



Designation: E1751/E1751M – 09^{ε1}

Standard Guide for Temperature Electromotive Force (emf) Tables for Non- Letter Designated Thermocouple Combinations¹

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^{ε1} NOTE—Units information and designation was corrected editorially in June 2009.

1. Scope

1.1 This guide consists of reference tables that give temperature-electromotive force (emf) relationships for special purpose, limited use, thermocouple combinations that do not have a letter designation.

1.2 Extension wire or compensating extension wires are not covered by this guide. ASTM MNL 12² or thermocouple alloy suppliers should be consulted.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards*:³

E344 Terminology Relating to Thermometry and Hydrometry

E696 Specification for Tungsten-Rhenium Alloy Thermocouple Wire

3. Terminology

3.1 *Definitions*:

3.1.1 For definitions of terms used in this guide see Terminology E344.

3.2 *Definitions of Terms Specific to This Standard*:

¹ This guide is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.04 on Thermocouples.

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² “Manual on the Use of Thermocouples in Temperature Measurement,” *ASTM Manual*, 12, ASTM, 1993.

³ 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.

3.2.1 *matched pairs, n*—a set of positive and negative thermoelements chosen so that a thermocouple fabricated from these thermoelements will match a specified temperature-electromotive force relationship to within a specified tolerance, at the time of first use.

4. Source of Data

4.1 The data in these tables are based on the SI Volt and the International Temperature Scale of 1990.

4.2 All temperature–electromotive force data in Tables 1-20 have been developed from NIST, NRC, and wire manufacturers’ data.

4.3 Tables 1-16 give emf values in millivolts to three decimal places (1 μ V) at 1 °C or 1 °F intervals. Tables 17-20 give emf values in microvolts to one decimal place (0.1 μ V) at 1 °C or 1 °F intervals. If greater precision is required, refer to the equation and coefficients listed for each thermocouple alloy.

5. Significance and Use

5.1 These thermocouple combinations have been developed for specific applications by the wire manufacturer(s). If additional information is required, consult ASTM MNL 12 or one of the following thermocouple manufacturers: Carpenter Technology, Engelhard Corp. Specialty Metals Div., Hoskins Mfg. Co., Johnson Matthey, Sigmund Cohn Corp.

6. Thermocouple Types

6.1 Letter symbols have not been assigned. Identification is made by alloy composition with the thermoelectrically positive material listed first.

6.1.1 Tungsten versus tungsten–26 % rhenium.

6.1.2 Tungsten–3 % rhenium versus tungsten–25 % rhenium.

6.1.3 Platinel II.⁴

6.1.4 KP versus gold–0.07 % iron.⁵

⁴ Trademark of Engelhard Corp., Specialty Metals Division.

⁵ Alloy compositions are expressed in percentages by mass, except for the gold–0.07 % iron alloy, which is given in atomic percent.

- 6.1.5 Platinum–5 % molybdenum versus platinum–0.1 % molybdenum.
- 6.1.6 Platinum–40 % rhodium versus platinum–20 % rhodium.
- 6.1.7 Nickel–18 % molybdenum versus nickel–0.8 % cobalt.⁶
- 6.1.8 Iridium–40 % rhodium versus iridium.
- 6.1.9 Gold versus platinum.
- 6.1.10 Platinum versus palladium.

- Table 13 Nickel–18 % Molybdenum versus Nickel–0.8 % Cobalt –50 °C to 1410 °C
- Table 14 Nickel–18 % Molybdenum versus Nickel–0.8 % Cobalt –58 °F to 2570 °F
- Table 15 Iridium 40 % Rhodium versus Iridium 0 °C to 2110 °C
- Table 16 Iridium 40 % Rhodium versus Iridium 32 °F to 3830 °F
- Table 17 Gold versus Platinum 0 °C to 1000 °C
- Table 18 Gold versus Platinum 32 °F to 1832 °F
- Table 19 Platinum versus Palladium 0 °C to 1500 °C
- Table 20 Platinum versus Palladium 32 °F to 2732 °F
- Table 21 Polynomial Coefficients for the Computation of Temperatures in °C or °F as a Function of Thermocouple emf

7. Tolerances on Initial Values of emf versus Temperature

7.1 Tolerances on initial values of emf versus temperature have not been established for the thermocouples in this guide except for the Tungsten–3 % Rhenium versus Tungsten–25 % Rhenium, and that data can be found in Specification E696. When required, tolerances on initial values of emf versus temperature should be established by agreement between the consumer and the producer. These thermocouple combinations are supplied typically as matched pairs.

8. Table Information

8.1 The following is a list of emf versus temperature tables included in this guide.

Table Number	Thermocouple Type	Temperature Range
Table 1	Tungsten versus Tungsten–26 % Rhenium	0 °C to 2315 °C
Table 2	Tungsten versus Tungsten–26 % Rhenium	32 °F to 4200 °F
Table 3	Tungsten–3 % Rhenium versus Tungsten–25 % Rhenium	0 °C to 2315 °C
Table 4	Tungsten–3 % Rhenium versus Tungsten–25 % Rhenium	32 °F to 4200 °F
Table 5	Platinel II	0 °C to 1395 °C
Table 6	Platinel II	32 °F to 2543 °F
Table 7	KP versus Gold–0.07 % Iron	–273 °C to 7 °C
Table 8	KP versus Gold–0.07 % Iron	–459 °F to 44 °F
Table 9	Platinum–5 % Molybdenum versus Platinum–0.1 % Molybdenum	0 °C to 1600 °C
Table 10	Platinum–5 % Molybdenum versus Platinum–0.1 % Molybdenum	32 °F to 2912 °F
Table 11	Platinum–40 % Rhodium versus Platinum–20 % Rhodium	0 °C to 1888 °C
Table 12	Platinum–40 % Rhodium versus Platinum–20 % Rhodium	32 °F to 3430 °F

8.2 Tables 1-20 were derived from equations of the form:

$$E = c_0 + c_1T + c_2T^2 + \dots c_nT^n \tag{1}$$

where:

- E = the emf in millivolts (except for Tables 17-20 where E is in microvolts), and
- T = the temperature in °C or °F. The coefficients used to calculate each table are given at the end of the table.

