### DECO PRODUCTS CO. DESIGNING WITH ZINC

#### ZINC ALLOY PROPERTIES

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Zamak #3</th>
<th>Zamak #5</th>
<th>Zamak #7</th>
<th>Zamak #2</th>
<th>2A-8</th>
<th>EZAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Properties</td>
<td>Die Cast</td>
<td>Die Cast</td>
<td>Die Cast</td>
<td>Die Cast</td>
<td>Die Cast</td>
<td>Die Cast</td>
</tr>
<tr>
<td>Ultimate Tensile Strength: psi X 10^3 (MPa)</td>
<td>41 (283)</td>
<td>48 (328)</td>
<td>41 (283)</td>
<td>52 (359)</td>
<td>54 (374)</td>
<td>60 (416)</td>
</tr>
<tr>
<td>Yield Strength - 0.2% Offset: psi X 10^3 (MPa)</td>
<td>32 (221)</td>
<td>39 (269)</td>
<td>32 (221)</td>
<td>41 (283)</td>
<td>42 (290)</td>
<td>57 (396)</td>
</tr>
<tr>
<td>Elongation: % in 2&quot;</td>
<td>10</td>
<td>7</td>
<td>13</td>
<td>7</td>
<td>6-10</td>
<td>1</td>
</tr>
<tr>
<td>Shear Strength: psi X 10^3 (MPa)</td>
<td>31 (214)</td>
<td>38 (262)</td>
<td>31 (214)</td>
<td>46 (317)</td>
<td>40 (275)</td>
<td>-</td>
</tr>
<tr>
<td>Hardness: Brinell</td>
<td>82</td>
<td>91</td>
<td>80</td>
<td>100</td>
<td>95-100</td>
<td>120</td>
</tr>
<tr>
<td>Impact Strength: ft-lb (J)</td>
<td>49 (58)</td>
<td>48-65 (65)</td>
<td>43-58 (58)</td>
<td>35-48 (48)</td>
<td>31-42 (42)</td>
<td>-</td>
</tr>
<tr>
<td>Fatigue Strength Rotary Bend- 5X10^6 cycles psi X 10^3 (MPa)</td>
<td>8.8 (62.5)</td>
<td>8.2 (57)</td>
<td>8.2 (57)</td>
<td>8.7 (59)</td>
<td>10 (123)</td>
<td>-</td>
</tr>
<tr>
<td>Compressive Yield Strength - 0.1% Offset: psi X 10^3 (MPa)</td>
<td>60 (414)</td>
<td>87 (600)</td>
<td>60 (414)</td>
<td>93 (641)</td>
<td>37 (252)</td>
<td>-</td>
</tr>
<tr>
<td>Modulus of Elasticity - psi X 10^6 (MPa X 10^6)</td>
<td>12.4 (85.5)</td>
<td>12.4 (85.5)</td>
<td>12.4 (85.5)</td>
<td>12.4 (85.5)</td>
<td>12.4 (85.5)</td>
<td>16.2 (112)</td>
</tr>
<tr>
<td>Poisson's Ratio</td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
<td>0.29</td>
<td>-</td>
</tr>
</tbody>
</table>

### Physical Properties

| Density: lb/cu in [g/cm³] | 24 (6.6) | 24 (6.6) | 24 (6.6) | 24 (6.6) | 227 (6.3) | 234 (6.48) |
| Melting Range: °F(°C) | 718-728 (381-387) | 717-727 (380-386) | 718-728 (381-387) | 715-734 (379-390) | 707-759 (375-404) | 715-752 (379-400) |
| Electrical Conductivity: % IACS | 27 | 26 | 27 | 25 | 27.7 | - |
| Thermal Conductivity: BTU/ft/°F (W/m/°C) | 65.3 (233.0) | 62.9 (108.9) | 65.3 (233.0) | 60.5 (104.7) | 66.3 (114.7) | - |
| Coefficient of Thermal Expansion (68-212°F/100-200°C) [µin/µm/°C] | 10 (419) | 10 (419) | 10 (419) | 10 (419) | 104 (435) | - |
| Pattern or Die Shrinkage: in/in | 0.003 (0.07) | 0.003 (0.07) | 0.003 (0.07) | 0.003 (0.07) | - | - |

