INCOLOY® alloy DS (W. Nr. 1.4862), first developed for woven wire furnace conveyor belts, is now widely used for a range of heat-treatment applications where its strength and corrosion resistance at high temperatures enable its use in light section.

Alloys for use in high-temperature processes must be able to withstand exposure to hot combustion gases and operating atmospheres for a considerable period of time without the loss of effective section that can be caused by corrosion.

INCOLOY alloy DS, in common with other Special Metals Corporation heat-resisting alloys, develops a tightly adherent oxide film that protects its surface against corrosion processes. It is also resistant to ‘green rot’ which can occur in nickel-chromium alloys when atmospheres vary between reducing and oxidizing, and in some cases where the reducing atmosphere is of a carburizing nature. In these conditions chromium carbide can form along the grain boundaries and preferential oxidation of the depleted chromium matrix follows, a form distinct from ordinary oxidation which produces a passive oxide film.

INCOLOY alloy DS is also resistant to ‘sigma’ phase, a hard, brittle, complex intermetallic compound, basically iron-chromium, which precipitates in the 600-900°C range from structures that are either ferritic, mixed ferrite and austenite, or marginally austenitic. Nickel, an austenite former, suppresses the tendency to ‘sigma’ phase formation and INCOLOY alloy DS, with a nominal 37% nickel content, may be heated indefinitely within the 600-900°C range without fear of ‘sigma’ phase embrittlement.

Thus, the corrosion resistance and strength of INCOLOY alloy DS account for its use in a wide variety of high temperature process equipment ranging from furnace retorts and heat treatment jigs to components used in domestic appliances.

### Table 1 - Composition, % (max. unless stated)

<table>
<thead>
<tr>
<th>Element</th>
<th>Max. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni + Co</td>
<td>34.5-41.0</td>
</tr>
<tr>
<td>C</td>
<td>0.10</td>
</tr>
<tr>
<td>Mn</td>
<td>0.8-1.5</td>
</tr>
<tr>
<td>Fe</td>
<td>Balance*</td>
</tr>
<tr>
<td>Si</td>
<td>1.9-2.6</td>
</tr>
<tr>
<td>Cr</td>
<td>17.0-19.0</td>
</tr>
<tr>
<td>Cu</td>
<td>0.50</td>
</tr>
<tr>
<td>Ti</td>
<td>0.20</td>
</tr>
<tr>
<td>S</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*Reference to the ‘balance’ of an alloy’s composition does not guarantee this is exclusively of the element mentioned, but that it predominates and others are present only in minimal quantities.

### Table 2 - Density

<table>
<thead>
<tr>
<th>Density</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>g/cm³</td>
<td>7.86</td>
</tr>
<tr>
<td>lb/ft³</td>
<td>0.284</td>
</tr>
</tbody>
</table>

### Table 3 - Melting Range

<table>
<thead>
<tr>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1330-1400</td>
</tr>
</tbody>
</table>

The data contained in this publication is for informational purposes only and may be revised at any time without prior notice. The data is believed to be accurate and reliable, but Special Metals makes no representation or warranty of any kind (express or implied) and assumes no liability with respect to the accuracy or completeness of the information contained herein. Although the data is believed to be representative of the product, the actual characteristics or performance of the product may vary from what is shown in this publication. Nothing contained in this publication should be construed as guaranteeing the product for a particular use or application.
**INCOLOY® alloy DS**

### Table 4 - Mean Coefficient of Linear Thermal Expansion

<table>
<thead>
<tr>
<th>°C</th>
<th>10^-6/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-100</td>
<td>15.0</td>
</tr>
<tr>
<td>20-200</td>
<td>15.5</td>
</tr>
<tr>
<td>20-300</td>
<td>15.9</td>
</tr>
<tr>
<td>20-400</td>
<td>16.2</td>
</tr>
<tr>
<td>20-500</td>
<td>16.5</td>
</tr>
<tr>
<td>20-600</td>
<td>17.0</td>
</tr>
<tr>
<td>20-700</td>
<td>17.5</td>
</tr>
<tr>
<td>20-800</td>
<td>17.8</td>
</tr>
<tr>
<td>20-900</td>
<td>18.2</td>
</tr>
<tr>
<td>20-1000</td>
<td>18.7</td>
</tr>
</tbody>
</table>