8.3 Table 21 gives coefficients of inverse equations that may be used to compute approximate values of temperature (T) in either °C or °F for each thermocouple combination. The inverse equations are of the form:

$$T = b_0 + b_1E + b_2E^2 + \dots b_nE^n \tag{2}$$

except for the gold versus platinum thermocouple in the ranges 209 °C to 1000 °C (408.2 °F to 1832 °F), where the inverse equation is of the form:

$$T = b_0 + \sum_{i=1}^{11} b_i \left(\frac{E - 9645}{7620} \right)^i \tag{3}$$

For these equations, the thermocouple emf (E) is in units of millivolts, except for gold versus platinum and platinum versus palladium thermocouples, for which the emf is in units of microvolts.

8.3.1 Table 21 also gives the temperature range, emf range, and error range of each inverse equation.

9. Keywords

9.1 cobalt; coefficients; gold; iridium; iron; molybdenum; nickel; palladium; platinel; platinum; polynomial; rhenium; rhodium; thermocouple; tungsten

⁶ Nickel–18 % molybdenum versus nickel 0.8 % cobalt is supplied by Carpenter Technology as 20 alloy and 19 alloy.

TABLE 1 Tungsten versus Tungsten–26 % Rhenium Thermocouples—Thermoelectric Voltage as a Function of Temperature (°C), Reference Junctions at 0 °C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
Thermoelectric Voltage in Millivolts												
0	0.000	0.001	0.003	0.004	0.005	0.007	0.008	0.010	0.012	0.013	0.015	0
10	0.015	0.017	0.018	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.034	10
20	0.034	0.036	0.038	0.041	0.043	0.045	0.048	0.050	0.053	0.055	0.058	20
30	0.058	0.060	0.063	0.065	0.068	0.071	0.074	0.076	0.079	0.082	0.085	30
40	0.085	0.088	0.091	0.094	0.097	0.100	0.104	0.107	0.110	0.113	0.117	40
50	0.117	0.120	0.123	0.127	0.130	0.134	0.138	0.141	0.145	0.148	0.152	50
60	0.152	0.156	0.160	0.164	0.168	0.172	0.175	0.179	0.184	0.188	0.192	60
70	0.192	0.196	0.200	0.204	0.209	0.213	0.217	0.222	0.226	0.231	0.235	70
80	0.235	0.240	0.244	0.249	0.254	0.258	0.263	0.268	0.273	0.277	0.282	80
90	0.282	0.287	0.292	0.297	0.302	0.307	0.312	0.318	0.323	0.328	0.333	90
100	0.333	0.339	0.344	0.349	0.355	0.360	0.366	0.371	0.377	0.382	0.388	100

TABLE 1 *Continued*

°C	0	1	2	3	4	5	6	7	8	9	10	°C
Thermoelectric Voltage in Millivolts												
110	0.388	0.394	0.399	0.405	0.411	0.417	0.422	0.428	0.434	0.440	0.446	110
120	0.446	0.452	0.458	0.464	0.471	0.477	0.483	0.489	0.495	0.502	0.508	120
130	0.508	0.514	0.521	0.527	0.534	0.540	0.547	0.553	0.560	0.567	0.573	130
140	0.573	0.580	0.587	0.594	0.601	0.607	0.614	0.621	0.628	0.635	0.642	140
150	0.642	0.649	0.656	0.664	0.671	0.678	0.685	0.693	0.700	0.707	0.715	150
160	0.715	0.722	0.729	0.737	0.744	0.752	0.760	0.767	0.775	0.782	0.790	160
170	0.790	0.798	0.806	0.813	0.821	0.829	0.837	0.845	0.853	0.861	0.869	170
180	0.869	0.877	0.885	0.893	0.902	0.910	0.918	0.926	0.935	0.943	0.951	180
190	0.951	0.960	0.968	0.976	0.985	0.993	1.002	1.011	1.019	1.028	1.037	190
200	1.037	1.045	1.054	1.063	1.072	1.080	1.089	1.098	1.107	1.116	1.125	200
210	1.125	1.134	1.143	1.152	1.161	1.170	1.180	1.189	1.198	1.207	1.217	210
220	1.217	1.226	1.235	1.245	1.254	1.264	1.273	1.283	1.292	1.302	1.311	220
230	1.311	1.321	1.331	1.340	1.350	1.360	1.369	1.379	1.389	1.399	1.409	230
240	1.409	1.419	1.429	1.439	1.449	1.459	1.469	1.479	1.489	1.499	1.509	240
250	1.509	1.520	1.530	1.540	1.550	1.561	1.571	1.582	1.592	1.602	1.613	250
