Designation: B388 – 06 (Reapproved 2012)

Standard Specification for Thermostat Metal Sheet and Strip[1]

This standard is issued under the fixed designation B388; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers thermostat metals in the form of sheet or strip that are used for the temperature-sensitive elements of devices for controlling, compensating, or indicating temperature and is intended to supply acceptance requirements to purchasers ordering this material by type designation.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B63 Test Method for Resistivity of Metallically Conducting Resistance and Contact Materials

B106 Test Methods for Flexivity of Thermostat Metals

B223 Test Method for Modulus of Elasticity of Thermostat Metals (Cantilever Beam Method)

B362 Test Method for Mechanical Torque Rate of Spiral Coils of Thermostat Metal

B389 Test Method for Thermal Deflection Rate of Spiral and Helical Coils of Thermostat Metal

B478 Test Method for Cross Curvature of Thermostat Metals

B753 Specification for Thermostat Component Alloys

C351 Test Method for Mean Specific Heat of Thermal Insulation (Withdrawn 2008)[3]

E92 Test Method for Vickers Hardness of Metallic Materials (Withdrawn 2010)[3]

E384 Test Method for Knoop and Vickers Hardness of Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *thermostat metal, n*—a composite material comprising two or more metallic layers of differing coefficients of thermal expansion such that the radius of curvature of the composite changes with temperature change.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Type designation (Table 1 and Table 2),

4.1.2 Thickness (see 9.1),

4.1.3 Width (see 9.2),

4.1.4 Temper (designated as percent cold reduction as needed),

4.1.5 Marking to identify vendor, type, high-expansion side or low-expansion side,

4.1.6 Weight.

5. Material Segregation

5.1 The thermostat metal shall be supplied segregated into two groups after slitting: (*1*) the burr on the low-expansive component, and (*2*) the burr on the high-expansive component. These two groups shall be identified and packaged separately or together as mutually agreed upon between the producer and the user.

6. Chemical Composition

6.1 The nominal composition of component materials is given in Table 1.

6.1.1 The component alloys shall be as specified in Specification B753.

7. Component Ratio

7.1 The typical thickness ratio of the component materials is given in Table 1. The component thickness ratios are given for

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.10 on Thermostat Metals and Electrical Resistance Heating Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

TABLE 1 Composition

NOTE 1—TM6 and TM7 are no longer manufactured due to availability, difficulty to produce, commercial interest, or combinations thereof.

			ASTM Type						
		Element	TM1	TM2	TM3	TM4	TM5	TM8	TM9
Nominal chemical composition, weight,%	high-expansive component	nickel	22	10	25	25	25	10	22
		chromium	3	...	8.5	8.5	8.5	...	3
		manganese	...	72	...	...	...	72	...
		copper	...	18	...	...	...	18	...
		iron	75	...	66.5	66.5	66.5	...	75
		aluminum	...	...	...	...	...	...	...
		carbon	...	...	...	...	...	...	...
	intermediate component	nickel	...	...	...	...	...	...	100
		manganese	...	...	...	...	...	...	...
	low-expansive component	nickel	36	36	42	45	50	36	36
		iron	64	64	58	55	50	64	64
		cobalt	...	...	...	...	...	...	...
Component ratio, thickness, %	high-expansive component		50	53	50	50	50	80	27
	intermediate component		...	...	...	...	...	...	46
	low-expansive component		50	47	50	50	50	20	27

			ASTM Type						
		Element	TM10	TM11	TM12	TM13	TM14	TM15	TM16
Nominal chemical composition, weight,%	high-expansive component	nickel	22	22	22	22	22	22	22
		chromium	3	3	3	3	3	3	3
		manganese	...	...	...	...	...	...	...
		copper	...	...	...	...	...	...	...
		iron	75	75	75	75	75	75	75
		aluminum	...	...	...	...	...	...	...
		carbon	...	...	...	...	...	...	...
	intermediate component	nickel	100	100	100	100	100	100	100
		manganese	...	...	...	...	...	...	...
	low-expansive component	nickel	36	36	36	36	36	36	36
		iron	64	64	64	64	64	64	64
		cobalt	...	...	...	...	...	...	...
Component ratio, thickness, %	high-expansive component		34	36	40	42	44	47	48
	intermediate component		32	28	20	16	12	6	4
	low-expansive component		34	36	40	42	44	47	48