Average of 5 casts. Hot-rolled plate 11 mm thick. Heat treated 11 min/1020°C/AC

### Table 5 - Specific Heat

<table>
<thead>
<tr>
<th>°C</th>
<th>J/kg °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>452</td>
</tr>
<tr>
<td>100</td>
<td>473</td>
</tr>
<tr>
<td>200</td>
<td>502</td>
</tr>
<tr>
<td>300</td>
<td>528</td>
</tr>
<tr>
<td>400</td>
<td>557</td>
</tr>
<tr>
<td>500</td>
<td>582</td>
</tr>
<tr>
<td>600</td>
<td>611</td>
</tr>
<tr>
<td>700</td>
<td>636</td>
</tr>
<tr>
<td>800</td>
<td>662</td>
</tr>
<tr>
<td>900</td>
<td>691</td>
</tr>
<tr>
<td>1000</td>
<td>716</td>
</tr>
</tbody>
</table>

### Table 6 - Electrical Resistivity

<table>
<thead>
<tr>
<th>°C</th>
<th>Relative Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>1.000</td>
</tr>
<tr>
<td>100</td>
<td>1.029</td>
</tr>
<tr>
<td>200</td>
<td>1.061</td>
</tr>
<tr>
<td>300</td>
<td>1.094</td>
</tr>
<tr>
<td>400</td>
<td>1.123</td>
</tr>
<tr>
<td>500</td>
<td>1.141</td>
</tr>
<tr>
<td>600</td>
<td>1.160</td>
</tr>
<tr>
<td>700</td>
<td>1.176</td>
</tr>
<tr>
<td>800</td>
<td>1.191</td>
</tr>
<tr>
<td>900</td>
<td>1.206</td>
</tr>
<tr>
<td>1000</td>
<td>1.220</td>
</tr>
</tbody>
</table>

Electrical resistivity at 20°C = 108 microhm cm.
Average of 5 casts. Hot-rolled plate 11 mm thick. Heat treated 11 min/1020°C/AC

### Table 7 - Magnetic Properties

<table>
<thead>
<tr>
<th>Field strength (H, oersted)</th>
<th>Permeability (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>1.038</td>
</tr>
<tr>
<td>300</td>
<td>1.031</td>
</tr>
<tr>
<td>500</td>
<td>1.024</td>
</tr>
<tr>
<td>1000</td>
<td>1.017</td>
</tr>
<tr>
<td>1500</td>
<td>1.014</td>
</tr>
<tr>
<td>2000</td>
<td>1.014</td>
</tr>
<tr>
<td>3000</td>
<td>1.013</td>
</tr>
</tbody>
</table>

Mass susceptibility at 1000 oersted = 1.72 x 10^-4 cm^3/g.
Volume susceptibility at 1000 oersted = 1.36 x 10^-3
Hot-rolled plate. Heat treated 10 min/1020°C/AC
### Table 8 - Dynamic Young's Modulus

<table>
<thead>
<tr>
<th>°C</th>
<th>Hot rolled plate (GPa)</th>
<th>Sheet (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>194</td>
<td>197</td>
</tr>
<tr>
<td>100</td>
<td>191</td>
<td>193</td>
</tr>
<tr>
<td>200</td>
<td>184</td>
<td>188</td>
</tr>
<tr>
<td>300</td>
<td>178</td>
<td>181</td>
</tr>
<tr>
<td>400</td>
<td>171</td>
<td>174</td>
</tr>
<tr>
<td>500</td>
<td>164</td>
<td>168</td>
</tr>
<tr>
<td>600</td>
<td>157</td>
<td>159</td>
</tr>
<tr>
<td>700</td>
<td>149</td>
<td>151</td>
</tr>
<tr>
<td>800</td>
<td>142</td>
<td>144</td>
</tr>
<tr>
<td>900</td>
<td>132</td>
<td>134</td>
</tr>
<tr>
<td>1000</td>
<td>118</td>
<td>119</td>
</tr>
</tbody>
</table>

Average of 5 casts. Hot-rolled plate, 11 mm thick. Heat treated 11 min/1020°C/AC
Average of 4 casts. Sheet 0.7-2.0 mm thick. Heat treated 6 min/1020°C/AC