260	1.613	1.623	1.634	1.644	1.655	1.666	1.676	1.687	1.698	1.708	1.719	260
270	1.719	1.730	1.741	1.752	1.762	1.773	1.784	1.795	1.806	1.817	1.828	270
280	1.828	1.839	1.850	1.862	1.873	1.884	1.895	1.906	1.918	1.929	1.940	280
290	1.940	1.951	1.963	1.974	1.986	1.997	2.009	2.020	2.032	2.043	2.055	290
300	2.055	2.066	2.078	2.090	2.101	2.113	2.125	2.136	2.148	2.160	2.172	300
310	2.172	2.184	2.196	2.208	2.219	2.231	2.243	2.255	2.267	2.280	2.292	310
320	2.292	2.304	2.316	2.328	2.340	2.353	2.365	2.377	2.389	2.402	2.414	320
330	2.414	2.426	2.439	2.451	2.464	2.476	2.489	2.501	2.514	2.526	2.539	330
340	2.539	2.552	2.564	2.577	2.590	2.602	2.615	2.628	2.641	2.653	2.666	340
350	2.666	2.679	2.692	2.705	2.718	2.731	2.744	2.757	2.770	2.783	2.796	350
360	2.796	2.809	2.822	2.836	2.849	2.862	2.875	2.888	2.902	2.915	2.928	360
370	2.928	2.942	2.955	2.968	2.982	2.995	3.009	3.022	3.036	3.049	3.063	370
380	3.063	3.076	3.090	3.104	3.117	3.131	3.145	3.158	3.172	3.186	3.200	380
390	3.200	3.214	3.227	3.241	3.255	3.269	3.283	3.297	3.311	3.325	3.339	390
400	3.339	3.353	3.367	3.381	3.395	3.409	3.423	3.438	3.452	3.466	3.480	400
410	3.480	3.494	3.509	3.523	3.537	3.552	3.566	3.580	3.595	3.609	3.624	410
420	3.624	3.638	3.653	3.667	3.682	3.696	3.711	3.725	3.740	3.755	3.769	420
430	3.769	3.784	3.799	3.813	3.828	3.843	3.858	3.872	3.887	3.902	3.917	430
440	3.917	3.932	3.947	3.962	3.977	3.992	4.007	4.022	4.037	4.052	4.067	440
450	4.067	4.082	4.097	4.112	4.127	4.142	4.158	4.173	4.188	4.203	4.219	450
460	4.219	4.234	4.249	4.264	4.280	4.295	4.311	4.326	4.341	4.357	4.372	460
470	4.372	4.388	4.403	4.419	4.434	4.450	4.465	4.481	4.497	4.512	4.528	470
480	4.528	4.544	4.559	4.575	4.591	4.606	4.622	4.638	4.654	4.670	4.685	480
490	4.685	4.701	4.717	4.733	4.749	4.765	4.781	4.797	4.813	4.829	4.845	490
500	4.845	4.861	4.877	4.893	4.909	4.925	4.941	4.957	4.974	4.990	5.006	500
510	5.006	5.022	5.038	5.055	5.071	5.087	5.104	5.120	5.136	5.153	5.169	510
520	5.169	5.185	5.202	5.218	5.235	5.251	5.267	5.284	5.300	5.317	5.334	520
530	5.334	5.350	5.367	5.383	5.400	5.416	5.433	5.450	5.466	5.483	5.500	530
540	5.500	5.517	5.533	5.550	5.567	5.584	5.600	5.617	5.634	5.651	5.668	540
550	5.668	5.685	5.702	5.718	5.735	5.752	5.769	5.786	5.803	5.820	5.837	550
560	5.837	5.854	5.871	5.888	5.906	5.923	5.940	5.957	5.974	5.991	6.008	560
570	6.008	6.026	6.043	6.060	6.077	6.095	6.112	6.129	6.146	6.164	6.181	570
580	6.181	6.198	6.216	6.233	6.250	6.268	6.285	6.303	6.320	6.338	6.355	580
590	6.355	6.373	6.390	6.408	6.425	6.443	6.460	6.478	6.495	6.513	6.531	590
600	6.531	6.548	6.566	6.583	6.601	6.619	6.636	6.654	6.672	6.690	6.707	600
610	6.707	6.725	6.743	6.761	6.778	6.796	6.814	6.832	6.850	6.868	6.886	610
620	6.886	6.903	6.921	6.939	6.957	6.975	6.993	7.011	7.029	7.047	7.065	620
630	7.065	7.083	7.101	7.119	7.137	7.155	7.173	7.191	7.210	7.228	7.246	630
640	7.246	7.264	7.282	7.300	7.319	7.337	7.355	7.373	7.391	7.410	7.428	640
650	7.428	7.446	7.465	7.483	7.501	7.519	7.538	7.556	7.575	7.593	7.611	650
660	7.611	7.630	7.648	7.667	7.685	7.703	7.722	7.740	7.759	7.777	7.796	660
670	7.796	7.814	7.833	7.852	7.870	7.889	7.907	7.926	7.944	7.963	7.982	670
680	7.982	8.000	8.019	8.038	8.056	8.075	8.094	8.113	8.131	8.150	8.169	680
690	8.169	8.187	8.206	8.225	8.244	8.263	8.281	8.300	8.319	8.338	8.357	690
700	8.357	8.376	8.395	8.414	8.432	8.451	8.470	8.489	8.508	8.527	8.546	700

