WELD FILLER METAL SELECTION GUIDELINE FOR VARIOUS METAL COMBINATIONS

DIVISION OF FACILITIES DEVELOPMENT

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Weld Filler Metal Selection Chart for Shielded Metal Arc Welding (SMAW) For Various Metal Combinations:

The attached Tables provide generally accepted electrode selections for the base materials shown, along with process areas that need special consideration. The special consideration cases have come about from past experiences in industry. The attached tables are as follows:

Table 1: Carbon and Alloy Steels

Table 2: Austenitic, Super-austenitic and Duplex Stainless Steels

Note that these tables DO NOT attempt to include all possible choices. Further, there are a number of proprietary base materials and castings for which the filler metals used do not have an AWS Classification available at this time.

When you are faced with a particular material or combination of materials not shown in these tables, please consult the manufacturer or the DFD

There is an explanation of the salient designations where appropriate (next two pages). For a complete listing of electrode designations, usability Classifications, weld metal chemical compositions and testing methods involved, refer to the appropriate AWS Filler metal specifications mentioned in tables 1 and 2.
Welding Filler Metal Designators:

1. Carbon Steel Electrodes:

Mandatory Classification Designators:

- Designates an Electrode
- Designates minimum tensile strength, in Ksi, of the as-deposited weld metal
- Designates the welding position, the type of covering and the type of welding current for which the electrodes are suitable (see table below)

Optional Supplemental Designators:

- Designates that the electrode meets the requirements of absorbed moisture
- Designates that the electrode meets the requirements of the diffusible hydrogen test—with an average value not exceeding “Z” mL of H₂ per 100gms of deposited metal
- Designates that the electrode meet the requirements for improved toughness and ductility

<table>
<thead>
<tr>
<th>Electrode Classification</th>
<th>Type of Covering</th>
<th>Welding Position&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Type of Current&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 6010</td>
<td>High cellulose, sodium</td>
<td>F, V, OH, H</td>
<td>dcep</td>
</tr>
<tr>
<td>E 6011</td>
<td>High Cellulose, Potassium</td>
<td>F, V, OH, H</td>
<td>ac or dcep</td>
</tr>
<tr>
<td>E 7018</td>
<td>Low hydrogen, Potassium, Iron Powder</td>
<td>F, V, OH, H</td>
<td>ac or dcep</td>
</tr>
<tr>
<td>E 7024</td>
<td>Iron Powder, Titania</td>
<td>H-Fillets, F</td>
<td>ac, dcep or dcen</td>
</tr>
</tbody>
</table>

Notes:  
<sup>a</sup> The abbreviations indicate the welding positions  
F=Flat; V=Vertical, OH=Overhead, H=Horizontal,  
H-Fillets=Horizontal Fillets.  
<sup>b</sup> The term dcep refers to direct current electrode positive (dc, reverse polarity). The term dcen is direct current electrode negative (dc, straight polarity)

Also note that the above electrode classifications are the most widely used and does not include all of the available classifications. Refer to AWS A 5.1 for complete listing.

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2. Alloy Steel Electrodes:

**Mandatory Classification Designators:**

- Designates an Electrode
- Designates minimum tensile strength, in Ksi, of the as-deposited weld metal
- Designates the welding position, the type of covering and the type of welding current for which the electrodes are suitable
- Designates the chemical composition of the undiluted weld metal produced by the electrode using SMAW process

**Optional Supplemental Designators:**

- Designates that the electrode meets the requirements of absorbed moisture
- Designates that the electrode meets the requirements of the diffusible hydrogen test—with an average value not exceeding “Z”mL of H₂ per 100gms of deposited metal, where “Z” is 4, 8 or 16

Refer to AWS A 5.5 for complete listing of mechanical properties, chemical composition of as-deposited weld metal and testing procedures for SMAW process.

3. Stainless Steel Filler Metal

**Usability Classification**

<table>
<thead>
<tr>
<th>Type of Welding Current and Position of Welding</th>
<th>AWS Classification</th>
<th>Welding Current</th>
<th>Welding position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXX(X)-15</td>
<td>dcep</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>EXX(X)-16</td>
<td>dcep or ac</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>EXX(X)-17</td>
<td>dcep or ac</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>EXX(X)-25</td>
<td>dcep</td>
<td>H, F</td>
</tr>
<tr>
<td></td>
<td>EXX(X)-26</td>
<td>dcep or ac</td>
<td>H, F</td>
</tr>
</tbody>
</table>

For more details on the usability classifications, refer to AWS A 5.4

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Table 1: Carbon and Low-Alloy Steel Welding Consumables for SMAW Process