### Table 9 - Dynamic Torsional Modulus

<table>
<thead>
<tr>
<th>°C</th>
<th>GPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>51.7</td>
</tr>
<tr>
<td>100</td>
<td>51.7</td>
</tr>
<tr>
<td>200</td>
<td>49.6</td>
</tr>
<tr>
<td>300</td>
<td>47.6</td>
</tr>
<tr>
<td>400</td>
<td>45.5</td>
</tr>
<tr>
<td>500</td>
<td>43.4</td>
</tr>
<tr>
<td>600</td>
<td>40.7</td>
</tr>
<tr>
<td>700</td>
<td>37.9</td>
</tr>
<tr>
<td>800</td>
<td>35.9</td>
</tr>
<tr>
<td>900</td>
<td>33.8</td>
</tr>
<tr>
<td>1000</td>
<td>29.6</td>
</tr>
</tbody>
</table>

Average of 4 casts. Sheet 0.7-2.0 mm thick. Heat treated 6 min/1020°C/AC

### Table 10 - Tensile Properties (sheet, cold-rolled, heat treated)

<table>
<thead>
<tr>
<th>°C</th>
<th>0.1% proof stress (MPa)</th>
<th>0.2% proof stress (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Elongation on 50 mm %</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>327</td>
<td>363</td>
<td>687</td>
<td>37.1</td>
</tr>
<tr>
<td>100</td>
<td>310</td>
<td>329</td>
<td>629</td>
<td>36.3</td>
</tr>
<tr>
<td>200</td>
<td>284</td>
<td>303</td>
<td>616</td>
<td>32.7</td>
</tr>
<tr>
<td>300</td>
<td>292</td>
<td>304</td>
<td>607</td>
<td>36.7</td>
</tr>
<tr>
<td>400</td>
<td>286</td>
<td>297</td>
<td>602</td>
<td>35.2</td>
</tr>
<tr>
<td>500</td>
<td>269</td>
<td>283</td>
<td>578</td>
<td>35.4</td>
</tr>
<tr>
<td>600</td>
<td>239</td>
<td>253</td>
<td>482</td>
<td>40.1</td>
</tr>
<tr>
<td>700</td>
<td>195</td>
<td>208</td>
<td>335</td>
<td>48.8</td>
</tr>
<tr>
<td>800</td>
<td>107</td>
<td>116</td>
<td>181</td>
<td>75.7</td>
</tr>
<tr>
<td>900</td>
<td>63</td>
<td>66</td>
<td>105</td>
<td>79.9</td>
</tr>
<tr>
<td>1000</td>
<td>31</td>
<td>36</td>
<td>65</td>
<td>74.6</td>
</tr>
</tbody>
</table>

Average of 5 casts. Cold-rolled sheet 0.7-2.0 mm thick. Heat treated 6 min/1020°C/AC
### Table 11 - Tensile Properties (plate, hot-rolled, heat treated 10 min/1020°C/AC)

<table>
<thead>
<tr>
<th>°C</th>
<th>0.1% proof stress (MPa)</th>
<th>0.2% proof stress (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Elongation on 5.65 % So</th>
<th>Reduction of area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>-196</td>
<td>473</td>
<td>485</td>
<td>914</td>
<td>54.5</td>
<td>68.1</td>
</tr>
<tr>
<td>20</td>
<td>298</td>
<td>301</td>
<td>670</td>
<td>47.6</td>
<td>71.5</td>
</tr>
<tr>
<td>100</td>
<td>263</td>
<td>269</td>
<td>618</td>
<td>44.1</td>
<td>69.0</td>
</tr>
<tr>
<td>200</td>
<td>242</td>
<td>247</td>
<td>581</td>
<td>41.1</td>
<td>64.0</td>
</tr>
<tr>
<td>300</td>
<td>219</td>
<td>222</td>
<td>593</td>
<td>41.5</td>
<td>62.1</td>
</tr>
<tr>
<td>400</td>
<td>213</td>
<td>219</td>
<td>593</td>
<td>46.7</td>
<td>60.8</td>
</tr>
<tr>
<td>500</td>
<td>196</td>
<td>202</td>
<td>568</td>
<td>43.6</td>
<td>57.3</td>
</tr>
<tr>
<td>600</td>
<td>196</td>
<td>201</td>
<td>490</td>
<td>45.3</td>
<td>45.0</td>
</tr>
<tr>
<td>700</td>
<td>179</td>
<td>185</td>
<td>351</td>
<td>56.7</td>
<td>44.9</td>
</tr>
<tr>
<td>800</td>
<td>136</td>
<td>142</td>
<td>208</td>
<td>74.0</td>
<td>60.7</td>
</tr>
<tr>
<td>900</td>
<td>63</td>
<td>71</td>
<td>119</td>
<td>90.9</td>
<td>75.1</td>
</tr>
<tr>
<td>1000</td>
<td>37</td>
<td>42</td>
<td>73</td>
<td>111.3</td>
<td>82.2</td>
</tr>
</tbody>
</table>

Average of 5 casts. Hot-rolled plate 11 mm thick.

