























Table 1 Thermal Spray Wire and Bare Wire Welding Products (continued)

| ALLOY          | UNS       | Normal Composition, Weight Percent |       |      |       |      |      |       |       |      |      |       |        |                             |
|----------------|-----------|------------------------------------|-------|------|-------|------|------|-------|-------|------|------|-------|--------|-----------------------------|
|                | Alloy No. | Ni▲                                | Co▲   | Cr▲  | Mo    | W    | Fe   | Si    | Mn▲   | Al▲  | Ti   | Cu▲   | B      | Others (V▲)                 |
| 20CB3 alloy    | N08020    | 33                                 | <0.1  | 20   | 3*    | --   | 71   | 0.4*  | 2*    | <0.1 | <0.1 | 3.4   | <0.1   | Cb-.06*, V-<0.1, Ta-<0.1    |
| 52 alloy       | N14052    | 50                                 | <0.1  | <0.1 | --    | --   | 49   | 0.1   | 0.5*  | <0.1 | <0.1 | <0.1  | --     |                             |
| 72 alloy       | N06072    | 55                                 | <0.1  | 44   | <0.1  | --   | 0.3  | <0.1  | <0.1  | 0.2* | 0.5  | <0.1  | <0.1   |                             |
| 80/20 alloy    | N06003    | 78                                 | <0.1  | 20   | --    | --   | 0.7  | 1.3   | <0.1  | 0.2  | --   | <0.1  | --     |                             |
| 80/20 CB alloy | N06009    | 77                                 | --    | 19   | --    | --   | 0.7  | 1.3   | 0.3   | --   | --   | --    | --     | Cb-0.8                      |
| 95/5 alloy     | N03301    | 94                                 | <0.1  | --   | --    | --   | <0.1 | 0.5*  | 0.3   | 5    | 0.7* | 0.1*  | --     | Cb-<0.1, Ta-<0.1            |
| 200 alloy      | N02200    | 99.4                               | --    | <0.1 | <0.1  | --   | 0.2  | <0.1  | <0.1  | --   | <0.1 | <0.1  | --     |                             |
| 214W alloy     | N07214    | <70                                | 2*    | <17  | 0.5*  | 0.5* | <4   | 0.2*  | 0.5*  | <5   | 0.5* | --    | 0.004* | Cb 0.15*; Y<0.04; Zir 0.02* |
| 202 alloy      | S20200    | 5*                                 | --    | 18*  | --    | --   | 69*  | 0.6*  | 8     | --   | --   | --    | --     |                             |
| 302 alloy      | S30200    | 8                                  | --    | 18   | 0.3*  | --   | 72   | 0.6*  | 1.8*  | --   | --   | 0.4*  | --     |                             |
| 302 MO alloy   | S30200    | 9                                  | 0.1   | 17   | 1.3   | --   | 71   | 0.5   | 1.2   | <0.1 | --   | 0.1   | --     |                             |
| 302 N alloy    | S30200    | 9                                  | --    | 18   | --    | --   | 70   | 0.6*  | 1.9   | --   | --   | 0.4   | --     |                             |
| 302 NC alloy   | S30200    | 8                                  | --    | 17   | <0.1  | <0.1 | 74   | 0.4   | 0.3   | <0.1 | <0.1 | <0.1  | <0.1   | V-0.1, Ta-<0.1              |
| 302 V alloy    | S30200    | 8                                  | <0.1  | 18   | 0.4   | --   | 72   | 0.4   | 1     | <0.1 | --   | 0.2   | --     |                             |
| 304 alloy      | S30400    | 9                                  | --    | 18   | 0.3*  | --   | 71   | 0.5*  | 1.8*  | --   | --   | 0.3*  | --     |                             |
| 304 L alloy    | S30403    | 9                                  | 0.2*  | 18   | 0.4*  | --   | 70   | 0.7*  | 1.8*  | <0.1 | --   | 0.5*  | --     | Y-<0.1                      |
| 304 V alloy    | S30400    | 8                                  | 0.15  | 18   | 0.2*  | --   | 72   | 0.6*  | 0.7*  | --   | --   | 0.3*  | --     |                             |
| 305 alloy      | S30500    | 12*                                | --    | 18   | 0.3*  | --   | 68   | 0.5*  | 1.4*  | --   | --   | 0.4*  | --     |                             |
| 308 L alloy    | S30800    | 10                                 | --    | 21   | --    | --   | 66   | 0.8   | 1.9   | --   | --   | --    | --     |                             |
| 316 alloy      | S31600    | 10                                 | --    | 17*  | 2     | --   | 69   | 0.5*  | 1.5*  | --   | --   | 0.5*  | --     |                             |
| 316 L alloy    | S31603    | 10                                 | --    | 16   | 2     | --   | 70   | 0.5*  | 1.5*  | --   | --   | <0.1  | --     |                             |
| 347 alloy      | S34700    | 9                                  | <0.1  | 17   | 0.3   | --   | 70   | 0.6   | 1.5   | <0.1 | <0.1 | 0.2   | <0.1   | Cb-0.6, V-<0.1, Ta-<0.1     |
| 416 alloy      | S41600    | 0.3*                               | --    | 13   | <0.1  | --   | 85   | 0.5*  | 0.9*  | <0.1 | --   | 0.1   | --     |                             |
| 420H alloy     | S42080    | 0.5*                               | --    | <14  | 0.75* | --   | 82   | 0.5*  | <0.6  | --   | --   | 0.75* | --     |                             |
| 420 alloy      | S42000    | 0.1                                | --    | 13   | --    | --   | 86   | 0.2   | 0.5*  | <0.1 | --   | 0.1   | --     |                             |
| 430 alloy      | S43000    | 0.2*                               | --    | 17   | <0.1  | --   | 82   | 0.5*  | 0.5*  | <0.1 | --   | 0.1   | --     |                             |
| 455 alloy      | S45500    | 8                                  | --    | 11   | <0.1  | --   | 77   | <0.1  | <0.1  | --   | 1.2  | 2.2   | --     | Cb-0.2                      |
| 600 alloy      | N06600    | 74                                 | 0.05* | 16   | 0.3   | <0.1 | 9    | 0.4*  | 0.8   | 0.2  | 0.3* | 0.02* | --     |                             |
| 601 alloy      | N06601    | 60                                 | --    | 23   | --    | --   | 16   | 0.3*  | 0.6   | 1.5  | 0.3  | <0.1  | 0.003  |                             |
| 622 alloy      | N06022    | 52                                 | 2.5*  | <23  | 14    | <3.5 | <3   | 0.08* | 0.05* | --   | --   | 0.5*  | --     | V 0.35*;                    |

