



**DISC SPRING**  
**BY SCHNORR**

Schnorr Corporation has specialized in the manufacture of disc springs for more than 50 years. During this period of extraordinary technical development many applications have been found for Schnorr disc springs because of their unique characteristics and advantages.

Original SCHNORR DISC SPRINGS offer a number of benefits with particular mention for the following features:

1. Load/deflection curves of straight, progressive, or regressive character according to the design requirements.
2. The simple adjustment of the spring stack length by the addition or removal of individual discs, thus altering the spring stack characteristic.
3. An efficient use of space and high spring forces with small deflections.
4. Self-demanding, particularly with parallel stacking.
5. No setting or fatigue under normal loads.
6. Long service life.
7. A large range of possible applications for individual spring sizes simplifies stockkeeping.

## Terms and Symbols

- D— Outside diameter in millimeters
- d— Inside diameter in millimeters
- P— Spring load
- h— Formed height of unloaded single disc in millimeters
- OH— Overall height of unloaded single disc in millimeters
- N— Number of cycles to fracture
- f— Deflection in millimeters
- t— Thickness of a single disc in millimeters

## Materials for Disc Springs

The most important characteristic of a spring is its ability to absorb elastic deformations caused by outside loads. Because of their high load/deflection ratios disc springs are especially suitable for storing energy, dissipating shock loads, suspending moving masses, and for load measurement.

It is preferable to make a spring as small as possible, so special materials are used which are highly elastic, or which possess high tensile strength and a high elastic limit.

They should also have sufficient plastic deformation ability beyond the elastic limit to permit the manufacture of cold worked springs, as well as to minimize failure of springs under unexpectedly high loads.

## The Design and Manufacturing of Disc Springs

According to Standard DIN 2093 there are three different groups of execution:

- Group 1: under 1.25 mm
- Group 2: from 1.25 to 6.0 mm
- Group 3: 1 over 6 up to 16 mm

Schnorr manufactures the three groups as follows:

- Group 1: Cold formed
- Group 2: Cold formed, outside and inside diameters turned, corners on inner edge radiused.
- Group 3: Hot formed, springs turned all over, contact surfaces formed, all corners radiused, and material thickness reduced.

## Tolerances

Allowable variations are laid down in DIN 2093, the tolerances on disc spring diameters are H 12/h 12. The permissible tolerance for the spring force  $F$  at  $s=0.75 h_0$  is given in the following table:

Group	Spring Thickness mm	Permissible deviation for the spring force $F$ at the test length $l_s = 0.75 h_0$	
		%	%
1	under 1.25	+25	-7.5
	1.25 to 3.0	+15	-7.5
2	over 3.0 to 6.0	+10	-5
	over 6.0 to 16.0	+5	-5

The spring force must be measured on a single disc exactly as specified in the standard.

The following table gives the tolerances for the overall height OH according to DIN 2093:

Group	Spring Thickness mm	Permissible deviation for $l_s$ mm	
		mm	mm
1	under 1.25	+0.10	-0.05
	1.25 to 2.0	+0.15	-0.08
2	over 2.0 to 3.0	+0.20	-0.10
	over 3.0 to 6.0	+0.30	-0.15
3	over 6.0 to 16.0	+0.30	-0.30

Since these tolerances were computed for disc sizes specified in DIN 2093 certain limitations must be imposed for other discs in which the dimensional ratios differ from the standard springs. This also applies in the case of "K" disc springs.

## Heat Treatment

All our springs are austempered. This method of heat treatment is particularly effective for springs, as it gives the maximum toughness and therefore considerable durability.

According to DIN 2093 the hardness should be RC 42-52 and in manufacture the optimum value is selected with regard to spring size and tensile stress.

## Pre-setting

After heat treatment each disc spring is scragged, i.e., pressed flat at least once. By doing so the spring is preset in such a way that the overall height OH stays within the permissible tolerance after being subjected to loads up to 1.5, the maximum force at  $l=h$ .

## Surface Protection

Unless stated, all our disc springs are supplied Phosphated or oil blackened before oil dipping. The Phosphated surface is preferred for the better protection it provides over oil blackening.

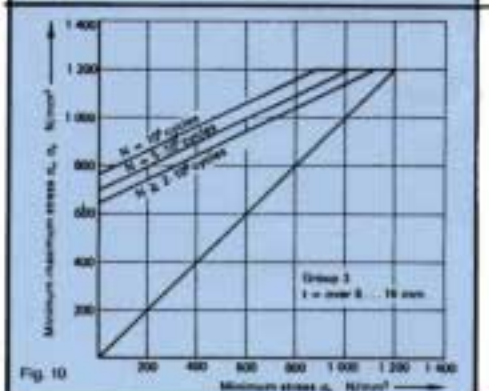
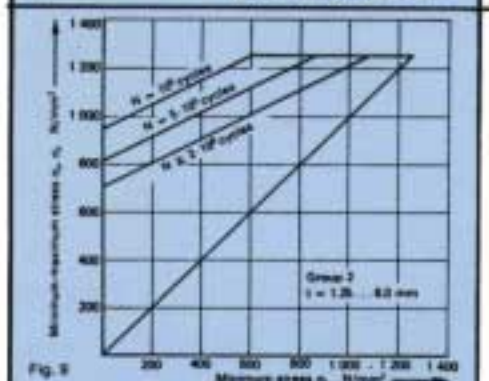
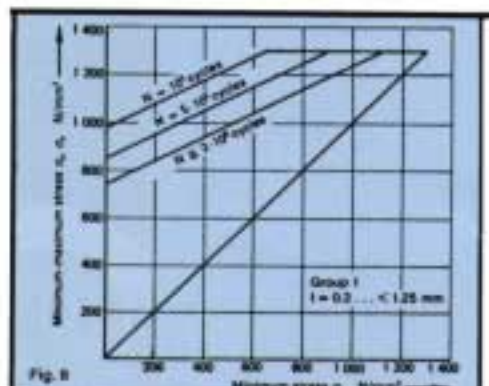
Deposition of a metal coating on the surface is also possible. The most frequently used material is Zinc with a final passivation in Chrome solution. Unfortunately, current methods of electronically depositing metal coating from aqueous solutions cause hydrogen embrittlement which cannot be completely avoided in cases of higher tensile steels - this is the case with disc springs and safety washers. Schnorr therefore introduced a mechanical plating process which proves to be very successful over a number of years where no Hydrogen embrittlement occurs. Since the method is carried out in a

drum it is possible only with larger quantities, and a limitation of an external diameter up to approximately 80mm. Zinc and Cadmium are lower than steel in the electrochemical table and therefore a self-protecting effect occurs in the case of surface damage.

A chemical Nickel plating surface treatment is also possible i.e., the Dumi-Coat process. With this method embrittlement is also avoided to a large extent. Because of the greater hardness of the nickel layer, durability under dynamic loading comes into question. In the event of damage, no self protection occurs since nickel lies higher than steel in the electrochemical table. Further advice on specific applications can be obtained from our engineers.

## Surface Working

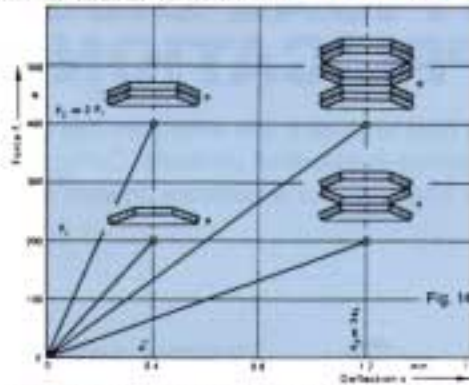
Surface working, especially by shot-peening, has proved to be beneficial for disc springs subjected to dynamic loads. The result may increase the working life far in excess of the values shown in Figs 8, 9 and 10. However, as shot-peening reduces the internal tensile stresses arising from scragging, shot-peening or other methods of surface working are not recommended for discs carrying static loads.



by Schnorr

## Combinations of Single Disc Springs

When disc springs with similar dimensions are formed to different heights the character lines change. The load at flat will correspondingly increase along linear lines (Fig. 12). If, for example, a preliminary calculation does not produce a satisfactory result, the desired character line may be obtained by first of all changing the height  $h$ . Care must be taken to stay within the permissible stress as this determines the maximum height to which the disc can be formed. The spring rate of a single disc can be changed as required by combining a number of discs in a stack (Fig. 14).



## Progressive Spring Characteristics

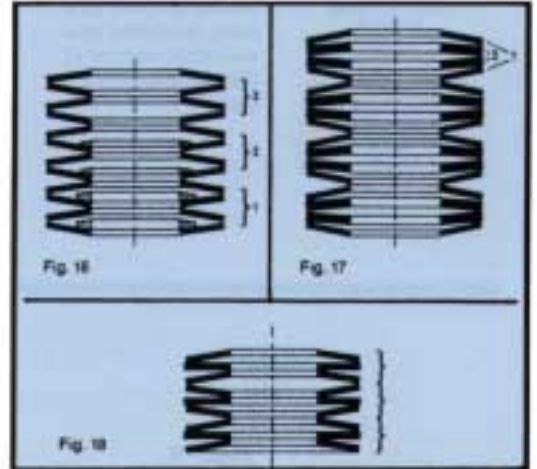
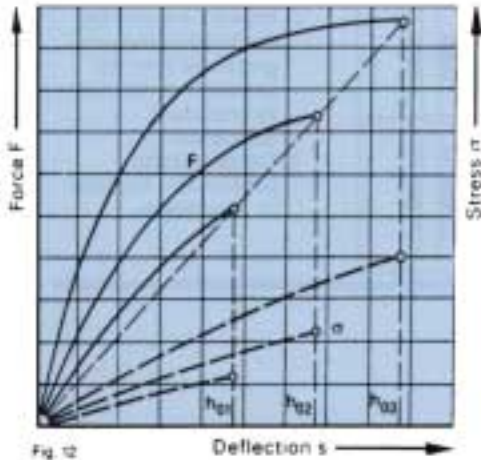
It will be obvious that single sets of discs make of thinner materials will be subjected to considerable stress if disc springs of standard design are used. This excess stress can be eliminated however by decreasing the formed height of a disc, or by using spacing washers or rings to limit the deflection.

