

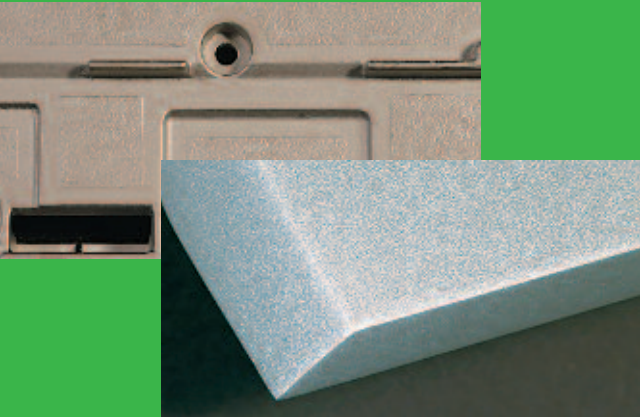
**The CWM Die Cast Component**

# OEM Quick Guide to Surface Finishing

## A Condensed Resource on Die Cast Part Surface Finishing for OEM Design Engineers & Specifiers

A preliminary guide for evaluation of die cast surface finishing alternatives for product appearance, durability and protection to aid in cost-effective specification of parts produced in Aluminum, Magnesium & Zinc—and ZA-8—die casting alloys.

A companion piece to the CWM Comprehensive Surface Finishing Guide and Sample Portfolio, which contains detailed finishing recommendations and die cast plates in the most widely used alloys, with surface finishes applied.



**Chicago  
White Metal  
Casting, Inc.**



**Browse CWM's DC<sup>2</sup>**  
(Die Cast Design Center)

Over 70 die casting design guides & bulletins are available to OEM product designers and engineers for download 24/7 at our website:

<http://dc2.cwmdiecast.com>

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## Introduction to Surface Finishing for Die Cast Parts

The three main reasons for the application of specific coatings and finishes to die cast components are these:

### ■ Meet cosmetic/decorative appearance requirements

### ■ Enhance resistance to wear

### ■ Provide a protective barrier against environmental or galvanic corrosion

In certain cases, die castings are also called upon to meet very special shielding specifications or special pressure tightness requirements:

### ■ Special EMI/RFI shielding requirements

Die cast housings and components, in all alloys, provide assured built-in EMI/RFI shielding. When shielding requirements are particularly critical, with special designs or products subject to extreme abuse, surface plating can be used to achieve such optimum specifications. The resulting plated surface finish will also provide an enhanced appearance. When specialized EMI gasketing must be used, plating may also be required.

### ■ 100% pressure tightness requirements

Impregnation is a post-casting sealing process which, under vacuum, brings organic material into the surface and subsurface pores of a die casting, providing highest pressure tightness. It is routinely recommended for critical air or water sealing applications, and, in addition, assures high output for any final surface finishing required.

This CWM Condensed Quick Guide, or its companion—the CWM Comprehensive Surface Finishing Portfolio with sample finished plates—should not be viewed as self-selection tools for specifying precise finishes for die cast parts. They are published as aids to understanding the range, characteristics and relative costs of the post-casting finishing operations available to OEMs from CWM to meet final product requirements.

Over 70 years of CWM experience, and that of its surface finishing production partners, are reflected in their content, to aid in assuring that CWM Al, Mg and Zn die cast housings and components meet stringent protection, durability and decorative specifications.

The final decision on any post-casting finishing operation should always be made in advance of die casting die design and only after detailed consultation with CWM engineering. The specific design features of your die cast part in almost every case have a direct impact on achieving your precise surface finish specifications.

This is also true in the case of any post-casting machining requirements, a subject not treated

here. Advanced die casting processing has the unique ability to deliver extremely close tolerances as-cast, with machining often entirely eliminated; where such as-cast processing is not feasible, pre-die-design consultation with CWM is essential to assure successful post-casting machining results.