### Chemical Specifications (per ASTM) (% by Weight)

<table>
<thead>
<tr>
<th>Ingot</th>
<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
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</thead>
<tbody>
<tr>
<td>Al (%)</td>
<td>3.9-4.3</td>
<td>3.7-4.3</td>
<td>3.9-4.3</td>
<td>3.7-4.3</td>
<td>3.9-4.3</td>
<td>3.7-4.3</td>
<td>3.9-4.3</td>
<td>3.7-4.3</td>
<td>3.9-4.3</td>
<td>3.7-4.3</td>
<td>3.9-4.3</td>
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<tr>
<td>Cu (%)</td>
<td>0.10 max</td>
<td>0.1 max⁶</td>
<td>0.7-1.1</td>
<td>0.7-1.2</td>
<td>0.10 max</td>
<td>0.1 max⁶</td>
<td>2.7-3.3</td>
<td>2.5-3.0</td>
<td>0.9-1.3</td>
<td>0.8-1.3</td>
<td></td>
</tr>
<tr>
<td>Fe (%)</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.05</td>
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<tr>
<td>Pb (%)</td>
<td>0.004</td>
<td>0.005</td>
<td>0.004</td>
<td>0.005</td>
<td>0.003</td>
<td>0.003</td>
<td>0.004</td>
<td>0.005</td>
<td>0.005</td>
<td>0.006</td>
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<tr>
<td>Mn (%)</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
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<tr>
<td>Ni (other)⁸</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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### Industry Standards

<table>
<thead>
<tr>
<th>Ingot</th>
<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
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<th>Casting</th>
<th>Ingot</th>
<th>Casting</th>
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<th>Ingot</th>
<th>Casting</th>
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<tbody>
<tr>
<td>ASTM</td>
<td>B240</td>
<td>AG40A</td>
<td>8240</td>
<td>8440</td>
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<td>8440</td>
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<tr>
<td>UNS</td>
<td>235521</td>
<td>235520</td>
<td>235530</td>
<td>235531</td>
<td>233522</td>
<td>233523</td>
<td>233524</td>
<td>233540</td>
<td>233541</td>
<td>2356365</td>
<td>235636</td>
</tr>
</tbody>
</table>

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1° 3 hr at 610°F and furnace cool. 2° 7/4" square specimen untreated 3° 10 mm square specimen untreated 4° Comprehensive strength 5° Previous industry accepted standard 6° Estimated values to be confirmed by research.

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Additional info on backside.
**THE ADVANTAGES CAN BE YOURS AT DECO**

This guide is to help design engineers and material specifiers to better understand the capabilities of zinc die casting alloys for product applications.

### Advantages

**Zinc Casting Alloys** are versatile engineering materials. Not other alloy system provides the combination of strength, toughness, rigidity, bearing performance and economical castability. Listed are zinc alloy attributes which can reduce component costs. Improving precision quality and product performance are other zinc alloy design advantages discussed in this brochure.

<table>
<thead>
<tr>
<th>Zinc Alloy</th>
<th>Attributes</th>
</tr>
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<tbody>
<tr>
<td>ZAMAK NO. 2</td>
<td>No. 5 alloy castings are marginally stronger and harder than No. 3. However, these improvements are tempered with a reduction in ductility which can affect formability during secondary bending, riveting, swaging or crimping operations. No. 5 contains an addition of 1% copper which accounts for these property changes. The alloy is widely die cast in Europe and does exhibit excellent castability characteristics, as well as, improved creep performance over No. 3. No. 5 alloy castings are usually the first choice when considering zinc for die casting. Its excellent balance of desirable physical and mechanical properties, superb castability and long-term dimensional stability are the reasons why over 70% of all North American zinc die castings are in No. 2 alloy. It is, therefore, the most widely available alloy from die casting sources. ZAMAK No. 3 also offers excellent finishing characteristics for plating, painting and chromate treatments. It is the “standard” by which other zinc alloys are rated in terms of die casting. Because of No. 3’s wide availability, material specifiers often strengthen components by design modification instead of using No. 5. However, when an extra measure of tensile performance is needed, No. 5 alloy casting are recommended. The alloy is readily plated, finished and machined, comparable to No. 3 alloy.</td>
</tr>
<tr>
<td>ZAMAK NO. 7</td>
<td>No. 7 alloy is a modification of No. 3 alloy in which lower magnesium content is specified in order to increase the fluidity. To avoid problems with intergranular corrosion lower levels of impurities are called for and a small quantity of nickel is specified. Alloy No. 7 has slightly better ductility than No. 3 with other properties remaining at the same level.</td>
</tr>
<tr>
<td>ZAMAK NO. 8</td>
<td>A good gravity die casting alloy, ZA-8 is rapidly growing for pressure die casting. ZA-8 can be hot chamber die cast, with improved strength, hardness and creep properties over ZAMAKS, with the exception of a No. 2 alloy which is very similar in performance. ZA-8 is readily plated and finished using standard procedures for ZAMAKS. When the performance of standard No. 3 and No. 5 is in question, ZA-8 is the die casting choice because of high strength and creep properties and efficient hot chamber castability.</td>
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</tbody>
</table>