Another possibility of obtaining a progressive characteristic using the same thickness of disc throughout the stack is to use spacer rings of decreasing thickness as shown in Fig. 16. By reducing from the thickest rings in section 1, the spring rate increases as the remaining springs are deflected further. Care must also be taken that the permissible stress is not exceeded in section 3 of the stack which has no spacers.

Fig. 17 shows another useful arrangement using different thicknesses of discs. This special arrange-

ment eliminates the necessity for stroke limiting rings for the thinner springs. With disc springs of the same diameter and varying thicknesses, the thinner springs always have a larger free height  $h$ . This enables the arrangement illustrated to be achieved.

Yet another possibility of achieving a progressive spring characteristic lies in the combining of disc springs with flat spring washers. With the arrangement in Fig. 18 a set of 2 disc springs with a flat washer between deflect as single discs until all three are lying parallel. From this point onwards the two disc springs operate as a parallel pair with load continuing to increase and the flat washer is unloaded as it returns to its' initial state.



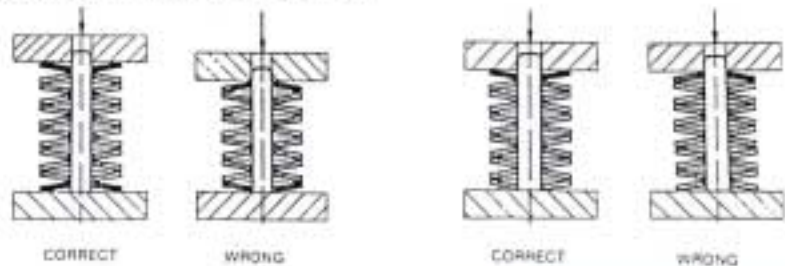
## GUIDING THE DISC SPRING

Disc springs arranged in stacks require a guide to prevent lateral movement under load. Guides may be located on the inside diameter  $D$  or on the outside diameter  $D$  of the springs, but the internal guide is to be preferred. The following values are recommended for the clearance between the guide surface and the inside or outside diameter of the spring: (chart lists values).

Using close tolerances for the guides, the clearance can be reduced a little since the inside diameter does not reduce during the stroke when the edges are at right angles to the flank. See para. 6.6.

If possible, and particularly on dynamic applications, the guide rod and end thrust faces should be case hardened to a minimum of RC 55. The guide surface should be turned to a fine finish,

or better still, ground. Additionally, lubrication with a molybdenum based high pressure grease is recommended.



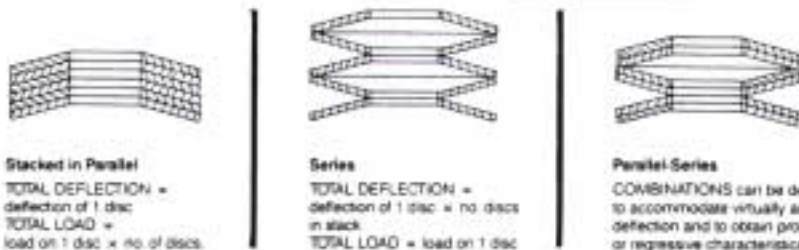
## DISC SPRINGS MAY BE USED SINGLY OR IN COMBINATION

When disc springs are used in stacks, effort should be made to keep the stacks as short as possible. As the length increases so does the friction and therefore the deflection of the individual discs becomes unequal, with the greatest deflection being at the moving end. As a guide it is recommended that the stack length be restricted to approximately 3 times the outside diameter of the disc, and the largest possible disc diameter be used.

Not more than 2 or 3 discs should normally be used in parallel for multiple stacks, especially under dynamic conditions where considerable heat is generated.

To ensure stack stackability the end springs should have their outside diameters in contact with the abutment faces. This is only possible of course with an even number of disc springs.

It is necessary to have the inside diameter in contact when the abutment faces are just a little larger than the inside diameter of the disc springs.



**Stacked in Parallel**  
TOTAL DEFLECTION = deflection of 1 disc  
TOTAL LOAD = load on 1 disc x no. of discs.

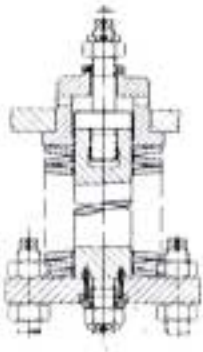
**Series**  
TOTAL DEFLECTION = deflection of 1 disc x no. discs in stack  
TOTAL LOAD = load on 1 disc

**Parallel-Series**  
COMBINATIONS can be designed to accommodate virtually any load or deflection and to obtain progressive or regressive characteristics.

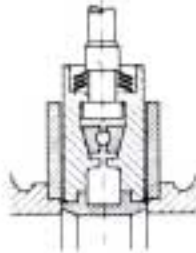
Diameter $D_1$ or $D_2$	Clearance
up to 16	0.2
over 16 up to 20	0.3
over 20 up to 25	0.4
over 25 up to 31.5	0.5
over 31.5 up to 50	0.6
over 50 up to 80	0.8
over 80 up to 140	1
over 140 up to 250	1.5

# TYPICAL DISC SPRING APPLICATIONS

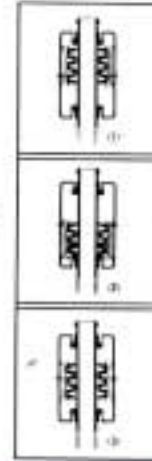
Shown here are just a few examples that show the versatility of Lamina Disc Springs in industrial products. Contact our Sales Representatives or Design Engineers for assistance on your specific spring application.



This picture shows M.A.N. steam turbine condensers weighing several hundred tons being supported by a very small number of discs arranged in 3 stacks.

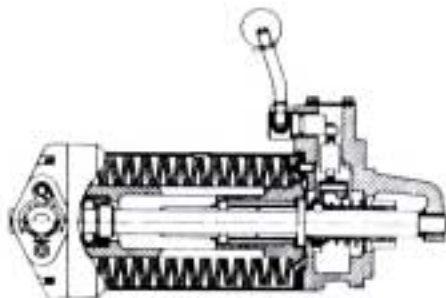


Improvement of sealing performance applies to closing the gate until the cone engages. The springs compress and the wedge forces the side plates into close water-tight contact with the valve faces.

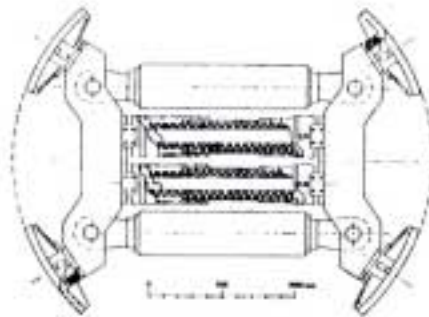


This disc spring stack is used in a pile-driving machine. The operation is shown in three typical phases:

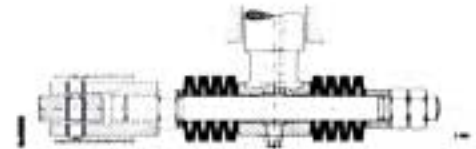
1. Initial position
2. Impact - the springs are compressed progressively from top to bottom carried out by pneumatic assistance.
3. Return to initial position also assisted by pneumatics.



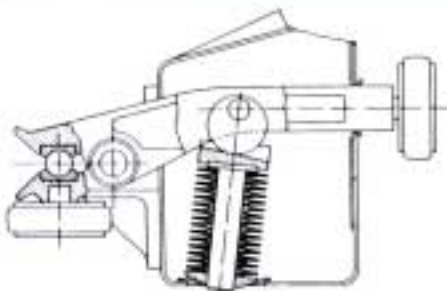
Sectional view of the starter showing the general arrangement of components. The winding spindle with ratchet is on the left.



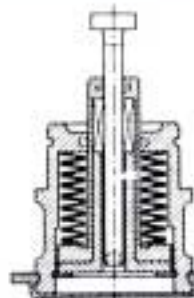
This illustration highlights the rear safety support with spring assemblies. In case of hydraulics failure the spring action rear safety support is expanded, pressing the shield against the tunnel wall, preventing the machine from slipping backward.



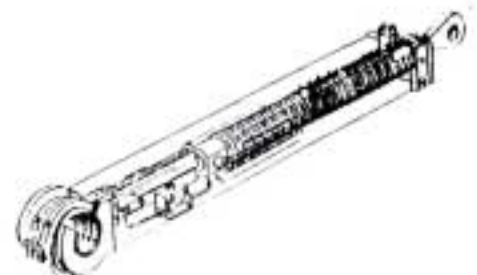
This illustration shows a shear pin assembly to a main shaft. To protect the shear pin from transient shock overload while working the connection link is fitted with double acting SCHNORR disc spring stacks.



