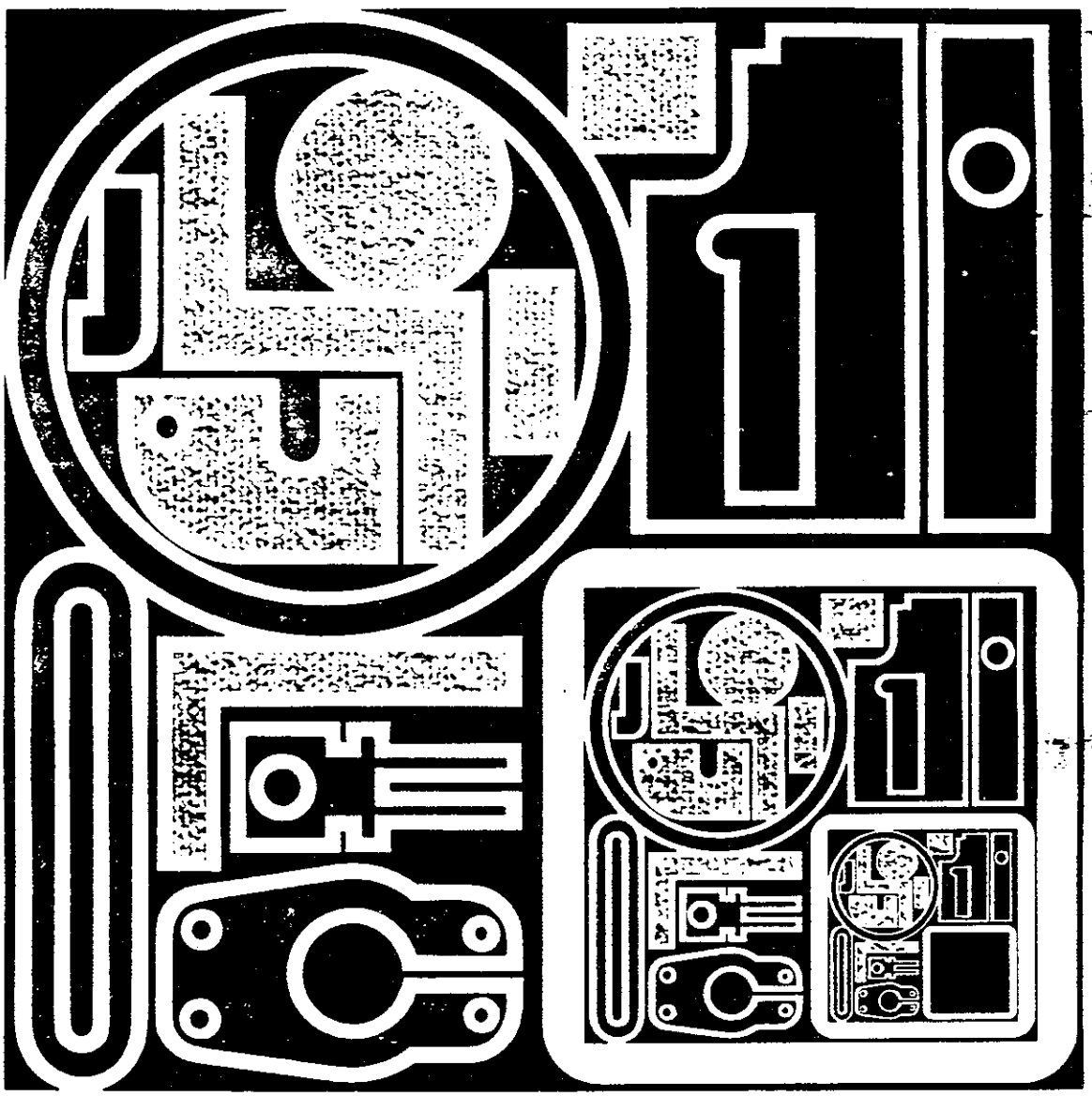
Westinghouse Micarta® Industrial Plate, Rods, Angles, Channels, Zees

