1997 DIE CAST PRODUCT STANDARDS

Summary of the new NADCA standards manual, essential OEM resource now expanded to include Miniature, Semi-Solid, and Squeeze casting

Prepared for OEM designers, specifiers and purchasers by the Diecasting Development Council of NADCA

Bulletin No. 7B

NADCA's Product Specification Standards for Die Castings manual presents the latest design standards and guidelines to aid product engineers and specifiers in preplanning the production of their part designs as die castings.

Published by the North American Die Casting Association, the 1997 198-page reference is a major expansion of valuable specification, quality assurance and purchasing guidance—a companion to the DDC OEM Design Sourcebook. It now includes Miniature, Semi-Solid and Squeeze casting data. It can help assure that your designs are producible to your exact requirements at the most economical cost.

This bulletin summarizes the important content of the major sections of the new Product Standards manual. The manual is available at special discounts from any DDC custom die caster, or can be purchased from the DDC.

1. Material Selection: Recycling

Facts on this important new requirement for manufacturing process and material selection are presented in this introductory section. Die casting alloys offer the designer concerned with recyclability the most advantageous material options—both in terms of the post-consumer origins of the raw material and its potential for efficent recycling at the end of useful product life.

Not all product engineers are aware that nearly 95% of all aluminum die castings produced in North America are cast from post-consumer reclaimed aluminum. And that these die castings are being recycled, through a well-established reclamation infrastructure, and cast into similar high-performance parts.

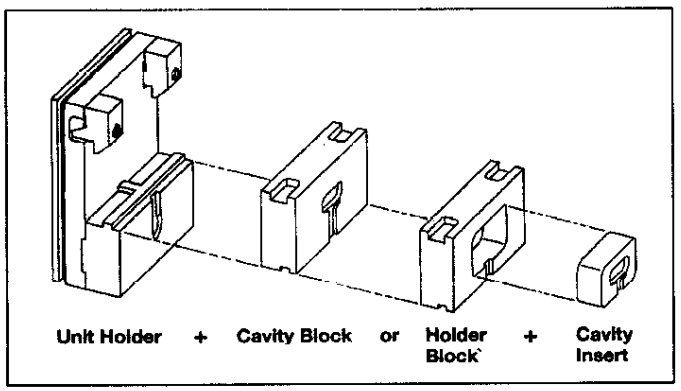


Fig. 1. Two unit die systems are shown here: The unit holder can accommodate either a cavity block or a holder block with cavity insert.

2. Tooling for Die Casting

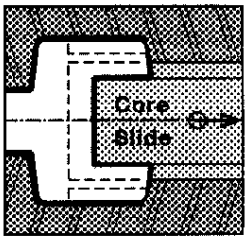
Understanding the unique tooling requirements for die cast part production and trimming can result in significant savings.

This section describes the range of die casting dies and die materials commonly used, with specific recommendation depending on the alloy selected, size of the part to be cast, part volume, requirements for "family" sets of parts, and the economic advantage of using core slides or cast-in inserts.

The use of prototype dies is discussed, along with other prototyping strategies for product testing and market evaluation prior to the construction of production dies.

Interchangeable unit die systems (Fig. 1), usually restricted to smaller parts with few or no core slides, allow significant cost savings on die construction where they can be used.

Specific design features that drive die construction costs are outlined, together with the important consideration of placement of the casting's parting line. To achieve the full benefits of net-shape or near-net-shape die casting, with any secondary machining performed precisely as desired, careful preplanning is essential before any die construction begins.



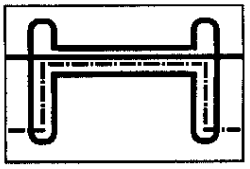


Fig. 2. Two parting line alternatives: Parting line shown by a solid horizontal line will result in better casting fill, cleaner trim, reduced die cost and extended die life compared to the alternative shown.

3. Die Casting Alloy Data

An expanded alloy section provides comprehensive, updated data on die casting materials commercially available. Included are the aluminum alloys; aluminum metal matrix composites; copper, brass and bronze alloys; magnesium alloys; zinc (Zamak) alloys; and zinc-aluminum (ZA) alloys.