Surface finishing test results, executed under controlled laboratory conditions, are available to CWM customers for many of the finishing operations outlined in this Quick Guide. Contact the CWM Sales Department regarding your specific finishing questions.

## How Die Cast Part Features Impact Surface Finishing

Superior as-cast cosmetic surface finishes characterize die castings produced by today's advanced technology. To consistently achieve such results at the lowest cost per part, it is essential that early discussions clarify precisely how the part will mate with other components in the final product assembly. This analysis is as important to final surface finish quality as it is to meeting tolerance specifications.

Those sections of the die casting which will be "hidden" from view, and cosmetically non-critical, can be considered for placement of the part's gating for metal entry and for its required parting lines. The presence of either of these features of die construction can create a severe cost penalty if they fall on a viewable, cosmetic surface of the part. Likewise, a potential sink mark on a non-cosmetic surface can be largely ignored, or steps can be taken to overcome its possible appearance by wall redesign—for example, internal support features which will be invisible to the user.

While the exterior finish is dictated by the required appearance specifications, the specific surface preparation called for is usually more dependent on functional design features. Critical edges may require a shave trim, followed by special polishing, a chromate coating and then final painting. Specified tight-tolerance holes may call for acid etching or chromating followed by reaming, milling or boring.

The type and quality of the final finish produced is impacted by the geometry of the design of specific part features. Minor modifications of critical surfaces, edges, and mounting features can change a costly finishing scenario to highly cost-efficient processing with minimum surface preparation prior to application of a final coating.

Preplanning, well before the final component design is locked in, is the essential step. Design consultation on post-casting machining, as well as final surface finishing, prior to tooling design, die construction and die cast production, is the recommended guideline.

## Design Guidelines for Enhancing Finishing Results

Design modifications to aid surface finishing quality are not always feasible. Where they can be made, significantly improved results will follow.

### Die Cast Part Edges

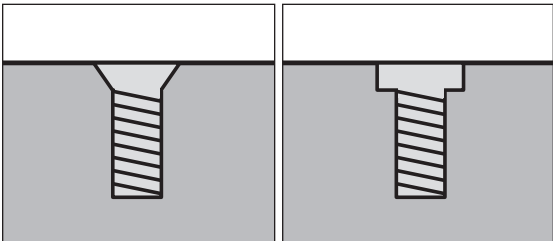
Part designs which hide any trimmed edges within the final product assembly will eliminate any need for post-casting edge polishing. Early CWM consultation on cosmetic features will assure that necessary parting lines will be placed to conceal trimmed visible edges (Fig. 1).



**Fig. 1** A plastic bumper joining this 2-part case will conceal all parting lines, thus avoiding any edge polishing.

### Die Cast Holes for Machining

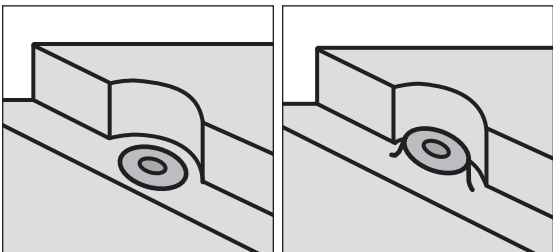
Design in chamfers (countersinks) or counter bores on holes to assure integrity of the surface edge of tapped holes. Leading threads will be protected from deburring or polishing. (Figs. 2a & 2b).



**Fig. 2a** A cast-in countersink protects lead threads. **Fig. 2b** A counter bore also serves as a thread protector.

### Die Cast Mounting Features

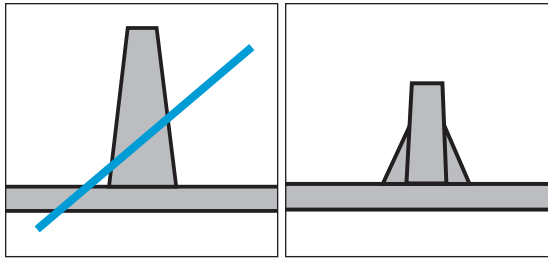
Whenever possible, create raised “shoulders” on bosses which will receive painting masks; scuffing can thus be avoided on surrounding painted surface areas during fastener torquing and mounting of mated parts (see Figs. 3a & 3b).