		Element	ASTM Type						
			TM17	TM18	TM19	TM20	TM21	TM22	TM23
Nominal chemical composition, weight,%	high-expansive component	nickel	22	19.4	19.4	18	18	100	10
		chromium	3	2.25	2.25	11.5	11.5	...	...
		manganese	...	...	...	...	...	...	72
		copper	...	...	...	...	...	...	18
		iron	75	78.3	78.3	70.5	70.5	...	...
		aluminum	...	...	...	...	...	...	...
		carbon	...	0.5	0.5	...	...	...	...
	intermediate component	nickel	100	...	...	...	...	...	...
		manganese	...	...	...	...	...	...	...
	low-expansive component	nickel	36	42	39	36	42	36	42
		iron	64	58	61	64	58	64	58
		cobalt	...	...	...	...	...	...	...
Component ratio, thickness,%	high-expansive component		49	50	50	50	50	50	54
	intermediate component		2	...	...	...	...	...	...
	low-expansive component		49	50	50	50	50	50	46

			ASTM Type						
		Element	TM24	TM25	TM26	TM27	TM28	TM29	TM30
Nominal chemical composition, weight, %	high-expansive component	nickel	22	22	22	22	22	20	22
		chromium	3	3	3	3	3	...	3
		manganese	...	...	...	...	...	6.5	...
		copper	...	...	...	...	...	...	...
		iron	75	75	75	75	75	73.5	75
		aluminum	...	...	...	...	...	...	...
		carbon	...	...	...	...	...	...	...

TABLE 1 *Continued*

		Element	ASTM Type						
			TM24	TM25	TM26	TM27	TM28	TM29	TM30
	intermediate component	copper	100	100	100	100	100	...	...
		manganese	...	...	...	...	...	...	...
	low-expansive component	nickel	36	36	36	36	36	36	42
		iron	64	64	64	64	64	64	58
		cobalt	...	...	...	...	...	...	...

		ASTM Type						
		TM24	TM25	TM26	TM27	TM28	TM29	TM30
	resistivity ohm cir mil/ft	20	30	50	70	90	477	415
Component ratio, thickness, %	high-expansive component	10	20	31	38	42	50	50
	intermediate component	53	35	20	14	10	...	...
	low-expansive component	37	45	49	48	48	50	50

		Element	ASTM Type					
			TM31	TM32	TM33	TM34	TM35	TM36
Nominal chemical composition, weight, %	high-expansive component	nickel	10	10	10	10	19	25
		chromium	...	...	...	...	2	8
		manganese	72	72	72	72	...	...
		copper	18	18	18	18	...	...
		iron	...	...	...	...	79	67
		aluminum	...	...	...	...	...	...
		carbon	...	...	...	...	...	...
	intermediate component	copper	100	100	100	100	...	...
		manganese	...	...	...	...	...	...
	low-expansive component	nickel	36	36	36	36	36	36
		iron	64	64	64	64	64	64
		cobalt	...	...	...	...	...	...

		ASTM Type					
		TM31	TM32	TM33	TM34	TM35	TM36
	resistivity ohm cir mil/ft	30	150	50	70	482	500
Component ratio, thickness, %	high-expansive component	26	50	42	45	50	50
	intermediate component	38	6	21	15	...	...
	low-expansive component	36	44	37	40	50	50

reference as they are lot-to-lot variable to produce required flexivity and resistivity. Barrier(s) layer(s) for stability of resistivity is (are) allowable. Flexivity may vary.

8. Physical Requirements

8.1 *Maximum Sensitivity Range*—The temperature ranges of maximum thermal response of designated types of thermostat metals are given in Table 2 and Table 3. These are nominal values presented only to aid users in designing devices.

8.2 *Maximum Recommended Temperature*—The maximum recommended temperatures of use of designated types of thermostat metals are given in Table 2 and Table 3. These values are presented to aid users in designing devices.

8.3 *Flexivity*—The flexivity of a designated thermostat metal shall conform to the values in Table 2 and Table 3. Component materials designated in Specification B753 shall, in thermostat metal combinations, yield product in conformance with the values designated in Table 2 and Table 3.