MWBB-0034610



PLAINTIFF'S EXHIBIT
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Application Guide

	Major application requirements	Typical use
Paper base materials	High tensile, flexural and compressive strength (uses where machining or humidity characteristics are not important)	insulating washers
	Electrical insulation in dry or humid conditions where fair mechanical strength and good machining are needed	Switchboard panels; relay and switch bases
	High humidity resistance, good dimensional stability, excellent resistance to splitting	Panelboards
	Electrical insulation in applications requiring low dielectric losses in severe humidity conditions	Punched parts for electronic equipment
	Low 60-cycle power factor—Low cold flow and dielectric constant	Tap-changer boards—Transformers
	Cold shearing and cold punching under normal conditions; low loss at high humidity. Excellent electrical properties.	Radio and TV terminal boards
	Self-extinguishing, punchable, good dimensional stability	Commercial computer terminal boards
	Excellent cold punching and cold shearing characteristics under normal conditions, punchable up through 3/32" thickness only.	Intricate punched parts requiring some preheating
	Good warm shearing and warm punching under normal conditions; punchable up through 3/32" thickness only; laminate should be preheated between 100°-150° F	Intricate punched parts requiring little preheating
	Ultra-soft punch plate	Thick punched parts
	Fair to good electrical and mechanical properties with decorative surface for exposed general purpose panels. Good arc and track resistance.	Switchboard panels, control panels, appliance panels, relay and switch bases, panelboard
	Same as above grade 51P64 plus flame retardance, 94-VO when tested per U.L. method 94. Good electrical insulation under humid conditions. Properties similar to NEMA XX	Same as above (grade 51P64)
Cotton cloth base materials	Good machining qualities, mechanical and electrical strength, moisture resistance, toughness, good appearance	Marine relay bases; terminal boards; radio parts
	Economical fine weave with good machining & mechanical properties and fair electrical properties	Intricate, high strength machined parts
	Low moisture absorption, toughness, fair dimensional stability	Paper mill doctor blades; pump valves; marine bearings; piston and packing rings
	High mechanical strength, good appearance, strength in punching	Fine tooth gears; radio parts; terminal boards
	Good mechanical properties with especially high impact strength	Gears; pinions; spacers
	Good mechanical properties, good machining qualities	Gears; pinions
	Low moisture absorption, good dimensional stability, good resistance to acids and alkalis	Valves and plating tanks
	Low-voltage, low-frequency electrical performance, mechanical performance in moderately humid conditions	Marine switchboard panels; small gears and pinions; radio parts
	Low coefficient of friction, self-lubricating (graphite filled)	Textile mill bearings; pistons; packing rings
	Good mechanical heat resistance and low abrasion	Bearings; slot wedges and gears. A replacement for asbestos in many applications.
Glass cloth base materials	High mechanical strength and hardness; high arc and heat resistance, excellent electrical properties under dry conditions; self-extinguishing	Switchboard panels; arc barriers; circuit-breaker parts; structural electrical parts
	Retention of high mechanical strength at temperatures up to 150°C, self-extinguishing, retention of 50% of initial flexural strength at 150°C	Rotor-slot insulation, structural members at elevated temperature
	Good machining qualities, high flexural, impact and bond strength at room temperatures, good electrical properties under dry and humid conditions, should not be used under mechanical load at elevated temperatures	Electrical-mechanical applications—good for high humidity areas. Terminal boards
	High mechanical strength, high arc and heat resistance, excellent electrical properties under dry and humid conditions, self-extinguishing	Marine switchboard panels and structural parts
	Self-extinguishing, good machining and punching qualities, high flexural, impact and bond strength at room temperatures, should not be used under mechanical load at elevated temperatures	Terminal boards
	Excellent heat and arc resistance, good electrical properties under humid conditions, good mechanical properties, self-extinguishing	Class H insulation; heating appliance insulation
	Excellent heat resistance—self-extinguishing. Excellent mechanical and machining properties—stable at high temperature	High temperature mechanical applications
	Good heat resistance. Excellent mechanical and machining properties	Gaskets, seals; a replacement for asbestos in many applications