Table 1 Thermal Spray Wire and Bare Wire Welding Products (continued)

| ALLOY     | UNS       | Normal Composition, Weight Percent |             |             |           |          |           |           |             |             |           |             |          |                     |
|-----------|-----------|------------------------------------|-------------|-------------|-----------|----------|-----------|-----------|-------------|-------------|-----------|-------------|----------|---------------------|
|           | Alloy No. | <u>Ni</u> ▲                        | <u>Co</u> ▲ | <u>Cr</u> ▲ | <u>Mo</u> | <u>W</u> | <u>Fe</u> | <u>Si</u> | <u>Mn</u> ▲ | <u>Al</u> ▲ | <u>Ti</u> | <u>Cu</u> ▲ | <u>B</u> | <u>Others (V</u> ▲) |
| 800 alloy | N08800    | 32                                 | 0.2*        | 19.5        | 0.2*      | --       | 46*       | 0.8*      | 1.0         | 0.6*        | 0.5       | 0.2*        | --       |                     |
| 825 alloy | N08825    | 41*                                | 0.06*       | 23*         | 3*        | --       | 31*       | 0.3*      | 0.6*        | 0.1         | 1*        | 2.5*        | --       |                     |

(▲) Reportable ingredients per Section 313 of SARA - See Section 15 for additional information. XX\* - indicates maximum value. XX<sup>b</sup> - indicates minimum value. XX\*\* - Haynes metal No.

HAYNES and HASTELLOY are trademarks of Haynes International, Inc.

Table 2 Product Hazard Rating - Hazardous Materials Identification System (HMIS)

H = Health Rating F = Flammability Rating R = Reactivity Rating

| ALLOY                        | Alloy No. | H  | F | R | ALLOY          | Alloy No. | H  | F | R |
|------------------------------|-----------|----|---|---|----------------|-----------|----|---|---|
| HASTELLOY® HYBRID-BC1® alloy | N10362    | 3* | 0 | 0 | M-400 alloy    | N04400    | 2* | 0 | 0 |
| HASTELLOY® B-3® alloy        | N10675    | 3* | 0 | 0 | M-413 alloy    | C71581    | 2* | 0 | 0 |
| HASTELLOY® C-4 alloy         | N06455    | 3* | 0 | 0 | N 61 alloy     | N02061    | 2* | 0 | 0 |
| HASTELLOY® C-22® alloy       | N06022    | 3* | 0 | 0 | NFE 258 alloy  | W82002    | 2* | 0 | 0 |
| HASTELLOY® C-22HS® alloy     | N07022    | 3* | 0 | 0 | NIT 32 alloy   | S20000    | 3* | 0 | 0 |
| HASTELLOY® C-86 alloy        | N06686    | 3* | 0 | 0 | NIT 50 alloy   | S20000    | 3* | 0 | 0 |
| HASTELLOY® C-276 alloy       | N10276    | 3* | 0 | 0 | NIT 60 alloy   | S21800    | 3* | 0 | 0 |
| HASTELLOY® C-2000® alloy     | N06200    | 3* | 0 | 0 | MP35N alloy    | R30035    | 3* | 2 | 0 |
| HASTELLOY® G-30® alloy       | N06030    | 3* | 2 | 0 | ULTIMET® alloy | R31233    | 2* | 2 | 0 |
| HASTELLOY® G-35® alloy       | N06035    | 3* | 0 | 0 | 17/7 PH alloy  | S17700    | 3* | 0 | 0 |
| HASTELLOY® N alloy           | N10003    | 3* | 0 | 0 | 20CB3 alloy    | N08021    | 3* | 0 | 0 |
| HASTELLOY® S alloy           | N06635    | 3* | 0 | 0 | 52 alloy       | N14052    | 2* | 0 | 0 |
| HASTELLOY® W alloy           | N10004    | 3* | 0 | 0 | 72 alloy       | N06072    | 3* | 0 | 0 |
| HASTELLOY® X alloy           | N06002    | 3* | 0 | 0 | 80/20 alloy    | N06003    | 3* | 0 | 0 |
| HAYNES® C-263 alloy          | N07263    | 3* | 2 | 0 | 80/20 CB alloy | N06003    | 3* | 0 | 0 |
| HAYNES® GTD222 alloy         | 2220**    | 3* | 2 | 0 | 95/5 alloy     | N03301    | 2* | 0 | 0 |
| HAYNES® HR-120® alloy        | N08120    | 3* | 0 | 0 | 200 alloy      | N02200    | 2* | 0 | 0 |
| HAYNES® HR-160® alloy        | N12160    | 3* | 2 | 0 | 202 alloy      | S20200    | 3* | 0 | 0 |
| HAYNES® HR224® alloy         | 2224**    | 3* | 0 | 0 | 214 W          | N07214    | 3* | 0 | 0 |
| HAYNES® HR235™ alloy         | 2431      | 3* | 0 | 0 | 302 alloy      | S30200    | 3* | 0 | 0 |
| HAYNES® Waspaloy alloy       | N07001    | 3* | 2 | 0 | 302 MO alloy   | S30200    | 3* | 0 | 0 |
| HAYNES® NS-163® alloy        | 1630**    | 3* | 2 | 0 | 302 N alloy    | S30200    | 3* | 0 | 0 |
| HAYNES® X-750 alloy          | N07750    | 3* | 0 | 0 | 302 NC alloy   | S30200    | 3* | 0 | 0 |
| HAYNES® 25 alloy             | R30605    | 2* | 2 | 0 | 302 V alloy    | S30200    | 3* | 0 | 0 |
| HAYNES® 82                   | N06082    | 3* | 0 | 0 | 304 alloy      | S30400    | 3* | 0 | 0 |
| HAYNES® 92 alloy             | N07092    | 3* | 0 | 0 | 304 L alloy    | S30403    | 3* | 0 | 0 |
| HAYNES® 188 alloy            | R30188    | 3* | 2 | 0 | 304 V alloy    | S30400    | 3* | 0 | 0 |
| HAYNES® 214® alloy           | N07214    | 3* | 0 | 0 | 305 alloy      | S30500    | 3* | 0 | 0 |