**Fig. 3a** Flush bosses for mounting mated parts may cause adjacent paint damage. **Fig. 3b** Cast-in boss shoulders protect adjacent painted areas during assembly.

### Die Cast Bosses

Include correctly designed gussets to improve die fill and avoid resulting sink marks on Class “A” surfaces. Short and stocky bosses are preferable to tall, thin designs to optimize metal flow and insure integrity of the feature (Figs. 4a & 4b).



**Fig. 4a** Tall bosses can lack integrity for support. **Fig. 4b** Shorter bosses with gussets optimize designs.

### Die Cast Corners

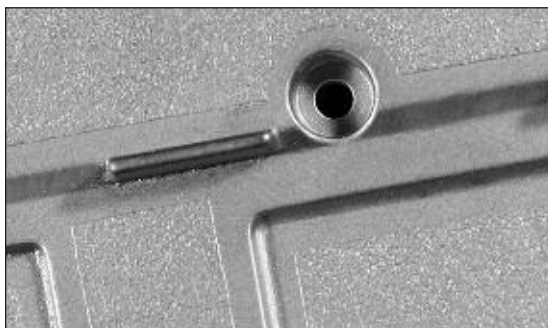
Use the maximum allowable radius for all internal and external corners to permit vibratory deburring media to reach all part surfaces. This design guideline for die cast corners of housings is also vital to assuring the complete filling of the die cavity and maintaining the integrity of the corners of the part (see Fig. 5).



**Fig. 5** While advanced technology can execute most corner designs, gentle radii, as above, will reduce finishing steps.

### Die Cast Surfaces

Subtle textured surfaces can be produced, as-cast, on selected areas of a component by special preparation of the die casting die. These cast-in textures are created by photoengraving techniques during die construction and are sometimes recommended for use on the underside of complex parts to aid in smooth die fill (Fig. 6).



**Fig. 6** The addition of cast-in surface textures, as in this internal frame, can aid smooth filling of the die cavity.

## Finishing Steps and Alternatives

Depending on requirements to meet durability, protection and cosmetic appearance specs, most Al, Mg and Zn die cast components will receive from one to three standard post-casting finishing steps: deburring, conversion or combined conversion-functional coating, and a final surface finish coating.

### Post-Trim Deburring

Vibratory processes including highly automated operations, using a range of media types, can round sharp edges, remove burrs, loose flash and debris, and smooth and brighten part surfaces. Liquid, selective media, calibrated vibration, and special compounds to cushion against damage are employed. Virtually all CWM die castings go through a mechanical deburring operation prior to post-trim finishing. For 100% burr-free specifications, an additional operation may be required.

### Surface Conversion Coating

Deburring is usually followed by a conversion coating that removes any remaining oil, die cast part release agents and other contaminants. Where final painting is specified, this coating serves as preparation and primer. In many non-cosmetic applications, this conversion coating can serve as the component's final finish.

**Trivalent Clear Chromate (TCP).** Environmentally friendly Trivalent clear chromium is now a proven, economical alternative to widely used hexavalent chromium coatings, offering high corrosion resistance for Al, Mg & Zn die cast parts in a wide range of applications. With a bright, cosmetically pleasing finish, it meets stricter EPA regulations and RoHS European Union mandates, avoiding concerns with prohibited toxic hexavalent chromates. ASTM test results demonstrate salt-spray protection up to 168 hours on Al 380.

### Combined Conversion Coatings/Functional Finishes

Where a die cast component has a specific functional requirement, such as added corrosion protection, the need for added durability, and/or a semi-decorative appearance, one of the combined conversion-functional finishes is often recommended. A combined coating replaces the use of a surface conversion coating. It can serve either as a paint base or, in many applications, as the part's final finish.