Alloy tables present the latest standards for chemical composition and properties, plus comparative guidelines, by individual alloy, for expected die casting, machining and surface finishing characteristics.

To aid in performing finite element analysis, Poisson's Ratio is included for each alloy for which this value is available.

4. Engineering: Coordinate Dimensioning Tolerances

Fig. 3. New Precision Tolerances represent significant reductions from former "E" Series standards. For precision linear dimension tolerances, up to 50% reductions. For parting line and moving die component tolerances, now stated as "plus side only" tolerances, up to 65% and up to 41% reductions, respectively.

The updated engineering and design section replaces the former ADCI/NADCA "E" Series standards to enable product designers to properly evaluate the capabilities of today's North American die casting industry in relation to their planned component designs.

Six important tolerancing specification guidelines are presented as both "Standard" Tolerances and "Precision" Tolerances: linear dimensions, dimensions across parting lines, dimensions formed by moving die components (moving die parts), draft; flatness; and cored holes for cut and formed threads. The "Standard" and "Precision" tables appear on facing pages incorporating both "English" and "metric" values. Wall thickness recommendations and machining stock allowances are included in this section.

Table P-4-1 Tolerances for Linear Dimensions (Precision)
In inches, three-place decimals (.xxx); in millimeters, two-place decimals (.xx)

Length of Dimension "E₁"	Die Casting Alloy			
	Zinc	Aluminum	Magnesium	Copper
Basic Tolerance up to 1" (25.4 mm)	±0.002 (±0.05 mm)	±0.002 (±0.05 mm)	±0.002 (±0.05 mm)	±0.007 (±0.18 mm)
Add[illegible] for [illegible]	±0.001	±0.001	±0.001	±0.002

Table P-4-2 Parting Line Tolerances (Precision)—*Added to Linear Tolerances*

Projected Area of Die Casting inches² (cm²)	Die Casting Alloy *(Tolerances shown are "plus" values only)*			
	Zinc	Aluminum	Magnesium	Copper
up to 10 in² (64.5 cm²)	+0.003 (+0.076 mm)	+0.0035 (+0.089 mm)	+0.0035 (+0.089 mm)	+0.006 (+0.153 mm)
11 in² to 20 in² (71.0 cm² to 129.0 cm²)	+0.0035 (+0.089 mm)	+0.004 (+0.102 mm)	+0.004 (+0.102 mm)	+0.007 (+0.178 mm)
21 in² to 50 in² (135.5 cm² to 322.6 cm²)	+0.004 (+0.102 mm)	+0.005 (+0.153 mm)	+0.005 (+0.153 mm)	+0.008 (+0.203 mm)
51 in² to 100 in² (329.0 cm² to 645.2 cm²)	+0.006 (+0.153 mm)	+0.008 (+0.203 mm)	+0.008 (+0.203 mm)	+0.009 (+0.229 mm)
101 in² to 200 in²	+0.008	+0.012	+0.012	+0.010

Table P-4-3 MDC Tolerances (Precision)—*Added to Linear Dimension Tolerances*

Projected Area of Die Casting inches² (cm²)	Die Casting Alloy *(Tolerances shown are "plus" values only)*			
	Zinc	Aluminum	Magnesium	Copper
up to 10 in² (64.5 cm²)	+0.005 (+0.127 mm)	+0.006 (+.152 mm)	+0.005 (+.127 mm)	+0.010 (+0.254 mm)
11 in² to 20 in² (71.0 cm² to 129.0 cm²)	+0.007 (+0.178 mm)	+0.010 (+0.254 mm)	+0.007 (+.178 mm)	—
21 in² to 50 in² (135.5 cm² to 322.6 cm²)	+0.010 (+0.254 mm)	+0.014 (+0.356 mm)	+0.010 (+0.254 mm)	—
51 in² to 100 in² (329.0 cm² to 645.2 cm²)	+0.014 (+0.356 mm)	+0.018 (+0.457 mm)	+0.014 (+0.356 mm)	—
101 in² to 200 in² (651.6 cm² to 1290.3 cm²)	+0.019 (+0.483 mm)	+0.024 (+0.61 mm)	+0.019 (+0.483 mm)	—
201 in² to 300 in² (1296.8 cm² to 1935.5 cm²)	+0.024 (+0.61 mm)	+0.030 (+0.762 mm)	+0.024 (+0.61 mm)	—

For projected area of a die casting over 300 in² (1935.5 cm²), consult with your die caster.

