasma Spray	None	75%Cr ₃ C ₂ , 20%NiCr, 5% Cr	Unk.	1.63E-02	-	3.75E-01	-
Plasma Spray	None	80%Ni, 20%Cr	20%	2.58E-04	1.29E-03	1.86E-03	9.30E-03
Plasma Spray	None	100% Chromium Oxide	68%	8.90E-03	1.31E-02	1.42E-01	2.09E-01
Plasma Spray	Air Filter	70%Ni, 4%Cr	4%	1.81E-04	4.53E-03	1.86E-04	4.65E-03
Plasma Spray	Air Filter	49% Ni, 44%Cr	44%	3.01E-04	6.84E-04	4.03E-04	9.16E-04

* General Thermal Spraying of Powdered Metal – SCC 30904010

Plasma Arc Spraying of Powdered Metal – SCC 30904020

"Unk." – The total weight percent for chromium is unknown, because the chromium weight percentage in the Nickel-Chromium (NiCr) alloy was not specified.

Average CATEF hexavalent chromium emission factors were calculated as follows:

Plasma Spraying – Uncontrolled: $(1.29E-03 + 1.31E-02)/2 = 7.20E-03$ lbs Cr⁺⁶/ lb Cr used

Plasma Spraying – Air Filter: $(4.53E-03 + 6.84E-04)/2 = 2.61E-03$ lbs Cr⁺⁶/ lb Cr used

The uncontrolled CATEF value was then combined with factors from other sources to develop an overall average emission factor for plasma spraying (see Section C.4.5.)

C.4.3. SDAPCD Emission Factors for Plasma Spraying & Flame Spraying

The San Diego County Air Pollution Control District (SDAPCD) has compiled the following emission factors for various plasma spraying and flame spraying facilities, based on stack test data (SDAPCD, 1998).

Table C-6:
SDAPCD Emission Factors – Hexavalent Chromium and Nonhexavalent Chromium

SDAPCD Method #	Process	Control Device	Emission Factors	
			(lb Cr ⁺⁶ /lb Cr sprayed)	(lb non-hex Cr/lb Cr)
M01	Plasma Spray	HEPA	3.94E-06	3.31E-05
M02	Plasma Spray	HEPA	2.19E-06	1.35E-05
M03	Plasma Spray	HEPA	3.07E-06	2.32E-05
M04	Plasma Spray	Water Curtain	1.02E-03	2.70E-04
M05	Plasma Spray	Water Curtain	2.83E-03	2.08E-02
M06	Plasma Spray	Water Curtain	1.93E-03	1.05E-02
M08	Flame Spray	HEPA	1.86E-06*	1.52E-04
M09	Flame Spray	Water Curtain	1.17E-03*	7.15E-02

* Bold highlighting indicates a value that appears in the emission factor summary table.

For flame spraying facilities, the following controlled emission factors were used from SDAPCD Methods M08 and M09 –

HEPA Filter: **1.86E-06** lbs Cr⁺⁶/lb chromium sprayed
Water Wash Booth: **1.17E-03** lbs Cr⁺⁶/lb chromium sprayed

To determine an uncontrolled emission factor for a flame spraying facility, we used the following equation:

$$\text{Eqn. 3: } [\text{Uncontrolled Emission Factor}] = [\text{Controlled Emission Factor}] / [1 - \text{Control Efficiency}]$$

The uncontrolled emission factor for flame spraying was calculated as shown below:

Emission Factor for Flame Spraying with a HEPA Filter = 1.86E-06 lb Cr⁺⁶/lb Cr sprayed
Estimated Control Efficiency for a HEPA Filter = 99.97%
[Uncontrolled Emission Factor] = [1.86E-06]/[1 - 0.9997] = **6.2E-03** lb Cr⁺⁶/lb Cr sprayed

The emission factor for flame spraying with a dry filter was calculated as shown below:

Uncontrolled Emission Factor for Flame Spraying = 6.2E-03 lb Cr⁺⁶/lb Cr sprayed
Control Efficiency = 99% (e.g., a dry filter)
[Controlled Emission Factor @ 99%] = [6.2E-03]*[1 - 0.99] = **6.2E-05** lb Cr⁺⁶/lb Cr sprayed

The emission factors for flame spraying were also used to estimate emissions from HVOF processes, because they are both combustion-based operations that achieve comparable temperatures.

The emission factors in Table C-6 are based on stack test data from several thermal spraying facilities in the San Diego area. ARB staff reviewed these stack test results and selected tests that had the strongest staff evaluations. In addition to these tests, SDAPCD provided results from two stack tests that were conducted in 2002 at a plasma spraying facility. For plasma spraying, results from the following eight tests were selected to develop an average emission factor. All of the tests in Table C-6 used ARB Method 425 to measure hexavalent chromium emissions.

Table C-6:
Stack Test Results from Plasma Spraying Facilities in SDAPCD

Test #	Control Device	Material Sprayed During Test		Emissions (lbs Cr ⁺⁶ /hr) per ARB Method 425	Emission Factor	
		Spray Rate (lb/hr)	Wt.% Chromium		(lbs Cr ⁺⁶ / lb Cr sprayed)	(lbs total Cr/ lb Cr)
#1	HEPA	19.1	20.3%	1.037E-05	2.67E-06	2.36E-05
#2	Water Wash Booth	1.24	25.5%	5.23E-04	1.66E-03	1.64E-03
#3	HEPA	13.4	20%	1.03E-05	3.94E-06	3.70E-05
#4	Water Wash Booth	11.5	20%	6.15E-04	2.67E-04	6.72E-04
#5	HEPA	7.27	19%	8.19E-06	5.96E-06	2.02E-05
#6	HEPA	9.37	19%	6.59E-06	3.74E-06	1.62E-05
#7	HEPA	10.09	19%	8.28E-07	4.32E-07	6.42E-05
#8	HEPA	9.8	19%	8.29E-07	4.44E-07	1.06E-04
Average:				HEPA	2.86E-06	4.45E-05
Average:				Water Wash	9.64E-04	1.16E-03

(ERM, 1995; SCEC, 1998; SCEC, 1998a; SCEC, 2001; SDAPCD, 2002; SDAPCD, 2004)

The average value for the water wash booth in Table C-6 was combined with other data to develop an overall average emission factor for plasma spraying (see Section C.4.5.)