NVBB-003461

Grade Selection Guide

Micarta grade	NEMA grade	Military specifications type and number	Base material	Color	Resin
213	X	—	Paper	Tan	Phenolic
		—	Paper	Black	Phenolic
219	XX	LP 513a-PBG	Paper	Tan	Phenolic
429	XX	—	Paper	Black	Phenolic
254	XXX	LP 513a-PBE	Paper	Tan	Phenolic
H-17900	XXP	—	Paper	Tan	Phenolic
H-18720	—	—	Paper	Natural	Phenolic
H-5639	XXXPC	LP 513a-PBEP	Paper	Tan	Phenolic
H-9454	FR-3	—	Paper	Cream	Epoxy
H-18331	XPC	—	Paper	Chocolate	Phenolic
H-18332	XPC	—	Paper	Tan	Phenolic
H-18333	XPC	—	Paper	Black	Phenolic
51P86	—	—	Paper	Tan-Choc.-Black	Phenolic
H-19128	XP	—	Paper	Tan	Phenolic
H-19242	XP	—	Paper	Black	Phenolic
H-19243	XP	—	Paper	Chocolate	Phenolic
51P77	—	—	Paper	Tan-Choc.-Black	Phenolic
H-23655	XPC	—	Paper	Tan	Phenolic
51P64	—	—	Paper	Red-Orange-Blue-Gray-Black	Melamine/ Phenolic
53P66	—	—	Paper	Red-Orange-Blue-Gray-Black	Melamine/ Phenolic
221	LE	Mil-P-15035-FBE	Fine weave fabric	Tan	Phenolic
431	LE	—	Fine weave fabric	Black	Phenolic
51F60	—	—	Fine weave fabric	Natural	Phenolic
223	—	Mil-P-18324	Medium weave fabric	Tan	Phenolic
238	L	Mil-P-15035-FBI	Fine weave fabric	Natural	Phenolic
262	C	Mil-P-15035-FBM	Medium weave fabric	Natural	Phenolic
H-26000	C	Mil-P-15035-FBM	Medium weave fabric	Natural	Phenolic
H-25126	—	—	Fine weave fabric	Natural	Phenolic
281	—	—	Medium weave fabric	Natural	Phenolic
286	CE	Mil-P-15035-FBG	Medium weave fabric	Natural	Phenolic
H-24721	CE	Mil-P-15035-FBG	Medium weave fabric	Natural	Phenolic
51F33	CE	Mil-P-15035-FBG	Medium weave fabric	Natural	Phenolic
496	CE	—	Medium weave fabric	Black	Phenolic
400	—	Mil-P-5431	Medium weave fabric	Black	Phenolic
H-24907	—	—	Synthetic fiber	Tan	Phenolic
259-2	G-5	—	Glass cloth	Gray	Melamine
H-23842	G-11	Mil-P-18177-GEB	Glass cloth	Natural	Epoxy
H-22033	G-10	Mil-P-18177-GEE	Glass cloth	Natural	Epoxy
H-12426	G-9	Mil-P-15037-GME	Glass cloth	Gray	Melamine
H-16010	FR-4	Mil-P-18177-GEE	Glass cloth	Natural	Epoxy
H-17825	G-7	Mil-997D-GSG	Glass cloth	White	Silicone
H-25219	—	—	Glass cloth	White	Silicone
51G19	G-3		Glass Cloth	Natural	Phenolic

