YODER INDUSTRIES DIE CASTING GUIDE

Why Die Casting?

- Die castings are specified for high volume production parts when strength, weight control, long service life, contours and complex shapes, textures and finishes, blind holes, external threads, projections, durability and repeatable accuracy are required.
- Aluminum die cast parts are lighter, dimensionally stable, and offer good mechanical properties and corrosion resistance. Parts can withstand temperatures from 300° to 600°F (continuous), provide electrical or thermal conductivity and good heat dissipation.
- Production advantages include fast delivery, minimal secondary operations and low unit costs.
- Die casting is very often the superior choice over stamping, forging, permanent mold, sand casting or plastic molding.

Why Yoder Industries?

Quality & Process Control

- ISO/TS 16949:2009 and ISO 9001:9008 Certified
- Closed Loop and Visi-Trak® process shot monitoring system
- Fully equipped QA lab with real time X-ray, spectrograph alloy analysis and 60,000 lb Instron tensile testing machine – ASTM compliant

Engineering & Design

- Advanced engineer design support
- MAGMAsoft® HPDC mold flow software and casting design
- Mold Flow Analysis for all programs
- Fast prototype tooling and die cast parts
- Cost saving design solutions

Capabilities

- Two full service die casting facilities
- Complete “net shape” finishing and assembly
- Machining, flow through/tumble shot blast finish, wash, and leak test
- Unparalleled automotive expertise over 30 years
  - Specialize in automotive castings for:
    - Electronic Control Modules - Heat Sink
    - Dual Clutch Transmission (DCT) - Heat Sink
    - Electronic Power Steering
    - Rubber-to-metal applications for Engine and Transmission Mounts
    - Cast-in bearings and flash-free threaded studs and inserts
    - Variable Valve Timing (VVT), Chassis and Powertrain

YODER ALUMINUM & ZINC DIE CASTING ALLOYS

Commercial: **ANSI/AA:**	**A380** **A380.0**	**383** **383.0**	**A413** **A413.0**	**Zamak** **No. 3**	**ZA-12**	**ZA-27**
Nominal Composition	Cu 3.5 Si 8.5	Cu 2.5 Si 10.5	Si 12.0	Al 4.0 Mg 0.035	Al 11.0 Mg 0.023 Cu .88	Al 27.0 Mg 0.015 Cu 2.25
Detailed Composition (%)						
Copper (Cu)	3.0-4.0	2.0-3.0	1.0	0.25 max.	0.5-1.2	2-2.5
Magnesium (Mg)	0.10	0.10	0.10	0.02-0.05	0.015-.030	0.010-0.020
Tin (Sn)	0.35	0.15	0.15	0.003	0.003	0.003
Manganese (Mn)	0.50	0.50	0.35	—	—	—
Nickel (Ni)	0.5	0.30	0.50	—	—	—
Silicon (Si)	7.5-9.5	9.5-11.5	11-13	—	—	—
Iron (Fe)	1.3	1.3	1.3	0.10	0.075	0.075
Lead (Pb)	—	—	—	0.005	0.006	0.006
Cadmium (Cd)	—	—	—	0.004	0.006	0.006
Total Others	0.50	0.50	0.25	—	—	—
Aluminum (Al)	Balance	Balance	Balance	3.5-4.3	10.5-11.5	25.0-28.0
Zinc (Zn)	3.0	3.0	.50	Balance	Balance	Balance
Mechanical Properties						
Ultimate Tensile Strength						
ksi	47	45	42	41	59	62
(MPa)	(320)	(310)	(290)	(283)	(400)	(426)
Yield Strength						
ksi	23	22	19	32	45-48	52-55
(MPa)	(160)	(150)	(130)	(221)	(310-331)	(359-379)
Elongation						
% in 51 mm	3.5	3.5	3.5	10	4-7	2.0-3.5
Hardness						
BHN	80	75	80	82	95-105	116-122
Shear Strength						
ksi	27	—	25	31	43	47
(MPa)	(190)		(170)	(214)	(296)	(325)
Impact Strength						
ft-lb	—	3	—	43	15-27	7-12
(J)		(4)		(58)	(20-37)	(9-16)
Fatigue Strength						
ksi	20	21	19	6.9	—	21
(MPa)	(140)	(145)	(130)	(47.6)		(145)
Physical Properties						
Density						
lb/in^3	0.098	0.099	0.096	0.24	0.218	0.181
(g/cm^3)	(2.71)	(2.74)	(2.66)	(6.6)	(6.03)	(5.00)
Melting Range						
°F	1000-1100	960-1080	1065-1080	718-728	710-810	708-903
(°C)	(540-595)	(516-582)	(574-582)	(381-387)	(377-432)	(375-484)
Specific Heat						
BTU/lb°F	0.230	0.230	0.230	0.10	0.107	0.125
(J/kg°C)	(963)	(963)	(963)	(419)	(450)	(525)
Coefficient of Thermal Expansion						
µ in/in/°Fx10^{-6}	12.1	11.7	11.9	15.2	13.4	14.4
(µ m/m°K)	(21.8)	(21.1)	(21.6)	(27.4)	(24.1)	(26.0)
Thermal Conductivity						
BTU/ft hr °F	55.6	55.6	70.1	65.3	67.1	72.5
(W/m°K)	(96.2)	(96.2)	(121)	(113)	(116)	(122.5)
Electrical Conductivity						
% IACS	23.0	23.0	31.0	27.0	28.3	29.7