8.3.1 Flexivity shall be determined by Test Methods B106, Method A.

8.3.2 Residual stress loading can affect flexivity test results. Specimens shall be stabilized prior to testing by stress relief for 1 h at 500°F (260°C). Suitable stress relief conditions must be determined for individual end use applications. Initial condition recommendations are given in Table 2.

8.4 *Electrical Resistivity*—The electrical resistivity shall conform to the values given in Table 2 and Table 3. Component materials designated in Specification B753 shall, in thermostat metal combinations, yield product in conformance with the values designated in Table 2 and Table 3.

8.4.1 Electrical resistivity shall be determined by Test Method B63 at 75°F (24°C).

8.5 *Modulus of Elasticity*—The nominal moduli of elasticity of designated thermostat metals at a temperature of 75°F (24°C) are given in Table 2 and Table 3. These are nominal values presented to aid users in designing devices and shall not be used for rejection or acceptance purposes.

8.5.1 Modulus of elasticity shall be determined by Test Method B223.

TABLE 2 Properties of Thermostat Metals (Inch-Pound Units)

NOTE 1—TM6 and TM7 are no longer manufactured due to availability, difficulty to produce, commercial interest, or combinations thereof.

Properties	Units	ASTM Type						
		TM1	TM2	TM3	TM4	TM5	TM8	TM9
Maximum sensitivity temperature range	°F	0 to 300	0 to 400	200 to 600	250 to 700	300 to 850	0 to 400	0 to 300
Maximum recommended temperature	°F	1000	500	1000	1000	1000	500	900
Flexivity × 10^{-6}	50 to 200°F	15.0 ± 5 %	21.7 ± 5 %	10.4 ± 6 %	8.6 ± 6 %	6.4 ± 6 %	15.6 ± 8 %	11.5 ± 10 %
	100 to 300°F	14.6 ± 5 %	21.1 ± 5 %	10.6 ± 6 %	9.0 ± 6 %	6.6 ± 6 %	15.6 ± 8 %	11.2 ± 10 %
Heat treatment	°F	700	500	700	700	700	500	700
Electrical resistivity at	Ω·cmil/ft	475 ± 4 %	675 ± 5 %	435 ± 4 %	400 ± 4 %	345 ± 5 %	850 ± 5 %	100 ± 5.5 %
75°F	Ω·mil^2/ft	373 ± 4 %	530 ± 5 %	342 ± 4 %	314 ± 4 %	271 ± 5 %	66 8 ± 5 %	78 ± 5.5 %
Modulus of elasticity	psi × 10^6	25	20	25	25	25.5	19.5	26
Density	lb/$in.^3$	0.29	0.28	0.29	0.29	0.29	0.27	0.31
		TM10	TM11	TM12	TM13	TM14	TM15	TM16
Maximum sensitivity temperature range	°F	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300
Maximum recommended temperature	°F	900	900	900	900	900	900	900
Flexivity × 10^{-6}	50 to 200°F	13.1 ± 6 %	13.2 ± 6 %	13.7± 5.5 %	14.0 ± 5.5 %	14.7 ± 5.5 %	14.8 ± 5.5 %	14.9 ± 5.5 %
	100 to 300°F	12.7 ± 6 %	13.3 ± 6 %	13.7 ± 5.5 %	14.0 ± 5.5 %	14.3 ± 5.5 %	14.4 ± 5.5 %	14.6 ± 5.5 %
Heat treatment	°F	700	700	700	700	700	700	700
Electrical resistivity at	Ω·cmil/ft	125 ± 5.5 %	150 ± 5.5 %	175 ± 5.5 %	200 ± 5.5 %	250 ± 5.5 %	300 ± 5.5 %	350 ± 5.5 %
75°F	Ω·mil^2/ft	98 ± 5.5 %	118 ± 5.5 %	137 ± 5.5 %	157 ± 5.5 %	196 ± 5.5 %	236 ± 5.5 %	275± 5.5 %
Modulus of elasticity	psi × 10^6	26	26	25.5	25.5	25.5	25	25
Density	lb/$in.^3$	0.30	0.30	0.30	0.30	0.30	0.30	0.29
		TM17	TM18	TM19	TM20	TM21	TM22	TM23
Maximum sensitivity temperature range	°F	0 to 300	200 to 600	150 to 450	0 to 300	200 to 600	0 to 300	200 to 600
Maximum recommended temperature	°F	900	900	900	900	900	900	500
Flexivity × 10^{-6}	50 to 200°F	15.0 ± 5.5 %	11.9 ± 7 %	14.4 ± 7 %	13.8 ± 5 %	10.7 ± 7 %	10.2 ± 5 %	18.3 ± 5 %
	100 to 300°F	14.6 ± 5.5 %	11.9 ± 7 %	14.1 ± 7 %	13.5 ± 5 %	10.9 ± 7 %	10.2 ± 5 %	18.6± 5 %
Heat treatment	°F	700	700	700	700	700	700	500
Electrical resistivity at	Ω·cmil/ft	400 ± 5.5 %	420 ± 4 %	456 ± 5 %	479 ± 4 %	418 ± 4 %	92 ± 6 %	565 ± 4 %
75°F	Ω·mil^2/ft	314 ± 5.5 %	330 ± 4 %	358 ± 5 %	376 ± 4 %	328 ± 4 %	72 ± 6 %	444 ± 4 %
Modulus of elasticity	psi × 10^6	25	25	25	25	25	26	20
Density	lb/$in.^3$	0.29	0.29	0.29	0.29	0.29	0.31	0.28
		TM24	TM25	TM26	TM27	TM28	TM29	TM30
Maximum sensitivity temperature range	°F	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300	200 to 600
Maximum recommended temperature	°F	500	500	500	500	500	1000	1000
Flexivity × 10^{-6}	50 to 200°F	13.1 ± 5 %	14.0 ± 5 %	14.7 ± 5 %	14.7 ± 5 %	14.8 ± 5 %	15.8 ± 6 %	11.8 ± 6 %
	100 to 300°F	12.9 ± 5 %	13.6 ± 5 %	14.2 ± 5 %	14. 4± 5 %	14.6 ± 5 %	15.6 ± 6 %	12.2 ± 6 %
Heat treatment	°F	500	500	500	500	500	700	700
Electrical resistivity at	Ω·cmil/ft	20 ± 10 %	30 ± 7.5 %	50 ± 7.5 %	70 ± 7.5 %	90 ± 5 %	477 ± 4 %	415 ± 4 %
75°F	Ω·mil^2/ft	15.7 ± 10 %	23.6 ± 7.5 %	39.3 ± 7.5 %	55± 7.5 %	70.6 ± 5 %	375 ± 4 %	326 ± 4 %
Modulus of elasticity	psi × 10^6	24	24	23	23	22	25	25
Density	lb/$in.^3$	0.29	0.29	0.29	0.29	0.29	0.29	0.29