Table 2 Product Hazard Rating – Hazardous Materials Identification System (HMIS)  
H = Health Rating    F = Flammability Rating    R = Reactivity Rating

| ALLOY                        | Alloy No. | H  | F | R | ALLOY       | Alloy No. | H  | F | R |
|------------------------------|-----------|----|---|---|-------------|-----------|----|---|---|
| HAYNES® 230-W® alloy         | N06231    | 3* | 0 | 0 | 308 L alloy | S30800    | 3* | 0 | 0 |
| HAYNES® 242® alloy           | N10242    | 3* | 0 | 0 | 316 alloy   | S31600    | 3* | 0 | 0 |
| HAYNES® 244™ alloy           | 2444      | 3* | 0 | 0 | 316 L alloy | S31603    | 3* | 0 | 0 |
| HAYNES® 282® alloy           | N07208    | 3* | 2 | 0 | 347 alloy   | S34700    | 3* | 0 | 0 |
| HAYNES® M418 alloy           | N04060    | 2* | 0 | 0 | 416 alloy   | S41600    | 3* | 0 | 0 |
| HAYNES® 556® alloy           | R30556    | 3* | 0 | 0 | 420 alloy   | S42000    | 3* | 0 | 0 |
| HAYNES® 617 CE's             | N06617    | 3* | 0 | 0 | 420H alloy  | S42080    | 3* | 0 | 0 |
| HAYNES® 625 alloy            | N06625    | 3* | 0 | 0 | 430 alloy   | S43000    | 3* | 0 | 0 |
| HAYNES® 625 (low iron) alloy | N06625    | 3* | 0 | 0 | 455 alloy   | S45500    | 3* | 0 | 0 |
| HAYNES® 718 alloy            | N07718    | 3* | 0 | 0 | 600 alloy   | N06600    | 3* | 0 | 0 |
| I-35 alloy                   | K93601    | 2* | 0 | 0 | 601 alloy   | N06601    | 3* | 0 | 0 |
| MULTIMET® alloy              | R30155    | 3* | 0 | 0 | 622 alloy   | N06022    | 3* | 0 | 0 |
|                              |           |    |   |   | 800 alloy   | N08800    | 3* | 0 | 0 |
|                              |           |    |   |   | 825 alloy   | N08825    | 3* | 0 | 0 |

Note: Ratings applicable for the metal oxide components of each product. Metal oxides are typically found in welding fume. The flammability and reactivity hazard ratings are appropriate for large, concentrated quantities of welding fume, such as found in a dust collector.  
\* = Chronic health effects, see Table 5.  
XX\*\* - Haynes metal No. HAYNES and HASTELLOY are trademarks of Haynes International, Inc.