Source: North American Die Casting Assoc. - ASTM B85-92a; Aluminum Assoc., ASTM B86, ASTM B791

PRODUCT STANDARDS FOR ALUMINUM DIE CASTING

Linear Dimensional Tolerance

±0.004” for the first inch, or ±0.10 mm for the first 25.4 mm
±0.0015” for each additional inch, or ±0.04 mm for each additional 25.4 mm

Draft Requirements - Inside & Outside Walls

Wall Length		Draft for	Draft for
Inches	mm	Inside Walls	Outside Walls
0.13	3.2	6°	3°
0.25	6.4	4°	2°
0.50	12.7	2.5°	1.25°
0.75	19.1	2°	1°
1.00	25.4	1°	.5°

Flatness Requirement

0.002” per inch, or 0.05 mm per 25.4 mm

Cored Hole Requirements

Hole Diameter		Max. Hole Depth		Total Draft
Inches	mm	Inches	mm	Requirement
0.13	3.2	0.31	7.9	5°
0.25	6.4	1.00	25.4	3°
0.50	12.7	2.00	50.8	2°
1.00	25.4	6.00	152.4	1.5°
2.00	50.8	—	—	1°

Other Requirements

	Inches	mm	
Commercial trim is within	0.015	0.38	from the edge of the casting
Machining stock is	0.010	0.25	normal per side
Sharp corners minimum	0.020	0.51	corner radii & fillet radii
Wall thickness normal	0.090	2.29	standard minimum
Wall thickness minimum	0.030	0.76	produced in specific areas only

Yoder Industries’ Visi-Trak® process shot monitoring ensures the highest die casting quality

Yoder’s well-equipped quality assurance lab with real time X-ray analysis

Automated and manual assembly capabilities for a wide range of products

DRAFT ANGLES (metric)