		TM31	TM32	TM33	TM34	TM35	TM36
Maximum sensitivity temperature range	°F	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300	0 to 300
Maximum recommended temperature	°F	500	500	500	500	900	900
Flexivity × 10^{-6}	50 to 200°F	18.9 ± 5 %	21.7 ± 5 %	20.8 ± 5 %	21.4 ± 5 %	15.2 ± 7 %	13.7 ± 5 %
	100 to 300°F	18.7 ± 5 %	20.8 ± 5 %	20.1 ± 5 %	20.3 ± 5 %	14.9 ± 7 %	13.3 ± 5 %
Heat treatment	°F	500	500	500	500	700	700
Electrical resistivity at	Ω·cmil/ft	30 ± 10 %	150 ± 5 %	50 ± 10 %	70 ± 8 %	482 ± 4 %	500 ± 4 %
75°F	Ω·mil^2/ft	23.6 ± 10 %	117.8 ± 5 %	39.3 ± 10 %	55	378.6 ± 4 %	392.7 ± 4 %
Modulus of elasticity	psi × 10^6	19	19	19	19	25	24
Density	lb/$in.^3$	0.30	0.30	0.29	0.29	0.29	0.29

8.6 *Specific Heat*—The nominal specific heat of the designated thermostat metals is 0.12 BTU/lb°F (500 J/kg°K). This nominal value is presented to aid users in designing devices and shall not be used for rejection or acceptance purposes.