Physical Properties

Property	Density	Water absorption (⅛" thick)	Hardness	Ultimate strength			Bonding strength (⅛" thick)
				Tensile (with grain)	Compressive (flatwise)	Flexural (flatwise with grain) (⅛" thick)	
Dimension	(lb per cu in.)	percent	Rockwell "M"	psi	psi	psi	lb
ASTM method		D229	D229	D229	D229	D229	D229
Condition		E-1/105 D-24/23 T-23/50	A	A	A	A	A
Grade							
Paper base materials							
213	049	2.0	110	25,000	44,000	30,000	950
219, 429	047	0.5	100	13,500	30,000	17,000	1,000
254	047	0.5	110	20,000	38,000	23,000	1,000
H-17900	047	0.9	95	11,000	30,000	17,000	—
H-18720	045	3.3	115	22,000	37,000	27,000	1,000
H-5639	047	0.4	95	12,000	30,000	18,000	—
H-9454	052	0.6	105	20,000	32,000	22,000	1,300
H-18331 H-18332 H-18333	049	3.5*	95	12,000	—	22,000	—
51P88	049	3.8*	97	12,000	—	23,000	—
H-19128 H-19242 H-19243	049	3.3%*	105	—	—	28,000	—
51P77	049	3.8*	105	—	—	28,000	—
H-23655	049	1.8	90	14,000	30,000	20,000	—
Cotton cloth/synthetic base							
221, 431	048	1.0	105	16,000	38,000	22,000	1,700
223	049	1.2	105	12,000	38,000	18,000	1,700
238	048	1.3	100	11,500	36,000	19,000	1,900
262 H-26000	053	1.8	100	13,000	39,000	20,000	2,100
H-25126 51F60	048	1.7	105	12,000	36,000	20,000	1,800
281	049	1.2	105	12,000	38,000	18,000	1,700
51F33 H-24721	050	1.1	105	13,000	37,000	19,000	2,000
286, 496	49	1.1	105	13,000	39,000	22,000	1,900
400	051	1.1	109	13,000	45,000	21,000	2,200
H-24907	046	—	—	29,500	85,000	34,000	1,700
Glass cloth base materials							
259-2	072	0.4	115	40,000	65,000	50,000	1,800
H-23842	067	0.06	115	55,000	60,000	70,000	1,800
H-22033	069	0.05	115	50,000	60,000	70,000	2,600
H-12426	072	0.2	120	45,000	65,000	55,000	2,300
H-17825	066	0.02	105	—	—	25,000	900
H-25219	068	0.04	—	—	55,000	30,000	900
51G19	068	0.5	—	34,000	55,000	50,000	1,500

Condition A—Conditioned for 24 hours and tested in laboratory atmosphere (23° C, 50% RH). This is representative data taken from production material. Properties may vary slightly, but in all cases are guaranteed to meet the applicable NEMA standards only.

*Values based on 1.16" laminate

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Electrical Properties

Impact Strength Izod, edgewise (with grain)	Shear (flatwise) (⅛" thick)	Dielectric strength (perpendicular) (⅛" thick)	Dissipation factor (at 10^6 cycles/sec)	Dielectric constant (10^6 cycles/sec)	Volume resistivity	Surface resistivity	Arc resistance	Property	Parallel Dielectric KV Cond. A
ft-lb/in. (notch)	psi	vpm (short time)			megohm-cm	megohms	seconds	Dimension	
D732	D229	D229	D229	D229	D229	D229	D495	ASTM method	
E-48/50	A	Tested in transformer oil, 23° C	A	A	C-96/35/90 T-35/90	C-96/35/90 T-35/90	A	Condition	
								Grade	
0.8	14,000	450	0.0700	6.4	—	—	—	213, 423	50
0.55	10,000	500	0.0400	4.6	4×10^5	4×10^4	—	219, 429	60
0.5	12,000	500	0.0420	4.9	3×10^7	7×10^5	—	254	65
0.5	10,000	500	0.040	4.6	—	—	—	H-17900	60
0.6	9,000	400	0.060 @ 60 cy	—	—	—	—	H-18720	65
	—		—	—	—	—	—		
0.45	10,000	550	0.037	4.4	8.0×10^6	2×10^6	—	H-5639	70
0.7	—	550	0.034	4.2	5.0×10^7	1×10^6	100	H-9454	65
0.6	—	450	—	—	—	—	—		
0.8	—	450	—	—	—	—	—		
0.8	15,000	375	0.096	6.7	—	—	—	H-19128 H-19242 H-19243	55
-	—	300	—	—	—	—	—	51P77	35
0.8	11,000	400	0.064	5.5	—	—	—	H-23655	60
1.6	14,000	350	0.045	5.4	7×10^4	6×10^4	—	221, 431	55
1.6	13,000	200	—	—	—	—	—	223	—
1.6	13,000	250	—	—	—	—	—	238	25
2.3	13,000	150	—	—	—	—	—	262 H-26000	25
1.4	11,000	250	—	—	—	—	—	H-25126 51F60	—
1.6	13,000	—	—	—	—	—	—	281	—
1.8	10,000	200	—	—	—	—	—	51F33 H-24721	40
3.0	10,000	200	—	—	—	—	—	286, 496	50
1.7	15,000	—	—	—	—	—	—	400	—
0.0	—	—	—	—	—	—	—	H-24907	—
0.0	30,000	300	0.019	6.3*	6×10^7	6×10^6	180	259-2	50
4.0	24,000	450	0.022	4.9	5×10^6	1×10^7	—	H-23842	60
2.0	—	550	0.020	5.0	6×10^7	1×10^6	100	H-22033	60
3.0	—	—	0.018	7.2	1.5×10	1.5×10^7	180	H-12426	70
2.5	—	—	0.003	4.2	—	—	190	H-17825	55
3.0	—	—	0.032	4.4	—	—	190	H-25219	—
2.0	—	400	0.035	7.3	1.3×10^4	4.6×10^4		51G19	30