A spring with almost a "zero" rate is used for a negligible amount of force variance despite the differences in the cable diameter. Should one disc of the stack fracture, the clamping force would barely be affected and the unit would still be operational.



This device maintains a working clearance, while aircraft adjuster friction materials wear, to ensure constant fluid displacement during operation. The force/travel curve of the springs within the confines of such small assemblies must match the hydraulic pressure and friction bushings. The rate and accuracy of Lamina Disc Springs make them ideal for this purpose.



The Demag unit shown is a standard device on all cranes used to automatically compensate for load and angle. Note the small size of the disc spring stack when tremendous working loads are considered.



PART NO.	SIZE mm			SIZE inch					LOAD P - in lb., DEFLECTION f in inch							
	D	d	t	D	d	t	h	O.H.	f = 0.25h		f = 0.50h		f = 0.75h		f = h	
									P	f	P	f	P	f	P	f
DS2010	9.53	4.96	0.4	.375	.195	.016	.012	.028	23	.003	41	.006	55	.008	68	.012
DS2020	12.70	6.55	0.5	.500	.258	.020	.016	.035	35	.004	61	.008	82	.012	89	.016
DS2030	12.70	6.55	0.6	.500	.258	.024	.016	.038	55	.004	100	.008	137	.012	171	.016
DS2040	17.46	9.70	0.6	.687	.382	.024	.020	.043	44	.005	75	.010	100	.015	120	.020
DS2050	17.46	9.70	0.7	.687	.382	.028	.020	.047	83	.005	113	.010	154	.015	180	.020
DS2060	19.05	8.137	0.7	.750	.320	.028	.024	.051	61	.006	108	.012	138	.018	166	.024
DS2070	19.05	8.137	0.8	.750	.320	.031	.024	.055	78	.006	138	.012	184	.018	225	.024
DS2080	19.05	9.70	0.8	.750	.382	.031	.022	.053	74	.006	133	.011	181	.017	224	.022
DS2090	19.05	9.70	0.9	.750	.382	.035	.022	.057	101	.006	185	.011	256	.017	322	.022
DS2100	25.40	11.31	0.9	1.000	.445	.035	.031	.067	90	.008	154	.016	201	.023	239	.031
DS2110	25.40	11.31	1.0	1.000	.445	.039	.031	.071	117	.008	204	.018	272	.023	330	.031
DS2120	25.40	11.31	1.25	1.000	.445	.049	.026	.075	163	.007	304	.013	430	.020	549	.028
DS2121	28.00	13.0	1.0	1.100	.512	.039	.035	.075	119	.009	204	.018	264	.026	313	.035
DS2122	28.00	13.0	1.25	1.100	.512	.049	.033	.083	190	.008	342	.017	470	.025	585	.033
DS2123	28.00	13.0	1.5	1.100	.512	.059	.028	.087	248	.007	470	.014	672	.021	866	.028
DS2130	34.92	16.175	1.25	1.375	.637	.049	.045	.094	189	.011	337	.023	434	.034	511	.045
DS2140	34.92	16.175	1.5	1.375	.637	.059	.043	.102	288	.011	511	.022	693	.032	853	.043
DS2150	34.92	16.175	2.0	1.375	.637	.079	.031	.110	406	.008	781	.016	1130	.023	1480	.031
DS2160	38.10	19.35	1.5	1.500	.762	.059	.055	.114	378	.014	638	.028	820	.041	963	.055
DS2170	38.10	19.35	2.0	1.500	.762	.079	.043	.122	539	.011	1000	.022	1420	.032	1810	.043
DS2180	38.10	19.35	2.5	1.500	.762	.098	.035	.134	760	.008	1470	.018	2150	.026	2810	.035
DS2190	50.80	25.8	2.0	2.000	1.016	.078	.059	.138	476	.015	843	.030	1140	.044	1390	.059
DS2200	50.80	25.8	2.5	2.000	1.016	.098	.059	.157	824	.015	1510	.030	2110	.044	2660	.059
DS2210	50.80	25.8	3.0	2.000	1.016	.118	.047	.165	1020	.012	1960	.024	2840	.035	3700	.047
DS2220	60.33	25.8	2.0	2.375	1.016	.079	.079	.157	508	.020	840	.040	1060	.059	1220	.079
DS2230	60.33	25.8	2.5	2.375	1.016	.098	.079	.177	832	.020	1450	.040	1930	.058	2330	.079
DS2240	60.33	25.8	3.0	2.375	1.016	.118	.063	.181	964	.016	1800	.032	2540	.047	3250	.063

**When it comes to Pressure Control Devices**

 **Lamina INC.** offers the most comprehensive selection to choose from.



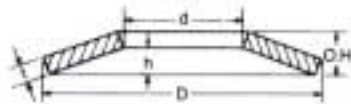
EN (NEWTON) = 0.102 KG INCHES × 25.4 = MM  
 = 0.225 LB LBS. × .454 = KG

PART NO.	O.D. D	I.D. d	MATL. t	O/A HGT O.H.	[ f = 0.25h ]		[ f = 0.50h ]		[ f = 0.75h ]		[ FLAT f = (h) ]	
					LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f
DSM0063203 MM	6.000	3.200	0.300	0.450	45	0.038	84	0.075	119	0.113	153	0.150
IN	0.236	0.126	0.012	0.018	10	0.001	19	0.003	27	0.004	35	0.006
DSM0083202 MM	8.000	3.200	0.200	0.400	12	0.050	20	0.100	26	0.150	30	0.200
IN	0.315	0.126	0.008	0.016	3	0.002	5	0.004	6	0.006	7	0.008
DSM0083203 MM	8.000	3.200	0.300	0.550	46	0.063	79	0.125	104	0.188	126	0.250
IN	0.315	0.126	0.012	0.022	10	0.002	18	0.005	24	0.007	28	0.010
DSM0083204 MM	8.000	3.200	0.400	0.600	69	0.050	130	0.100	185	0.150	238	0.200
IN	0.315	0.126	0.016	0.024	16	0.002	29	0.004	42	0.006	54	0.008
DSM0084202 MM	8.000	4.200	0.200	0.450	21	0.063	33	0.125	39	0.188	42	0.250
IN	0.315	0.165	0.008	0.018	5	0.002	8	0.005	9	0.007	9	0.010
DSM0084203 MM	8.000	4.200	0.300	0.550	52	0.063	147	0.100	210	0.150	269	0.200
IN	0.315	0.165	0.012	0.022	18	0.002	33	0.004	47	0.006	61	0.009
DSM0084204 MM	8.000	4.200	0.400	0.600	78	0.050	89	0.125	118	0.188	142	0.250
IN	0.315	0.165	0.016	0.024	18	0.002	20	0.005	27	0.007	32	0.010
DSM0103203 MM	10.000	3.200	0.300	0.650	51	0.068	82	0.175	98	0.263	108	0.350
IN	0.394	0.126	0.012	0.026	12	0.003	18	0.007	22	0.010	24	0.014
DSM0103204 MM	10.000	3.200	0.400	0.700	75	0.075	133	0.150	179	0.225	220	0.300
IN	0.394	0.126	0.016	0.028	17	0.003	30	0.006	40	0.009	50	0.012
DSM0103205 MM	10.000	3.200	0.500	0.750	104	0.063	195	0.125	279	0.188	357	0.250
IN	0.394	0.126	0.020	0.030	23	0.002	44	0.005	63	0.007	81	0.010
DSM0105202 MM	10.000	5.200	0.250	0.550	30	0.075	48	0.150	58	0.225	63	0.300
IN	0.394	0.205	0.010	0.022	7	0.003	11	0.006	13	0.009	14	0.012
DSM0105204 MM	10.000	5.200	0.400	0.700	88	0.075	155	0.150	209	0.225	257	0.300
IN	0.394	0.205	0.016	0.028	20	0.003	35	0.006	47	0.009	58	0.012
DSM0105205 MM	10.000	5.200	0.500	0.750	122	0.063	228	0.125	325	0.188	418	0.250
IN	0.394	0.205	0.020	0.030	27	0.002	52	0.005	73	0.007	94	0.010
DSM0124204 MM	12.000	4.200	0.400	0.800	85	0.100	141	0.200	178	0.300	206	0.400
IN	0.472	0.165	0.016	0.031	19	0.004	32	0.008	40	0.012	46	0.016
DSM0124205 MM	12.000	4.200	0.500	0.850	116	0.088	208	0.175	284	0.263	352	0.350
IN	0.472	0.165	0.020	0.033	26	0.003	47	0.007	64	0.010	79	0.014
DSM0124206 MM	12.000	4.200	0.600	1.000	224	0.100	405	0.200	557	0.300	694	0.400
IN	0.472	0.165	0.024	0.039	51	0.004	91	0.008	126	0.012	157	0.016
DSM0125205 MM	12.000	5.200	0.500	0.900	150	0.100	263	0.200	350	0.300	424	0.400
IN	0.472	0.205	0.020	0.035	34	0.004	59	0.008	79	0.012	96	0.016
DSM0125206 MM	12.000	5.200	0.600	0.950	196	0.088	361	0.175	506	0.263	641	0.350
IN	0.472	0.205	0.024	0.037	44	0.003	82	0.007	114	0.010	145	0.014
DSM0126205 MM	12.000	6.200	0.500	0.850	134	0.088	239	0.175	326	0.263	404	0.350
IN	0.472	0.244	0.020	0.033	30	0.003	54	0.007	74	0.010	91	0.014
DSM0126206 MM	12.000	6.200	0.600	0.950	214	0.088	394	0.175	552	0.263	699	0.350
IN	0.472	0.244	0.024	0.037	48	0.003	89	0.007	125	0.010	158	0.014
DSM0135205 MM	12.500	5.200	0.500	0.850	111	0.088	200	0.175	272	0.263	337	0.350
IN	0.492	0.205	0.020	0.033	25	0.003	45	0.007	61	0.010	76	0.014
DSM0136203 MM	12.500	6.200	0.350	0.800	84	0.113	130	0.225	151	0.338	160	0.450
IN	0.492	0.244	0.014	0.031	19	0.004	29	0.009	34	0.013	36	0.018
DSM0136205 MM	12.500	6.200	0.500	0.850	120	0.088	215	0.175	293	0.263	363	0.350
IN	0.492	0.244	0.020	0.033	27	0.003	49	0.007	66	0.010	82	0.014
DSM0136207 MM	12.500	6.200	0.700	1.000	239	0.075	457	0.150	660	0.225	855	0.300
IN	0.492	0.244	0.028	0.039	54	0.003	103	0.006	149	0.009	193	0.012
DSM0147203 MM	14.000	7.200	0.350	0.800	68	0.113	106	0.225	123	0.338	131	0.450
IN	0.551	0.283	0.014	0.031	15	0.004	24	0.009	28	0.013	29	0.018
DSM0147205 MM	14.000	7.200	0.500	0.900	120	0.100	210	0.200	279	0.300	338	0.400
IN	0.551	0.283	0.020	0.035	27	0.004	47	0.008	63	0.012	76	0.016
DSM0147208 MM	14.000	7.200	0.080	1.100	284	0.075	547	0.150	797	0.225	1040	0.300
IN	0.551	0.283	0.031	0.043	64	0.003	124	0.006	180	0.009	235	0.012
DSM0155204 MM	15.000	5.200	0.400	0.950	101	0.138	154	0.275	176	0.413	181	0.550
IN	0.591	0.205	0.016	0.037	23	0.005	35	0.011	40	0.016	41	0.022
DSM0155205 MM	15.000	5.200	0.500	1.000	133	0.125	221	0.250	278	0.375	321	0.500
IN	0.591	0.205	0.020	0.039	30	0.005	50	0.010	63	0.015	72	0.020
DSM0155206 MM	15.000	5.200	0.600	1.050	171	0.113	302	0.225	407	0.338	499	0.450
IN	0.591	0.205	0.024	0.041	39	0.004	68	0.009	92	0.013	113	0.018
DSM0155207 MM	15.000	5.200	0.700	1.100	214	0.100	395	0.200	555	0.300	704	0.400
IN	0.591	0.205	0.028	0.043	48	0.004	89	0.008	125	0.012	159	0.016
DSM0156205 MM	15.000	6.200	0.500	1.000	138	0.125	229	0.250	289	0.375	334	0.500
IN	0.591	0.244	0.020	0.039	31	0.005	52	0.010	65	0.015	75	0.022
DSM0156206 MM	15.000	6.200	0.600	1.050	178	0.113	314	0.225	423	0.338	519	0.450
IN	0.591	0.244	0.024	0.041	40	0.004	71	0.009	96	0.013	117	0.018
DSM0156207 MM	15.000	6.200	0.700	1.100	222	0.100	411	0.200	578	0.300	733	0.400
IN	0.591	0.244	0.028	0.043	50	0.004	93	0.008	130	0.012	165	0.016