C.4.4. SCAQMD Emission Factors for Plasma Spraying

The South Coast Air Quality Management District (SCAQMD) worked with Pacific Environmental Services to develop an emission inventory for metal welding, cutting, and spraying operations. In May, 2000, Pacific Environmental Services completed an emission inventory report which contained metal spraying emission factors for total chromium (PES, 2000). The emission factors for total chromium were based on stack tests that were conducted at six facilities in the SCAQMD and the SDAPCD from 1987 to 1991. All of the facilities conducted plasma spraying during the stack tests. The report did not recommend an emission factor for hexavalent chromium, because the authors felt that the stack tests were conducted before improvements in laboratory methods allowed for reliable discrimination between total and hexavalent chromium. However, the report did refer to the previously cited Sawatari study which found that the fumes from plasma spraying contain approximately 30% hexavalent chromium (Sawatari, 1986).

The SCAQMD report concluded that the data could be reduced to two emission factors: one factor for a facility with a HEPA filter (1.0×10^{-5} lb total Cr/lb Cr sprayed), and another factor for all other facilities (5.1×10^{-2} lb total Cr/lb Cr sprayed). For the purposes of this report, we have reviewed the available stack test data and have used the results from 10 test runs at facilities with water curtains and 2 test runs at uncontrolled facilities to support development of our emission factors. The tests were conducted from 1989 to 1991. Listed below are average emission factors for total chromium and hexavalent chromium, based on the stack test data in the SCAQMD report (see Table C-7).

Table C-7:
Emission Factors – SCAQMD Plasma Spraying

Control Devices	Emission Factors		Test Methods
	(lb total chromium/ lb Cr sprayed) ¹	(lb Cr ⁺⁶ / lb Cr sprayed) ²	
Water Curtain	4.15E-02	1.25E-02	ARB Method 425 SCAQMD Method 205.1
Uncontrolled	5.44E-02	1.63E-02	Unknown

1. These values are based on stack test results in the SCAQMD report (PES, 2000.)

2. These values are based on the assumption that 30% of the total chromium is in the hexavalent form.

C.4.5. Summary of Average Plasma Spraying Emission Factors

CATEF, SDAPCD, and SCAQMD provided emission factors for plasma spraying processes. We used average values from these sources for our emission factor calculations, as shown below:

Table C-8: Average Emission Factors – Plasma Spraying			
Reference	Control Device	Emission Factor (lb Cr ⁺⁶ /lb Cr)	Average Emission Factor (lb Cr ⁺⁶ /lb Cr)
SDAPCD	Water Curtain	9.64E-04	6.73E-03
SCAQMD	Water Curtain	1.25E-02	
CATEF	Uncontrolled	7.20E-03	1.18E-02
SCAQMD	Uncontrolled	1.63E-02	

C.4.6. Thermal Spraying Emission Data from Other States

ARB staff contacted regulatory agencies in the following states to gather information on their methods for estimating emissions from thermal spraying sources:

Connecticut	Michigan	Pennsylvania
Florida	New Jersey	Texas
Georgia	New York	Virginia
Massachusetts	Ohio	Wisconsin

Most of the states that we contacted have permitting thresholds that allow smaller facilities to be exempt from obtaining an air permit. For example, some states do not require permitting or toxics screening for facilities that emit less than 1 ton/yr of hazardous air pollutants. Since many thermal spraying facilities fall below this threshold, the available permit data were generally restricted to relatively large thermal spraying operations. Stack testing was not required in most cases, so emissions were frequently estimated using the following equation:

$$\text{Eqn. 4: Emissions, lbs PM/yr} = [\text{Material Usage, lbs/yr}] * [1 - \text{T.E.}] * [1 - \text{Dropout}] * [1 - \text{C.E.}]$$

where

Emissions, lbs PM/yr = Pounds of particulate matter emissions per year

T.E. = Transfer Efficiency, which is the fraction of sprayed material that adheres to the part surface. Material that does not adhere to the surface is called overspray.

Dropout = The fraction of particles that drop out of the overspray before it is sent through the control device. This drop out can occur in the booth or the ductwork.

C.E. = Control Efficiency, which is the fraction of pollutants that are not emitted into the air due to the control device.

Equation #4 can be rearranged to yield an emission factor equation, as shown below:

$$\text{Eqn. 5: Emission Factor, } \frac{\text{lbs PM}}{\text{lbs matl./yr}} = \frac{[\text{Emissions, lbs PM/yr}]}{[\text{Material Usage, lbs/yr}]} = [1 - \text{T.E.}] * [1 - \text{Dropout}] * [1 - \text{C.E.}]$$

ARB has used this equation to compare the emission factors from other states with those developed by ARB. The following sections contain information that we obtained from other states for some of the thermal spraying facilities that were identified. We've also included some emission factor comparisons, which demonstrate that ARB's emission estimation methods are generally comparable to the methods used by other states.

Connecticut

Sources Identified - Staff members identified one Title V source that operates two thermal spraying booths, one for plasma spraying and one for HVOF spraying.

Control Devices - Both booths are equipped with HEPA filter systems, rated at 99.99% and 99.97% efficiency.

Permit Limits - Maximum application rates are 15 lb/hr for each booth. The permit contains mass limits for total suspended particulate (TSP) and concentration limits for hazardous air pollutants. For plasma spraying, the TSP emissions limit is 5.25E-04 lb TSP/hr while the HVOF process has no hourly limit. Both processes have annual TSP limits of 2.3E-03 tons per 12 consecutive months. To control toxic emissions, the permit contains maximum allowable stack concentrations that are equivalent to 150 ug Cr⁺⁶/m³ for the plasma spraying and 6.8 ug Cr⁺⁶/m³ for the HVOF process. These limits were determined in accordance with state air toxic regulations.

Stack Testing/Modeling - No stack testing or air dispersion modeling was required, because the facility emits less than 3 tpy of PM.

Emission Factors -

$$\text{Emission Factor, } \frac{\text{lbs TSP}}{\text{lbs matl./yr}} = \frac{[5.25\text{E-}04 \text{ lb TSP/hr}]}{[15 \text{ lbs material/hr}]} = \frac{3.5\text{E-}05 \text{ lb TSP}}{\text{lb material}}$$

Since total chromium is a component of the thermal spraying material, this emission factor also applies to total chromium emissions. If it is assumed that the total chromium contains 30% hexavalent chromium (i.e., 0.3 lbs Cr⁺⁶/lb Cr), the following emission factor for hexavalent chromium can be derived:

$$\text{Emission Factor} = [3.5\text{E-}05 \text{ lbs total Cr/lb Cr sprayed}] * [0.3 \text{ lbs Cr}^{+6}/\text{lb Cr}] = [1.05\text{E-}05 \text{ lbs Cr}^{+6}/\text{lb Cr}]$$

This Connecticut emission factor lies between ARB's average HVOF/Plasma Spray emission factor for a control device with 99% efficiency and ARB's emission factors for a control device with 99.97% efficiency. Therefore, it appears that Connecticut's emission estimation methodology is reasonably consistent with ARB's methods.