TABLE 1 *Continued*

°C	0	1	2	3	4	5	6	7	8	9	10	°C
Thermoelectric Voltage in Millivolts												
710	8.546	8.565	8.584	8.603	8.622	8.641	8.660	8.679	8.698	8.717	8.737	710
720	8.737	8.756	8.775	8.794	8.813	8.832	8.851	8.870	8.890	8.909	8.928	720
730	8.928	8.947	8.966	8.986	9.005	9.024	9.043	9.063	9.082	9.101	9.120	730
740	9.120	9.140	9.159	9.178	9.198	9.217	9.236	9.256	9.275	9.295	9.314	740
750	9.314	9.333	9.353	9.372	9.392	9.411	9.430	9.450	9.469	9.489	9.508	750
760	9.508	9.528	9.547	9.567	9.586	9.606	9.625	9.645	9.665	9.684	9.704	760
770	9.704	9.723	9.743	9.763	9.782	9.802	9.821	9.841	9.861	9.880	9.900	770
780	9.900	9.920	9.939	9.959	9.979	9.998	10.018	10.038	10.058	10.077	10.097	780
790	10.097	10.117	10.137	10.156	10.176	10.196	10.216	10.236	10.256	10.275	10.295	790
800	10.295	10.315	10.335	10.355	10.375	10.395	10.414	10.434	10.454	10.474	10.494	800
810	10.494	10.514	10.534	10.554	10.574	10.594	10.614	10.634	10.654	10.674	10.694	810
820	10.694	10.714	10.734	10.754	10.774	10.794	10.814	10.834	10.854	10.874	10.894	820
830	10.894	10.914	10.934	10.954	10.974	10.995	11.015	11.035	11.055	11.075	11.095	830
840	11.095	11.115	11.136	11.156	11.176	11.196	11.216	11.236	11.257	11.277	11.297	840
850	11.297	11.317	11.338	11.358	11.378	11.398	11.419	11.439	11.459	11.479	11.500	850
860	11.500	11.520	11.540	11.561	11.581	11.601	11.622	11.642	11.662	11.683	11.703	860
870	11.703	11.723	11.744	11.764	11.784	11.805	11.825	11.845	11.866	11.886	11.907	870
880	11.907	11.927	11.948	11.968	11.988	12.009	12.029	12.050	12.070	12.091	12.111	880
890	12.111	12.132	12.152	12.173	12.193	12.214	12.234	12.255	12.275	12.296	12.316	890
900	12.316	12.337	12.357	12.378	12.398	12.419	12.439	12.460	12.481	12.501	12.522	900
910	12.522	12.542	12.563	12.583	12.604	12.625	12.645	12.666	12.686	12.707	12.728	910
920	12.728	12.748	12.769	12.790	12.810	12.831	12.852	12.872	12.893	12.914	12.934	920
930	12.934	12.955	12.976	12.996	13.017	13.038	13.058	13.079	13.100	13.121	13.141	930
940	13.141	13.162	13.183	13.204	13.224	13.245	13.266	13.287	13.307	13.328	13.349	940
950	13.349	13.370	13.390	13.411	13.432	13.453	13.474	13.494	13.515	13.536	13.557	950
960	13.557	13.578	13.598	13.619	13.640	13.661	13.682	13.702	13.723	13.744	13.765	960
970	13.765	13.786	13.807	13.828	13.848	13.869	13.890	13.911	13.932	13.953	13.974	970
980	13.974	13.995	14.015	14.036	14.057	14.078	14.099	14.120	14.141	14.162	14.183	980
990	14.183	14.204	14.225	14.245	14.266	14.287	14.308	14.329	14.350	14.371	14.392	990
1000	14.392	14.413	14.434	14.455	14.476	14.497	14.518	14.539	14.560	14.581	14.602	1000
1010	14.602	14.623	14.644	14.665	14.686	14.707	14.728	14.749	14.770	14.791	14.812	1010
1020	14.812	14.833	14.854	14.875	14.896	14.917	14.938	14.959	14.980	15.001	15.022	1020
1030	15.022	15.043	15.064	15.085	15.106	15.127	15.148	15.169	15.190	15.211	15.232	1030
1040	15.232	15.253	15.274	15.295	15.316	15.337	15.359	15.380	15.401	15.422	15.443	1040
1050	15.443	15.464	15.485	15.506	15.527	15.548	15.569	15.590	15.611	15.633	15.654	1050
1060	15.654	15.675	15.696	15.717	15.738	15.759	15.780	15.801	15.822	15.844	15.865	1060
1070	15.865	15.886	15.907	15.928	15.949	15.970	15.991	16.012	16.034	16.055	16.076	1070
1080	16.076	16.097	16.118	16.139	16.160	16.181	16.202	16.224	16.245	16.266	16.287	1080
1090	16.287	16.308	16.329	16.350	16.372	16.393	16.414	16.435	16.456	16.477	16.498	1090
1100	16.498	16.520	16.541	16.562	16.583	16.604	16.625	16.646	16.668	16.689	16.710	1100
1110	16.710	16.731	16.752	16.773	16.794	16.816	16.837	16.858	16.879	16.900	16.921	1110
1120	16.921	16.943	16.964	16.985	17.006	17.027	17.048	17.069	17.091	17.112	17.133	1120
1130	17.133	17.154	17.175	17.196	17.218	17.239	17.260	17.281	17.302	17.323	17.345	1130
1140	17.345	17.366	17.387	17.408	17.429	17.450	17.471	17.493	17.514	17.535	17.556	1140
1150	17.556	17.577	17.598	17.620	17.641	17.662	17.683	17.704	17.725	17.747	17.768	1150
1160	17.768	17.789	17.810	17.831	17.852	17.874	17.895	17.916	17.937	17.958	17.979	1160
1170	17.979	18.000	18.022	18.043	18.064	18.085	18.106	18.127	18.149	18.170	18.191	1170
1180	18.191	18.212	18.233	18.254	18.275	18.297	18.318	18.339	18.360	18.381	18.402	1180
1190	18.402	18.423	18.445	18.466	18.487	18.508	18.529	18.550	18.571	18.593	18.614	1190
1200	18.614	18.635	18.656	18.677	18.698	18.719	18.741	18.762	18.783	18.804	18.825	1200
1210	18.825	18.846	18.867	18.888	18.910	18.931	18.952	18.973	18.994	19.015	19.036	1210
1220	19.036	19.057	19.078	19.100	19.121	19.142	19.163	19.184	19.205	19.226	19.247	1220
1230	19.247	19.268	19.289	19.311	19.332	19.353	19.374	19.395	19.416	19.437	19.458	1230
1240	19.458	19.479	19.500	19.521	19.543	19.564	19.585	19.606	19.627	19.648	19.669	1240
1250	19.669	19.690	19.711	19.732	19.753	19.774	19.795	19.816	19.837	19.858	19.880	1250
1260	19.880	19.901	19.922	19.943	19.964	19.985	20.006	20.027	20.048	20.069	20.090	1260
1270	20.090	20.111	20.132	20.153	20.174	20.195	20.216	20.237	20.258	20.279	20.300	1270
1280	20.300	20.321	20.342	20.363	20.384	20.405	20.426	20.447	20.468	20.489	20.510	1280
1290	20.510	20.531	20.552	20.573	20.594	20.615	20.636	20.657	20.678	20.699	20.720	1290
1300	20.720	20.741	20.762	20.783	20.804	20.824	20.845	20.866	20.887	20.908	20.929	1300