EN (NEWTON) = 0.102 KG INCHES × 25.4 = MM  
 = 0.225 LB LBS. × .454 = KG

PART NO.	O.D. D	I.D. d	MATL. t	O/A HGT O.H.	[ f = 0.25h ]		[ f = 0.50h ]		[ f = 0.75h ]		[ FLAT f = (h) ]	
					LOAD P	DEFL. †	LOAD P	DEFL. †	LOAD P	DEFL. †	LOAD P	DEFL. †
DSM0158207 MM	15.000	8.200	0.700	1.100	256	0.100	474	0.200	666	0.300	844	0.400
IN	0.591	0.323	0.028	0.043	58	0.004	107	0.008	150	0.012	191	0.016
DSM0158208 MM	15.000	8.200	0.800	1.200	367	0.100	689	0.200	982	0.300	1260	0.400
IN	0.591	0.323	0.031	0.047	83	0.004	156	0.008	222	0.012	285	0.016
DSM0168204 MM	16.000	8.200	0.400	0.900	84	0.125	131	0.250	154	0.375	165	0.500
IN	0.630	0.323	0.016	0.035	19	0.005	30	0.010	35	0.015	37	0.020
DSM0168206 MM	16.000	8.200	0.600	1.050	172	0.113	304	0.225	410	0.338	503	0.450
IN	0.630	0.323	0.024	0.041	39	0.004	69	0.009	93	0.013	113	0.018
DSM0168207 MM	16.000	8.200	0.700	1.150	254	0.113	461	0.225	637	0.338	798	0.450
IN	0.630	0.323	0.028	0.045	57	0.004	104	0.009	144	0.013	180	0.018
DSM0168208 MM	16.000	8.200	0.800	1.200	308	0.100	579	0.200	825	0.300	1060	0.400
IN	0.630	0.323	0.031	0.047	70	0.004	131	0.008	186	0.012	239	0.016
DSM0168209 MM	16.000	8.200	0.900	1.250	363	0.088	697	0.175	1010	0.263	1320	0.350
IN	0.630	0.323	0.035	0.049	82	0.003	157	0.007	229	0.010	298	0.014
DSM0186204 MM	18.000	6.200	0.400	1.000	85	0.150	126	0.300	139	0.450	137	0.600
IN	0.709	0.244	0.016	0.039	19	0.006	28	0.012	31	0.018	31	0.024
DSM0186205 MM	18.000	6.200	0.500	1.100	130	0.150	206	0.300	245	0.450	267	0.600
IN	0.709	0.244	0.020	0.043	29	0.006	46	0.012	55	0.018	60	0.024
DSM0186206 MM	18.000	6.200	0.600	1.200	191	0.150	317	0.300	400	0.450	462	0.600
IN	0.709	0.244	0.024	0.047	43	0.006	72	0.012	90	0.018	104	0.024
DSM0186207 MM	18.000	6.200	0.700	1.250	236	0.138	414	0.275	553	0.413	672	0.550
IN	0.709	0.244	0.028	0.049	53	0.005	93	0.011	125	0.016	152	0.022
DSM0186208 MM	18.000	6.200	0.800	1.300	286	0.125	523	0.250	726	0.375	912	0.500
IN	0.709	0.244	0.031	0.051	65	0.005	118	0.010	164	0.015	206	0.020
DSM0188205 MM	18.000	8.200	0.500	1.100	140	0.150	222	0.300	265	0.450	288	0.600
IN	0.709	0.323	0.020	0.043	32	0.006	50	0.012	60	0.018	65	0.024
DSM0188207 MM	18.000	8.200	0.700	1.250	255	0.138	446	0.275	596	0.413	725	0.550
IN	0.709	0.323	0.028	0.049	57	0.005	101	0.011	135	0.016	164	0.022
DSM0188208 MM	18.000	8.200	0.800	1.300	309	0.125	564	0.250	783	0.375	984	0.500
IN	0.709	0.323	0.031	0.051	70	0.005	127	0.010	177	0.015	222	0.020
DSM0188210 MM	18.000	8.200	1.000	1.400	425	0.100	814	0.200	1180	0.300	1540	0.400
IN	0.709	0.323	0.039	0.055	96	0.004	184	0.008	267	0.012	347	0.016
DSM0189204 MM	18.000	9.200	0.450	1.050	121	0.150	186	0.300	214	0.450	223	0.600
IN	0.709	0.362	0.018	0.041	27	0.006	42	0.012	48	0.018	50	0.024
DSM0189207 MM	18.000	9.200	0.700	1.200	233	0.125	417	0.250	566	0.375	699	0.500
IN	0.709	0.362	0.028	0.047	53	0.005	94	0.010	128	0.015	158	0.020
DSM0189210 MM	18.000	9.200	1.000	1.400	451	0.100	865	0.200	1,250	0.300	1,630	0.400
IN	0.709	0.362	0.039	0.055	102	0.004	195	0.008	283	0.012	368	0.016
DSM0208206 MM	20.000	8.200	0.600	1.300	214	0.175	342	0.350	412	0.525	453	0.700
IN	0.787	0.323	0.024	0.051	48	0.007	77	0.014	93	0.021	102	0.028
DSM0208207 MM	20.000	8.200	0.700	1.350	262	0.163	442	0.325	569	0.488	668	0.650
IN	0.787	0.323	0.028	0.053	59	0.006	100	0.013	128	0.019	151	0.026
DSM0208208 MM	20.000	8.200	0.800	1.400	315	0.150	557	0.300	751	0.450	920	0.600
IN	0.787	0.323	0.031	0.055	71	0.006	126	0.012	170	0.018	208	0.024
DSM0208209 MM	20.000	8.200	0.900	1.450	374	0.138	685	0.275	964	0.413	1,200	0.550
IN	0.787	0.323	0.035	0.057	84	0.005	155	0.011	215	0.016	271	0.022
DSM0208210 MM	20.000	8.200	1.000	1.550	494	0.138	917	0.275	1,290	0.413	1,650	0.550
IN	0.787	0.323	0.039	0.061	111	0.005	207	0.011	292	0.016	372	0.022
DSM0201005 MM	20.000	10.200	0.500	1.150	141	0.163	219	0.325	254	0.488	268	0.650
IN	0.787	0.402	0.020	0.045	32	0.006	49	0.013	57	0.019	61	0.026
DSM0201008 MM	20.000	10.200	0.800	1.350	304	0.138	547	0.275	748	0.413	929	0.550
IN	0.787	0.402	0.031	0.053	69	0.005	123	0.011	169	0.016	210	0.022
DSM0201009 MM	20.000	10.200	0.900	1.450	412	0.138	754	0.275	1,050	0.413	1,320	0.550
IN	0.787	0.402	0.035	0.057	93	0.005	170	0.011	237	0.016	299	0.022
DSM0201010 MM	20.000	10.200	1.000	1.550	544	0.138	1,010	0.275	1,430	0.413	1,820	0.550
IN	0.787	0.402	0.039	0.061	123	0.005	228	0.011	322	0.016	410	0.022
DSM0201011 MM	20.000	10.200	1.100	1.550	548	0.113	1,050	0.225	1,520	0.338	1,980	0.450
IN	0.787	0.402	0.043	0.061	124	0.004	237	0.009	343	0.013	446	0.018
DSM0201012 MM	20.000	10.200	1.250	1.750	890	0.125	1,710	0.250	2,480	0.375	3,220	0.500
IN	0.787	0.402	0.049	0.069	201	0.005	385	0.010	559	0.015	727	0.020
DSM0201015 MM	20.000	10.200	1.500	1.800	857	0.075	1,700	0.150	2,520	0.225	3,340	0.300
IN	0.787	0.402	0.059	0.071	193	0.003	383	0.006	569	0.009	754	0.012
DSM0221106 MM	22.500	11.200	0.600	1.400	240	0.200	370	0.400	425	0.600	444	0.800
IN	0.886	0.441	0.024	0.055	54	0.008	84	0.016	96	0.024	100	0.31
DSM0221108 MM	22.500	11.200	0.800	1.450	306	0.163	533	0.325	707	0.488	855	0.650
IN	0.886	0.441	0.031	0.057	69	0.006	120	0.013	160	0.019	193	0.026
DSM0221112 MM	22.500	11.200	1.250	1.750	693	0.125	1,330	0.250	1,930	0.375	2,510	0.500
IN	0.886	0.441	0.049	0.069	156	0.005	300	0.010	435	0.015	566	0.020