Florida

Sources Identified - Staff members identified one thermal spraying facility that operated multiple booths.

Control Devices - The booths used two types of control devices - wet impingers (95% efficiency) and dry dust collectors (99% efficiency).

Permit Limits - ARB did not obtain a copy of the local permit.

Stack Testing/Modeling - No stack testing or air dispersion modeling was required.

Emission Factors - Emissions were calculated based on a 60% transfer efficiency (T.E.) and a 50% dropout rate. For a booth with a wet impinger (95% control efficiency), the emission factor would be -

$$\text{Emission Factor, } \frac{\text{lbs PM}}{\text{lbs matl./yr}} = [1 - \text{T.E.}] * [1 - \text{Dropout}] * [1 - \text{C.E.}] = [1 - 0.6] * [1 - 0.5] * [1 - 0.95] = 1.00\text{E-}02$$

Since total chromium is a component of the thermal spraying material, this emission factor also applies to total chromium emissions. If it is assumed that the total chromium contains 30% hexavalent chromium, the following emission factor for hexavalent chromium can be derived:

$$\text{Emission Factor} = [1.00\text{E-}02 \text{ lbs Cr/lb Cr}] * [0.3 \text{ lbs Cr}^{+6}/\text{lb Cr}] = [3.0\text{E-}03 \text{ lbs Cr}^{+6}/\text{lb Cr sprayed}]$$

This value is between the ARB overall average emission factor for a control device with 90% efficiency and a control device with 99% efficiency, as summarized in Table C-3. Therefore, these results are consistent with ARB's methods.

New York

Sources Identified – Staff members identified one Title V source that operates four thermal spraying booths for a combination of HVOF and plasma spraying. One booth contains three thermal spraying units. The source is primarily a research facility, but it is permitted to conduct manufacturing, if needed.

Control Devices – Control devices include a baghouse/filter (99%+); fabric filter (95%)/Dollinger filter (98%); and a water curtain (90%).

Permit Limits – Maximum spray rates range from 10 lbs/hr to 1,050 lbs/hr for the highest capacity process. Annual usage limits range from 10,000 lbs/yr to 250,000 lbs/yr.

Stack Testing/Modeling - No stack testing or air dispersion modeling was required.

Emission Factors - Emissions were calculated based on transfer efficiencies (50% or 75%, depending on booth), a 90% dropout rate, the efficiencies of the control devices, and other assumptions. For the largest unit which vents to a baghouse/filter, 0.5% of quantity sprayed is emitted (i.e., the emission factor is 5.0E-03 lbs PM/lb matl.) Since the material being sprayed contains chromium, this 0.5% emission factor also applies to the chromium being sprayed (5.0E-03 lbs Cr/lb Cr sprayed). If it is assumed that the total chromium contains 30% hexavalent chromium, the following emission factor for hexavalent chromium can be derived:

$$\text{Emission Factor} = [5.0\text{E-}03 \text{ lbs Cr/lb Cr}] * [0.3 \text{ lbs Cr}^{+6}/\text{lb Cr}] = [1.5\text{E-}03 \text{ lbs Cr}^{+6}/\text{lb Cr sprayed}]$$

This value is between the ARB HVOF emission factor for a control device with 90% efficiency and a control device with 99% efficiency, as summarized in Table C-3. Therefore, these results are reasonably consistent with ARB's methods.

Ohio

Sources Identified – Staff members identified four permitted thermal spraying facilities, one of which was a Title V source with three plasma spraying booths.

Control Devices – The booths were vented to baghouses with 99% control efficiency.

Permit Limits – The maximum material usage rate is 8 lbs/hr and the annual operating limits are either 1,814 hours/yr or 3,267 hours/yr, depending on the booth. Hourly particulate emissions are limited to 0.551 lbs PM/hr for all of the booths. Maximum allowable annual emissions are either 0.5 tpy or 0.9 tpy, depending on the booth.

Stack Testing/Modeling - No stack testing or air dispersion modeling was required.

Emission Factors - Emissions were calculated based on a 65% transfer efficiency (T.E.) and a 99% control efficiency. No assumption was made regarding dropout percentage (i.e., dropout = 0.)

$$\text{Emission Factor, } \frac{\text{lbs PM}}{\text{lbs matl./yr}} = [1 - \text{T.E.}] * [1 - \text{Dropout}] * [1 - \text{C.E.}] = [1 - 0.65] * [1 - 0] * [1 - 0.99] = 3.50\text{E-}03$$

The primary pollutant of concern for this facility was nickel, but it is possible to develop an estimated emission factor for chromium as well. If total chromium was a component of the thermal spraying material, the emission factor would also apply to total chromium emissions. If it is assumed that the total chromium contains 30% hexavalent chromium, the following emission factor for hexavalent chromium can be derived:

$$\text{Emission Factor} = [3.50\text{E-}03 \text{ lbs Cr/lb Cr}] * [0.3 \text{ lbs Cr}^{+6}/\text{lb Cr}] = [1.05\text{E-}03 \text{ lbs Cr}^{+6}/\text{lb Cr sprayed}]$$

This value is between the ARB Plasma Spray emission factor for a control device with 99% efficiency and a control device with 99.97% efficiency, as summarized in Table C-3. Therefore, these results are consistent with ARB's methods.

Pennsylvania

Sources Identified – Staff members identified a Title V permit for a facility that conducted HVOF spraying on print rollers, using a nickel-chromium-copper material.

Control Devices – Emissions are controlled with a HEPA filter that has 99.97% control efficiency.

Permit Limits – Material usage is limited to 1,800 lbs/yr.

Stack Testing/Modeling – No stack testing or air dispersion modeling was required.