Notes:

1. Moving die components (also called "moving die parts") are most commonly core slides (or pulls) which are used to form inset holes or features in a die casting. All values for dimensions formed by moving die components are stated as a "plus" tolerance only. The moving die component at a die closed position is the bottom of the tolerance range, i.e., 0.000 (zero). Due to the nature of the die casting process (parting line separation, wear on moving components, etc.), a moving die component can

2. By repeated sampling and recutting of the die casting tool, along with production capability studies, even closer dimensions can be held—at additional sampling or other costs.

3. During the die casting process, variations in dimensions may occur in moving die components due to parting-line separation, wear, etc. Thus, tolerances that are located from a fixture formed by a MDC should be checked in multiple locations.

Standard Tolerances

The Standard Tolerances presented are consistent with high die casting cycle speeds, uninterrupted production, reasonable die life and die maintenance costs, as well as normal inspection, packing and shipping costs. Specific Standard Tolerances represent reductions of up to 45% from former "E" Series standards.

These Standard Tolerances can be achieved today by the widely available production capabilities of die casters practicing standard methods and procedures. Conformity to these standards by designers assures the most predictable service and lowest cost.

Precision Tolerances

Critical requirements for dimensional accuracy beyond Standard Tolerances can be specified for today's die cast processing, when required. These Precision Tolerances represent reductions of up to 65% from former "E" Series standards; they require extra precision in die construction and/or special process controls in production and the use of newer technologies and equipment.

Precision requirements can often be incorporated with little additional cost, but such tolerances should be specified only when necessary.

The estimated tolerance values are, of necessity, guidelines only—highly dependent on the particular shape, specific features and wall thickness transitions of a given part design. These factors, under the control of the product designer, greatly influence the ability of the die casting process to achieve predetermined specifications in the final casting.

Where a number of critical requirements are combined in a single die casting, early die caster consultaton is essential. Design modifications for more cost-efficient die casting production can nearly always be suggested. Without such feedback, additional costs can usually be expected and the design, as originally planned, may be not be die castable.

When specific designs permit, tolerances closer than the new Precision Tolerance values can be held by repeated production sampling and modifications to the die casting die, together with production capability studies. While such steps will result in added tooling and production costs, significant savings can be achieved by eliminating substantial secondary machining and/or finishing operations.

5. Engineering: GD&T

For the growing number of design engineers who understand the advantages of using GD&T symbols on their engineering drawings, the new Geometric Dimensioning section provides guidelines for applying geometric tolerancing techniques to die cast part specs.

This functional dimensioning approach, basic to GD&T, aids the engineer in analyzing product function in the design stage and establishing part tolerances based on functional requirements. By enabling the designer to determine the maximum allowable tolerance that will not adversely affect product function, significant production savings can result.

While not intended as a short course in geometric dimensioning, the section reviews the basic nomenclature and symbols involved and presents a preferred datum reference framework for die cast part designs.

6. Engineering: Additional Specification Guidelines

For many important casting characteristics and design concerns, the setting of precise standards to cover a broad range of part designs is difficult.

These would include such factors as pressure tightness; design of fillets, ribs & corners; location of ejector pins; ejector pin flash; the specifications for as-cast surface finish; and die cast lettering and ornamentation.

While specifications for such characteristics must be individually addressed for each component design, certain guidelines have been established for die casting production under normal production practice. These guidelines can yield the most economic results and are presented in this section. This includes specific design recommendations to help achieve pressure-tight casting requirements and to assure that porosity will not affect secondary machining specifications.

7. Quality Assurance

While the entire manual is aimed at providing guidelines to assure consistent results in die casting production, the Quality Assurance section outlines those controls and procedures which should be addressed to achieve the tolerances and specifications presented.