EN (NEWTON) = 0.102 KG INCHES × 25.4 = MM  
= 0.225 LB LBS. × .454 = KG

PART NO.	O.D. D	I.D. d	MATL. t	O/A HGT O.H.	[ f = 0.25h ]		[ f = 0.50h ]		[ f = 0.75h ]		[ FLAT f = (h) ]	
					LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f
DSM0221108 MM	22.500	11.200	0.800	1.450	306	0.163	533	0.325	707	0.488	855	0.650
IN	0.886	0.441	0.031	0.057	69	0.006	120	0.013	160	0.019	193	0.026
DSM0221112 MM	22.500	11.200	1.250	1.750	693	0.125	1,330	0.250	1,930	0.375	2,510	0.500
IN	0.886	0.441	0.049	0.069	156	0.005	300	0.010	435	0.015	566	0.020
DSM0238207 MM	23.000	8.200	0.700	1.500	279	0.200	448	0.400	544	0.600	602	0.800
IN	0.906	0.323	0.028	0.059	63	0.008	101	0.016	123	0.024	136	0.031
DSM0238208 MM	23.000	8.200	0.800	1.550	332	0.188	560	0.375	719	0.563	842	0.750
IN	0.906	0.323	0.031	0.061	75	0.007	126	0.015	162	0.022	190	0.030
DSM0238209 MM	23.000	8.200	0.900	1.600	391	0.175	687	0.350	919	0.525	1120	0.700
IN	0.906	0.323	0.035	0.063	88	0.007	155	0.014	207	0.021	253	0.028
DSM0238210 MM	23.000	8.200	1.000	1.700	507	0.175	909	0.350	1240	0.525	1540	0.700
IN	0.906	0.323	0.039	0.067	115	0.007	205	0.014	280	0.021	347	0.028
DSM0231009 MM	23.000	10.200	0.900	1.650	463	0.188	802	0.375	1060	0.563	1270	0.750
IN	0.906	0.402	0.035	0.065	105	0.007	181	0.015	239	0.022	287	0.030
DSM0231010 MM	23.000	10.200	1.000	1.700	538	0.175	964	0.350	1320	0.525	1630	0.700
IN	0.906	0.402	0.039	0.067	122	0.007	218	0.014	297	0.021	368	0.028
DSM0231012 MM	23.000	10.200	1.250	1.900	870	0.163	1630	0.325	2310	0.488	2960	0.650
IN	0.906	0.402	0.049	0.075	196	0.006	367	0.013	521	0.019	667	0.026
DSM0231210 MM	23.000	12.200	1.000	1.600	475	0.150	872	0.300	1220	0.450	1540	0.600
IN	0.906	0.480	0.039	0.063	107	0.006	197	0.012	275	0.018	347	0.024
DSM0231212 MM	23.000	12.200	1.250	1.850	863	0.150	1630	0.300	2330	0.450	3000	0.600
IN	0.906	0.480	0.049	0.073	195	0.006	368	0.012	526	0.018	677	0.024
DSM0231215 MM	23.000	12.200	1.500	2.000	1160	0.125	2250	0.250	3300	0.375	4320	0.500
IN	0.906	0.480	0.059	0.079	262	0.005	508	0.010	744	0.015	975	0.020
DSM0251010 MM	25.000	10.200	1.000	1.750	492	0.188	870	0.375	1170	0.563	1440	0.750
IN	0.984	0.402	0.039	0.069	111	0.007	196	0.015	265	0.022	324	0.030
DSM0251207 MM	25.000	12.200	0.700	1.600	331	0.225	515	0.450	600	0.675	635	0.900
IN	0.984	0.480	0.028	0.063	75	0.009	116	0.018	135	0.027	143	0.035
DSM0251209 MM	25.000	12.200	0.900	1.600	367	0.175	644	0.350	862	0.525	1050	0.700
IN	0.984	0.480	0.035	0.063	83	0.007	145	0.014	195	0.021	237	0.028
DSM0251210 MM	25.000	12.200	1.000	1.800	585	0.200	1020	0.400	1360	0.600	1650	0.800
IN	0.984	0.480	0.039	0.071	132	0.008	230	0.016	307	0.024	372	0.031
DSM0251212 MM	25.000	12.200	1.250	1.950	848	0.175	1570	0.350	2210	0.525	2810	0.700
IN	0.984	0.480	0.049	0.077	192	0.007	355	0.014	500	0.021	635	0.029
DSM0251215 MM	25.000	12.200	1.500	2.050	1040	0.138	2010	0.275	2930	0.413	3830	0.550
IN	0.984	0.480	0.059	0.081	235	0.005	453	0.011	660	0.016	863	0.022
DSM0281008 MM	28.000	10.200	0.800	1.750	348	0.238	552	0.475	662	0.713	723	0.950
IN	1.102	0.402	0.031	0.069	79	0.009	125	0.019	149	0.028	163	0.037
DSM0281010 MM	28.000	10.200	1.000	1.900	512	0.225	872	0.450	1130	0.675	1340	0.900
IN	1.102	0.402	0.039	0.075	116	0.009	197	0.018	255	0.027	302	0.035
DSM0281012 MM	28.000	10.200	1.250	2.050	736	0.200	1340	0.400	1850	0.600	2320	0.800
IN	1.102	0.402	0.049	0.081	166	0.008	302	0.016	418	0.024	524	0.031
DSM0281015 MM	28.000	10.200	1.500	2.200	1000	0.175	1900	0.350	2720	0.525	3510	0.700
IN	1.102	0.402	0.059	0.087	226	0.007	429	0.014	615	0.021	792	0.028
DSM0281210 MM	28.000	12.200	1.000	1.950	590	0.238	992	0.475	1270	0.713	1480	0.950
IN	1.102	0.480	0.039	0.077	133	0.009	224	0.019	286	0.028	335	0.037
DSM0281212 MM	28.000	12.200	1.250	2.100	844	0.213	1520	0.425	2080	0.638	2590	0.850
IN	1.102	0.480	0.049	0.083	190	0.008	343	0.017	470	0.025	585	0.033
DSM0281215 MM	28.000	12.200	1.500	2.250	1150	0.188	2160	0.375	3080	0.563	3950	0.750
IN	1.102	0.480	0.059	0.089	259	0.007	487	0.015	695	0.022	891	0.030
DSM0281408 MM	28.000	14.200	0.800	1.800	435	0.250	681	0.500	801	0.750	859	1.000
IN	1.102	0.559	0.031	0.071	98	0.010	154	0.020	181	0.030	194	0.039
DSM0281410 MM	28.000	14.200	1.000	1.800	476	0.200	832	0.400	1110	0.600	1340	0.800
IN	1.102	0.559	0.039	0.071	108	0.008	188	0.016	250	0.024	303	0.031
DSM0281412 MM	28.000	14.200	1.250	2.100	907	0.213	1630	0.425	2240	0.638	2790	0.850
IN	1.102	0.559	0.049	0.083	205	0.008	369	0.017	506	0.025	629	0.033
DSM0281415 MM	28.000	14.200	1.500	2.150	1030	0.163	1970	0.325	2840	0.488	3680	0.650
IN	1.102	0.559	0.059	0.085	233	0.006	445	0.013	641	0.019	831	0.026
DSM0311210 MM	31.500	12.200	1.000	2.100	587	0.275	951	0.550	1170	0.825	1310	1.100
IN	1.240	0.480	0.039	0.083	132	0.011	215	0.022	263	0.032	295	0.043
DSM0311212 MM	31.500	12.200	1.250	2.200	761	0.238	1340	0.475	1810	0.713	2210	0.950
IN	1.240	0.480	0.049	0.087	172	0.009	303	0.019	407	0.028	496	0.037
DSM0311215 MM	31.500	12.200	1.500	2.350	1030	0.213	1910	0.425	2690	0.638	3410	0.850
IN	1.240	0.480	0.059	0.093	233	0.008	432	0.017	607	0.025	770	0.033
DSM0311608 MM	31.500	16.300	0.800	1.850	384	0.263	594	0.525	687	0.788	722	1.050
IN	1.240	0.642	0.031	0.073	87	0.010	134	0.021	155	0.031	163	0.041
DSM0311612 MM	31.500	16.300	1.250	2.150	791	0.225	1410	0.450	1910	0.675	2360	0.900
IN	1.240	0.642	0.049	0.085	178	0.009	318	0.018	432	0.027	533	0.035