Emission Factors – Emissions were calculated based on 92% transfer efficiency, because the roller faces are flat and uniform. No assumption was made regarding dropout percentage (i.e., dropout = 0.)

$$\text{Emission Factor, } \frac{\text{lbs PM}}{\text{lbs matl./yr}} = [1 - \text{T.E.}] * [1 - \text{Dropout}] * [1 - \text{C.E.}] = [1 - 0.92] * [1 - 0] * [1 - 0.9997] = 2.40\text{E-}05$$

Since total chromium is a component of the thermal spraying material, this emission factor also applies to total chromium emissions. If it is assumed that the total chromium contains 30% hexavalent chromium, the following emission factor for hexavalent chromium can be derived:

$$\text{Emission Factor} = [2.40\text{E-}05 \text{ lbs Cr/lb Cr}] * [0.3 \text{ lbs Cr}^{+6}/\text{lb Cr}] = [7.2\text{E-}06 \text{ lbs Cr}^{+6}/\text{lb Cr sprayed}]$$

This value is slightly larger than ARB's HVOF emission factor for a control device with 99.97% control efficiency, as summarized in Table C-3.

C.5. Emission Calculations - Annual

This section describes how emission factors were used to estimate annual hexavalent chromium emissions from thermal spraying processes. The general approach involved multiplying emission factors by annual usage rates, as shown in the following equation:

$$\text{Eqn. 6: } [Emissions, \text{ lbs Cr}^{+6}/\text{year}] = [Emission Factor, \text{ lbs Cr}^{+6}/\text{lb Cr}] * [Usage, \text{ lbs Cr}/\text{year}]$$

Emission factors were described in Section C.4 and were summarized in Table C-3.

ARB staff estimated annual emissions using two approaches: (1) potential to emit, based on manufacturer sales data, and (2) actual emissions, based on usage data as reported by individual facilities. When calculating the potential to emit, we used material sales data from ARB's 2003 Thermal Spraying Material Survey (ARB, 2004.) This survey collected sales quantities from thermal spraying materials manufacturers for calendar year 2002. The survey focussed on materials containing chemicals of concern (e.g., chromium and nickel). Based on this survey, more than 70 tons of thermal spraying materials containing chromium were sold or distributed in California during 2002. A report of the manufacturer survey results can be obtained on ARB's website (<http://www.arb.ca.gov/coatings/thermal/thermal.htm>). When calculating actual emissions, we used material throughput data from thermal spraying businesses, that was obtained from ARB's 2004 Thermal Spraying Facility Survey. The total estimated usage quantity provided by thermal spraying facilities was significantly less than the sales data provided by manufacturers. Since some facilities only provided rough estimates of their usage, we believe that the manufacturer's data are more accurate and yield a more reliable estimate of statewide usage for determining the potential to emit.

Data from ARB's 2003 Thermal Spraying Material Survey provided information on the annual material sales and ingredient percentages. We used these data to calculate the amount of chromium in each material and the potential annual usage of such materials, as shown in the following equations:

$$\text{Eqn. 7: For products with Chromium} \quad [Chromium \text{ Qty, } \frac{\text{Lbs}}{\text{Yr}}] = [Material \text{ Sales, } \frac{\text{lbs}}{\text{yr}}] * [Wt\% \text{ Chromium}]$$

$$\text{Eqn. 8: For products with Chromium Oxide (Cr}_2\text{O}_3) \quad [Chromium \text{ Qty, } \frac{\text{lbs}}{\text{yr}}] = [Material \text{ Sales, } \frac{\text{lbs}}{\text{yr}}] * [Wt\% \text{ Cr}_2\text{O}_3] * \frac{[104 \text{ g Cr}_2]}{[152 \text{ g Cr}_2\text{O}_3]}$$

The manufacturer survey also identified the types of thermal spraying processes associated with each product, which allowed us to select the appropriate emission factors. Some thermal spraying materials were designated as being suitable for two types of processes (e.g., flame spray and plasma spray).

For these multi-use products, an average emission factor value was used, as shown in the following example calculations:

Average Emission Factor Calculation - Uncontrolled Flame Spray & Plasma Spray:
 $(6.20E-03 + 1.18E-02)/2 = 9.00E-03$ lbs Cr⁺⁶/lb Cr sprayed

Example Annual Emissions Calculation - Uncontrolled Flame Spray & Plasma Spray:
 $[10,000 \text{ lbs Cr sprayed}] * [9.00E-03 \text{ lbs Cr}^{+6}/\text{lb Cr sprayed}] = 90 \text{ lbs Cr}^{+6}/\text{yr}$

To calculate potential emissions, we multiplied the applicable emission factor times the quantity of chromium sold. Table C-9 summarizes the California sales in 2002 for thermal spraying products that contain chromium and the associated quantity of chromium contained in those products. Table C-9 also contains the associated processes, emission factors, and emissions values. Potential statewide emissions of hexavalent chromium vary widely, depending on the type of control device used. For example, if all facilities used control devices with 99.97% control efficiency, statewide emissions would be only 0.1 lb/yr. However, statewide emissions would be almost 300 lbs/yr, if all facilities were uncontrolled. Therefore, it is important to identify a control effectiveness when estimating statewide emissions. ARB's 2004 Thermal Spraying Facility Survey provided information on the percentage of facilities that use control devices and the types of devices that were used. The results of this survey indicate that 87% of the thermal spraying facilities in California that use materials containing chromium have a control device. The most common type of control device at these facilities is the dry filter cartridge. Based on this information, the following assumptions were made:

- 87% of the thermal spraying material is used at controlled facilities with dry filters
- 13% of the thermal spraying material is used at uncontrolled facilities
- [Controlled Emissions] = [87%]*[Sales, lbs Cr]*[Emission Factor, lbs Cr⁺⁶/lb Cr sold]
- [Uncontrolled Emissions] = [13%]*[Sales, lbs Cr]*[Emission Factor, lbs Cr⁺⁶/lb Cr sold]

The survey data indicated that some facilities have HEPA filters (generally more efficient than dry filters) and some facilities have water curtains (usually less efficient than dry filters), so the assumption that controlled facilities use dry filters provides a reasonable representation of the average control efficiencies statewide.

Based on these assumptions, 18 tons of chromium were potentially used at thermal spraying facilities and the potential to emit is 66 pounds for hexavalent chromium statewide in 2002. Table C-9 provides details of potential material usage and potential to emit quantities, based on the manufacturer survey.