+Retains 50% of Condition A flexural strength at E-1/150° C, T-150° C *These values are for 1/16-inch thickness

*Up to 1/8-inch thickness only

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Tolerances of Molded Plate

Nominal thickness (inches)	Thickness tolerance (inches)								
Grade	213 219 254 423 429 51P77 51P88 H-23193 H-24753 H-2898	H-5639 H-9454 H-17900 H-18331 H-18332 H-18333 H-19128 H-19242 H-19243 H-23655	238	221 431 51F60	262 400 H-26000	223 281 286 496 51F33 H-24721 H-25126	H-24907	259-2 H-12426 H-22033	H-16010 H-17825 H-23842 H-25219
1/32	±.0035		±.005	±.005	±.0065	±.0065		±.0065	
3/64	±.0045		±.0055	±.0055	±.0075	±.0075	±.018	±.0075	
1/16	±.005		±.006	±.006	±.0075	±.0075	±.018	±.0075	
3/32	±.007		±.007	±.007	±.008	±.009	±.018	±.009	
1/8	±.008		±.008	±.008	±.010	±.010	±.020	±.012	
5/32	±.009		±.009	±.009	±.011	±.011	±.024	±.015	
3/16	±.010		±.010	±.010	±.0125	±.0125	±.024	±.019	
7/32	±.011		±.011	±.011	±.014	±.014	±.028	±.021	
1/4	±.012		+.024	±.012	+.030	±.015	±.028	±.022	
5/16	±.0145		+.029	±.0145	+.035	±.0175	±.034	±.026	
3/8	±.017		+.034	±.017	+.040	±.020	±.038	±.030	
7/16	±.019		+.038	±.019	+.044	±.022	±.044	±.033	
1/2	±.021		+.042	±.021	+.048	±.024	±.048	±.036	
5/8	±.024		+.048	±.024	+.053	±.027	±.058	±.040	
3/4	±.027		+.054	±.027	+.058	±.029	±.068	±.043	
7/8	±.030		+.060	±.030	+.062	±.031	±.076	±.046	
1	±.033		+.065	±.033	+.065	±.033	±.086	±.049	
1¼	±.037		±.073	±.037	+.073	±.037	±.106	±.055	
1½	±.041		+.081	±.041	+.081	±.041	±.124	±.061	
1¾	±.045		+.089	±.045	+.089	±.045	±.144	±.067	
2	±.049		+.097	±.049	+.097	±.049	±.160	±.073	