### Table 12 - Tensile Properties (plate, hot-rolled, heat treated 1h/1150°C/AC)

<table>
<thead>
<tr>
<th>°C</th>
<th>0.1% proof stress (MPa)</th>
<th>0.2% proof stress (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Elongation on 5.65 % So</th>
<th>Reduction of area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>-196</td>
<td>391</td>
<td>406</td>
<td>798</td>
<td>61.1</td>
<td>75.5</td>
</tr>
<tr>
<td>20</td>
<td>210</td>
<td>219</td>
<td>602</td>
<td>61.1</td>
<td>77.0</td>
</tr>
<tr>
<td>100</td>
<td>188</td>
<td>196</td>
<td>551</td>
<td>55.0</td>
<td>70.9</td>
</tr>
<tr>
<td>200</td>
<td>164</td>
<td>168</td>
<td>528</td>
<td>55.6</td>
<td>71.4</td>
</tr>
<tr>
<td>300</td>
<td>133</td>
<td>136</td>
<td>505</td>
<td>55.6</td>
<td>68.0</td>
</tr>
<tr>
<td>400</td>
<td>133</td>
<td>136</td>
<td>511</td>
<td>62.2</td>
<td>64.3</td>
</tr>
<tr>
<td>500</td>
<td>119</td>
<td>124</td>
<td>493</td>
<td>64.4</td>
<td>67.8</td>
</tr>
<tr>
<td>600</td>
<td>113</td>
<td>116</td>
<td>440</td>
<td>55.5</td>
<td>44.6</td>
</tr>
<tr>
<td>700</td>
<td>117</td>
<td>124</td>
<td>334</td>
<td>31.1</td>
<td>37.3</td>
</tr>
<tr>
<td>800</td>
<td>137</td>
<td>145</td>
<td>232</td>
<td>35.6</td>
<td>32.0</td>
</tr>
<tr>
<td>900</td>
<td>66</td>
<td>74</td>
<td>122</td>
<td>86.7</td>
<td>61.9</td>
</tr>
<tr>
<td>1000</td>
<td>37</td>
<td>42</td>
<td>73</td>
<td>97.8</td>
<td>66.3</td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 11 mm thick.
Table 13 - Tensile Properties (plate, hot-rolled, heat treated and welded)

<table>
<thead>
<tr>
<th>°C</th>
<th>0.1% proof stress (MPa)</th>
<th>0.2% proof stress (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Elongation on 5.85 % So</th>
<th>Reduction of area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>-196</td>
<td>558</td>
<td>579</td>
<td>951</td>
<td>31.1</td>
<td>41.6</td>
</tr>
<tr>
<td>20</td>
<td>360</td>
<td>380</td>
<td>672</td>
<td>38.9</td>
<td>77.1</td>
</tr>
<tr>
<td>100</td>
<td>290</td>
<td>314</td>
<td>468</td>
<td>13.3</td>
<td>22.3</td>
</tr>
<tr>
<td>200</td>
<td>303</td>
<td>317</td>
<td>595</td>
<td>33.3</td>
<td>66.7</td>
</tr>
<tr>
<td>300</td>
<td>300</td>
<td>306</td>
<td>588</td>
<td>38.9</td>
<td>58.6</td>
</tr>
<tr>
<td>400</td>
<td>280</td>
<td>297</td>
<td>582</td>
<td>37.8</td>
<td>63.9</td>
</tr>
<tr>
<td>500</td>
<td>276</td>
<td>300</td>
<td>562</td>
<td>36.7</td>
<td>48.0</td>
</tr>
<tr>
<td>600</td>
<td>252</td>
<td>266</td>
<td>513</td>
<td>36.7</td>
<td>56.5</td>
</tr>
<tr>
<td>700</td>
<td>221</td>
<td>233</td>
<td>408</td>
<td>32.2</td>
<td>47.8</td>
</tr>
<tr>
<td>800</td>
<td>159</td>
<td>171</td>
<td>235</td>
<td>35.6</td>
<td>65.9</td>
</tr>
<tr>
<td>900</td>
<td>82</td>
<td>88</td>
<td>124</td>
<td>52.2</td>
<td>81.2</td>
</tr>
<tr>
<td>1000</td>
<td>46</td>
<td>48</td>
<td>76</td>
<td>42.2</td>
<td>88.7</td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 11 mm thick. Heat treated 10 min/1020°C/AC prior to welding. Metal arc welded in 4 runs using INCO-WELD® ‘A’ electrode.