Summary of HMIS rating numbers: H = Health Hazard rating; 0 = minimal hazard; 1 = slight hazard; 2 = moderate hazard; 3 = serious hazard; 4 = severe hazard  
F = Flammability hazard rating: 0 = minimal hazard; 1 = slight hazard; 2 = moderate hazard; 3 = serious hazard; 4 = severe hazard  
R = Reactivity hazard rating: 0 = minimal hazard; 1 = slight hazard; 2 = moderate hazard; 3 = serious hazard; 4 = severe hazard

Table 3

| Shielded Metal Arc Welding (SMAW) Electrode Products |                   |   |  |
|--|-------------------|---|--|
| Alloy  | AWS/UNS Alloy No. | Core Wire composition <sup>(1)</sup><br>(~80% by Wt.) | Other Coating Ingredients <sup>(2)</sup><br>(~20% by Wt.)  |
| HASTELLOY® B-3® alloy                                | W80675            | N10675  | Oxides and/or<br>Fluorides of<br>Aluminum (Al) ▲<br>Barium (Ba)<br>Calcium (Ca)<br>Magnesium (Mg)<br>Potassium (K)<br>Sodium (Na)<br>Strontium (Sr)<br>and Titanium (Ti) |
| HASTELLOY® C-4 alloy                                 | W86455            | N06445  |  |
| HASTELLOY® C-22® alloy                               | W86022            | N06022  |  |
| HASTELLOY® C-276 alloy                               | W80276            | N10276  |  |
| HASTELLOY® C-2000® alloy                             | W86200            | N06200  |  |
| HASTELLOY® G-30® alloy                               | W86030            | N06030  |  |
| HASTELLOY® G-35® alloy                               | W86035            | N06035  |  |
| HASTELLOY® X alloy                                   | W86002            | N06002  |  |
| HAYNES® 230-W® alloy                                 | W86231            | N06231  |  |
| HAYNES® 182 alloy                                    | W86182            | N07092  |  |
| HAYNES® 117 alloy                                    | W86117            | N06617  |  |
| HAYNES® 112 alloy                                    | W86112            | N06625  |  |
| MULTIMET® alloy                                      | W73155            | R30155  |  |
| ULTIMET® alloy                                       | R31233            | R31233  |  |
| HAYNES® 25 alloy                                     | W73605            | R30605  |  |

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

(2) Chemical Abstracts Service (CAS) numbers, PEL and TLV®-TWA information are provided in Table 4.

(▲) Reportable ingredients per Section 313 of SARA - See Section 15 for additional information.

Table 4 Exposure Limits for Potentially Hazardous Constituents in Thermal Spray Wire and Welding Fumes

| Metal or Chemical, Symbol   | CAS Number              | Exposure Limits as 8-hour TWA (as mg/m <sup>3</sup> )  |  |
|---|-------------------------|--|--|
|   |                         | OSHA - Permissible Exposure Limit (PEL) <sup>(1)</sup>   | ACGIH - Threshold Limit Value (TLV <sup>®</sup> ) <sup>(1)</sup> |
| Aluminum (Al/Al <sub>2</sub> O <sub>3</sub> )   | 7429-90-5/<br>1344-28-1 | Aluminum Oxide as Al: 15, total Aluminum<br>Oxide as Al: 5, Respirable                           | Welding Fume as Al: 10   |
| Argon <sup>(2)</sup> (A)  | 7440-37-1               | Regarded as simple asphyxiant. Inert gases which may replace air and deprive the body of oxygen. |  |
| Carbon Dioxide <sup>(2)</sup> (CO <sub>2</sub> )  | 124-38-9                | Regarded as simple asphyxiant. Inert gases which may replace air and deprive the body of oxygen. |  |
| Helium <sup>(2)</sup> (He)  | 7440-59-7               | Regarded as simple asphyxiant. Inert gases which may replace air and deprive the body of oxygen. |  |
| Nitrogen <sup>(2)</sup> (N)   | 7727-37-9               | Regarded as simple asphyxiant. Inert gases which may replace air and deprive the body of oxygen. |  |
| Barium compounds (Ba X)   | 7440-39-3               | Soluble compounds as Ba: 0.5   | Soluble compounds as Ba: 0.5                                     |
| Boron Oxide (B <sub>2</sub> O <sub>3</sub> )  | 1303-86-2               | Oxide Dust Total: 15   | Oxide Dust Total: 10   |
| Calcium (Ca)  | 7440-70-2               | None   | None   |
| Calcium Oxide (CaO)   | 1305-78-8               | 5  | 2  |
| Carbon Monoxide <sup>(2)</sup> (CO)   | 630-08-0                | 55 (50 ppm)  | 29 (25 ppm)  |
| Chromium VI Soluble Compounds   | (3)                     | 0.005  | 0.05 (as Cr)   |
| Chromium VI Insoluble Compounds   | (3)                     | 0.005  | 0.01( as Cr)   |
| Chromium oxide Cr III (Cr <sub>2</sub> O <sub>3</sub> )   | 1308-38-9               | 0.5 (as Cr)  | 0.5 (as Cr)  |
| Chromium oxide Cr II (CrO)  | 12018-00-7              | 0.5 (as Cr)  | -  |
| Chromium metal (Cr)   | 7440-47-3               | 1 (as Cr)  | 0.5 (as Cr)  |
| Cobalt (Co) and inorganic compounds   | 7440-48-4               | 0.1 metal dust and fume (as Co)  | 0.02 (as Co)   |
| Columbium (Niobium)<br>(Cb/Cb <sub>2</sub> O <sub>8</sub> , Nb/Nb <sub>2</sub> O <sub>8</sub> ) | 7440-03-1/<br>1313-96-8 | None   | None   |
| Copper oxide fume (CuO)   | 1317-38-0               | 0.1 (as Cu)  | 0.2 (as Cu)  |
| Copper (Cu)   | 7440-50-8               | 1 (as Cu)  | 1 (as Cu)  |
| Fluorides   | (3)                     | 2.5 (as fluorine)  | 2.5 (as fluorine)  |
| Calcium Fluoride (CaF <sub>2</sub> )  | 7789-75-5               | None   | None   |
| Sodium Fluoride (NAF)   | 7681-49-4               | None   | None   |
| Potassium Fluoride (KF)   | 7789-23-3               | None   | None   |
| Aluminum Fluoride (AlF <sub>3</sub> )   | 7784-18-1               | None   | None   |
| Lithium Fluoride (LiF)  | 7789-24-4               | None   | None   |
| Hydrogen Fluoride (HF)  | 7664-39-3               | 3 ppm  | 0.41; 1.64 (ceiling) <sup>(4)</sup>                              |