### Final Cosmetic Surface Finish

While final painting or plating of die cast housings and components is most often specified for cosmetic purposes, and to sustain their decorative appearance over the life of the part, other functional purposes of a final applied finish may be of equal, or of even greater, importance. These include: maximizing corrosion resistance, heat dissipation, and surface performance under abuse, and adding greater insulation properties.

A wide range of painting applications are available for die castings in matching finished, mating

parts produced in other production processes. These final die cast finishes include powder coatings applied electrostatically in finishes from fine to coarsely textured in a variety of chemistries, to liquid paint polyurethane and water-based finishes applied at various thickness/texture levels by electrostatic or conventional means.

Component masking is an essential part of virtually all cosmetic surface finish applications, required to assure that part areas that must not receive finish coatings are protected during processing. Required protective masks must be applied during finishing production and later removed from each part. Costs are proportional to part complexity and the resulting masking required. Unique to die cast parts, special fixtures mated to the die castings can be constructed, in the case of longer finishing runs and those parts suited to such fixturing. If feasible, such fixture masks can reduce finishing production costs.

**Painting: Powder or Liquid.** Electrostatically applied, non-solvent-based powder coatings are environmentally friendly, enabling non-toxic waste disposal. Powder coatings for die castings produce a durable, uniform surface finish, from matte to semi-gloss, with a wide variety of standard colors available in a range of surface textures. Custom colors can be formulated at extra cost.

Powder coating is the only recommended painting process for die cast parts specified for operation in the field at temperatures over 300° F (148.8° C). Custom formulations are available to enable maintenance of coating integrity at even higher product operating temperatures.

Polyurethane and other wet paint chemistries are the most common final color finishes performed on die cast components, and have now been joined by water-based wet paints. Finishes from matte to high-gloss are available.

Total production costs and lead times for most liquid paints are lower than for powder coating, especially for short production runs—particularly those projects requiring a custom formulation.

**Plating.** Electro-deposition of a metallic coating on a die casting can provide the most attractive, durable and wear- and corrosion-resistant finish of any surface treatment, at proportionately added cost. While die castings offer excellent built-in EMI-RFI shielding, as cast, internal board design sometimes indicates additional plating to achieve maximum possible shielding protection.

### Additional Post-Casting Operations

Cosmetic parts routinely receive graphic identification and labeling, by silkscreening or pad printing, and “soft-touch” clear coatings in areas where portable housings will be gripped.

With pressure-tight specifications for air- or water-sealed applications, die castings may require resin impregnation.

Elastomer overmolding can also be used for premium product ruggedization.

# CWM Surface Finishing Cost/Performance Comparison Table for Al, Mg & Zn Die Cast Parts

Values shown are relative within categories. They are not based on specific die cast part designs, features or surface specifications, which can greatly influence costs.