8.6.1 The specific heat shall be determined by Test Method C351.

8.7 *Density*—The nominal densities of designated thermostat metals are given in Table 2 and Table 3. These are nominal values presented to aid users in designing devices and shall not be used for rejection or acceptance purposes.

8.8 *Hardness*—The hardness of the components of a designated thermostat metal shall conform to those specifications established by the producer and shall be as mutually agreed upon between the producer and the user. In the case of three or more components, the hardness of the outer components only are determined.

TABLE 3 Properties of Thermostat Metals (SI Units)

NOTE 1—TM6 and TM7 are no longer manufactured due to availability, difficulty to produce, commercial interest, or combinations thereof.

Properties	Units	ASTM Type						
		TM1	TM2	TM3	TM4	TM5	TM8	TM9
Maximum sensitivity temperature range	°C	−18 to 149	−18 to 204	93 to 316	121 to 371	149 to 454	−18 to 204	−18 to 149
Maximum recommended temperature	°C	538	260	538	538	538	260	482
Flexivity × 10^{-6}	10 to 93°C	27.0 ± 5 %	39.1 ± 5 %	18.7 ± 6 %	15.5 ± 6 %	11.5 ± 6 %	28.1 ± 8 %	20.7 ± 10 %
	38 to 149°C	26.3 ± 5 %	38.0 ± 5 %	19.1 ± 6 %	16.2 ± 6 %	11.9 ± 6 %	28.1 ± 8 %	20.2 ± 10 %
Heat treatment	°C	371	260	371	371	371	260	371
Electrical resistivity at 25°C	μΩ·m	0.790 ± 4 %	1.12 ± 5 %	0.732 ± 4 %	0.665 ± 4 %	0.573 ± 5 %	1.41 ± 5 %	0.166 ± 5.5 %
Modulus of elasticity	MPa	172 000	141 000	172 000	172 000	176 000	134 000	179 000
Density	kg/m^3	8030	7750	8030	8030	8030	7470	8580
		TM10	TM11	TM12	TM13	TM14	TM15	TM16
Maximum sensitivity temperature range	°C	−18 to 149	−18 to 149	−18 to 149	−18 to 149	−18 to 149	−18 to 149	−18 to 149
Maximum recommended temperature	°C	482	482	482	482	482	482	482
Flexivity × 10^{-6}	10 to 93°C	23.6 ± 6 %	23.8 ± 6 %	24.7 ± 5.5 %	25.2 ± 5.5 %	26.5 ± 5.5 %	26.6 ± 5.5 %	26.3 ± 5.5 %
	38 to 149°C	22.9 ± 6 %	23.9 ± 6 %	24.7 ± 5.5 %	25.2 ± 5.5 %	25.7 ± 5.5 %	25.9 ± 5.5 %	26.1 ± 5.5 %
Heat treatment	°C	371	371	371	371	371	371	371
Electrical resistivity at 25°C	μΩ·m	0.208 ± 5.5 %	0.249 ±5.5 %	0.291 ± 5.5 %	0.332 ±5.5 %	0.416 ± 5.5 %	0.499 ± 5.5 %	0.582 ± 5.5 %
Modulus of elasticity	MPa	179 000	179 000	176 000	176 000	176 000	172 000	172 000
Density	kg/m^3	8300	8300	8300	8300	8300	8300	8030
		TM17	TM18	TM19	TM20	TM21	TM22	TM23
Maximum sensitivity temperature range	°C	−18 to 149	93 to 316	65 to 232	−18 to 149	93 to 316	−18 to 149	93 to 316
Maximum recommended temperature	°C	482	482	482	482	482	482	260
Flexivity × 10^{-6}	10 to 93°C	27.0 ± 5.5 %	21.4 ± 7 %	25.9 ± 7 %	24.8± 5 %	19.3 ± 7 %	18.4± 5 %	32.9 ± 5 %
	38 to 149°C	26.3 ± 5.5 %	21.4 ± 7 %	25.4 ± 7 %	24.3 ± 5 %	19.6 ± 7 %	18.4 ± 5 %	33.5 ± 5 %
Heat treatment	°C	371	371	371	371	371	371	260
Electrical resistivity at 25°C	μΩ·m	0.665 ± 5.5 %	0.698 ± 4 %	0.758 ± 5 %	0.796 ± 4 %	0.694 ± 4 %	0.153 ± 6 %	0.939 ± 4 %
Modulus of elasticity	MPa	172 000	172 000	172 000	172 000	172 000	179 000	138 000
Density	kg/m^3	8030	8030	8030	8030	8030	8580	7750
		TM24	TM25	TM26	TM27	TM28	TM29	TM30
Maximum sensitivity temperature range	°C	−18 to 149	−18 to 149	−18 to 149	−18 to 149	−18 to 149	−18 to 149	93 to 316
Maximum recommended temperature	°C	260	260	260	260	260	538	538
Flexivity × 10^{-6}	10 to 93°C	23.0 ± 5 %	25.0 ± 5 %	26.3 ± 5 %	26.5 ± 5 %	26.6 ± 5 %	28.44 ± 6 %	21.24 ± 6 %
	38 to 149°C	22.7 ± 5 %	24.3 ± 5 %	25.7 ± 5 %	26.7 ± 5 %	26.3 ± 5 %	28.1 ± 6 %	22.0 ± 6 %
Heat treatment	°C	260	260	260	260	260	371	371
Electrical resistivity at 25°C	μΩ·m	.0333 ± 10 %	.050 ± 7.5 %	.083 ± 7.5 %	.116 ± 7.5 %	.150 ± 5 %	.793 ± 4 %	.690 ± 4 %
Modulus of elasticity	MPa	165 000	165 000	158 000	158 000	151 000	172 000	172 000
Density	kg/m^3	8030	8030	8030	8030	8030	8030	8030