DISTANCE mm	1/2°	1°	2°	3°	4°	5°	6°
1.00	0.009	0.017	0.035	0.052	0.070	0.087	0.105
1.50	0.013	0.026	0.052	0.079	0.105	0.131	0.158
2.00	0.017	0.035	0.070	0.105	0.140	0.175	0.210
2.50	0.022	0.044	0.087	0.131	0.175	0.219	0.263
3.00	0.026	0.052	0.105	0.157	0.210	0.262	0.315
3.50	0.031	0.061	0.122	0.183	0.245	0.306	0.368
4.00	0.035	0.070	0.140	0.210	0.280	0.350	0.420
4.50	0.039	0.079	0.157	0.236	0.315	0.394	0.473
5.00	0.044	0.087	0.175	0.262	0.350	0.437	0.526
5.50	0.048	0.096	0.192	0.288	0.385	0.481	0.578
6.00	0.052	0.105	0.210	0.314	0.420	0.525	0.631
6.50	0.057	0.113	0.227	0.341	0.455	0.569	0.683
7.00	0.061	0.122	0.244	0.367	0.489	0.612	0.736
7.50	0.065	0.131	0.262	0.393	0.524	0.656	0.788
8.00	0.070	0.140	0.279	0.419	0.559	0.700	0.841
9.00	0.079	0.157	0.314	0.472	0.629	0.787	0.946
10.00	0.087	0.175	0.349	0.524	0.699	0.875	1.051
11.00	0.096	0.192	0.384	0.576	0.769	0.962	1.156
12.00	0.105	0.209	0.419	0.629	0.839	1.050	1.261
13.00	0.113	0.227	0.454	0.681	0.909	1.137	1.366
14.00	0.122	0.244	0.489	0.734	0.979	1.225	1.471
15.00	0.131	0.262	0.524	0.786	1.049	1.312	1.577
16.00	0.140	0.279	0.559	0.839	1.119	1.400	1.682
17.00	0.148	0.297	0.594	0.891	1.189	1.487	1.787
18.00	0.157	0.314	0.629	0.943	1.259	1.575	1.892
19.00	0.166	0.332	0.663	0.996	1.329	1.662	1.997
20.00	0.175	0.349	0.698	1.048	1.399	1.750	2.102
21.00	0.183	0.367	0.733	1.101	1.468	1.837	2.207
22.00	0.192	0.384	0.768	1.153	1.538	1.925	2.312
23.00	0.201	0.401	0.803	1.205	1.608	2.012	2.417
24.00	0.209	0.419	0.838	1.258	1.678	2.100	2.523
25.40	0.222	0.443	0.887	1.331	1.776	2.222	2.670

EXAMPLE: To determine the amount of taper per side for a die cast part having a draft angle of 2° per side for a distance of 8 mm:

In the “Distance” column, go down to 8 mm, then across to the column showing the 2° taper. The amount of taper shown here is .279 mm per side.

To determine distances greater than 25.40 mm, i.e. for 37.4 mm distance, take the figure for 25.4 mm distance plus the figure for the 12.0 mm distance.