Table 14 - Charpy Impact Properties (plate, hot-rolled, heat treated 10 min/1020°C/AC)

<table>
<thead>
<tr>
<th>°C</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>-196</td>
<td>141</td>
</tr>
<tr>
<td>-100</td>
<td>156</td>
</tr>
<tr>
<td>20</td>
<td>180</td>
</tr>
<tr>
<td>100</td>
<td>199</td>
</tr>
<tr>
<td>200</td>
<td>197</td>
</tr>
<tr>
<td>300</td>
<td>201</td>
</tr>
<tr>
<td>400</td>
<td>178</td>
</tr>
<tr>
<td>500</td>
<td>171</td>
</tr>
<tr>
<td>600</td>
<td>174</td>
</tr>
<tr>
<td>700</td>
<td>156</td>
</tr>
<tr>
<td>800</td>
<td>148</td>
</tr>
<tr>
<td>900</td>
<td>156</td>
</tr>
<tr>
<td>1000</td>
<td>203</td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 11 mm thick. Heat treated 10 min/1020°C/AC prior to welding. Metal arc welded in 4 runs using INCO-WELD® ‘A’ electrode.

Table 15 - Charpy Impact Properties (plate, hot-rolled, heat treated 1h/1150°C/AC)

<table>
<thead>
<tr>
<th>°C</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>-196</td>
<td>217</td>
</tr>
<tr>
<td>-100</td>
<td>247</td>
</tr>
<tr>
<td>20</td>
<td>270</td>
</tr>
<tr>
<td>100</td>
<td>288</td>
</tr>
<tr>
<td>200</td>
<td>285</td>
</tr>
<tr>
<td>300</td>
<td>290</td>
</tr>
<tr>
<td>400</td>
<td>260</td>
</tr>
<tr>
<td>500</td>
<td>266</td>
</tr>
<tr>
<td>600</td>
<td>260</td>
</tr>
<tr>
<td>700</td>
<td>236</td>
</tr>
<tr>
<td>800</td>
<td>157</td>
</tr>
<tr>
<td>900</td>
<td>184</td>
</tr>
<tr>
<td>1000</td>
<td>184</td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 11 mm thick. Heat treated 1h/1150°C/AC prior to welding. Metal arc welded in 4 runs using INCO-WELD® ‘A’ electrode.

Average of 5 casts. Hot-rolled plate 11 mm thick. Charpy test specimen has square cross section 10 mm, test area 80 mm², V-notch 45° included angle.
## INCOLOY® alloy DS

### Table 16 - Charpy Impact Properties, J, at Room Temperature

<table>
<thead>
<tr>
<th>Soaking time, h</th>
<th>Soaking temperature, °C</th>
<th>800</th>
<th>850</th>
<th>900</th>
<th>950</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>137</td>
<td>153</td>
<td>142</td>
<td>171</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>142</td>
<td>136</td>
<td>156</td>
<td>151</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>136</td>
<td>136</td>
<td>156</td>
<td>170</td>
<td>298</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>163</td>
<td>142</td>
<td>176</td>
<td>155</td>
<td>292</td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>140</td>
<td>151</td>
<td>176</td>
<td>279</td>
<td>266</td>
<td></td>
</tr>
<tr>
<td>10 000</td>
<td>123</td>
<td>174</td>
<td>199</td>
<td>243</td>
<td>89</td>
<td></td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 11 mm thick. Heat treated 10 min/1020°C/AC
Charpy test specimen has square cross section 10 mm, test area 80 mm², V-notch 45° included angle.