Table 4 Exposure Limits for Potentially Hazardous Constituents in Thermal Spray Wire and Welding Fumes (continued)

| Metal or Chemical, Symbol                                       | CAS Number               | Exposure Limits as 8-hour TWA (as mg/m <sup>3</sup> )     |  |
|---|--------------------------|---|--|
|   |                          | OSHA - Permissible Exposure Limit (PEL) <sup>(1)</sup>    | ACGIH - Threshold Limit Value (TLV <sup>®</sup> ) <sup>(1)</sup>   |
| Iron oxide (dust and fume)<br>(Fe <sub>2</sub> O <sub>3</sub> ) | 1309-37-1                | 10 (as Fe)  | 5 <sup>(5)</sup> (as Fe)   |
| Lanthanum (La)  | 7439-91-0                | None  | None   |
| Lithium (Li/Li <sub>2</sub> O)                                  | 7439-92-2/<br>12057-24-8 | None  | 1 (as Li <sub>2</sub> O) (ceiling) <sup>(4), (6)</sup>   |
| Magnesium (Mg)  | 7439-95-4                | None  | None   |
| Magnesium Oxide (MgO)   | 1309-48-4                | Fume as MgO: 15   | Fume as MgO: 10 <sup>(7)</sup>   |
| Manganese (Mn, MnO)   | 7439-96-5                | 5 (ceiling) <sup>(4)</sup> (as Mn)                        | 0.02 (as Mn)   |
| Molybdenum compounds (Mo X)                                     | 7439-98-7                | Soluble Compounds as Mo: 5                                | Soluble Compounds as Mo: 0.5 <sup>(5)</sup><br>Insoluble Compounds as Mo: 3 <sup>(5)</sup> ; 10 <sup>(7)</sup> |
| Nickel (Ni, NiX)  | 7440-02-0                | 1 (elemental, soluble and insoluble compounds)<br>(as Ni) | 1.5 <sup>(7)</sup> elemental, 0.1 <sup>(7)</sup> soluble, 0.2 <sup>(7)</sup> insoluble<br>compounds as Ni      |
| Nitric Oxide <sup>(2)</sup> (NO)                                | 10102-43-2               | 30  | 31   |
| Nitrogen Dioxide <sup>(2)</sup> (NO <sub>2</sub> )              | 10102-44-2               | 9 (ceiling)   | 5.6; 9.4 (STEL) <sup>(8)</sup>   |
| Ozone <sup>(2)</sup> (O <sub>3</sub> )                          | 10028-15-6               | 0.2 (0.1 ppm)   | 0.1 (0.05 ppm), Heavy workload <sup>(9)</sup>  |
| Potassium (K/K <sub>2</sub> O)                                  | 7440-09-7/<br>12136-47-7 | None  | None   |
| Silica fume (amorp) (SiO <sub>2</sub> )                         | 69012-64-2               | None  | None   |
| Silicon (Si)  | 7440-21-3                | Total Dust: 15, Respirable Dust: 5                        | None   |
| Sodium (Na/Na <sub>2</sub> O)                                   | 7440-23-5/<br>1313-59-3  | None  | None   |
| Strontium (Sr/SrO)  | 7440-24-6/<br>1314-11-0  | None  | None   |
| Tantalum (Ta)   | 7440-25-7                | Metal and Oxide Dust: 5                                   | Metal and Oxide Dust as Ta: 5  |
| Titanium Dioxide (TiO <sub>2</sub> )                            | 13463-67-7               | 15  | 10   |
| Titanium (Ti)   | 7440-32-6                | None  | None   |
| Tungsten (W) compounds  | 7440-33-7                | None  | Insoluble compounds as W: 5; 10 (STEL) <sup>(8)</sup><br>Soluble compounds as W: 1; 3 (STEL) <sup>(8)</sup>    |
| Vanadium Pentoxide (V <sub>2</sub> O <sub>5</sub> )             | 1314-62-1                | 0.5 ceiling - respirable dust<br>0.1 ceiling - fume       | 0.05 Respirable Dust or Fume <sup>(5)</sup>  |
| Yttrium (Y)<br>HW-7031-5  | 7440-65-5                | 1   | Metal and Compounds as Y: 1  |

Table 4 Exposure Limits for Potentially Hazardous Constituents in Thermal Spray Wire and Welding Fumes (continued)

| Exposure Limits as 8-hour TWA (as mg/m <sup>3</sup> ) |            |  |  |
|---|------------|--|--|
| Metal or Chemical, Symbol                             | CAS Number | OSHA - Permissible Exposure Limit (PEL) <sup>(1)</sup> | ACGIH - Threshold Limit Value (TLV <sup>®</sup> ) <sup>(1)</sup> |
| Zirconium compounds (Zr X)                            | 7440-67-7  | Compounds as Zr: 5                                     | Zr Metal and Compounds as Zr: 5; 10 (STEL) <sup>(8)</sup>        |

(1) All limits are Total Dust unless indicated otherwise.