To calculate actual emissions, we multiplied the applicable emission factor times the quantity of chromium usage reported by individual facilities. Actual emissions were estimated to be 9.4 pounds, based on facility usage data, process descriptions, and control device information as provided by facilities. It is expected that our estimates of actual emissions and the potential to emit represent lower and upper boundaries for statewide emissions. Therefore, we estimate that annual hexavalent chromium

emissions from thermal spraying are in the range of 9.4 – 66 pounds. The difference between estimates of maximum potential emissions and actual emissions may be due to the following factors: 1) materials sold in one year may be used over multiple years; 2) some materials sold to California distributors may be redistributed out of State; and 3) some businesses that conduct thermal spraying may not have been captured by the ARB facility survey.

For this thermal spraying ATCM, we estimated the potential emission reductions based on data from the ARB 2004 Thermal Spraying Facility Survey, the ARB 2003 Thermal Spraying Materials Survey, and the proposed ATCM control efficiency requirements. For a facility with no existing control devices, the proposed ATCM would require at least a 99% reduction in emissions. For the largest facility in the State, the proposed ATCM would require that the control device efficiency be increased from a minimum of 81% to at least 99.97%. Overall, the proposed ATCM is expected to reduce hexavalent chromium emissions by nearly 80 percent (7 to 50 lbs/yr.)

Table C-9:

Thermal Spraying Sales & Potential to Emit Summary - Hexavalent Chromium

Process	Material	Sales of Products Containing Chromium (lbs) ¹	Qty. of Chromium in Products (lbs Cr)	Potential to Emit (lbs Cr ⁺⁶ /yr) ²
Flame Spray	Powder	6,788	713.4	0.6
Flame Spray/Other	Powder	PD	2,415.0	2.8
Flame Spray/Plasma Spray	Powder	PD	736.5	1.7
HVOF	Powder	7,731	3,279.0	2.8
HVOF/Flame Spray/Plasma Spray	Powder	PD	2,860.7	5.3
HVOF/Plasma Spray	Powder	10,918	5,307.9	12.4
Plasma Spray	Powder	14,780	6,962.3	26.5
Plasma Spray/Other	Powder	PD	22.8	0.1
Powder Subtotal =		63,612	22,298	52.1
Single-Wire Flame Spray	Wire	PD	1,330.1	0.9
Twin-Wire Electric Arc	Wire	PD	13,036.6	12.6
Wire Subtotal =		79,708	14,367	13.4
GRAND TOTAL =		143,320	36,664	65.6

1. "PD": Protected data (fewer than three companies reported sales).

2. Assume 13% of products are used at Uncontrolled facilities and 87% of products are used at facilities with a dry filter control device.

C.6. Emission Calculations –Hourly

When performing health risk assessments, it is typically necessary to identify the average hourly emissions and the maximum hourly emissions. The average hourly emissions are used when calculating the possible impacts from long-term chronic exposure, while the maximum hourly emissions are used to calculate impacts from short-term acute exposures. Reference Exposure Levels (RELs) for short-term acute exposures have not yet been established for hexavalent chromium. Therefore, we did not estimate acute risk for hexavalent chromium, based on the maximum hourly emissions.

Annual average hourly emissions were estimated using the following equation:

$$\text{Eqn. 5: [Annual Avg. Hourly Emissions, lbs Cr}^{+6}\text{/hour]} = \frac{\text{[Annual Emissions, lbs Cr}^{+6}\text{/yr]}}{\text{[350 days/yr]*[Daily Operating Hours, e.g., 8 hrs/day]}}$$

These values are converted into units of grams/second for the risk assessment calculations, using the following equation:

$$\text{Eqn. 6: [Hourly Emissions, g/s]} = \frac{\text{[Hourly Emissions, lb Cr}^{+6}\text{]}}{\text{[hr]}} * \frac{\text{[453.59 g]}}{\text{[1 lb]}} * \frac{\text{[1 hr]}}{\text{[60 min]}} * \frac{\text{[1 min]}}{\text{[60 sec]}}$$

C.6.1. Annual Average Hourly Emissions

Annual average hourly emissions vary, depending on individual facility operating schedules and other parameters. However, we can estimate statewide annual average hourly emissions, based on the total annual emissions statewide. According to the ARB 2004 Thermal Spraying Facility Survey, 30 facilities reported the use of materials that contain chromium.

$$\text{[Annual Avg. Hourly Emissions]} = \frac{\text{[65.6 lbs Cr}^{+6}\text{/yr]}}{\text{[350 days/yr]*[8 hrs/day]*[30 facilities statewide]}} = \frac{7.81\text{E-04 lbs Cr}^{+6}}{\text{hr}}$$

$$\text{[Hourly Emissions, g/s]} = \frac{\text{[7.81E-04 lbs Cr}^{+6}\text{]}}{\text{[hr]}} * \frac{\text{[453.59 g]}}{\text{[1 lb]}} * \frac{\text{[1 hr]}}{\text{[60 min]}} * \frac{\text{[1 min]}}{\text{[60 sec]}} = \frac{9.8\text{E-05 grams Cr}^{+6}}{\text{second}}$$

This statewide average, based on manufacturer sales data, is at the high end of the values that are based on individual facility data, as reported in the 2004 ARB Thermal Spraying Facility Survey. For most facilities that reported chromium usage, the annual average emissions were between 1E-09 g/s and 1E-05 g/s, with one outlier at approximately 1E-03 g/s. Since the total sales reported by manufacturers was greater than the total usage reported by individual facilities, it is not surprising that annual average emissions based on manufacturer sales would be higher than emissions based on individual facility data.

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Appendix 1 – Emission Calculation Method

Emissions of hexavalent chromium (Cr⁺⁶) and nickel (Ni) from thermal spraying operations must be calculated in accordance with the procedures specified in this Appendix 1.

Step 1: Identify all thermal spraying materials that contain chromium (Cr) or nickel (Ni) at a concentration of at least 0.1% by weight (or less than 0.1%, if listed on the Material Safety Data Sheet.) Include materials that contain chromium or nickel in the form of a metallic compound or alloy. Examples of compounds and alloys include, but are not limited to, stainless steel; chromium carbide (Cr₃C₂); nichrome alloys (NiCr); and chromium oxide (Cr₂O₃).

Step 2: Determine the total percentage of chromium and/or nickel contained in each thermal spraying material. These data can be obtained from the material safety data sheet (MSDS) or by contacting the manufacturer. If the MSDS contains a range of percentages, use the upper value of the range. If the material contains a compound (e.g., Cr₃C₂), include only the portion that is chromium or nickel.