Rating Code Key: L = Low M = Medium H = High VH = Very High

PLATE COATING CODE*	SURFACE FINISH	RELATIVE COST	RELATIVE APPEARANCE	WEAR RESISTANCE	CORROSION RESISTANCE	PORTFOLIO SUBSECTION*
<b>1. POST-TRIM DEBURRING</b>						
<b>Tumble Deburring</b>						
	Rough Deburr — Cutting-type media	L	L	---	---	1.A1
	Polished Deburr — Plastic media	M	M	---	---	1.A2a
	Polished Deburr — Ceramic media	M	H	---	---	1.A2b
	Aluminum Oxide Deburr	M	L	---	---	1.A3
	Ball Burnishing ( <i>Cost varies by media shapes</i> )	M-H	H	---	---	1.A4
<b>Mechanical/Pressure Deburring</b>						
	Bead Blasting — Al Oxide media	M	L	---	---	1.B1a
	Bead Blasting — Glass media	M	L	---	---	1.B1b
	Automated Bead Blasting -- Al Oxide media	L	L	---	---	1.B2a
	Automated Bead Blasting -- Glass media	M	L	---	---	1.B2b
	Wheelabrating™ — Al Oxide Shot media	L	L	---	---	1.B3a
	Wheelabrating™ — Steel Shot media	L	L	---	---	1.B3b
<b>2. CONVERSION COATINGS &amp; COMBINED CONVERSION/FUNCTIONAL FINISHES</b>						
<b>Surface Conversion Coatings</b>						
SC-A1	Trivalent Clear Chromate** (for Al, Mg, Zn parts)	M	L	L	L	
SC-A	Yellow Chromate (for Al parts only)	L	L	L	L	2.A
SC-B	Clear Chromate (for Al parts only)	L	L	L	L	2.B
SC-C	NH-35 (for Mg parts only)	L	L	L	L	2.C
SC-D1	Alodine 5200 (for Al parts)		M	L	L	L 2.D1
SC-D2	Alodine 5200 (for Mg parts)	M	L	L	L	2.D2
<b>Combined Conversion/Functional Finishes</b> ( <i>Combined Coatings replace use of Surface Conversion Coatings</i> )						
CC-E1	Anodize: Black (for Al parts only)	M	M	L	L	2.E1
CC-E2	Anodize: Clear (for Al parts only)	M	M	L	L	2.E2
CC-E3	Anodize: Clear Hard Coat (for Al parts only)	M	M	M	M	2.E3
	Anomag (for Mg parts only)	M	M	H	H	
CC-G	Dow 7 (for Mg parts only)	H	M	L	M	2.G
CC-H	Dow 9 (for Mg parts only)	H	M	L	M	2.H
CC-I	Gold Iridite/Chromate (for Zn parts only)	L	M	L	L	2.I
<b>3. COSMETIC FINISHES</b>						
<b>Painting</b> (for Al, Mg & Zn die cast parts)						
CF-A1a	Powder Coat — Fine Surface Finish	L-M	H	H	H	3.A1a
CF-A1b	Powder Coat — Medium Surface Finish	L-M	M	H	H	3.A1b
CF-A1c	Powder Coat — Coarse Surface Finish	L-M	L	H	H	3.A1c
CF-A2a	Liquid Paint — Fine Surface Finish	L-M	H	M-H	M	3.A2a
CF-A2b	Liquid Paint — Medium Surface Finish	L-M	M	M	M	3.A2b
<b>Plating</b>						
CF-B1	Electroless Nickel Plate (for Al, Mg & Zn parts)	H	M	M	M	3.B1
CF-B2	Copper, Nickel, Chrome Plate (for Zn parts)	M	H	H	H	3.B2
CF-B3	Polish & Buff ( <i>Copper, Nickel, Chrome Plate</i> ) (for Zn parts)	VH	VH	H	H	3.B3
CF-B4	Bright Acid Tin Plate (for Zn parts)	M	M	M	M	3.B4

\* The Coating Codes and page references refer to finished die cast sample plates & coating descriptions in CWM's Comprehensive Resource Portfolio (see back cover).

\*\* Trivalent Clear Coating (TCP) is U.S. EPA compliant & RoHS compliant with European mandates. (See page 4) © 2012 Chicago White Metal Casting, Inc. All Rights Reserved

## 9 Typical Die Cast Parts, Their Surface Finishing Requirements and Suggested Coatings for Each

This table is presented to enable OEM engineers & specifiers to better understand the factors involved in die cast coating selection. Coating & finishing recommendations will always depend on specific part designs and features, and discussion with CWM Engineering.