The terminology and criteria necessary to maintain acceptable product quality under normal die casting practice are set forth. Types of potential defects are discussed and

Engineering and Design: Geometric Dimensioning

Preferred Datum Reference Framework for a Die Cast Part Design as oriented in the ejector half of the die

Datum on Same Side of Parting Line (P/L)

The drawing shown here provides a preferred framework for a datum structure for a die cast part on the same side of the parting line. It achieves the lowest overall cost in the case of a part requiring secondary machining after die casting to near-net shape.

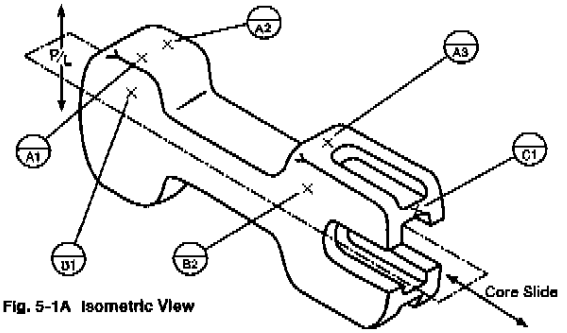
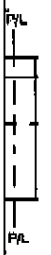


Fig. 5-1A Isometric View

As-Cast Surface Finish Classifications and Final Finish or End Use

Class	As-Cast Finish	Final Finish or End Use
1 Utility Grade	No cosmetic requirements. Surface imperfections (cold shut, rubs, surface porosity, lubricant build-up, etc.) are acceptable.	**Used as-cast or with protective coatings:** Anodize (non-decorative) Chromate
2 Functional Grade	Surface imperfections (cold shut, rubs, surface porosity, etc.), that can be removed by spot polishing or can be covered by heavy paint, are acceptable.	**Decorative Coatings:** Lacquers Enamels Plating (Al) Chemical Finish Polished finish
3 Commercial Grade	Slight surface imperfections that can be removed by agreed upon means are acceptable.	Structural Parts (high stress areas) Plating (Zn) Electrostatic Painting Transparent paints
4 Consumer Grade	No objectionable surface imperfections. Where surface waviness (flatness), noted by light reflection, is a reason for	Special Decorative Parts
5 Sup Gra		



Engineering and Design: Other Specification Guidelines

Ejector Pins, Pin Marks and Pin Flash

Ejector Pin Marks

Moveable ejector pins must be used to eject a die casting from the die casting die and will result in a residual ejector pin mark on die cast part.

In addition to automatically pushing the casting from the die after part solidification, ejector pins also serve to keep the casting from bending.

The three sequential illustrations at right demonstrate the action of the ejector pins in a die casting cycle.

Location Of Ejector Pins

Ejector pin locations should be at the option of the die caster, subject to the customer's agreement. Where considerations of cast surface cosmetics are important, ejector pin locations should always be discussed in advance of die design.

The number, size and location of ejector pins and bosses required will vary with the size and complexity of the die casting, as well as with other factors.

Acceptable Ejector Pin Marks

Ejector Pin Operation

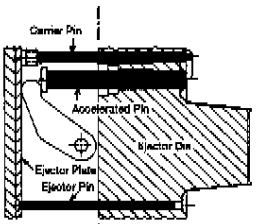


Fig. A

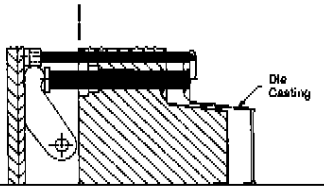


Fig. 4. Convenient checklists can be removed and reproduced to accompany RFQs and production specifications.

design approaches recommended to avoid casting problems.

Ten important requirements for the drawings and specifications provided to the die caster in a Request for Quotation and as final production instructions are discussed.