<table>
<thead>
<tr>
<th>Base Material</th>
<th>Carbon Steel</th>
<th>Carbon-Molybdenum Steel</th>
<th>1 and 1 1/4 Cr - 1/2 Mo Steel</th>
<th>2 1/4 Cr - 1Mo Steel</th>
<th>5Cr - 1/2 Mo Steel</th>
<th>9Cr - 1Mo Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon steel</td>
<td>AB</td>
<td>AC</td>
<td>AD</td>
<td>AE</td>
<td>AF</td>
<td>AG</td>
</tr>
<tr>
<td>Carbon-Molybdenum Steel</td>
<td>C</td>
<td>CD</td>
<td>CE</td>
<td>CF</td>
<td>CH</td>
<td></td>
</tr>
<tr>
<td>1 and 1 1/4 Cr - 1/2 Mo Steel</td>
<td>D</td>
<td>DE</td>
<td>DF</td>
<td>DH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 1/4 Cr - 1 Mo Steel</td>
<td>E</td>
<td>EF</td>
<td>EH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Cr - 1/2 Mo Steel</td>
<td>F</td>
<td>FH</td>
<td></td>
<td></td>
<td></td>
<td>H</td>
</tr>
<tr>
<td>9 Cr - 1 Mo Steel</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Legend:
A  AWS A 5.1 Classification E 70XX low hydrogen (E7018 preferred)
B  AWS A 5.1 Classification E6010
C  AWS A 5.5 Classification E70XX - A1, low hydrogen
D  AWS A 5.5 Classification E70XX-B2L or E80XX-B2, low hydrogen
E  AWS A 5.5 Classification E80XX-B3L or E90XX-B3, low hydrogen
F  AWS A 5.5 Classification E80XX-B6 or E80XX-B6L, low hydrogen
G  AWS A 5.5 Classification E80XX-B7 or E80XX-B7L, low hydrogen
H  AWS A 5.5 Classification E80XX-B8 or E80XX-B8L, low hydrogen

Notes:
1. Table 1 refers to coated electrodes (SMAW process) only. For bare wire welding (SAW, GMAW, GTAW and FCAW), use equivalent electrode classifications (AWS A 5.14, A 5.17, A 5.18, A 5.20, A 5.23, A 5.28)
2. Higher alloy electrode specified in the table should normally be used to meet the required tensile and toughness after post weld heat treatment (PWHT). If no PWHT is required, the lower alloy electrode specified may be required to meet the hardness requirements.
Table 2: Austenitic, Super-Austenitic and Duplex Stainless Steel Alloys

<table>
<thead>
<tr>
<th>Base Metal</th>
<th>304L SS</th>
<th>304H SS</th>
<th>316L SS</th>
<th>317L SS</th>
<th>904L SS</th>
<th>6% Mo SS</th>
<th>7% Mo SS</th>
<th>Alloy 20Cb-3</th>
<th>2304 Duplex SS</th>
<th>2205 Duplex SS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon and Low Alloy Steel</td>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
<td>N</td>
<td>N</td>
<td>N</td>
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<tr>
<td>Type 304L Stainless Steel</td>
<td>D</td>
<td>DE</td>
<td>DF</td>
<td>DG</td>
<td>DC</td>
<td>C</td>
<td>C</td>
<td>DCH</td>
<td>NL</td>
<td>NL</td>
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<tr>
<td>Type 304H Stainless Steel</td>
<td>E</td>
<td>EF</td>
<td>EG</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>ECH</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<tr>
<td>Type 316L Stainless Steel</td>
<td>FG</td>
<td>FG</td>
<td>FC</td>
<td>FC</td>
<td>FC</td>
<td>FCH</td>
<td>NL</td>
<td>NL</td>
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<tr>
<td>Type 317L Stainless Steel</td>
<td>GC</td>
<td>GC</td>
<td>GC</td>
<td>GC</td>
<td>GC</td>
<td>GC</td>
<td>L</td>
<td>L</td>
<td></td>
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</tr>
<tr>
<td>Type 904L Stainless Steel</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>L</td>
<td>L</td>
<td></td>
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<tr>
<td>Type 6% Mo Stainless Steel</td>
<td>Eg: 254 SMO, AL 6XN</td>
<td>CJK</td>
<td>CJK</td>
<td>*</td>
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</tr>
<tr>
<td>Type 7% Mo Stainless Steel</td>
<td>Eg: 654 SMO</td>
<td>CJK</td>
<td>*</td>
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<td></td>
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</tr>
<tr>
<td>Type Alloy 20Cb-3</td>
<td>H</td>
<td>*</td>
<td>*</td>
<td></td>
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<tr>
<td>Type 2304 Duplex SS</td>
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<td>LM</td>
<td>LM</td>
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<tr>
<td>Type 2205 Duplex SS</td>
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<td>LM</td>
<td>LM</td>
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</tr>
</tbody>
</table>

**Legend**

A - AWS A 5.4 Classification E309L-XX
B - AWS A 5.4 Classification E308L-XX
C - AWS A 5.11 Classification ENiCrMo-3 (Inconel 625)
D - AWS A 5.4 Classification E308H-XX
E - AWS A 5.4 Classification E317L-XX
F - AWS A 5.4 Classification E316L-XX
G - AWS A 5.4 Classification E320LR-XX
H - AWS A 5.4 Classification E309MoL-XX
J - AWS A 5.11 Classification ENiCrMo-4 (Hastelloy C-276)
K - AWS A 5.11 Classification ENiCrMo-11 (Hastelloy G-30)
L - AWS A 5.4 Classification E2209-XX
M - AWS A 5.4 Classification E2553-XX
N - AWS A 5.4 Classification E309L-XX

**Notes:**

1. Table 2 refers to coated electrodes only. For wire welding (GMAW & GTAW) use equivalent electrode classification (AWS A 5.14)

2. There are many proprietary alloys available in the market and material combinations you might encounter. Consult the manufacturer or the DFD for proper filler metal selection.

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