NOTE: Tolerance of length and width of trimmed plate is plus or minus 1" from standard size. To minimize warpage material should be stored flat, not on edge

Thicknesses and Plate Sizes

Grade	Plate sizes (inches)				
	36 x 36	36 x 72	36 x 48	48 x 48*	48 x 96
281	.031-5	.031-5	.031-5	.031-5	[illegible]
213, 423	.015-2	.031-2.250	.031-2	.031-2	[illegible]
219, 429	.031-2	.031-2	.031-2	.031-2	.031-2
221, 431	.015-5	.031-5	.031-5	.031-5	[illegible]
223	.031-5	.031-5	.031-5	.031-5	.031-5
51F60	.031-5	.031-5	.031-5	.031-5	.031-5
238	.031-5	.031-5	.031-5	.031-5	.031-5
H-25126	.031-5	.031-5	.031-5	.031-5	.031-5
254	.020-2	.031-2	.031-2	.031-2	.031-2
259-2	.015-5	031-4	.031-4	.031-4	.031-4
262	.031-10	031-6	.031-10	.031-6	.031-6
H-26000	031-10	.031-6	.031-10	031-6	.031-6
H-23842	.031-5	.031-5	.031-5	.031-5	.031-5
281	.031-5	.031-6	.031-5	.031-5	.031-5
286, 496	.031-6	.031-6	.031-6	.031-6	.031-6
H-24721	031-6	.031-6	.031-6	.031-6	.031-6
51F33	031-6	.031-6	.031-6	[illegible]	.031-6
[illegible]	.031-5	.031-5	.031-5	[illegible]	.031-5
H-[illegible]	031-2	.031-2	.031-2	[illegible]	[illegible]
H-23193-H-24753	012-.500	.012-.500	.012-.500	.012-.500	.012-[illegible]
H-24907	062-1.500	062-1.500	—	—	—
H-5639	031-.250	.031-.250	.031-.250	.031-.250	.031-[illegible]
H-[illegible]	015-.250	031-.250	.031-.250	.031-.250	.031-.250
H-22030			.031-5	.031-5	.031-5
H-[illegible]	031-1.500	.031-1.500	.031-1.500	.031-1.500	.031-1.500
H-12426	015-5	.031-4	.031-4	.031-4	.031-4
H-16010	.031-5	.031-2	.031-2	.031-2	.031-2
H-25219	031-2	031-2	.031-2	.031-2	.031-2
H-17825	031-2	.031-2	.031-2	.031-2	.031-2
H-[illegible]	031-2	031-2	.031-2	.031-2	.031-2
H-[illegible]	031-2	031-2	.031-2	.031-2	.031-2
H-[illegible]	031-2	031-2	031-2	.031-2	.031-2
H-19128	.031-2	.031-2	.031-2	.031-2	.031-2
H-19242	.031-2	.031-2	.031-2	.031-2	[illegible]
H-19243	.031-2	.031-2	.031-2	.031-2	[illegible]
51P77	.031-.093	031-.093	.031-.093	.031-.093	.031-.093
[illegible]	.031-2	031-2	.031-2	.031-2	.031-2
H-23655	031-.750	031-.750	.031-.750	031-.750	.031-.750

*Must be ordered in multiples of two sheets. Contact local Westinghouse representative for additional sheet size availability.

Check with factory on availability of thicknesses greater than shown.

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Angles, channels and zees

Materials used for angles, channels, and zees are the same as those used for Micarta Industrial Plate. Refer to Industrial Plate section, for application information.

NEMA requirements are not applicable to angles, channels and zees.

NWBB-0034617

	Measurement	Dimensions (inches) Minimum	Maximum
Angles	Length	—	48
	Long leg	—	9.75
	Short leg	—	3.75
	Thickness	.062	.500*
Channels	Length	—	48
	Inside width	.250	9.0
	Over-all depth	—	5.750
	Thickness	.062	.250
Zees	Length	—	35
	Inside depth	1.750	9.625
	Leg dimension	.250	2.625
	Thickness	.125	.250

Right angle may vary from 90° by plus or minus 5° because of distortion. Twist and warp may be 3% of the length for 1/16-inch to 1/8-inch thickness and 1.5% for 1/8-inch to 1/4-inch thickness. Tolerances on leg length is ±1/64-inch.