		TM31	TM32	TM33	TM34	TM35	TM36
Maximum sensitivity temperature range	°C	−18 to 149	−18 to 149	−18 to 149	−18 to 149	...	...
Maximum recommended temperature	°C	260	260	260	260	371	371
Flexivity × 10^{-6}	10 to 93°C	34.0 ± 5 %	39.1 ± 5 %	37.4 ± 5 %	38.5 ± 5 %	27.4 ± 7 %	24.7 ± 5 %
	38 to 149°C	33.7 ± 5 %	37.4 ± 5 %	36.2 ± 5 %	36.5 ± 5 %	26.8 ± 7 %	23.9 ± 5 %
Heat treatment	°C	260	260	260	260	371	371
Electrical resistivity at 25°C	μΩ·m	.050 ± 10 %	.249 ± 5 %	0.83 ± 10 %	.116 ± 8 %	.802 ± 4 %	.832 ± 4 %
Modulus of elasticity	MPa						
Density	kg/m^3	8300	8030	8030	8030	8030	8030

8.8.1 The hardness shall be determined by Test Method E92, when test loads of 1 kgf (9.8 N) or higher are used. For thinner materials requiring the use of test loads less than 1 kgf, hardness shall be determined by Test Method E384.

8.8.1.1 When using Test Method E384, the preferred unit of measurement shall be Vickers hardness (HV) as defined in the formulae definition of that method.

8.8.1.2 When testing thermostat metals, the thickness of an individual component shall be at least one and one-half times the diagonal length of the hardness indenter impression.

8.8.1.3 The center of the impression shall not be closer to any edge of test specimen or to another impression than a distance equal to two and one-half times the length of diagonal of the impression. When laminated material is tested, a bond

interface shall be considered as an edge for spacing of indentation calculations.

9. Dimensions and Permissible Variations

9.1 *Thickness*—The thickness shall be that specified in the purchase order or drawing and the tolerance shall be as specified in Table 4.

9.2 *Width*—The width shall be that specified in the purchase order or drawing and the tolerance shall be as specified in Tables 5 and 6.

9.3 *Coils*—Material furnished in the form of coils shall be supplied as mutually agreed upon between the producer and the user. The inner diameter and the outer diameter or the inner diameter and the maximum or minimum weight may be specified. As mutually agreed upon between the producer and the user a specified maximum percentage may be supplied less than the minimum outer diameter or weight specified.

9.3.1 *Welds*—Welds used to provide single continuous lengths necessary to meet coil size or weight specifications shall be clearly identified as established by the producer or as mutually agreed upon between the producer and the user. The welds shall be to the material dimensions or smaller. A minimum length between welds may be specified.