(2) Gases generated by arc welding processes.

(3) Varies with compound.

(4) Ceiling limit - shall not be exceeded instantaneously.

(5) Respirable fraction of particulate - refer to the ACGIH-TLV<sup>®</sup> booklet for a definition.

(6) Workplace Environmental Exposure Levels (WEEL), published by the American Industrial Hygiene Association.

(7) Inhalable fraction of particulate - refer to the ACGIH-TLV<sup>®</sup> booklet for a definition.

(8) STEL = Short-term exposure limit - A 15-minute TWA exposure limit.

(9) See additional TLV<sup>®</sup> listings for moderate or light workloads.

(10) National Institute For Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL).

Table 5 Health Hazards

The following table shows the compounds and gases which have been discussed previously, and which may be encountered, their names and formulas, their CAS number, and briefly describes possible known short term and long term health effects which may result from excessive exposure.

| Name of Compound,<br>Formula and CAS Number   | On Any<br>Carcinogens List?<br>If So,<br>Which Ones? | Health Effects Resulting From Excessive Exposure  |   |
|---|--|---|---|
|   |  | Acute (Short Term)  | Chronic (Long Term)   |
| <b>Welding Fumes and Components of Welding Fumes</b>  |  |   |   |
| Welding Fumes (not otherwise classified)<br>CAS No. - none  | Yes<br>IARC  | May include metallic taste, nausea, tightness of chest, fever, dizziness, dryness or irritation of eyes, nose or throat   | Excessive levels may cause bronchial asthma, lung fibrosis, pneumoconiosis or siderosis.  |
| Hexavalent Chromium (Cr VI)<br>Sodium Chromate<br>Na <sub>2</sub> CrO <sub>3</sub> (soluble)<br>CAS No. 7775-11-3<br>Potassium Chromate<br>K <sub>2</sub> CrO <sub>3</sub> (soluble)<br>CAS No. 7789-00-6 | Yes<br>IARC group 1<br>NTP-K<br>OSHA                 | Inhalation and Skin Contact: Irritation of mucous membranes   | Inhalation: Perforation of the nasal septum.<br>Increased incidence of lung cancer.<br>Skin Contact: Skin ulceration, dermatitis.   |
| Chromium Metal-Cr<br>CAS No. 7740-47-3<br>Chromium oxide (Cr II) CrO<br>CAS No. 12018-00-7<br>Chromium oxide (Cr III) Cr <sub>2</sub> O <sub>3</sub>  | Yes<br>IARC group 3                                  | Skin Contact: Allergic reactions (dermatitis) in some people.   | None known.   |
| Nickel-Ni<br>CAS No. 7440-02-0<br>Nickel oxide-NiO<br>CAS No. 1313-99-1   | Yes<br>IARC group 1<br>NTP-K                         | Inhalation: Respiratory irritation. Allergic reactions in some people. Metallic taste, nausea, tightness in chest, metal fume fever.<br>Skin Contact: Contact dermatitis with permanent sensitization.                                | Inhalation: Chronic pulmonary irritation.<br>Perforation of nasal septum.<br>Increased incidence of lung and larynx cancer.   |
| Cobalt-Co<br>CAS No. 7440-48-4<br>Cobalt Oxide - CoO<br>CAS no. 1307-96-6   | No   | Inhalation: Pulmonary irritant, sensitization, cough.<br>Eye Contact: Irritation, conjunctivitis<br>Skin: Mild irritation sensitization, allergic dermatitis.<br>Ingestion: Pain, nausea, vomiting, hypotension (low blood pressure). | Chronic exposure to cobalt is more dangerous than isolated exposures.<br>Possible lung fibrosis and respiratory hypersensitivity.<br>Heart disease, elevated red blood cell counts, chest pain and edema. |
| Copper-Cu<br>CAS No. 7440-50-8<br>Copper oxide-CuO<br>CAS No. 1317-38-0   | No   | Inhalation: Metal fume fever, muscle ache, respiratory irritant.<br>Skin: Irritation,<br>Ingestion: Nausea, vomiting, abdominal pain; large doses may cause stomach and intestine ulceration, and kidney and liver damage.            | Mild dermatitis and degeneration of mucous membranes.<br>Repeated inhalation can cause chrome respiratory disease.  |

Table 5 Health Hazards (continued)