*Grade 262 can be obtained up to 1-inch thick with 1/8-inch radius on ID.

All channels have 1/64-inch inside and outside radius.

Channels with an inside width dimension greater than 1" will have a .05 inch maximum high ridge formed by resin binder. If undesirable, a note should be added to orders to remove ridge.

Nominal thickness (inches)	Tolerance (inches)	
Grade	213 219 254 429	259-2 286 281 400 496 H-12426 H-22033 238 221 H-17825 262 H-23842
1/16	±.015	±.015
1/8	±.016	±.020
3/16	±.020	±.024
1/4	±.024	±.030

Tolerance of Sanded Plate

Nominal thickness (inches)	Thickness tolerance (inches)			
	Fine weave cloth Paper		Medium and coarse weave cloth Glass	
	Sanded one side	Sanded both sides	Sanded one side	Sanded both sides
.031 to .060	±.003	±.002	±.005	±.003
.061 to .125	±.004	±.003	±.006	±.004
.126 to .250	±.005	±.004	±.007	±.005
.251 to .375	±.0055	±.0045	±.0075	±.006
.376 to .500	±.006	±.005	±.0075	±.007
.501 to .625	±.0065	±.0055	±.008	±.0075
.626 to .750	±.0075	±.0065	±.010	±.0085
.751 to .875	±.009	±.007	±.011	±.0095
.876 to 1.000	±.010	±.0075	±.012	±.010
1.001 to 2.000	±.018	±.015	±.018	±.015

NOTE If tighter tolerances are required contact division.

Molded rods

Materials used for molded rod are the same as those used for Micarta industrial plate. Refer to the Industrial Plate section for application information.

NEMA requirements for physical properties are guaranteed for molded rods.

Grade	NEMA	Standard lengths (inches)				Finish	
		Diameter (inches)				Standard*	Special‡
		.125 to .187	.188 to 1.00	1.01 to 2.375	2.376 to 4.00		
281		†	36	48	†	Ground	Oil, wax or varnish
213, 423	X	†	36	48	†	Ground	Oil, wax, or varnish
219, 429	XX	12	36	48	†	Ground	Oil, wax, or varnish
221, 431	LE	†	36	48	†	Ground	Oil, wax, or varnish
254	XXX	†	36	48	†	Ground	Oil, wax, or varnish
259-2	G-5	†	36	48	†	Ground	—
262 H-26000	C	†	36	48	36	Ground	Oil, wax, or varnish
286 496 H-24721, 51F33	CE	†	36	48	†	Ground	Oil, wax, or varnish
238	L	†	36	48	†	Ground	Oil, wax, or varnish
H-17825	G-7	†	†	36§	†	Ground	—
H-23842	G-11	†	36	48	†	Ground	—
H-22033	G-10	†	36	48**	†	Ground	—
H-12426	G-9	†	36	48	†	Ground	—

*Rods larger than 2.375 inches diameter machined from plate. Must utilize full sheet in all grades except 262.
†Not available
‡Wax or varnish finish, when specified, at 10% increase in price; oil finish at no increase in price
§H-17825 available only in diameters ¾ inch through 2 inches, in lengths of 36 inches, machined from plate stock only. Must utilize full sheet.
**H-22033 available up to and including 1¾-inch diameter. H-23842 is a G-11 material, but only G-10 properties are guaranteed.

Tolerances—Molded Rod

Rod diameter (inches)	Diameter tolerance (inches)	Length tolerance (inches)			
		Rod length (inches)			
		Up to 3	3 to 6	6 to 12	Over 12
125 to 1.999	± .005	± .010	± .010	± .015	± .032
2.00 to 4.00	± .008	± .010	± .015	± .020	± .032

HWBB-0034618

Sales Offices

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