Step 3: For each thermal spraying operation, compile the annual usage for each thermal spraying material that contains chromium or nickel. For thermal spraying operations that have air permits, the annual usage is the maximum allowable under the permit.

Step 4: For each thermal spraying operation, calculate the annual usage quantities for chromium and nickel using the following equations:

Eqn. 1: [Annual Usage, lbs Cr/yr] = [Material Usage, lbs material used/yr]*[weight % Cr in Material]

Eqn. 2: [Annual Usage, lbs Ni/yr] = [Material Usage, lbs material used/yr]*[weight % Ni in Material]

Step 5. Identify the applicable emission factor(s) for each thermal spraying operation, based on the applicable control efficiency level. If a material is used for multiple thermal spraying operations and material usage records document the quantity of material used for each operation, use the applicable emission factors for each operation. If material usage records do not document the quantity of material used for each operation, use the highest emission factor.

Table 1-1 specifies the applicable emission factors for thermal spraying operations using materials that contain chromium, chromium compounds, or chromium alloys.

Table 1-2 specifies the applicable emission factors for thermal spraying operations using materials that contain nickel, nickel compounds, or nickel alloys.

Table 1-1: Thermal Spraying Emission Factors for Hexavalent Chromium

Operation	Emission Factors (lbs Cr ⁺⁶ /lb Cr sprayed)*			
	0% Control Efficiency (Uncontrolled)	90% Control Efficiency (e.g. Water Curtain)	99% Control Efficiency (e.g. Dry Filter)	99.97% Control Efficiency (e.g., HEPA Filter)
Single-Wire Flame Spray	4.68E-03	4.68E-04	4.68E-05	1.40E-06
Twin-Wire Electric Arc Spray	6.96E-03	6.96E-04	6.96E-05	2.09E-06
Flame Spray	6.20E-03	1.17E-03	6.20E-05	1.86E-06
HVOF	6.20E-03	1.17E-03	6.20E-05	1.86E-06
Plasma Spray	1.18E-02	6.73E-03	2.61E-03	2.86E-06
Other Thermal Spraying	7.17E-03	2.05E-03	5.70E-04	2.01E-06

*Some emission factors are based directly on stack test results while others are calculated values, derived from stack test results and control efficiencies.

Table 1-2: Thermal Spraying Emission Factors for Nickel

Operation	Emission Factors (lbs Ni/lb Ni sprayed)*			
	0% Control Efficiency (Uncontrolled)	90% Control Efficiency (e.g. Water Curtain)	99% Control Efficiency (e.g. Dry Filter)	99.97% Control Efficiency (e.g., HEPA Filter)
Twin-Wire Electric Arc Spray	6.0E-03	6.0E-04	6.0E-05	1.8E-06
Flame Spray	1.10E-01	4.64E-02	1.10E-03	3.30E-05
HVOF	1.10E-01	4.64E-02	1.10E-03	3.30E-05
Plasma Spray	1.5E-01	3.67E-02	1.5E-03	1.72E-05
Other Thermal Spraying	9.4E-02	3.25E-02	9.4E-04	2.13E-05

*Some emission factors are based directly on stack test results while others are calculated values, derived from stack test results and control efficiencies.

Step 6 – Annual Emissions. For each thermal spraying operation, calculate the annual emissions by multiplying the applicable emission factors by the annual usage rates, using the following equations:

$$\text{Eqn. 3: [Annual Emissions, lbs Cr}^{+6}\text{/yr]} = [\text{Emission Factor, lbs Cr}^{+6}\text{/lb Cr sprayed}] * [\text{Annual Usage, lbs Cr sprayed/yr}]$$

$$\text{Eqn. 4: [Annual Emissions, lbs Ni/yr]} = [\text{Emission Factor, lbs Ni/lb Ni sprayed}] * [\text{Annual Usage, lbs Ni sprayed/yr}]$$

Step 7 – Maximum Hourly Nickel Emissions: For each thermal spraying operation that uses nickel, calculate the maximum hourly emissions by multiplying the applicable emission factors by the maximum hourly usage rates, using the following equations:

Eqn. 5:

$$[\text{Max. Hourly Emissions, lbs Ni/hr}] = [\text{Emission Factor, lbs Ni/lb Ni sprayed}] * [\text{Max. Hourly Usage, lbs Ni sprayed/hr}]$$

Eqn. 6:

$$[\text{Max. Hourly Usage, lbs Ni sprayed/hr}] = [\text{Max. Gun Spray Rate, lbs material sprayed/hr}] * [\text{Max. wt. \% Ni in material}]$$

where

“Maximum Gun Spray Rate” is the highest material throughput rate that a thermal spraying gun can achieve, based on manufacturer specifications or actual user experience, whichever is greater. If multiple guns have the potential to be operated at the same time (e.g., in two separate booths), the maximum gun spray rate must include the total throughput from all guns.

“Maximum Weight % Nickel in Material” is the highest weight percentage of nickel for all of the thermal spraying materials that are used in thermal spraying operations at a facility.

Point Source Example:

Thermal Spraying Inc. operates two thermal spraying booths. One booth is used for plasma spraying and the other booth is used for flame spraying and twin-wire electric arc spraying. Listed below is information on the facility's operations:

Booth	Control Device	Operation	Materials Used	Quantity Used	% Total Chromium	% Nickel
Booth #1	HEPA Filter	Plasma Spray	Powder ABC	25 lbs/yr	25%	0%
			Powder XYZ	50 lbs/yr	20%	75%
Booth #2	Dry Filter (99% effic.)	Flame Spray	Powder 123	10 lbs/yr	0%	95%
			Powder XYZ	75 lbs/yr	20%	75%
		Twin-Wire	Wire #1	80 lbs/yr	20%	5%

An example calculation is provided below for Thermal Spraying Inc.:

Step 1: Identify all thermal spraying materials that contain at least 0.1% by weight of chromium (Cr), chromium compounds, nickel (Ni), or nickel compounds.

The following four products contain chromium or nickel: Powder 123; Powder ABC; Powder XYZ; Wire #1.

Step 2: Determine the total percentage of chromium and/or nickel.