9.4 *Camber*—Camber is a longitudinal deviation from a straight line measured as a chord height. The camber shall not exceed 9/32 in. (7.1 mm) maximum chord height in a 3-ft (0.91-m) length.

9.5 *Cross Curvature*—Cross curvature is a deviation from flat at 75°F (24°C) across the width and is measured as a chord height. The cross curvature tolerance shall be as mutually agreed to between the producer and the user.

9.5.1 The cross curvature shall be determined by Test Method B478.

9.6 *Flatness*—The maximum deviation (expressed as a chord height) from flat at 75°F (25°C) shall be: Chord height, in. = 0.0005/t where t = thickness of material, in. Chord height, mm = 0.323/t where t = thickness of material, mm. This equation applies to chord length of 3 in. (76 mm).

10. Bond

10.1 The bond between the component materials shall be strong and complete over the entire area of the sheet or strip.

11. Workmanship, Finish, and Appearance

11.1 The surface of the material shall be free of cracks, seams, laps, scratches, blisters, rust, or other defects detrimental to the performance of the material or to the manufacture of parts therefrom. Surface of strip at welds for continuous coils shall be reasonably free of the above defects, but not to the extent specified on the balance of the material surface.

TABLE 4 Permissible Variations in Thickness of Sheet or Strip

Thickness		Tolerances, plus and minus	
in.	mm	in.	mm
Under 0.005	Under 0.1	0.00030	0.008
0.005 to 0.0099, incl	0.1 to 0.25, incl	0.00035	0.009
0.010 to 0.0149, incl	0.25 to 0.38, incl	0.0004	0.010
0.015 to 0.0199, incl	0.38 to 0.51, incl	0.0005	0.013
0.020 and over	0.51 and over		2.5 %

TABLE 5 Permissible Variations in Width of Sheet or Strip

Width		Tolerances, plus and minus	
in.	mm	in.	mm
Up to ½ , incl	12.7, incl	0.003	0.08
Over ½ to 1, incl	12.7 to 25.4, incl	0.004	0.10
Over 1 to 3, incl	25.4 to 76.2, incl	0.008	0.20
Over 3	Over 76.2	0.010	0.25

TABLE 6 Permissible Variations in Flat Lengths of Sheet or Strip

Length	Tolerance	
	in.	mm
Up to 1 ft (30.48 cm)	±1/32	±0.8
Over 1 to 4 ft incl (30.48 to 121.92 cm incl)	±1/16	±1.6
Over 4 to 12 ft incl (121.92 cm to 3.66 m incl)	+½	+ 12.7
	−1/16	−1.6

12. Edges

12.1 The edges of a thermostat metal product shall be as slit with burr less than 10 % of metal thickness.

13. Identification

13.1 Identification of the thermostat metal sheet or strip by means of repetitive characters or patterns shall be as mutually agreed upon between the producer and the user. Any marking shall be over the entire length and width preferably on the low-expansion side with a durable and legible etching stain.

14. Sampling

14.1 The producer shall assign a lot number to each lot for identification and traceability. The lot shall be one continuous bonding sequence for which component alloy heat numbers shall be documented.

14.2 The lot shall be sampled for certification at one representative location.

15. Precision and Bias

15.1 Precision has been incorporated by reference to specified measurement methods.

15.2 Bias was not detected in round-robin measurements of flexivity and electrical resistivity.

16. Inspection

16.1 Inspection shall be for conformance to this specification. Other inspection parameters shall be as agreed upon between the producer and the user.

17. Rejection

17.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer promptly and in writing. Rejection disputes shall be resolved by agreement between the producer and the user.

18. Certification

18.1 When specified by the user, a producer's certification shall be furnished to the user that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. A report of the test results shall be furnished as required.

19. Marking

19.1 Each box or package of material shall be plainly marked with the following information:

19.1.1 Purchase order number,

19.1.2 Net weight of material,

19.1.3 ASTM type designation,

19.1.4 Manufacturer's type of material,

19.1.5 Manufacturer's name,

19.1.6 User's specification number.

20. Packaging

20.1 The thermostat metal shall be packaged in such a manner as to prevent damage in ordinary handling and transportation. Each individual size and type of material shall be packaged separately.

21. Keywords

21.1 elastic modulus; flexivity; material specification; physical properties; resistivity