	<b>1</b> <b>Basic Functional</b> <b>Die Cast Part (Al)</b>	<b>2</b> <b>High Durability</b> <b>Die Cast Part (Al)</b>	<b>3</b> <b>Cosmetic</b> <b>Die Cast Part (Mg)</b>	<b>4</b> <b>High Cosmetic</b> <b>Die Cast Part (Zn)</b>
<b>Standard Post-Casting Surface Finishing Steps for Die Cast Parts</b>	Internal bracket for a commercial/industrial housing. <i>Requirements:</i> Good durability and strength. Normal corrosion exposure. Non-cosmetic surface.	External electronic housing for commercial application. <i>Requirements:</i> <b>(A)</b> High durability. Non-cosmetic. Corrosion exposure above average. Good strength. Relatively thick walls. <b>(B)</b> As above, but additional cosmetic surface requirement.	Functional housing components for commercial power tool. <i>Requirements:</i> Good appearance. Good durability. Good drop strength. Light weight. Above-average corrosion exposure.	Functional housing components for premium indoor modular lighting fixture. <i>Requirements:</i> Premium appearance. High durability. Good strength. Normal corrosion exposure.
<b>DEBURRING</b>				
<b>Tumble Deburring</b>		<b>(A &amp; B)</b> Polished Deburr — Plastic media (recommended to protect machined surfaces)	Polished Deburr — Ceramic media	Polish Deburr — Ceramic media
<b>Mechanical/Pressure Deburring</b>	Automated Bead Blasting — Al Oxide Shot media			
<b>CONVERSION COATINGS &amp; FUNCTIONAL FINISHES</b>				
<b>Conversion Coating</b>	Yellow Chromate for Al (Note: With environmentally-sealed housing, no conversion coat needed)	<b>(B)</b> Yellow Chromate for Al	Trivalent Clear Chromate (TCP)	None required
<b>Combined Conversion-Functional Finish</b>		<b>(A)</b> Clear Hard Coat Anodize (plus nickel acetate and sodium dichromate seal)		
<b>COSMETIC FINISH</b>				
<b>Painting</b>	None required	<b>(A)</b> None required <b>(B)</b> Fine Finish Powder Coat to match plastic parts	Medium-Textured Finish Powder Coat to match company color and plastic parts	
<b>Plating</b>				Copper, Nickel, Chrome Plate (For very high cosmetic appearance, wear & corrosion resistance, a series of polish and buffing operations would be substituted for polish deburring)

The nine hypothetical die cast examples above illustrate typical finishing steps. CWM publishes a Comprehensive Surface Finishing Resource Portfolio which details recommended uses, advantages and limitations for all coatings listed in this Quick Guide (see back cover).

**5**  
**Anti-Corrosion**  
**Die Cast Part (Zn)**

Functional housing/heat sink component for outdoor application.  
*Requirements:* High corrosion exposure. Good appearance. High durability and strength. Relatively light weight.

Polished Deburr —  
Ceramic media

Gold Iridite/Chromate  
for Zn

Medium-Textured Finish  
Liquid Paint  
(with catalyst added for  
higher durability in outdoor  
use)

**6**  
**High Anti-Corrosion**  
**Die Cast Part (Mg)**

Functional housing component for marine application.  
*Requirements:* Light weight. High corrosion exposure. Premium appearance. High durability & strength.

Rough Deburr —  
Cutting type media

Anomag

Fine Finish Powder  
Coat  
in a two-coat application for  
added durability

**7**  
**EMI Shielded**  
**Die Cast Part (Al)**

Housing components for an electronic measuring device designed with good board-level shielding.  
*Requirements:* Fail-safe EMI-RFI shielding. Good appearance. Excellent drop strength. Good durability. Above-average corrosion exposure. Relatively light weight.

Polished Deburr —  
Ceramic media

Yellow Chromate for Al

Fine Finish Liquid Paint  
to match company color  
and plastic parts

**8**  
**High Cosmetic/EMI**  
**Die Cast Part (Mg)**

Housing components for electronic hand-held medical device with limited board-level shielding.  
*Requirements:* 100% fail-safe shielding. Good appearance. Excellent drop strength. Good durability. High corrosion exposure. Light weight.