EN (NEWTON) = 0.102 KG INCHES × 25.4 = MM  
= 0.225 LB LBS. × .454 = KG

PART NO.	O.D. D	I.D. d	MATL. t	O/A HGT O.H.	[ f = 0.25h ]		[ f = 0.50h ]		[ f = 0.75h ]		[ FLAT f = (h) ]	
					LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f
DSM0311615 MM	31.500	16.300	1.500	2.400	1260	0.225	2310	0.450	3230	0.675	4080	0.900
IN	1.240	0.642	0.059	0.094	284	0.009	522	0.018	729	0.027	920	0.035
DSM0311617 MM	31.500	16.300	1.750	2.450	1390	0.175	2670	0.350	3870	0.525	5040	0.700
IN	1.240	0.642	0.069	0.096	314	0.007	602	0.014	874	0.021	1140	0.028
DSM0311620 MM	31.500	16.300	2.000	2.750	2200	0.188	4240	0.375	6170	0.563	8050	0.750
IN	1.240	0.642	0.079	0.108	496	0.007	957	0.015	1390	0.022	1820	0.030
DSM0341210 MM	34.000	12.300	1.000	2.250	637	0.313	998	0.625	1170	0.938	1260	1.250
IN	1.339	0.484	0.039	0.089	144	0.012	225	0.025	265	0.037	284	0.049
DSM0341212 MM	34.000	12.300	1.250	2.350	815	0.275	1400	0.550	1820	0.825	2160	1.100
IN	1.339	0.484	0.049	0.093	184	0.011	315	0.022	410	0.032	488	0.043
DSM0341215 MM	34.000	12.300	1.500	2.500	1100	0.250	1990	0.500	2730	0.750	3400	1.000
IN	1.339	0.484	0.059	0.098	248	0.010	447	0.020	615	0.030	767	0.039
DSM0341412 MM	34.000	14.300	1.250	2.400	913	0.288	1550	0.575	1990	0.863	2350	1.150
IN	1.339	0.563	0.049	0.094	206	0.011	349	0.023	450	0.034	530	0.045
DSM0341415 MM	34.000	14.300	1.500	2.550	1220	0.263	2190	0.525	2990	0.788	3700	1.050
IN	1.339	0.563	0.059	0.100	276	0.010	495	0.021	675	0.031	836	0.041
DSM0341615 MM	34.000	16.300	1.500	2.550	1290	0.263	2310	0.525	3160	0.788	3910	1.050
IN	1.339	0.642	0.059	0.100	291	0.010	522	0.021	712	0.031	882	0.041
DSM0341620 MM	34.000	16.300	2.000	2.850	2100	0.213	4000	0.425	5780	0.638	7500	0.850
IN	1.339	0.642	0.079	0.112	473	0.008	904	0.017	1310	0.025	1690	0.033
DSM0351809 MM	35.500	18.300	0.900	2.050	458	0.288	712	0.575	832	0.863	884	1.150
IN	1.398	0.720	0.035	0.081	103	0.011	161	0.023	188	0.034	200	0.045
DSM0351812 MM	35.500	18.300	1.250	2.250	731	0.250	1280	0.500	1700	0.750	2060	1.000
IN	1.398	0.720	0.049	0.089	165	0.010	288	0.020	383	0.030	465	0.039
DSM0351820 MM	35.500	18.300	2.000	2.800	1860	0.200	3580	0.400	5190	0.600	6750	0.800
IN	1.398	0.720	0.079	0.110	421	0.008	807	0.016	1170	0.024	1520	0.031
DSM0401412 MM	40.000	14.300	1.250	2.650	904	0.350	1460	0.700	1780	1.050	1980	1.400
IN	1.575	0.563	0.049	0.104	204	0.014	329	0.028	402	0.041	448	0.055
DSM0401415 MM	40.000	14.300	1.500	2.750	1110	0.313	1930	0.625	2550	0.938	3060	1.250
IN	1.575	0.563	0.059	0.108	251	0.012	436	0.025	575	0.037	691	0.049
DSM0401420 MM	40.000	14.300	2.000	3.050	1800	0.263	3360	0.525	4770	0.788	6100	1.050
IN	1.575	0.563	0.079	0.120	406	0.010	759	0.021	1080	0.031	1380	0.041
DSM0401615 MM	40.000	16.300	1.500	2.800	1220	0.325	2100	0.650	2750	0.975	3290	1.300
IN	1.575	0.642	0.059	0.110	276	0.013	475	0.026	621	0.038	741	0.051
DSM0401620 MM	40.000	16.300	2.000	3.100	1970	0.275	3660	0.550	5170	0.825	6580	1.100
IN	1.575	0.642	0.079	0.122	445	0.011	827	0.022	1170	0.032	1490	0.043
DSM0401820 MM	40.000	18.300	2.000	3.150	2180	0.288	4030	0.575	5660	0.863	7170	1.150
IN	1.575	0.720	0.079	0.124	492	0.011	910	0.023	1280	0.034	1620	0.045
DSM0402010 MM	40.000	20.400	1.000	2.300	565	0.325	876	0.650	1020	0.975	1070	1.300
IN	1.575	0.803	0.039	0.091	128	0.013	198	0.026	229	0.038	242	0.051
DSM0402015 MM	40.000	20.400	1.500	2.650	1110	0.288	1950	0.575	2620	0.863	3200	1.150
IN	1.575	0.803	0.059	0.104	250	0.011	441	0.023	592	0.034	723	0.045
DSM0402020 MM	40.000	20.400	2.000	3.100	2180	0.275	4040	0.550	5700	0.825	7260	1.100
IN	1.575	0.803	0.079	0.122	491	0.011	912	0.022	1290	0.032	1640	0.043
DSM0402022 MM	40.000	20.400	2.250	3.150	2340	0.225	4480	0.450	6500	0.675	8460	0.900
IN	1.575	0.803	0.089	0.124	527	0.009	1010	0.018	1470	0.027	1910	0.035
DSM0402025 MM	40.000	20.400	2.500	3.450	3350	0.238	6450	0.475	9390	0.713	12,200	0.950
IN	1.574	0.803	0.098	0.136	756	0.009	1460	0.019	2120	0.028	2760	0.037
DSM0452212 MM	45.000	22.400	1.250	2.850	1040	0.400	1620	0.800	1890	1.200	2010	1.600
IN	1.772	0.882	0.049	0.112	235	0.016	366	0.031	427	0.047	453	0.063
DSM0452217 MM	45.000	22.400	1.750	3.050	1520	0.325	2700	0.650	3650	0.975	4480	1.300
IN	1.772	0.882	0.069	0.120	344	0.013	610	0.026	823	0.038	1010	0.051
DSM0452225 MM	45.000	22.400	2.500	3.500	2770	0.250	5320	0.500	7720	0.750	10,000	1.000
IN	1.772	0.882	0.098	0.138	626	0.010	1200	0.020	1740	0.030	2270	0.039
DSM0501812 MM	50.000	18.400	1.250	2.850	757	0.400	1180	0.800	1370	1.200	1460	1.600
IN	1.969	0.724	0.049	0.112	171	0.016	266	0.031	310	0.047	329	0.063
DSM0501815 MM	50.000	18.400	1.500	3.300	1380	0.450	2180	0.900	2610	1.350	2840	1.800
IN	1.969	0.724	0.059	0.130	311	0.018	493	0.035	588	0.053	640	0.071
DSM0501820 MM	50.000	18.400	2.000	3.500	1920	0.375	3390	0.750	4570	1.125	5600	1.500
IN	1.969	0.724	0.079	0.138	423	0.015	766	0.030	1030	0.044	1260	0.059
DSM0501825 MM	50.000	18.400	2.500	4.100	3700	0.400	6730	0.800	9320	1.200	11,700	1.600
IN	1.969	0.724	0.098	0.161	836	0.016	1520	0.031	2100	0.047	2630	0.063
DSM0501830 MM	50.000	18.400	3.000	4.400	5040	0.350	9550	0.700	13,700	1.050	17,600	1.400
IN	1.969	0.724	0.118	0.173	1140	0.014	2150	0.028	3090	0.041	3980	0.055
DSM0502020 MM	50.000	20.400	2.000	3.500	1970	0.375	3480	0.750	4690	1.125	5750	1.500
IN	1.969	0.803	0.079	0.138	444	0.015	785	0.030	1060	0.044	1300	0.059
DSM0502025 MM	50.000	20.400	2.500	3.850	3010	0.338	5600	0.675	7920	1.013	10,100	1.350
IN	1.969	0.803	0.098	0.152	679	0.013	1260	0.027	1790	0.040	2280	0.053