### Table 17 - Charpy Impact Properties, J, at High Temperatures

<table>
<thead>
<tr>
<th>Soaking time, h</th>
<th>Soaking and test temperature, °C</th>
<th>800</th>
<th>850</th>
<th>900</th>
<th>950</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>190</td>
<td>176</td>
<td>180</td>
<td>209</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>152</td>
<td>189</td>
<td>231</td>
<td>170</td>
<td>201</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>203</td>
<td>136</td>
<td>155</td>
<td>178</td>
<td>202</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>144</td>
<td></td>
<td>168</td>
<td>168</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>160</td>
<td>155</td>
<td>161</td>
<td>194</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>10 000</td>
<td>153</td>
<td>186</td>
<td>161</td>
<td>217</td>
<td>71</td>
<td></td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 11 mm thick. Heat treated 10 min/1020°C/AC
Charpy test specimen has square cross section 10 mm, test area 80 mm², V-notch 45° included angle.

### Table 18 - Creep Rupture Properties, MPa, (plate, hot-rolled)

<table>
<thead>
<tr>
<th>°C</th>
<th>Heat treated 15 min/1020°C/AC</th>
<th>Heat treated 1 h/1150°C/AC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100 h</td>
<td>1000 h</td>
</tr>
<tr>
<td>750</td>
<td>67.3</td>
<td>44.5</td>
</tr>
<tr>
<td>850</td>
<td>34.9</td>
<td>20.4</td>
</tr>
<tr>
<td>950</td>
<td>18.1</td>
<td>9.4</td>
</tr>
<tr>
<td>1050</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Data from one cast. Hot-rolled plate 3.2 mm thick.

### Table 19 - Cyclic Oxidation Resistance

<table>
<thead>
<tr>
<th>°C</th>
<th>Time to break-away (h)</th>
<th>Rate of spalling (mg/cm²/h)</th>
<th>Weight change in 1000 h (mg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>890</td>
<td>&gt;1000</td>
<td>—</td>
<td>2.08</td>
</tr>
<tr>
<td>910</td>
<td>&gt;1000</td>
<td>—</td>
<td>3.19</td>
</tr>
<tr>
<td>990</td>
<td>400</td>
<td>0.112</td>
<td>-50.4</td>
</tr>
<tr>
<td>1010</td>
<td>375</td>
<td>0.174</td>
<td>-87.8</td>
</tr>
<tr>
<td>1090</td>
<td>50</td>
<td>0.5</td>
<td>-541</td>
</tr>
<tr>
<td>1110</td>
<td>50</td>
<td>0.5</td>
<td>-487</td>
</tr>
</tbody>
</table>
INCOLOY alloy DS is readily fabricated hot and cold and can be joined by standard welding processes.

**Working instructions**

**Hot and cold working**

The usual hot working range is 900-1200°C with heavy working being carried out between 1000 and 1200°C. Normal forging operations are usually started from 1200°C and light forging is possible down to 900°C.

The rate of cooling does not affect the alloy’s hardness and air cooling or quenching are satisfactory. Quenching forgings should be avoided where the variation in the cross-sectional area of the forging is high.

Cold working procedures are similar to those for carbon and stainless steels. The alloy’s rate of work hardening is greater than that of low carbon steel but less than that of 18/8 stainless steel.

**Machining**

INCOLOY alloy DS is best machined in the annealed condition, with hot-rolled, as-rolled and hot-forged material showing the next best results.

It is best machined on heavy duty equipment using tools large and heavy enough to withstand the loads and dissipate heat quickly.

**Annealing**

The alloy should be annealed within the range 1000-1150°C, the temperature and holding time depending on the thickness of the material and the proposed application. Cooling rate does not affect hardness.

Furnace fuel should preferably be sulfur-free. Town’s gas, natural gas, distillate fuel oils and electricity are suitable. For most heat treatments and heating processes, atmosphere should be adjusted to maintain slight oxidizing conditions.

Bright annealing can be carried out in dry hydrogen or cracked ammonia.

**Pickling**

A fused caustic soda mixture is a suitable pre-treatment to be followed by a cold water rinse before acid pickling (HNO₃/FeCl₃) at 65°C for 5-20 minutes, and a final rinse in cold water.

**Joining**

INCOLOY alloy DS is readily joined to itself or to other metals by standard processes. It is important that material to be welded is in the annealed condition. Removal of welding slag residue is essential to avoid subsequent corrosion in service.

Welding materials to be used are:

- For shielded metal arc: INCO-WELD® ‘A’ electrode
- For inert-gas shielded arc: NC 80/20 filler metal

**Available Products and Specifications**

INCOLOY alloy DS is available in pipe, tube, sheet, strip, plate, round bar, forging stock, hexagon and wire. The alloy is designated Werkstoff Number 1.4862.