Polished Deburr —  
Plastic media

Trivalent Clear Chromate  
(TCP)

Fine Finish Powder Coat  
to match plastic parts  
("Soft-Touch" clear coat  
applied to handle grip. EMI  
finger gaskets for shielding  
integrity)

**9**  
**Internal EMI Shielded**  
**Die Cast Part (Mg)**

Functional internal EMI electronic shield/stiffener frame.  
*Requirements:* 100% fail-safe EMI/RFI shielding. Excellent rigidity and drop strength. Mild corrosion exposure. Non-cosmetic.

Aluminum Oxide Deburr

None required

Electroless Nickel Plate

Contact your CWM Sales-Engineering Representative, or the CWM Sales Dept., to access a copy of the CWM Comprehensive Die Cast Surface Finishing Portfolio, companion to this Quick Guide.

Shown below are samples of the 4.25 x 3 x .1875 in. (10.79 x 7.62 x .476 cm) die cast plates, with individual coatings applied, which are part of CWM's Surface Finishing Portfolio.



## The CWM Surface Finishing Portfolio with sample finished plates

This Quick Guide is based on CWM's Comprehensive Surface Finishing Portfolio, which includes a library of finished die cast "plates." The Portfolio contains detailed information on the most widely used post-casting surface coatings and finishing alternatives available for die cast components in aluminum, magnesium and zinc.

The recommended uses, advantages and limitations outlined in the Portfolio for each coating provide a clear picture of what can be expected from CWM in performance from alternate surface finishes. In evaluating finished appearance, however, there is no substitute for examining a finishing alternative applied under production conditions to the actual die cast alloy surface to be used for your product. Such cast and finished samples are provided as die cast plates, in the appropriate alloy, with each described coating applied.

For Portfolio information, contact your CWM Sales-Engineering Representative, or the CWM Sales Dept. This surface finishing resource, and those listed at the right, are further examples of how CWM strives to assure OEMs better-performing, lower-cost die cast parts. Founded in 1937, CWM is one of the leading custom die casting producers in North America.

For a detailed look at CWM's CNC Precision Machining and Contract Manufacturing capabilities, see the additional websites below.

### DISCLAIMER

Every effort has been made to assure the accuracy of data presented in this Surface Finishing Quick Guide, but Chicago White Metal Casting cannot be responsible for results obtained with this data. CWM disclaims any liability arising out of use of this material. No warranties, express or implied, are given in connection with this publication.

## CWM Design Resources for OEMs

To aid OEM product design engineers and specifiers in making all of the right design-for-die casting decisions early in the product concept stage, Chicago White Metal offers a variety of resources.

**CWM Sales/Engineers.** As an arm of our engineering and sales departments, CWM sales/engineer representatives are located in most major design and production centers throughout the U.S., and in Canada & Mexico. They can answer your initial questions on designing for die casting, provide you with specific information on CWM capabilities and arrange a visit to our modern 136,000 sq. ft. facility; all can be located through our website ([www.cwmdiecast.com](http://www.cwmdiecast.com)), or by calling CWM.

**60+ Design Aids from CWM by 24/7 Download.** Valuable design and specification guides, reference manuals, case studies and online Webinars are available in the OEM Resource Center at the CWM website: [www.cwmdiecast.com/OEM](http://www.cwmdiecast.com/OEM) design engineers can also obtain a copy of the 211p *NADCA Product Specification Standards* manual from CWM at a special discount.

**Profile CWM Capabilities.** To profile CWM's die casting design and production capabilities, go to the CWM website's virtual "Tour" section. You can also download or request a free copy of the CWM full-color *Capabilities* brochure.

For a detailed look at CWM's CNC Precision Machining and Contract Manufacturing capabilities, see the additional websites below.

**Chicago White Metal Casting, Inc.**



Certified Aluminum, Magnesium & Zinc Die Casting and Miniature Zinc & ZA-8 Die Cast Parts

**Our Quality Management & Environmental Management Systems are ISO 9001 and ISO 14001 Registered**

**EXCELLENCE IS EXPECTED**

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Sales & Engineering Representation throughout North America and in Central America. See our Websites.

### MEMBER:

North American Die Casting Association

International Magnesium Association

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