TABLE 1 *Continued*

°C	0	1	2	3	4	5	6	7	8	9	10	°C
Thermoelectric Voltage in Millivolts												
1310	20.929	20.950	20.971	20.992	21.013	21.034	21.055	21.076	21.097	21.117	21.138	1310
1320	21.138	21.159	21.180	21.201	21.222	21.243	21.264	21.285	21.305	21.326	21.347	1320
1330	21.347	21.368	21.389	21.410	21.431	21.452	21.472	21.493	21.514	21.535	21.556	1330
1340	21.556	21.577	21.597	21.618	21.639	21.660	21.681	21.702	21.722	21.743	21.764	1340
1350	21.764	21.785	21.806	21.826	21.847	21.868	21.889	21.910	21.930	21.951	21.972	1350
1360	21.972	21.993	22.014	22.034	22.055	22.076	22.097	22.117	22.138	22.159	22.180	1360
1370	22.180	22.200	22.221	22.242	22.263	22.283	22.304	22.325	22.345	22.366	22.387	1370
1380	22.387	22.408	22.428	22.449	22.470	22.490	22.511	22.532	22.552	22.573	22.594	1380
1390	22.594	22.614	22.635	22.656	22.676	22.697	22.718	22.738	22.759	22.780	22.800	1390
1400	22.800	22.821	22.841	22.862	22.883	22.903	22.924	22.945	22.965	22.986	23.006	1400
1410	23.006	23.027	23.047	23.068	23.089	23.109	23.130	23.150	23.171	23.191	23.212	1410
1420	23.212	23.233	23.253	23.274	23.294	23.315	23.335	23.356	23.376	23.397	23.417	1420
1430	23.417	23.438	23.458	23.479	23.499	23.520	23.540	23.561	23.581	23.602	23.622	1430
1440	23.622	23.643	23.663	23.683	23.704	23.724	23.745	23.765	23.786	23.806	23.826	1440
1450	23.826	23.847	23.867	23.888	23.908	23.928	23.949	23.969	23.990	24.010	24.030	1450
1460	24.030	24.051	24.071	24.091	24.112	24.132	24.152	24.173	24.193	24.213	24.234	1460
1470	24.234	24.254	24.274	24.295	24.315	24.335	24.356	24.376	24.396	24.416	24.437	1470
1480	24.437	24.457	24.477	24.498	24.518	24.538	24.558	24.578	24.599	24.619	24.639	1480
1490	24.639	24.659	24.680	24.700	24.720	24.740	24.760	24.781	24.801	24.821	24.841	1490
1500	24.841	24.861	24.881	24.902	24.922	24.942	24.962	24.982	25.002	25.022	25.042	1500
1510	25.042	25.063	25.083	25.103	25.123	25.143	25.163	25.183	25.203	25.223	25.243	1510
1520	25.243	25.263	25.283	25.303	25.324	25.344	25.364	25.384	25.404	25.424	25.444	1520
1530	25.444	25.464	25.484	25.504	25.524	25.544	25.564	25.584	25.604	25.623	25.643	1530
1540	25.643	25.663	25.683	25.703	25.723	25.743	25.763	25.783	25.803	25.823	25.843	1540
1550	25.843	25.862	25.882	25.902	25.922	25.942	25.962	25.982	26.001	26.021	26.041	1550
1560	26.041	26.061	26.081	26.101	26.120	26.140	26.160	26.180	26.200	26.219	26.239	1560
1570	26.239	26.259	26.279	26.298	26.318	26.338	26.358	26.377	26.397	26.417	26.437	1570
1580	26.437	26.456	26.476	26.496	26.515	26.535	26.555	26.574	26.594	26.614	26.633	1580
1590	26.633	26.653	26.673	26.692	26.712	26.731	26.751	26.771	26.790	26.810	26.829	1590
1600	26.829	26.849	26.869	26.888	26.908	26.927	26.947	26.966	26.986	27.005	27.025	1600
1610	27.025	27.044	27.064	27.083	27.103	27.122	27.142	27.161	27.181	27.200	27.220	1610
1620	27.220	27.239	27.259	27.278	27.297	27.317	27.336	27.356	27.375	27.394	27.414	1620
1630	27.414	27.433	27.453	27.472	27.491	27.511	27.530	27.549	27.569	27.588	27.607	1630
1640	27.607	27.627	27.646	27.665	27.685	27.704	27.723	27.742	27.762	27.781	27.800	1640
1650	27.800	27.819	27.839	27.858	27.877	27.896	27.915	27.935	27.954	27.973	27.992	1650
1660	27.992	28.011	28.031	28.050	28.069	28.088	28.107	28.126	28.145	28.164	28.184	1660
1670	28.184	28.203	28.222	28.241	28.260	28.279	28.298	28.317	28.336	28.355	28.374	1670
1680	28.374	28.393	28.412	28.431	28.450	28.469	28.488	28.507	28.526	28.545	28.564	1680
1690	28.564	28.583	28.602	28.621	28.640	28.659	28.678	28.697	28.716	28.734	28.753	1690
1700	28.753	28.772	28.791	28.810	28.829	28.848	28.866	28.885	28.904	28.923	28.942	1700
1710	28.942	28.961	28.979	28.998	29.017	29.036	29.054	29.073	29.092	29.111	29.129	1710
1720	29.129	29.148	29.167	29.186	29.204	29.223	29.242	29.260	29.279	29.298	29.316	1720
1730	29.316	29.335	29.354	29.372	29.391	29.409	29.428	29.447	29.465	29.484	29.502	1730
1740	29.502	29.521	29.539	29.558	29.577	29.595	29.614	29.632	29.651	29.669	29.688	1740
1750	29.688	29.706	29.725	29.743	29.762	29.780	29.798	29.817	29.835	29.854	29.872	1750
1760	29.872	29.891	29.909	29.927	29.946	29.964	29.982	30.001	30.019	30.038	30.056	1760
1770	30.056	30.074	30.092	30.111	30.129	30.147	30.166	30.184	30.202	30.220	30.239	1770
1780	30.239	30.257	30.275	30.293	30.312	30.330	30.348	30.366	30.384	30.403	30.421	1780
1790	30.421	30.439	30.457	30.475	30.493	30.511	30.530	30.548	30.566	30.584	30.602	1790
1800	30.602	30.620	30.638	30.656	30.674	30.692	30.710	30.728	30.746	30.764	30.782	1800
1810	30.782	30.800	30.818	30.836	30.854	30.872	30.890	30.908	30.926	30.944	30.962	1810
1820	30.962	30.980	30.997	31.015	31.033	31.051	31.069	31.087	31.105	31.122	31.140	1820
1830	31.140	31.158	31.176	31.194	31.211	31.229	31.247	31.265	31.282	31.300	31.318	1830
1840	31.318	31.336	31.353	31.371	31.389	31.406	31.424	31.442	31.459	31.477	31.495	1840
1850	31.495	31.512	31.530	31.548	31.565	31.583	31.600	31.618	31.636	31.653	31.671	1850
1860	31.671	31.688	31.706	31.723	31.741	31.758	31.776	31.793	31.811	31.828	31.846	1860
1870	31.846	31.863	31.881	31.898	31.915	31.933	31.950	31.968	31.985	32.002	32.020	1870
1880	32.020	32.037	32.054	32.072	32.089	32.106	32.124	32.141	32.158	32.176	32.193	1880
1890	32.193	32.210	32.227	32.245	32.262	32.279	32.296	32.313	32.331	32.348	32.365	1890
1900	32.365	32.382	32.399	32.417	32.434	32.451	32.468	32.485	32.502	32.519	32.536	1900