- Sheet and plate: BS 3072
- Strip: BS 3073
- Seamless tube: BS 3074
- Wire: BS 3075
- Bar: BS 3076
U.S.A.
Special Metals Corporation
Billet, rod & bar, flat & tubular products
3200 Riverside Drive
Huntington, WV 25705-1771
Phone +1 (304) 526-5100
Fax +1 (304) 526-5643

Billet & bar products
4317 Middle Settlement Road
New Hartford, NY 13413-5392
Phone +1 (315) 798-2900
Fax +1 (315) 798-6860

Atomized powder products
100 Industry Lane
Princeton, KY 42445
Phone +1 (270) 365-9551
Fax +1 (270) 365-5910

Shape Memory Alloys
4317 Middle Settlement Road
New Hartford, NY 13413-5392
Phone +1 (315) 798-2939
Fax +1 (315) 798-8680

United Kingdom
Special Metals Wiggin Ltd.
Holmer Road
Hereford HR4 9SL
Phone +44 (0) 1432 382200
Fax +44 (0) 1432 264030

Special Metals Wire Products
Holmer Road
Hereford HR4 9SL
Phone +44 (0) 1432 382556
Fax +44 (0) 1432 352984

China
Special Metals Pacific Pte. Ltd.
Room 1802, Plaza 66
1266 West Nanjing Road
Shanghai 200040
Phone +86 21 3229 0011
Fax +86 21 6288 1811

Special Metals Pacific Pte. Ltd.
Room 910, Ke Lun Mansion
12A Guanghua Road
Chaoyang District
Beijing 100020
Phone +86 10 6581 8396
Fax +86 10 6581 8381

France
Special Metals Services SA
17 Rue des Frères Lumière
69680 Chassieu (Lyon)
Phone +33 (0) 4 72 47 46 46
Fax +33 (0) 4 72 47 46 59

Germany
Special Metals Deutschland Ltd.
Postfach 20 04 09
40102 Düsseldorf
Phone +49 (0) 211 38 63 40
Fax +49 (0) 211 37 98 64

Hong Kong
Special Metals Pacific Pte. Ltd.
Unit A, 17th Floor, On Hing Bldg
1 On Hing Terrace
Central, Hong Kong
Phone +852 2439 9336
Fax +852 2530 4511

India
Special Metals Services Ltd.
No. 60, First Main Road, First Block
Vasantha Vallyabha Nagar
Subramanyapura Post
Bangalore 560 061
Phone +91 (0) 80 2666 9159
Fax +91 (0) 80 2666 8918

Italy
Special Metals Services SpA
Via Assunta 59
20054 Nova Milanese (MI)
Phone +39 362 4941
Fax +39 362 494224

The Netherlands
Special Metals Service BV
Postbus 8681
3009 AR Rotterdam
Phone +31 (0) 10 451 44 55
Fax +31 (0) 10 450 05 39

Singapore
Special Metals Pacific Pte. Ltd.
24 Raffles Place
#27-04 Clifford Centre
Singapore 048621
Phone +65 6532 3823
Fax +65 6532 3621

United Kingdom
Affiliated Companies
Special Metals Welding Products
1401 Burris Road
Newton, NC 28658, U.S.A.
Phone +1 (888) 465-0352
Fax +1 (800) 624-3411

Canada House
Bidavon Industrial Estate
Waterloo Road
Bilford-On-Avon
Warwickshire B50 4JN, U.K.
Phone +44 (0) 789 491 780
Fax +44 (0) 789 491 781

Controlled Products Group
590 Seaman Street, Stoney Creek
Ontario L8E 4H1, Canada
Phone +1 (815) 226-0477
Fax +1 (800) 426-6380

A-1 Wire Tech, Inc.
A Special Metals Company
4550 Kishwaukee Street
Rockford, IL 61109, U.S.A.
Phone +1 (815) 226-0477
Fax +1 (800) 426-6380

Rescal SA
A Special Metals Company
200 Rue de la Couronne des Prés
78681 Épône Cédex, France
Phone +33 (0) 1 30 90 04 00
Fax +33 (0) 1 30 90 02 11

DAIDO-SPECIAL METALS Ltd.
A Joint Venture Company
Daido Shingawa Building
6-35, Kohnan 1-chome
Minato-ku, Tokyo 108-0057, Japan
Phone +81 (0) 3 5495 7237
Fax +81 (0) 3 5495 1853