Materials Used	% Total Chromium	% Nickel
Powder 123	0%	95%
Powder ABC	25%	0%
Powder XYZ	20%	75%
Wire #1	20%	5%

If a thermal spraying material contains a compound, include only the portion that is chromium or nickel. For example, if the material contains 95% chromium oxide (Cr_2O_3), the weight percent of chromium would be calculated as follows:

$$[\text{Chromium Weight \%}] = [\text{Weight \% Cr}_2\text{O}_3] * \frac{[\text{Molecular Weight of Chromium (Cr}_2\text{)}]}{[\text{Molecular Weight of Chromium Oxide (Cr}_2\text{O}_3\text{)}]}$$

$$\text{Molecular Weight of Chromium (Cr}_2\text{)} = (52 \text{ g/g-mol}) * (2) = 104 \text{ g/g-mol}$$

$$\text{Molecular Weight of Chromium Oxide (Cr}_2\text{O}_3\text{)} = (52 \text{ g/g-mol}) * (2) + (16) * (3) = 152 \text{ g/g-mol}$$

$$[\text{Chromium Weight \%}] = [95 \% \text{ Cr}_2\text{O}_3] * \frac{[104 \text{ g/g-mol}]}{[152 \text{ g/g-mol}]} = 65\%$$

Step 3: Compile the annual material usage.

Operation	Materials Used	Quantity Used
Plasma Spray	Powder ABC	25 lbs/yr
	Powder XYZ	50 lbs/yr
Flame Spray	Powder 123	10 lbs/yr
	Powder XYZ	75 lbs/yr
Twin-Wire	Wire #1	80 lbs/yr

Step 4: Calculate the annual usage quantities for chromium and nickel.

Materials Used	Quantity Used	% Total Chromium	% Nickel	Qty. of Total Chromium Used	Qty. of Nickel Used
Powder ABC	25 lbs/yr	25%	0%	$[25 \text{ lbs/yr}] \times [25\% \text{ Cr}] = 6.25 \text{ lbs Cr/yr}$	$[25 \text{ lbs/yr}] \times [0\% \text{ Ni}] = 0 \text{ lbs Ni/yr}$
Powder XYZ	50 lbs/yr	20%	75%	$[50 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 10.0 \text{ lbs Cr/yr}$	$[50 \text{ lbs/yr}] \times [75\% \text{ Ni}] = 37.5 \text{ lbs Ni/yr}$
Powder 123	10 lbs/yr	0%	95%	$[10 \text{ lbs/yr}] \times [0\% \text{ Cr}] = 0 \text{ lbs Cr/yr}$	$[10 \text{ lbs/yr}] \times [95\% \text{ Ni}] = 9.5 \text{ lbs Ni/yr}$
Powder XYZ	75 lbs/yr	20%	75%	$[75 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 15.0 \text{ lbs Cr/yr}$	$[75 \text{ lbs/yr}] \times [75\% \text{ Ni}] = 56.25 \text{ lbs Ni/yr}$
Wire #1	80 lbs/yr	20%	5%	$[80 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 16.0 \text{ lbs Cr/yr}$	$[80 \text{ lbs/yr}] \times [5\% \text{ Ni}] = 4.0 \text{ lbs Ni/yr}$

Step 5: Identify the applicable emission factors.

Control Device	Operation	Emission Factor - Hexavalent Chromium (lb Cr ⁺⁶ /lb Cr sprayed)	Emission Factor – Nickel (lb Ni/lb Ni sprayed)
HEPA Filter	Plasma Spray	2.86E-06	1.72E-05
Dry Filter (99% effic.)	Flame Spray	6.20E-05	1.10E-03
	Twin-Wire	6.96E-05	6.0E-05

Step 6: Calculate annual emissions ($[Annual\ Emissions] = [Emission\ Factor] \times [Annual\ Usage].$)

For hexavalent chromium, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Total Chromium Used (lbs Cr sprayed/yr)	Emission Factor (lb Cr ⁶⁺ /lb Cr sprayed)	Annual Emissions (lb Cr ⁶⁺ /yr)
#1	HEPA Filter	Plasma Spray	Powder ABC	6.25	2.86E-06	$[6.25] \times [2.86E-06] = 1.79E-05$
			Powder XYZ	10.0	2.86E-06	$[10.0] \times [2.86E-06] = 2.86E-05$
#2	Dry Filter (99% effic.)	Flame Spray	Powder 123	0	6.20E-05	$[0] \times [6.20E-05] = 0$
			Powder XYZ	15.0	6.20E-05	$[15.0] \times [6.20E-05] = 9.30E-04$
		Twin-Wire	Wire #1	16.0	6.96E-05	$[16.0] \times [6.96E-05] = 1.11E-03$
					Total =	0.002

Based on this emission level, Thermal Spraying Inc. is below the Tier 1 threshold for hexavalent chromium. Therefore, no new control efficiency requirements would be imposed by this ATCM because of hexavalent chromium emissions. However, Thermal Spraying Inc. will still need to comply with the permitting, monitoring, and recordkeeping requirements of the ATCM. In addition, if the workload increased and emissions exceeded Tier 1 thresholds, it would be necessary to upgrade the dry filter system or limit the usage of all chromium materials to the booth that has the HEPA filter.

For nickel, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Nickel Used (lbs Ni sprayed/yr)	Emission Factor (lb Ni/lb Ni sprayed)	Annual Emissions (lb Ni/yr)
#1	HEPA Filter	Plasma Spray	Powder ABC	0	1.72E-05	$[0] \times [1.72E-05] = 0$
			Powder XYZ	37.5	1.72E-05	$[37.5] \times [1.72E-05] = 6.45E-04$
#2	Dry Filter (99% effic.)	Flame Spray	Powder 123	9.5	1.10E-03	$[9.5] \times [1.10E-03] = 1.05E-02$
			Powder XYZ	56.25	1.10E-03	$[56.25] \times [1.10E-03] = 6.19E-02$
		Twin-Wire	Wire #1	4.0	6.0E-05	$[4.0] \times [6.0E-05] = 2.40E-04$
					Total =	0.073

Based on this emission level, Thermal Spraying Inc. is below the Tier 1 threshold for nickel. Therefore, no new control efficiency requirements would be imposed by this ATCM because of nickel emissions. However, Thermal Spraying Inc. will still need to comply with the permitting, monitoring, and recordkeeping requirements of the ATCM. In addition, if the workload increased and emissions exceeded Tier 1 thresholds, it would be necessary to upgrade the dry filter system or limit the usage of all nickel materials to the booth that has the HEPA filter.

Step 7: Calculate the maximum hourly emissions for nickel.