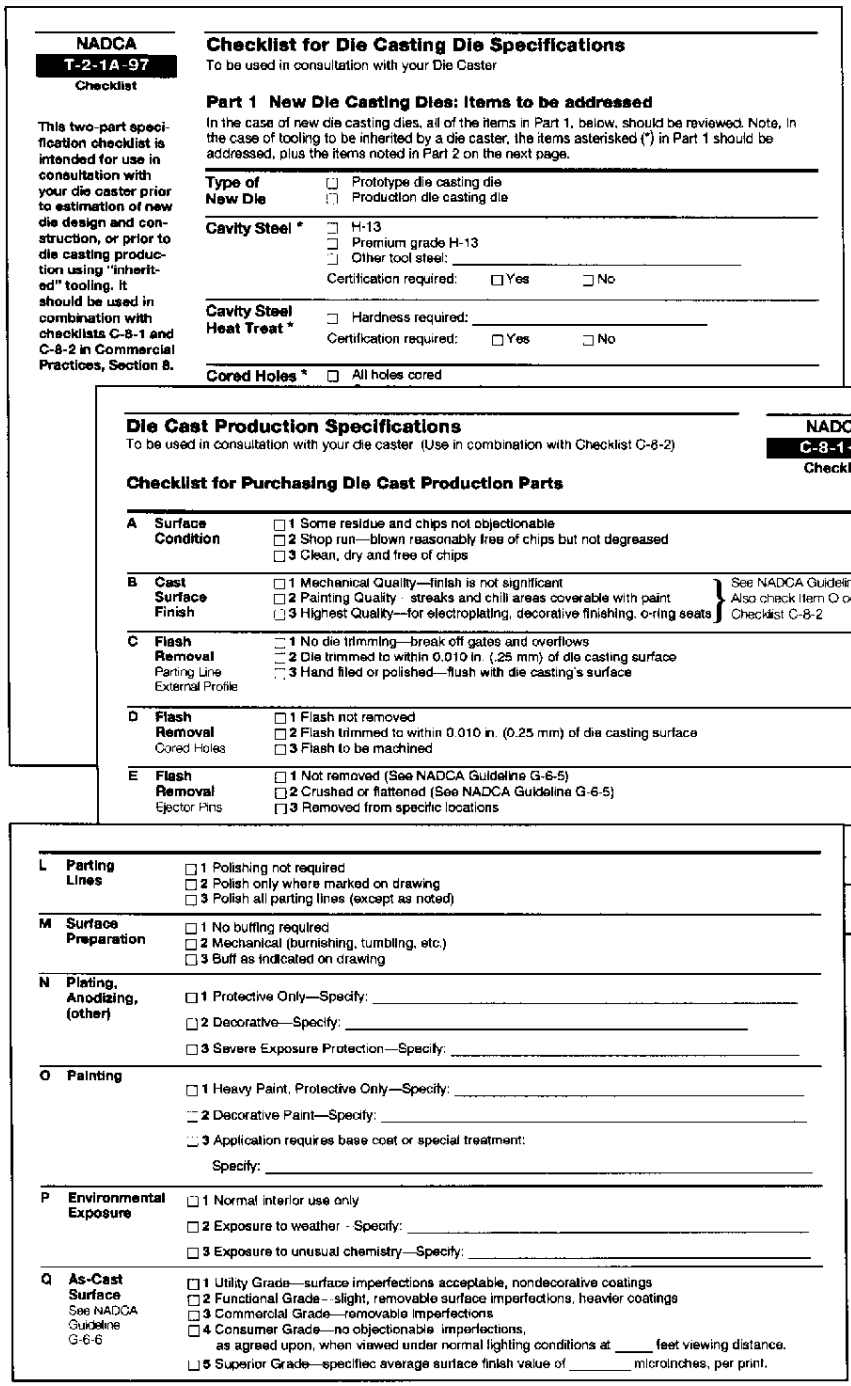
Other subjects covered are gage, measurement and testing equipment; statistical quality control; SPC procedures; process variables; internal and parting-line porosity; pressure-tight castings; and the procedures of first-piece inspection.

8. Commercial Practices

This final section of the manual presents a complete overview of standard practices in the North American die casting industry covering die casting dies and production tooling, production part orders, purchased components, price adjustments, patent obligations, warranties, and product liability.

A comprehensive checklist is provided for addressing considerations in new die casting die construction, as well as for tooling to be transferred to a new production facility. Also included are updated die cast product checklists outlining the important production and finishing specifications which should be addressed at the quotation stage or in every instance before the onset of production. All of the checklists can be reproduced to accompany requests for quotation and/or production specs.