EN (NEWTON) = 0.102 KG INCHES × 25.4 = MM  
= 0.225 LB LBS. × .454 = KG

PART NO.	O.D. D	I.D. d	MATL. t	O/A HGT O.H.	[ f = 0.25h ]		[ f = 0.50h ]		[ f = 0.75h ]		[ FLAT f = (h) ]	
					LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f
DSM0502220 MM	50.000	22.400	2.000	3.600	2250	0.400	3920	0.800	5220	1.200	6330	1.600
IN	1.969	0.882	0.079	0.142	507	0.016	886	0.031	1180	0.047	1430	0.063
DSM0502225 MM	50.000	22.400	2.500	3.900	3260	0.350	6040	0.700	8510	1.050	10,800	1.400
IN	1.969	0.882	0.098	0.154	736	0.014	1360	0.028	1920	0.041	2440	0.055
DSM0502512 MM	50.000	25.400	1.250	2.850	854	0.400	1330	0.800	1550	1.200	1650	1.600
IN	1.969	1.000	0.049	0.112	193	0.016	300	0.031	350	0.047	371	0.063
DSM0502515 MM	50.000	25.400	1.500	3.100	1240	0.400	2030	0.800	2510	1.200	2840	1.600
IN	1.969	1.000	0.059	0.122	280	0.016	458	0.031	567	0.047	642	0.063
DSM0502520 MM	50.000	25.400	2.000	3.400	1950	0.350	3490	0.700	4760	1.050	5900	1.400
IN	1.969	1.000	0.079	0.134	440	0.014	788	0.028	1070	0.041	1330	0.055
DSM0502525 MM	50.000	25.400	2.500	3.900	3470	0.350	6440	0.700	9060	1.050	11,500	1.400
IN	1.969	1.000	0.098	0.154	784	0.014	1450	0.028	2050	0.041	2600	0.055
DSM0502530 MM	50.000	25.400	3.000	4.100	4250	0.275	8210	0.550	12,000	0.825	15,600	1.100
IN	1.969	1.000	0.118	0.161	960	0.011	1850	0.022	2700	0.032	3530	0.043
DSM0562815 MM	56.000	28.500	1.500	3.450	1460	0.488	2260	0.975	2620	1.463	2770	1.950
IN	2.205	1.122	0.059	0.136	329	0.019	510	0.038	582	0.058	624	0.077
DSM0562820 MM	56.000	28.500	2.000	3.600	1910	0.400	3340	0.800	4440	1.200	5380	1.600
IN	2.205	1.122	0.079	0.142	431	0.016	753	0.031	1000	0.047	1210	0.063
DSM0562830 MM	56.000	28.500	3.000	4.300	4140	0.325	7900	0.650	11,400	0.975	14,800	1.300
IN	2.205	1.122	0.118	0.169	935	0.013	1780	0.026	2570	0.038	3330	0.051
DSM0602020 MM	60.000	20.500	2.000	4.100	2320	0.525	3800	1.050	4730	1.575	5380	2.100
IN	2.362	0.807	0.079	0.161	523	0.021	858	0.041	1070	0.062	1210	0.083
DSM0602025 MM	60.000	20.500	2.500	4.300	3020	0.450	5380	0.900	7300	1.350	9010	1.800
IN	2.362	0.807	0.098	0.169	681	0.018	1210	0.035	1650	0.053	2030	0.071
DSM0602030 MM	60.000	20.500	3.000	4.700	4450	0.425	8230	0.850	11,600	1.275	14,700	1.700
IN	2.362	0.807	0.118	0.185	1000	0.017	1860	0.033	2610	0.050	3320	0.067
DSM0602525 MM	60.000	25.500	2.500	4.400	3450	0.475	6080	0.950	8180	1.425	10,000	1.900
IN	2.362	1.004	0.098	0.173	778	0.019	1370	0.037	1850	0.056	2260	0.075
DSM0602530 MM	60.000	25.500	3.000	4.650	4500	0.413	8350	0.825	11,800	1.238	15,000	1.650
IN	2.362	1.004	0.118	0.183	1010	0.016	1890	0.032	2660	0.049	3390	0.065
DSM0603025 MM	60.000	30.500	2.500	4.300	3450	0.450	6150	0.900	8348	1.350	10,300	1.800
IN	2.362	1.201	0.098	0.169	778	0.018	1390	0.035	1880	0.053	2320	0.071
DSM0603030 MM	60.000	30.500	3.000	4.700	5080	0.425	9410	0.850	13,200	1.275	16,800	1.700
IN	2.362	1.201	0.118	0.185	1150	0.017	2120	0.033	2990	0.050	3790	0.067
DSM0603035 MM	60.000	30.500	3.500	5.000	6590	0.375	12,600	0.750	18,200	1.125	23,500	1.500
IN	2.362	1.201	0.138	0.197	1490	0.015	2840	0.030	4100	0.044	5310	0.059
DSM0633118 MM	63.000	31.000	1.800	4.150	2360	0.588	3660	1.175	4240	1.763	4460	2.350
IN	2.480	1.220	0.071	0.163	534	0.023	826	0.046	957	0.069	1010	0.093
DSM0633125 MM	63.000	31.000	2.500	4.250	2940	0.438	5270	0.875	7190	1.313	8900	1.750
IN	2.480	1.220	0.098	0.167	664	0.017	1190	0.034	1620	0.052	2010	0.069
DSM0633130 MM	63.000	31.000	3.000	4.800	4890	0.450	8980	0.900	12,500	1.350	15,800	1.800
IN	2.480	1.220	0.118	0.189	1100	0.018	2030	0.035	2830	0.053	3570	0.071
DSM0633135 MM	63.000	31.000	3.500	4.900	5400	0.350	10,400	0.700	15,000	1.050	19,500	1.400
IN	2.490	1.220	0.138	0.193	1220	0.014	2340	0.028	3390	0.041	4410	0.055
DSM0702520 MM	70.000	25.500	2.000	4.500	2410	0.625	3770	1.250	4440	1.875	4760	2.500
IN	2.756	1.004	0.079	0.177	544	0.025	851	0.049	1000	0.074	1070	0.098
DSM0703025 MM	70.000	30.500	2.500	4.900	3760	0.600	6300	1.200	8030	1.800	9360	2.400
IN	2.756	1.201	0.098	0.193	848	0.024	1420	0.047	1810	0.071	2110	0.094
DSM0703030 MM	70.000	30.500	3.000	5.100	4680	0.525	8380	1.050	11,400	1.575	14,200	2.100
IN	2.756	1.201	0.118	0.201	1060	0.021	1890	0.041	2580	0.062	3190	0.083
DSM0703530 MM	70.000	35.500	3.000	5.100	5030	0.525	9010	1.050	12,300	1.575	15,200	2.100
IN	2.756	1.398	0.118	0.201	1130	0.021	2030	0.041	2770	0.062	3440	0.083
DSM0703540 MM	70.000	35.500	4.000	5.800	8760	0.450	16,600	0.900	23,900	1.350	30,900	1.800
IN	2.756	1.398	0.257	0.228	1980	0.018	3750	0.035	5400	0.053	6980	0.071
DSM0704040 MM	70.000	40.500	4.000	5.600	8390	0.400	16,100	0.800	23,400	1.200	30,400	1.600
IN	2.756	1.594	0.157	0.220	1890	0.016	3360	0.031	5270	0.047	6860	0.063
DSM0704050 MM	70.000	40.500	5.000	6.000	11,500	0.300	22,700	0.600	33,700	0.900	44,500	1.200
IN	2.756	1.594	0.197	0.244	2,610	0.012	5130	0.024	7600	0.035	10,000	0.047
DSM0713620 MM	71.000	36.000	2.000	4.600	2860	0.650	4430	1.300	5140	1.950	5430	2.600
IN	2.795	1.417	0.079	0.181	646	0.026	1000	0.051	1160	0.077	1220	0.102
DSM0713625 MM	71.000	36.000	2.500	4.500	2890	0.500	5050	1.000	6730	1.500	8150	2.000
IN	2.795	1.417	0.098	0.177	653	0.020	1140	0.039	1520	0.059	1840	0.079
DSM0713640 MM	71.000	36.000	4.000	5.600	7380	0.400	14,200	0.800	20,500	1.200	26,700	1.600
IN	2.795	1.417	0.157	0.220	1670	0.016	3200	0.031	4640	0.047	6030	0.063
DSM0803125 MM	80.000	31.000	2.500	5.300	3680	0.700	5930	1.400	7240	2.100	8070	2.800
IN	3.150	1.220	0.098	0.209	830	0.028	1340	0.055	1630	0.083	1820	0.110
DSM0803130 MM	80.000	31.000	3.000	5.500	4530	0.625	7850	1.250	10,400	1.875	12,500	2.500
IN	3.150	1.220	0.118	0.217	1020	0.025	1770	0.049	2340	0.074	2810	0.098