TABLE 1 *Continued*

°C	0	1	2	3	4	5	6	7	8	9	10	°C
Thermoelectric Voltage in Millivolts												
1910	32.536	32.553	32.570	32.587	32.605	32.622	32.639	32.656	32.673	32.690	32.707	1910
1920	32.707	32.724	32.741	32.758	32.774	32.791	32.808	32.825	32.842	32.859	32.876	1920
1930	32.876	32.893	32.910	32.927	32.943	32.960	32.977	32.994	33.011	33.027	33.044	1930
1940	33.044	33.061	33.078	33.095	33.111	33.128	33.145	33.162	33.178	33.195	33.212	1940
1950	33.212	33.228	33.245	33.262	33.278	33.295	33.312	33.328	33.345	33.361	33.378	1950
1960	33.378	33.395	33.411	33.428	33.444	33.461	33.477	33.494	33.510	33.527	33.543	1960
1970	33.543	33.560	33.576	33.593	33.609	33.626	33.642	33.659	33.675	33.691	33.708	1970
1980	33.708	33.724	33.741	33.757	33.773	33.790	33.806	33.822	33.839	33.855	33.871	1980
1990	33.871	33.887	33.904	33.920	33.936	33.952	33.969	33.985	34.001	34.017	34.033	1990
2000	34.033	34.050	34.066	34.082	34.098	34.114	34.130	34.146	34.163	34.179	34.195	2000
2010	34.195	34.211	34.227	34.243	34.259	34.275	34.291	34.307	34.323	34.339	34.355	2010
2020	34.355	34.371	34.387	34.403	34.419	34.435	34.451	34.467	34.482	34.498	34.514	2020
2030	34.514	34.530	34.546	34.562	34.578	34.593	34.609	34.625	34.641	34.657	34.672	2030
2040	34.672	34.688	34.704	34.720	34.735	34.751	34.767	34.782	34.798	34.814	34.829	2040
2050	34.829	34.845	34.861	34.876	34.892	34.908	34.923	34.939	34.954	34.970	34.985	2050
2060	34.985	35.001	35.016	35.032	35.047	35.063	35.078	35.094	35.109	35.125	35.140	2060
2070	35.140	35.156	35.171	35.187	35.202	35.217	35.233	35.248	35.263	35.279	35.294	2070
2080	35.294	35.309	35.325	35.340	35.355	35.371	35.386	35.401	35.416	35.432	35.447	2080
2090	35.447	35.462	35.477	35.492	35.508	35.523	35.538	35.553	35.568	35.583	35.598	2090
2100	35.598	35.613	35.629	35.644	35.659	35.674	35.689	35.704	35.719	35.734	35.749	2100
2110	35.749	35.764	35.779	35.794	35.809	35.824	35.839	35.853	35.868	35.883	35.898	2110
2120	35.898	35.913	35.928	35.943	35.958	35.972	35.987	36.002	36.017	36.032	36.046	2120
2130	36.046	36.061	36.076	36.091	36.105	36.120	36.135	36.149	36.164	36.179	36.193	2130
2140	36.193	36.208	36.223	36.237	36.252	36.266	36.281	36.296	36.310	36.325	36.339	2140
2150	36.339	36.354	36.368	36.383	36.397	36.412	36.426	36.441	36.455	36.469	36.484	2150
2160	36.484	36.498	36.513	36.527	36.541	36.556	36.570	36.584	36.599	36.613	36.627	2160
2170	36.627	36.642	36.656	36.670	36.684	36.699	36.713	36.727	36.741	36.756	36.770	2170
2180	36.770	36.784	36.798	36.812	36.826	36.840	36.855	36.869	36.883	36.897	36.911	2180
2190	36.911	36.925	36.939	36.953	36.967	36.981	36.995	37.009	37.023	37.037	37.051	2190
2200	37.051	37.065	37.079	37.092	37.106	37.120	37.134	37.148	37.162	37.176	37.189	2200
2210	37.189	37.203	37.217	37.231	37.245	37.258	37.272	37.286	37.299	37.313	37.327	2210
2220	37.327	37.341	37.354	37.368	37.381	37.395	37.409	37.422	37.436	37.449	37.463	2220
2230	37.463	37.477	37.490	37.504	37.517	37.531	37.544	37.558	37.571	37.585	37.598	2230
2240	37.598	37.611	37.625	37.638	37.652	37.665	37.678	37.692	37.705	37.718	37.732	2240
2250	37.732	37.745	37.758	37.771	37.785	37.798	37.811	37.824	37.838	37.851	37.864	2250
2260	37.864	37.877	37.890	37.903	37.917	37.930	37.943	37.956	37.969	37.982	37.995	2260
2270	37.995	38.008	38.021	38.034	38.047	38.060	38.073	38.086	38.099	38.112	38.125	2270
2280	38.125	38.138	38.151	38.163	38.176	38.189	38.202	38.215	38.228	38.240	38.253	2280
2290	38.253	38.266	38.279	38.291	38.304	38.317	38.329	38.342	38.355	38.367	38.380	2290
2300	38.380	38.393	38.405	38.418	38.431	38.443	38.456	38.468	38.481	38.493	38.506	2300
2310	38.506	38.518	38.531	38.543	38.556	38.568						2310

Coefficients and temperature ranges of equations used to compute the above ITS–90 based table for Tungsten versus Tungsten – 26% Rhenium thermocouples.

0 °C to 630.615 °C

$$\begin{aligned}
 c_0 &= 0.000\ 000\ 0 \\
 c_1 &= 1.279\ 220\ 1 \times 10^{-03} \\
 c_2 &= 2.163\ 475\ 4 \times 10^{-06} \\
 c_3 &= -1.139\ 323\ 4 \times 10^{-08} \\
 c_4 &= 4.385\ 002\ 2 \times 10^{-12} \\
 c_5 &= -1.708\ 920\ 2 \times 10^{-15}
 \end{aligned}$$

630.615 °C to 2315 °C

$$\begin{aligned}
 c_0 &= -1.106\ 441\ 2 \\
 c_1 &= 9.496\ 245\ 5 \times 10^{-03} \\
 c_2 &= -3.646\ 751\ 6 \times 10^{-06} \\
 c_3 &= 3.114\ 133\ 0 \times 10^{-08} \\
 c_4 &= -3.861\ 522\ 2 \times 10^{-11} \\
 c_5 &= 2.445\ 501\ 2 \times 10^{-14} \\
 c_6 &= -8.988\ 805\ 3 \times 10^{-18} \\
 c_7 &= 1.812\ 023\ 7 \times 10^{-21} \\
 c_8 &= -1.553\ 459\ 1 \times 10^{-25}
 \end{aligned}$$

**TABLE 2 Tungsten versus Tungsten–26 % Rhenium Thermocouples—Thermoelectric Voltage as a Function of Temperature (°F),
Reference Junctions at 32 °F**