Example: 25.4 @ 2° = .887 mm
+12.0 @ 2° = .419 mm
37.4 @ 2° = 1.306 mm

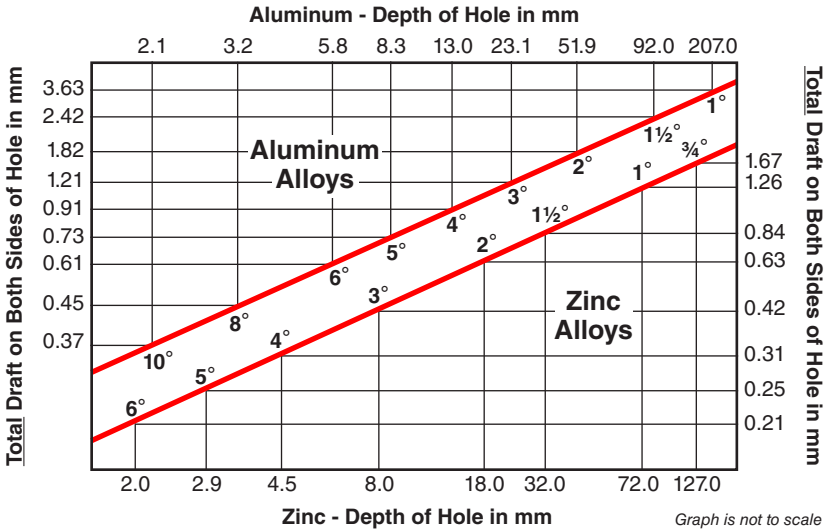
METRIC EQUIVALENTS

inches	mm	inches	mm	inches	mm	inches	mm
0.0001	0.0025	0.160	4.064	0.490	12.446	0.820	20.828
0.0002	0.0051	0.170	4.318	0.500	12.700	0.830	21.082
0.0003	0.0076	0.180	4.572	0.510	12.954	0.840	21.336
0.0004	0.0102	0.190	4.826	0.520	13.208	0.850	21.590
0.0005	0.0127	0.200	5.080	0.530	13.462	0.860	21.844
0.0006	0.0152	0.210	5.334	0.540	13.716	0.870	22.098
0.0007	0.0178	0.220	5.588	0.550	13.970	0.880	22.352
0.0008	0.0203	0.230	5.842	0.560	14.224	0.890	22.606
0.0009	0.0229	0.240	6.096	0.570	14.478	0.900	22.860
0.001	0.025	0.250	6.350	0.580	14.732	0.910	23.114
0.002	0.051	0.260	6.604	0.590	14.986	0.920	23.368
0.003	0.076	0.270	6.858	0.600	15.240	0.930	23.622
0.004	0.102	0.280	7.112	0.610	15.494	0.940	23.876
0.005	0.127	0.290	7.366	0.620	15.748	0.950	24.130
0.006	0.152	0.300	7.620	0.630	16.002	0.960	24.384
0.007	0.178	0.310	7.874	0.640	16.256	0.970	24.638
0.008	0.203	0.320	8.128	0.650	16.510	0.980	24.892
0.009	0.229	0.330	8.382	0.660	16.764	0.990	25.146
0.010	0.254	0.340	8.636	0.670	17.018	1.0	25.4
0.020	0.508	0.350	8.890	0.680	17.272	2.0	50.8
0.030	0.762	0.360	9.144	0.690	17.526	3.0	76.2
0.040	1.016	0.370	9.398	0.700	17.780	4.0	101.6
0.050	1.270	0.380	9.652	0.710	18.034	5.0	127.0
0.060	1.524	0.390	9.906	0.720	18.288	6.0	152.4
0.070	1.778	0.400	10.160	0.730	18.542	7.0	177.8
0.080	2.032	0.410	10.414	0.740	18.796	8.0	203.2
0.090	2.286	0.420	10.668	0.750	19.050	9.0	228.6
0.100	2.540	0.430	10.922	0.760	19.304	10.0	254.0
0.110	2.794	0.440	11.176	0.770	19.558	11.0	279.4
0.120	3.048	0.450	11.430	0.780	19.812	12.0	304.8
0.130	3.302	0.460	11.684	0.790	20.066	13.0	330.2
0.140	3.556	0.470	11.938	0.800	20.320	14.0	355.6
0.150	3.810	0.480	12.192	0.810	20.574	15.0	381.0

CONVERSION FORMULAS

Multiply By	From → / ← To	To → / ← From	Multiply By
0.0394	inch	millimeter	25.4
0.0016	$inch^2$	$millimeter^2$	645.16
0.061	$inch^3$	$centimeter^3$	16.3871
0.2642	gallon (U.S.)	liter	3.7854
0.03527	oz. (avdp.)	gram	28.3495
2.2044	pound	kilogram	0.4536
62.43	lbs/ft^3	g/cm^3	0.0160
1.8°C+32	°F	°C	(°F-32)/1.8
0.145	psi	kPa	6.8948
14.2247	psi	kg/cm^2	0.0703

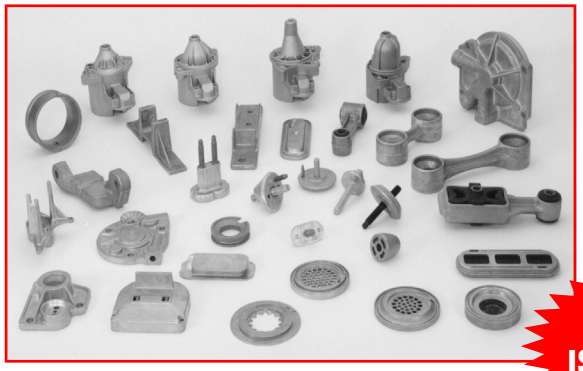
DRAFT REQUIREMENTS IN CORED HOLES



Graph is not to scale

EXAMPLE: In an aluminum die casting, a cored cylindrical hole that is 23.1 mm deep will have a total draft of 3°, or 1½° per side, which is 1.21 mm total draft (taper), or 0.605 mm draft (taper) per side.

Note - The values shown herein represent normal production practice at the most economic level. Lesser draft involving extra close work or care in production should be specified only when and where necessary since additional cost may be involved.



ISO/TS 16949:2009
ISO 9001:2008
Certified

YODER INDUSTRIES, INC.
ALUMINUM AND ZINC DIE CASTINGS

2520 Needmore Road
Dayton, Ohio 45414
937-278-5769
937-278-6321 Fax
www.yoderindustries.com