Powder 123 is the material that has the highest weight percentage of nickel (95%).
The maximum spray rate for the flame spraying gun is 10 lbs/hr.
The emission factor for flame spraying is 1.10E-03 lb Ni/lb Ni sprayed.

[Maximum Hourly Usage] = [Maximum Gun Spray Rate]*[Maximum Wt.% Nickel]
[Maximum Hourly Usage] = [10 lbs/hr]*[95% Ni] = 9.5 lbs Ni sprayed/hr

[Maximum Hourly Emissions] = [Emission Factor]*[Maximum Hourly Usage]
Maximum Hourly Emissions = [1.10E-03 lb Ni/lb Ni sprayed]*[9.5 lbs Ni sprayed/hr] = 0.01 lb Ni/hr

The maximum hourly emissions for nickel are 0.01 lbs Ni/hr, which is well below the compliance limit of 0.1 lb Ni/hr for point sources. Therefore, this thermal spraying operation complies with the maximum hourly limit for nickel.

Volume Source Example:

Machine Shop Inc. conducts flame spraying with powder on small parts. The parts are turned on a lathe while spraying is being performed. Since the lathe is not located in a booth, the shop uses a portable local exhaust fan to remove fumes from the worker's breathing area. This type of operation would be considered a volume source with 0% control efficiency. Listed below is information on the facility's operations:

Booth	Control Device	Operation	Materials Used	Quantity Used	% Total Chromium	% Nickel
None	None (uncontrolled)	Flame Spray	Powder 123	20 lbs/yr	0%	95%
			Powder XYZ	5 lbs/yr	20%	75%

An example calculation is provided below for Machine Shop Inc.:

Step 1: Identify all thermal spraying materials that contain at least 0.1% by weight of chromium (Cr), chromium compounds, nickel (Ni), or nickel compounds.

The following two products contain chromium or nickel: Powder 123 and Powder XYZ.

Step 2: Determine the total percentage of chromium and/or nickel.

Materials Used	% Total Chromium	% Nickel
Powder 123	0%	95%
Powder XYZ	20%	75%

Step 3: Compile the annual material usage.

Operation	Materials Used	Quantity Used
Flame Spray	Powder 123	20 lbs/yr
	Powder XYZ	5 lbs/yr

Step 4: Calculate the annual usage quantities for chromium and nickel.

Materials Used	Quantity Used	% Total Chromium	% Nickel	Qty. of Total Chromium Used	Qty. of Nickel Used
Powder 123	20 lbs/yr	0%	95%	$[20 \text{ lbs/yr}] \times [0\% \text{ Cr}] = 0 \text{ lbs Cr/yr}$	$[20 \text{ lbs/yr}] \times [95\% \text{ Ni}] = 19.0 \text{ lbs Ni/yr}$
Powder XYZ	5 lbs/yr	20%	75%	$[5 \text{ lbs/yr}] \times [20\% \text{ Cr}] = 1.0 \text{ lbs Cr/yr}$	$[5 \text{ lbs/yr}] \times [75\% \text{ Ni}] = 3.75 \text{ lbs Ni/yr}$

Step 5: Identify the applicable emission factors.

Control Device	Operation	Emission Factor - Hexavalent Chromium (lb Cr ⁺⁶ /lb Cr sprayed)	Emission Factor – Nickel (lb Ni/lb Ni sprayed)
Uncontrolled	Flame Spray	6.20E-03	1.10E-01

Step 6: Calculate annual emissions ($[Annual\ Emissions] = [Emission\ Factor] \times [Annual\ Usage].$)

For hexavalent chromium, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Total Chromium Used (lbs Cr sprayed/yr)	Emission Factor (lb Cr ⁺⁶ /lb Cr sprayed)	Annual Emissions (lb Cr ⁺⁶ /yr)
None	None	Flame Spray	Powder 123	0	6.20E-03	$[0] \times [6.20E-03] = 0$
			Powder XYZ	1.0	6.20E-03	$[1.0] \times [6.20E-03] = 6.20E-03$
					Total =	0.006

Based on this emission level, Machine Shop Inc. is classified as Tier 1 for hexavalent chromium. Therefore, the thermal spraying operation would need to install a new booth with a control device that met the Tier 1 minimum efficiency requirement of 99%. In addition, Machine Shop Inc. would need to comply with the permitting, monitoring, and recordkeeping requirements of the ATCM. Machine Shop Inc. could avoid having to install a new booth and control device, if they eliminated the use of chromium-containing materials.

For nickel, the annual emissions are –

Booth	Control Device	Operation	Materials Used	Qty. of Nickel Used (lbs Ni sprayed/yr)	Emission Factor (lb Ni/lb Ni sprayed)	Annual Emissions (lb Ni/yr)
None	None	Flame Spray	Powder 123	19.0	1.10E-01	$[19.0] \times [1.10E-01] = 2.09$
			Powder XYZ	3.75	1.10E-01	$[3.75] \times [1.10E-01] = 4.13E-01$
					Total =	2.50

Based on this emission level, Machine Shop Inc. is below the Tier 1 threshold for nickel. Therefore, no new control efficiency requirements would be imposed by this ATCM because of nickel emissions. However, this ATCM requires thermal spraying operations to comply with the most stringent control efficiency. Since the control efficiency

requirement based on hexavalent chromium is the most stringent, they must comply with the 99% control efficiency.

Step 7: Calculate the maximum hourly emissions for nickel.

Powder 123 is the material that has the highest weight percentage of nickel (95%).

The maximum spray rate for the flame spraying gun is 10 lbs/hr.

The emission factor for flame spraying is 1.10E-01 lb Ni/lb Ni sprayed.

[Maximum Hourly Usage] = [Maximum Gun Spray Rate]*[Maximum Wt. % Nickel]

[Maximum Hourly Usage] = [10 lbs/hr]*[95 % Ni] = 9.5 lbs Ni sprayed/hr

[Maximum Hourly Emissions] = [Emission Factor]*[Maximum Hourly Usage]

Maximum Hourly Emissions = [1.10E-01 lb Ni/lb Ni sprayed]*[9.5 lbs Ni sprayed/hr] = 1.1 lb Ni/hr

The maximum hourly emissions for nickel are 1.1 lbs Ni/hr, which exceeds the compliance limit of 0.01 lb Ni/hr for volume sources. Therefore, this thermal spraying operation does not comply with the maximum hourly limit for nickel and it would be necessary to reduce emissions (e.g., install a control device, limit usage, etc.)