For ease of use, in addition to its condensed contents page, each major section includes its own comprehensive table of contents. A complete listing by assigned number is included for all NADCA standards, guidelines and checklists which appear in the manual. A comprehensive glossary of tooling, die casting design, production, secondary machining and finishing terms is also provided. A detailed index appears at the end of the 198-page volume.



NADCA
T-2-1A-97
Checklist

This two-part specification checklist is intended for use in consultation with your die caster prior to estimation of new die design and construction, or prior to die casting production using "inherited" tooling. It should be used in combination with checklists C-8-1 and C-8-2 in Commercial Practices, Section 8.

Checklist for Die Casting Die Specifications
To be used in consultation with your Die Caster

Part 1 New Die Casting Dies: Items to be addressed
In the case of new die casting dies, all of the items in Part 1, below, should be reviewed. Note, in the case of tooling to be inherited by a die caster, the items asterisked (*) in Part 1 should be addressed, plus the items noted in Part 2 on the next page.

Type of New Die — ☐ Prototype die casting die ☐ Production die casting die

Cavity Steel * — ☐ H-13 ☐ Premium grade H-13 ☐ Other tool steel: _____ Certification required: ☐ Yes ☐ No

Cavity Steel Heat Treat * — ☐ Hardness required: _____ Certification required: ☐ Yes ☐ No

Cored Holes * — ☐ All holes cored

Die Cast Production Specifications
To be used in consultation with your die caster (Use in combination with Checklist C-8-2)

NADCA
C-8-1-97
Checklist

Checklist for Purchasing Die Cast Production Parts

A Surface Condition — ☐ 1 Some residue and chips not objectionable ☐ 2 Shop run—blown reasonably free of chips but not degreased ☐ 3 Clean, dry and free of chips

B Cast Surface Finish — ☐ 1 Mechanical Quality—finish is not significant ☐ 2 Painting Quality - streaks and chill areas coverable with paint ☐ 3 Highest Quality—for electroplating, decorative finishing, o-ring seats } See NADCA Guideline G-6-6; Also check Item O on Checklist C-8-2

C Flash Removal Parting Line External Profile — ☐ 1 No die trimming—break off gates and overflows ☐ 2 Die trimmed to within 0.010 in. (.25 mm) of die casting surface ☐ 3 Hand filed or polished—flush with die casting's surface

D Flash Removal Cored Holes — ☐ 1 Flash not removed ☐ 2 Flash trimmed to within 0.010 in. (0.25 mm) of die casting surface ☐ 3 Flash to be machined

E Flash Removal Ejector Pins — ☐ 1 Not removed (See NADCA Guideline G-6-5) ☐ 2 Crushed or flattened (See NADCA Guideline G-6-5) ☐ 3 Removed from specific locations

L Parting Lines — ☐ 1 Polishing not required ☐ 2 Polish only where marked on drawing ☐ 3 Polish all parting lines (except as noted)

M Surface Preparation — ☐ 1 No buffing required ☐ 2 Mechanical (burnishing, tumbling, etc.) ☐ 3 Buff as indicated on drawing

N Plating, Anodizing, (other) — ☐ 1 Protective Only—Specify: _____ ☐ 2 Decorative—Specify: _____ ☐ 3 Severe Exposure Protection—Specify: _____

O Painting — ☐ 1 Heavy Paint, Protective Only—Specify: _____ ☐ 2 Decorative Paint—Specify: _____ ☐ 3 Application requires base coat or special treatment: Specify: _____

P Environmental Exposure — ☐ 1 Normal interior use only ☐ 2 Exposure to weather - Specify: _____ ☐ 3 Exposure to unusual chemistry—Specify: _____

Q As-Cast Surface See NADCA Guideline G-6-6 — ☐ 1 Utility Grade—surface imperfections acceptable, nondecorative coatings ☐ 2 Functional Grade - slight, removable surface imperfections, heavier coatings ☐ 3 Commercial Grade—removable imperfections ☐ 4 Consumer Grade—no objectionable imperfections, as agreed upon, when viewed under normal lighting conditions at ____ feet viewing distance. ☐ 5 Superior Grade—specified average surface finish value of _____ microinches, per print.

DDC
DIECASTING DEVELOPMENT COUNCIL
OF THE NORTH AMERICAN DIE CASTING ASSOCIATION
NADCA