| Name of Compound,<br>Formula and CAS Number   | On Any<br>Carcinogens List?<br>If So,<br>Which Ones? | Health Effects Resulting From Excessive Exposure  |  |
|---|--|---|--|
|   |  | Acute (Short Term)  | Chronic (Long Term)  |
| Manganese-Mn<br>CAS No. 7439-96-5<br>Manganese dioxide-as Mn for<br>fume MnO <sub>2</sub><br>CAS No. 1313-13-9  | No   | Can include metal fume fever, dry throat, coughing, tight chest, low back pain, vomiting, fatigue, headache | "Manganism." SENSITIVITY VARIES. Affects central nervous system. Muscular weakness, tremors, symptoms similar to Parkinson=s disease. Exposed employees should get quarterly medical examinations for manganism. |
| Vanadium Pentoxide (V <sub>2</sub> O <sub>5</sub> )   | No   | Irritant to mucous membranes. Metallic taste, cough, throat and eye irritation, eczema.                     | Nasal catarrh, nose bleeds, chronic respiratory problems.  |
| Iron-Fe<br>CAS No. 7439-89-6<br>Iron Oxide-FeO<br>CAS No. 1345-25-1<br>Iron Oxide-Fe <sub>2</sub> O <sub>3</sub><br>CAS No. 1309-37-1<br>Iron Oxide-Fe <sub>3</sub> O <sub>4</sub><br>CAS No. 1309-38-2   | No   | Probably none, except as nuisance dust.   | Possible siderosis if exposures are excessive and long term. Regarded as benign. Lungs clear gradually after exposure is ended.  |
| Calcium Fluoride CaF <sub>2</sub><br>(Insoluble)<br>CAS No. 7789-75-5<br>Sodium fluoride NaF fume<br>(Soluble)<br>CAS No. 7681-49-4<br>Potassium fluoride KF<br>(Soluble)<br>CAS No. 7789-23-3<br>Aluminum Fluoride AlF <sub>3</sub><br>(Insoluble)<br>CAS No. 7784-18-1<br>Lithium Fluoride LiF<br>(Slightly soluble)<br>CAS No. 7789-24-4 | No   | CaF <sub>2</sub> probably inert. Soluble fluorides may be irritants and corrosive to mucous membranes.      | Soluble portions may cause osteoporosis and mottling of teeth, but effects seem reduced in the presence of iron as found in welding electrode fumes.   |
| <b>Gases Generated by Arc Welding processes</b>   |  |   |  |
| Fluorides: i.e., Silicon<br>Tetrafluoride SiF <sub>4</sub><br>CAS No. 7783-61-1<br>Hydrogen fluoride HF<br>CAS No. 7664-39-3  |  | See soluble fluorides portion under Welding Fumes   |  |
| Nitric oxide-NO<br>CAS No. 10102-43-2   | No   | Irritant to mucous membranes, drowsiness.   | Chronic respiratory disease.   |
| Nitrogen dioxide-NO <sub>2</sub><br>CAS No. 10102-44-2  | No   | Irritant to mucous membranes, coughing, chest pain, pulmonary edema.  | Chronic respiratory disease.   |

Table 5 Health Hazards (continued)

| Name of Compound,<br>Formula and CAS Number  | On Any<br>Carcinogens List?<br>If So,<br>Which Ones? | Health Effects Resulting From Excessive Exposure   |                              |
|--|--|--|------------------------------|
|  |  | Acute (Short Term)   | Chronic (Long Term)          |
| Ozone-O <sub>3</sub><br>CAS No. 10028-15-6   | No   | Irritant to mucous membranes, pulmonary edema.   | Chronic respiratory disease. |
| Carbon monoxide-CO<br>CAS No. 630-08-0   | No   | Headache, rapid breathing, oxygen deprivation, confusion, dizziness, weakness.   | Oxygen deprivation.          |
| Argon-A<br>CAS No. 7440-37-1<br>Carbon dioxide-CO <sub>2</sub><br>CAS No. 124-38-9<br>Helium-HE<br>CAS No. 7440-59-7<br>Nitrogen-N | No   | Inert gases which may replace air and deprive the body of oxygen. (CO <sub>2</sub> is not inert but effect is as above). | None known                   |

Table 6

Welding Fumes and Gases Information

| PRODUCTS  | FUMES EXPECTED   | GASES EXPECTED  |
|---|--|---|
| Bare Wire Products used in Gas Metal Arc Welding (all alloys listed in Table 1)   | Complex oxide combinations of all elements present in the welding wire grade listed in Table 1 (including trivalent, and hexavalent chromium)<br><br>The exposure limit for hazardous constituents in welding fumes is listed in Table 4 | Normally low. Ozone and oxides of nitrogen generation possible at welding arc or well away from arc.<br><br>Inert shielding gases can cause asphyxiation in confined welding spaces and unventilated areas. |
| Bare Wire Products used in Gas Tungsten Arc Welding, plasma arc welding and other similar processes (all alloys listed in Table 1)  | Same as above, however, fume volume is very small under normal GTAW conditions   | Same as above   |
| All Shielded Metal Arc Welding electrode alloys listed in Table 3   | Complex oxide and fluoride combinations of all electrode ingredients listed in Table 3   | Normally low, if any symptoms indicate the need, check for gaseous fluorides and/or oxides of nitrogen<br><br>See Health Hazard Data given in Table 5 for symptoms.   |
| Bare Wire Products used in Submerged Arc Welding (some alloys listed in Table 1)  | Same as above, however, fume volume is very small under normal SAW conditions  | Same as above   |
| <p>Other conditions which also influence the composition and quantity of the fume and gases to which employees may be exposed include:</p> <ul style="list-style-type: none"> <li>(1) coatings on the metal being welded (such as paint, plating, galvanizing)</li> <li>(2) the number of welders and volume of the work space</li> <li>(3) the quality and amount of ventilation</li> <li>(4) position of the welder=s head relative to the fume plume, and</li> <li>(5) presence of contamination in the atmosphere (such as chlorinated hydrocarbon vapors from cleaning and degreasing).</li> </ul> |  |   |

## LABEL INFORMATION

### Welding Products and Thermal Spray Wire

Notice: The following hazard statements and precautionary statements apply only to the metal fume and dust created during welding and thermal spray operations.