°F	0	1	2	3	4	5	6	7	8	9	10	°F
Thermoelectric Voltage in Millivolts												
30			0.000	0.001	0.001	0.002	0.003	0.004	0.005	0.005	0.006	30
40	0.006	0.007	0.008	0.009	0.009	0.010	0.011	0.012	0.013	0.014	0.015	40
50	0.015	0.016	0.017	0.018	0.019	0.020	0.021	0.022	0.023	0.024	0.025	50
60	0.025	0.026	0.027	0.028	0.030	0.031	0.032	0.033	0.034	0.035	0.037	60
70	0.037	0.038	0.039	0.040	0.041	0.043	0.044	0.045	0.047	0.048	0.049	70
80	0.049	0.051	0.052	0.053	0.055	0.056	0.058	0.059	0.060	0.062	0.063	80
90	0.063	0.065	0.066	0.068	0.069	0.071	0.072	0.074	0.075	0.077	0.079	90
100	0.079	0.080	0.082	0.083	0.085	0.087	0.088	0.090	0.092	0.093	0.095	100
110	0.095	0.097	0.099	0.100	0.102	0.104	0.106	0.107	0.109	0.111	0.113	110
120	0.113	0.115	0.117	0.119	0.120	0.122	0.124	0.126	0.128	0.130	0.132	120
130	0.132	0.134	0.136	0.138	0.140	0.142	0.144	0.146	0.148	0.150	0.152	130
140	0.152	0.154	0.156	0.159	0.161	0.163	0.165	0.167	0.169	0.172	0.174	140
150	0.174	0.176	0.178	0.180	0.183	0.185	0.187	0.189	0.192	0.194	0.196	150
160	0.196	0.199	0.201	0.203	0.206	0.208	0.211	0.213	0.215	0.218	0.220	160
170	0.220	0.223	0.225	0.228	0.230	0.233	0.235	0.238	0.240	0.243	0.245	170
180	0.245	0.248	0.250	0.253	0.256	0.258	0.261	0.264	0.266	0.269	0.272	180
190	0.272	0.274	0.277	0.280	0.282	0.285	0.288	0.291	0.293	0.296	0.299	190
200	0.299	0.302	0.305	0.307	0.310	0.313	0.316	0.319	0.322	0.325	0.327	200
210	0.327	0.330	0.333	0.336	0.339	0.342	0.345	0.348	0.351	0.354	0.357	210
220	0.357	0.360	0.363	0.366	0.369	0.372	0.375	0.379	0.382	0.385	0.388	220
230	0.388	0.391	0.394	0.397	0.401	0.404	0.407	0.410	0.413	0.417	0.420	230
240	0.420	0.423	0.426	0.430	0.433	0.436	0.440	0.443	0.446	0.450	0.453	240
250	0.453	0.456	0.460	0.463	0.466	0.470	0.473	0.477	0.480	0.484	0.487	250
260	0.487	0.491	0.494	0.498	0.501	0.505	0.508	0.512	0.515	0.519	0.522	260
270	0.522	0.526	0.529	0.533	0.537	0.540	0.544	0.548	0.551	0.555	0.559	270
280	0.559	0.562	0.566	0.570	0.573	0.577	0.581	0.585	0.588	0.592	0.596	280
290	0.596	0.600	0.604	0.607	0.611	0.615	0.619	0.623	0.627	0.631	0.634	290
300	0.634	0.638	0.642	0.646	0.650	0.654	0.658	0.662	0.666	0.670	0.674	300
310	0.674	0.678	0.682	0.686	0.690	0.694	0.698	0.702	0.706	0.710	0.715	310
320	0.715	0.719	0.723	0.727	0.731	0.735	0.739	0.744	0.748	0.752	0.756	320
330	0.756	0.760	0.765	0.769	0.773	0.777	0.782	0.786	0.790	0.794	0.799	330
340	0.799	0.803	0.807	0.812	0.816	0.820	0.825	0.829	0.834	0.838	0.842	340
350	0.842	0.847	0.851	0.856	0.860	0.865	0.869	0.874	0.878	0.883	0.887	350
360	0.887	0.892	0.896	0.901	0.905	0.910	0.914	0.919	0.923	0.928	0.933	360
370	0.933	0.937	0.942	0.947	0.951	0.956	0.961	0.965	0.970	0.975	0.979	370
380	0.979	0.984	0.989	0.993	0.998	1.003	1.008	1.013	1.017	1.022	1.027	380
390	1.027	1.032	1.037	1.041	1.046	1.051	1.056	1.061	1.066	1.071	1.076	390
400	1.076	1.080	1.085	1.090	1.095	1.100	1.105	1.110	1.115	1.120	1.125	400
410	1.125	1.130	1.135	1.140	1.145	1.150	1.155	1.160	1.165	1.170	1.176	410
420	1.176	1.181	1.186	1.191	1.196	1.201	1.206	1.211	1.217	1.222	1.227	420
430	1.227	1.232	1.237	1.243	1.248	1.253	1.258	1.264	1.269	1.274	1.279	430
440	1.279	1.285	1.290	1.295	1.301	1.306	1.311	1.317	1.322	1.327	1.333	440
450	1.333	1.338	1.343	1.349	1.354	1.360	1.365	1.371	1.376	1.381	1.387	450
460	1.387	1.392	1.398	1.403	1.409	1.414	1.420	1.425	1.431	1.437	1.442	460
470	1.442	1.448	1.453	1.459	1.464	1.470	1.476	1.481	1.487	1.492	1.498	470
480	1.498	1.504	1.509	1.515	1.521	1.526	1.532	1.538	1.544	1.549	1.555	480
490	1.555	1.561	1.567	1.572	1.578	1.584	1.590	1.595	1.601	1.607	1.613	490
500	1.613	1.619	1.625	1.630	1.636	1.642	1.648	1.654	1.660	1.666	1.672	500
510	1.672	1.677	1.683	1.689	1.695	1.701	1.707	1.713	1.719	1.725	1.731	510
520	1.731	1.737	1.743	1.749	1.755	1.761	1.767	1.773	1.779	1.785	1.792	520
530	1.792	1.798	1.804	1.810	1.816	1.822	1.828	1.834	1.841	1.847	1.853	530
540	1.853	1.859	1.865	1.871	1.878	1.884	1.890	1.896	1.903	1.909	1.915	540
550	1.915	1.921	1.928	1.934	1.940	1.946	1.953	1.959	1.965	1.972	1.978	550
560	1.978	1.984	1.991	1.997	2.003	2.010	2.016	2.023	2.029	2.035	2.042	560
570	2.042	2.048	2.055	2.061	2.068	2.074	2.080	2.087	2.093	2.100	2.106	570
580	2.106	2.113	2.119	2.126	2.132	2.139	2.146	2.152	2.159	2.165	2.172	580
590	2.172	2.178	2.185	2.192	2.198	2.205	2.211	2.218	2.225	2.231	2.238	590