### APPLICATIONS

<table>
<thead>
<tr>
<th>Zinc Alloy</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZAMAK NO. 3</td>
<td>Precision Tolerances: Zinc alloys are castable to closer tolerances than other materials or molded plastics, therefore presenting the opportunity to reduce or eliminate machining. “Net Shape” or “Zero Machining” manufacturing is a major advantage of zinc casting.</td>
</tr>
<tr>
<td>ZAMAK NO. 5</td>
<td>Toughness: Few materials provide the strength and toughness of zinc alloys. Impact resistance is significantly higher than cast aluminum alloys, plastics and grey cast iron. Bearing Properties: Bushing and wear inserts in component designs can often be eliminated because of zinc’s excellent bearing properties. For example, zinc alloys have outperformed bronze in heavy duty industrial applications. Machinability: Fast, trouble-free machining characteristics of zinc materials minimize tool wear and machining costs.</td>
</tr>
<tr>
<td>ZAMAK NO. 7</td>
<td>Strength &amp; Ductility: Zinc alloys offer high strengths (to 60,000 psi) and superior elongation for strong designs and formability for bending, crimping and riveting operations. Rigidity: Zinc alloys have the rigidity of metals with a modulus of elasticity characteristics equivalent to other die cast materials. Stiffness properties are, therefore, far superior to engineering plastics. Easy Finishing: Zinc castings are readily polished, plated, painted, chromated or anodized for decorative and/or functional service.</td>
</tr>
<tr>
<td>ZAMAK NO. 8</td>
<td>Anti-Sparking: Zinc alloys are non-sparking and suitable for hazardous location applications such as coal mines, tankers, and refineries. Thin Wall Castability: High casting fluidity, regardless of casting process, allows for thinner wall sections to be cast in zinc compared to other metal. Long Tool Life: Low casting temperatures result in less thermal shock and, therefore, extended life for die casting tools. For example, tooling life can be more than 10 times that of aluminum dies. Zinc alloys are among the cleanest melting materials available. Zinc metal is non-toxic, and scrap items are reusable resource which are efficiently recycled. Clean and recyclable: Zinc alloys are among the cleanest melting materials available. Zinc metal is non-toxic, and scrap items are reusable resource which are efficiently recycled.</td>
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<td>ZAMAK NO. 2</td>
<td>The alloy is therefore popular for those special cases where the die casters is making thin walled components requiring a good surface finish. However, research testing has shown that metal and die temperatures have a bigger effect than changing alloys. Close attention to control of die casting process parameters is important so as to eliminate defects and achieve consistent quality. For die casting, No. 2 offers the highest strength and hardness of the ZAMAK family. However, its high copper content (3%) results in properties changes upon long term aging. These changes include slight dimensional growth (0.0004 in/in/after 20yrs.), lower elongation and reduced impact performance (levels similar to aluminum alloy0 for die cast products. Although No. 2 alloy exhibits excellent castability, it has never been used by die casters in North America. It does, however, provide some interesting characteristics which may assist designers. It’s creep performance is rated higher than other ZAMAKS and No. 2 alloy is a good bearing material, and may eliminate bushings and wear inserts in die cast designs.</td>
</tr>
<tr>
<td>ZA-8</td>
<td>EZAC™ This is the most recent development in commercially available zinc die casting alloys. Research has shown EZAC™ to be the most creep resistant of all the zinc die casting alloys with over an order of magnitude improvement over ZAMAK 5 and ZA-8. This is also a very strong alloy with a yield strength (57 ksi) and hardness [102.134 brinell] comparable to ZA-27.</td>
</tr>
</tbody>
</table>

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