**HAZARD STATEMENTS:**

May cause cancer by inhalation.  
May cause an allergic skin reaction.  
Causes skin irritation.  
Harmful if inhaled.  
Harmful if swallowed

**PRECAUTIONARY STATEMENTS:**

Obtain special instructions before use.  
Do not handle until all safety precautions have been read and understood.  
Avoid breathing dust or fume.  
Do not eat, drink or smoke when using this product.  
Use only outdoors or in a well-ventilated area.  
In case of inadequate ventilation, wear respiratory protection.  
Wear protective gloves, protective clothing, eye, and face protection  
Contaminated work clothing should not be allowed out of the workplace.  
If exposed or concerned, get medical advice/attention.  
Refer to special instructions; Safety Data Sheet.



**Signal Word: DANGER**



**NOTICE:** PROTECT yourself and others. Be sure this label is read and understood by the welder (end user). FUMES AND GASES can be hazardous to your health. ARC RAYS can injure eyes and burn skin. ELECTRIC SHOCK can KILL.

- o Before use, read and understand the manufacturer's instructions, the Safety Data Sheet and your employer's safety practices.
- o Keep your head out of fumes.
- o Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from breathing zone and the general area.
- o Special care should be taken when welding galvanized, plated, or painted parts to avoid exposure to toxic fumes.
- o Wear correct eye, ear, and body protection. Wear welder's gloves when inserting the electrode into the holder. Do not touch any unprotected part of your body.
- o Do not touch live electric parts.
- o Use of thermal spray wire will create similar hazards described for welding products, and may also create high noise levels.
- o See American National Standard ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, published by the American Welding Society, 550 Northwest LaJeune Road, Miami, Florida 33126. United States (U.S.) Occupational Safety and Health Administration (OSHA) *Safety and Health Standards* are published by the U.S. Government Printing Office, 732 North Capitol Street, Washington, D.C. 20401.

**NOTICE:** This product and fumes generated from the normal use of this product contain Manganese. The inhalation of welding rod fumes containing Manganese has been associated with the development of serious Parkinson's Disease-like symptoms, Parkinsonism, Manganism, and other central nervous system conditions. Such symptoms may include impaired speech, balance and movement. Avoid breathing fumes generated in the welding process by utilizing appropriate environmental controls, including but not limited to ventilation, exhaust, and respirators.

**NOTICE:** Read and understand the warning label, affixed to this package and the Safety Data Sheet for this product before using. The following chemicals and their oxides may be hazardous during welding: manganese, silicon dioxide, iron oxide, cobalt, hexavalent chromium, molybdenum, nickel, vanadium, and tungsten. Lung damage, nervous system damage and allergic skin reaction may result from overexposure. The U.S. OSHA considers hexavalent chromium and nickel compounds as carcinogens.

**NOTICE:** SPECIAL VENTILATION AND/OR EXHAUST REQUIRED: Use industrial hygiene monitoring to ensure that use of this material will not exceed the applicable OSHA Permissible Exposure Limit (PEL), Threshold Limit Value® (TLV®) and equivalent exposure limits. The TLV® for manganese (0.02 mg/m<sup>3</sup>), cobalt (0.02 mg/m<sup>3</sup>), and PEL for hexavalent chromium (0.005 mg/m<sup>3</sup>) may be exceeded during welding. Use enough ventilation, local exhaust and respirators to keep the worker's breathing zone and general area below the TLV® for exposure to manganese.

## LABEL INFORMATION

### Welding Products and Thermal Spray Wire

**NOTICE:** This product contains or produces a chemical known to the State of California to cause cancer and birth defects (or other reproductive harm). (California Health & Safety Code Section 25249.5 et seq.).

#### **FIRST AID\_(The following instructions apply only to welding dust and fume forms of the product)**

**Inhalation:** Breathing difficulty caused by inhalation of dust or fume requires removal to fresh air and keep the person comfortable. If breathing has stopped, perform artificial respiration and obtain medical assistance if exposed or concerned.

**Ingestion:** If swallowed, rinse mouth, but never give anything by mouth to an unconscious person. Contact a poison control center. Unless the poison control center advises otherwise, have that conscious person slowly drink 1 to 2 glasses of water to dilute, inducement of vomiting is not necessary. Obtain medical assistance if you feel unwell.

**Skin:** Remove contaminated clothing. Do not shake clothing. Wash clothing before reuse. Skin contamination with dust or fume can be removed by washing with soap and water. If skin irritation or rash occurs, call a poison center. Get medical advice/attention.

**Eyes:** Do not allow victim to rub or keep eyes tightly shut. Dust or fume should be flushed from the eyes with copious amounts of clean water, until transported to an emergency medical facility. Consult a physician at once.

#### Typical Welding Fume Constituents:

|                    |                      |                   |                   |                  |
|--------------------|----------------------|-------------------|-------------------|------------------|
| Sodium Dichromate  | Potassium Dichromate | Nickel (Ni)       | Cobalt (Co)       | Manganese        |
| CAS No. 10588-01-9 | CAS No. 7778-50-9    | CAS No 7440-02-0. | CAS NO. 7440-48-4 | CAS No.7439-96-5 |

#### **Conditioning Information**

All welding electrodes should be stored in a dry rod oven after the canister has been opened. It is recommended that the dry rod oven be maintained at about 250 to 400°F (121 to 204°C). The HASTELLOY B-2 and B-3 alloys coating formulation are considered a low moisture formulation and therefore it is mandatory that those electrodes be carefully controlled. If electrodes are exposed to an uncontrolled atmosphere, they can be reconditioned by heating in a reconditioning oven at 600 to 700°F (316 to 371°C) for 2 to 3 hours.

**HAYNES**  
**Wire Company**

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