EN (NEWTON) = 0.102 KG INCHES × 25.4 = MM  
 = 0.225 LB LBS. × .454 = KG

PART NO.	O.D. D	I.D. d	MATL. t	O/A HGT O.H.	[ f = 0.25h ]		[ f = 0.50h ]		[ f = 0.75h ]		[ FLAT f = (h) ]	
					LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f	LOAD P	DEFL. f
DSM0803140 MM	80.000	31.000	4.000	6.100	7320	0.525	13,700	1.050	19,400	1.575	24,800	2.100
IN	3.150	1.220	0.157	0.240	1650	0.021	3090	0.041	4380	0.062	5600	0.083
DSM0803630 MM	80.000	36.000	3.000	5.700	5400	0.675	9200	1.350	11,900	2.025	14,100	2.700
IN	3.150	1.417	0.118	0.224	1220	0.027	2080	0.053	2690	0.080	3180	0.106
DSM0803640 MM	80.000	36.000	4.000	6.200	8160	0.550	15,200	1.100	21,400	1.650	27,200	2.200
IN	3.150	1.417	0.157	0.224	1840	0.022	3420	0.043	4830	0.065	6150	0.087
DSM0804122 MM	80.000	41.000	2.250	5.200	3700	0.738	5720	1.475	6610	2.213	6950	2.950
IN	3.150	1.614	0.089	0.205	835	0.029	1290	0.058	1490	0.087	1570	0.116
DSM0804130 MM	80.000	41.000	3.000	5.300	4450	0.575	7840	1.150	10,500	1.725	12,800	2.300
IN	3.150	1.614	0.118	0.209	1000	0.023	1770	0.045	2370	0.068	2900	0.091
DSM0804140 MM	80.000	41.000	4.000	6.200	8730	0.550	16,200	1.100	22,900	1.650	29,100	2.200
IN	3.150	1.614	0.157	0.244	1970	0.022	3660	0.043	5160	0.065	6570	0.087
DSM0804150 MM	80.000	41.000	5.000	6.700	11,800	0.425	22,900	0.850	33,600	1.275	44,000	1.700
IN	3.150	1.614	0.197	0.264	2670	0.017	5180	0.033	7580	0.050	9920	0.067
DSM0904625 MM	90.000	46.000	2.500	5.700	4230	0.800	6580	1.600	7680	2.400	8160	3.200
IN	3.543	1.811	0.098	0.224	955	0.031	1490	0.063	1730	0.094	1840	0.126
DSM0904635 MM	90.000	46.000	3.500	6.000	5840	0.625	10,400	1.250	14,200	1.875	17,500	2.500
IN	3.543	1.811	0.138	0.236	1320	0.025	2350	0.049	3200	0.074	3950	0.098
DSM0904650 MM	90.000	46.000	5.000	7.000	11,300	0.500	21,600	1.000	31,400	1.500	40,800	2.000
IN	3.543	1.811	0.197	0.276	2540	0.020	4880	0.039	7060	0.059	9210	0.079
DSM1004140 MM	100.000	41.000	4.000	7.200	8710	0.800	15,200	1.600	20,300	2.400	24,500	3.200
IN	3.937	1.614	0.157	0.283	1970	0.031	3440	0.063	4570	0.094	5540	0.126
DSM1004150 MM	100.000	41.000	5.000	7.750	12,300	0.688	22,900	1.375	32,400	2.063	41,200	2.750
IN	3.937	1.614	0.197	0.305	2790	0.027	5180	0.054	7300	0.081	9300	0.108
DSM1005127 MM	100.000	51.000	2.700	6.200	4780	0.875	7410	1.750	8610	2.625	9090	3.500
IN	3.937	2.008	0.106	0.244	1080	0.034	1670	0.069	1940	0.103	2050	0.138
DSM1005135 MM	100.000	51.000	3.500	6.300	5620	0.700	9820	1.400	13,100	2.100	15,800	2.800
IN	3.937	2.008	0.138	0.248	1270	0.028	2220	0.055	2950	0.083	3580	0.110
DSM1005140 MM	100.000	51.000	4.000	7.000	8760	0.750	15,300	1.500	20,700	2.250	25,300	3.000
IN	3.937	2.008	0.157	0.276	1960	0.030	3460	0.059	4670	0.089	5720	0.118
DSM1005150 MM	100.000	51.000	5.000	7.800	13,900	0.700	25,800	1.400	36,300	2.100	46,200	2.800
IN	3.937	2.008	0.197	0.307	3140	0.028	5830	0.055	8200	0.083	10,400	0.110
DSM1005160 MM	100.000	51.000	6.000	8.200	17,100	0.550	32,900	1.100	48,000	1.650	62,700	2.200
IN	3.937	2.008	0.236	0.323	3850	0.022	7430	0.043	10,800	0.065	14,200	0.087
DSM1125730 MM	112.000	57.000	3.000	6.900	5830	0.975	9040	1.950	10,500	2.925	11,100	3.900
IN	4.409	2.244	0.118	0.272	1320	0.038	2040	0.077	2370	0.115	2500	0.154
DSM1125740 MM	112.000	57.000	4.000	7.200	7640	0.800	13,300	1.600	17,800	2.400	21,500	3.200
IN	4.409	2.244	0.157	0.283	1720	0.031	3010	0.063	4010	0.094	4860	0.126
DSM1125760 MM	112.000	57.000	6.000	8.500	15,800	0.625	30,200	1.250	43,700	1.875	56,700	2.500
IN	4.409	2.244	0.236	0.335	3570	0.025	6820	0.049	9870	0.074	12,800	0.098
DSM1254140 MM	125.000	41.000	4.000	8.200	8500	1.050	13,900	2.100	17,300	3.150	19,700	4.200
IN	4.921	1.614	0.157	0.323	1920	0.041	3150	0.083	3920	0.124	4450	0.165
DSM1255140 MM	125.000	51.000	4.000	8.500	10,100	1.125	16,300	2.250	19,800	3.375	22,100	4.500
IN	4.921	2.008	0.157	0.335	2280	0.044	3670	0.089	4470	0.133	4980	0.177
DSM1255150 MM	125.000	51.000	5.000	8.900	13,100	0.975	22,900	1.950	30,700	2.925	37,300	3.900
IN	4.921	2.008	0.197	0.350	2950	0.038	5180	0.077	6920	0.115	8430	0.154
DSM1255160 MM	125.000	51.000	6.000	9.400	17,000	0.850	31,500	1.700	44,300	2.550	56,300	3.400
IN	4.921	2.008	0.236	0.370	3840	0.033	7110	0.067	10,000	0.100	12,700	0.134
DSM1256150 MM	125.000	61.000	5.000	9.000	14,600	1.000	25,500	2.000	34,000	3.000	41,200	4.000
IN	4.921	2.402	0.197	0.354	3300	0.039	5760	0.079	7670	0.118	9290	0.157
DSM1256160 MM	125.000	61.000	6.000	9.600	19,800	0.900	36,300	1.800	50,700	2.700	64,000	3.600
IN	4.921	2.402	0.236	0.378	4470	0.035	8200	0.071	11,400	0.106	14,500	0.142
DSM1256180 MM	125.000	61.000	8.000	10.900	33,200	0.725	64,100	1.450	93,600	2.175	122,000	2.900
IN	4.921	2.402	0.315	0.429	7,490	0.029	14,500	0.057	21,100	0.086	27,600	0.114
DSM1256435 MM	125.000	64.000	3.500	8.000	8510	1.125	13,200	2.250	15,400	3.375	16,300	4.500
IN	4.921	2.520	0.138	0.315	1920	0.044	2990	0.089	3480	0.133	3690	0.177
DSM1256450 MM	125.000	64.000	5.000	8.500	12,200	0.875	21,900	1.750	29,900	2.625	37,000	3.500
IN	4.921	2.520	0.197	0.335	2760	0.034	4950	0.069	6750	0.103	8360	0.138
DSM1256480 MM	125.000	64.000	8.000	10.600	30,100	0.650	58,600	1.300	85,900	1.950	113,000	2.600
IN	4.921	2.520	0.315	0.417	6800	0.026	13,200	0.051	19,400	0.077	25,400	0.102
DSM1257160 MM	125.000	71.000	6.000	9.300	19,500	0.825	36,300	1.650	51,200	2.475	65,200	3.300
IN	4.921	2.795	0.236	0.366	4410	0.032	8190	0.065	11,600	0.097	14,700	0.130
DSM1257180 MM	125.000	71.000	8.000	10.400	29,800	0.600	58,100	1.200	85,500	1.800	112,000	2.400
IN	4.921	2.795	0.315	0.409	6720	0.024	13,100	0.047	19,300	0.071	25,400	0.094
DSM1257199 MM	125.000	71.000	10.000	11.800	42,000	0.450	83,300	0.900	124,000	1.350	165,000	1.800
IN	4.921	2.795	0.394	0.465	9490	0.018	18,800	0.035	28,000	0.053	37,200	0.071

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