TABLE 2 *Continued*

°F	0	1	2	3	4	5	6	7	8	9	10	°F
Thermoelectric Voltage in Millivolts												
600	2.238	2.245	2.251	2.258	2.265	2.272	2.278	2.285	2.292	2.298	2.305	600
610	2.305	2.312	2.319	2.325	2.332	2.339	2.346	2.353	2.359	2.366	2.373	610
620	2.373	2.380	2.387	2.393	2.400	2.407	2.414	2.421	2.428	2.435	2.442	620
630	2.442	2.448	2.455	2.462	2.469	2.476	2.483	2.490	2.497	2.504	2.511	630
640	2.511	2.518	2.525	2.532	2.539	2.546	2.553	2.560	2.567	2.574	2.581	640
650	2.581	2.588	2.595	2.602	2.609	2.616	2.624	2.631	2.638	2.645	2.652	650
660	2.652	2.659	2.666	2.673	2.681	2.688	2.695	2.702	2.709	2.717	2.724	660
670	2.724	2.731	2.738	2.745	2.753	2.760	2.767	2.774	2.782	2.789	2.796	670
680	2.796	2.803	2.811	2.818	2.825	2.833	2.840	2.847	2.855	2.862	2.869	680
690	2.869	2.877	2.884	2.891	2.899	2.906	2.914	2.921	2.928	2.936	2.943	690
700	2.943	2.951	2.958	2.965	2.973	2.980	2.988	2.995	3.003	3.010	3.018	700
710	3.018	3.025	3.033	3.040	3.048	3.055	3.063	3.070	3.078	3.086	3.093	710
720	3.093	3.101	3.108	3.116	3.123	3.131	3.139	3.146	3.154	3.161	3.169	720
730	3.169	3.177	3.184	3.192	3.200	3.207	3.215	3.223	3.230	3.238	3.246	730
740	3.246	3.254	3.261	3.269	3.277	3.284	3.292	3.300	3.308	3.315	3.323	740
750	3.323	3.331	3.339	3.347	3.354	3.362	3.370	3.378	3.386	3.394	3.401	750
760	3.401	3.409	3.417	3.425	3.433	3.441	3.449	3.456	3.464	3.472	3.480	760
770	3.480	3.488	3.496	3.504	3.512	3.520	3.528	3.536	3.544	3.552	3.560	770
780	3.560	3.568	3.576	3.584	3.592	3.600	3.608	3.616	3.624	3.632	3.640	780
790	3.640	3.648	3.656	3.664	3.672	3.680	3.688	3.696	3.704	3.712	3.721	790
800	3.721	3.729	3.737	3.745	3.753	3.761	3.769	3.777	3.786	3.794	3.802	800
810	3.802	3.810	3.818	3.826	3.835	3.843	3.851	3.859	3.868	3.876	3.884	810
820	3.884	3.892	3.900	3.909	3.917	3.925	3.934	3.942	3.950	3.958	3.967	820
830	3.967	3.975	3.983	3.992	4.000	4.008	4.017	4.025	4.033	4.042	4.050	830
840	4.050	4.058	4.067	4.075	4.084	4.092	4.100	4.109	4.117	4.126	4.134	840
850	4.134	4.142	4.151	4.159	4.168	4.176	4.185	4.193	4.202	4.210	4.219	850
860	4.219	4.227	4.236	4.244	4.253	4.261	4.270	4.278	4.287	4.295	4.304	860
870	4.304	4.312	4.321	4.329	4.338	4.346	4.355	4.364	4.372	4.381	4.389	870
880	4.389	4.398	4.407	4.415	4.424	4.433	4.441	4.450	4.458	4.467	4.476	880
890	4.476	4.484	4.493	4.502	4.511	4.519	4.528	4.537	4.545	4.554	4.563	890
900	4.563	4.571	4.580	4.589	4.598	4.606	4.615	4.624	4.633	4.641	4.650	900
910	4.650	4.659	4.668	4.677	4.685	4.694	4.703	4.712	4.721	4.730	4.738	910
920	4.738	4.747	4.756	4.765	4.774	4.783	4.791	4.800	4.809	4.818	4.827	920
930	4.827	4.836	4.845	4.854	4.863	4.872	4.880	4.889	4.898	4.907	4.916	930
940	4.916	4.925	4.934	4.943	4.952	4.961	4.970	4.979	4.988	4.997	5.006	940
950	5.006	5.015	5.024	5.033	5.042	5.051	5.060	5.069	5.078	5.087	5.096	950
960	5.096	5.105	5.114	5.123	5.133	5.142	5.151	5.160	5.169	5.178	5.187	960
970	5.187	5.196	5.205	5.214	5.224	5.233	5.242	5.251	5.260	5.269	5.278	970
980	5.278	5.288	5.297	5.306	5.315	5.324	5.334	5.343	5.352	5.361	5.370	980
990	5.370	5.380	5.389	5.398	5.407	5.416	5.426	5.435	5.444	5.453	5.463	990
1000	5.463	5.472	5.481	5.491	5.500	5.509	5.518	5.528	5.537	5.546	5.556	1000
1010	5.556	5.565	5.574	5.584	5.593	5.602	5.612	5.621	5.630	5.640	5.649	1010
1020	5.649	5.658	5.668	5.677	5.687	5.696	5.705	5.715	5.724	5.734	5.743	1020
1030	5.743	5.752	5.762	5.771	5.781	5.790	5.800	5.809	5.818	5.828	5.837	1030
1040	5.837	5.847	5.856	5.866	5.875	5.885	5.894	5.904	5.913	5.923	5.932	1040
1050	5.932	5.942	5.951	5.961	5.970	5.980	5.989	5.999	6.008	6.018	6.027	1050
1060	6.027	6.037	6.047	6.056	6.066	6.075	6.085	6.095	6.104	6.114	6.123	1060
1070	6.123	6.133	6.143	6.152	6.162	6.171	6.181	6.191	6.200	6.210	6.220	1070
1080	6.220	6.229	6.239	6.249	6.258	6.268	6.278	6.287	6.297	6.307	6.316	1080
1090	6.316	6.326	6.336	6.345	6.355	6.365	6.374	6.384	6.394	6.404	6.413	1090
1100	6.413	6.423	6.433	6.443	6.452	6.462	6.472	6.482	6.491	6.501	6.511	1100
1110	6.511	6.521	6.531	6.540	6.550	6.560	6.570	6.580	6.589	6.599	6.609	1110
1120	6.609	6.619	6.629	6.638	6.648	6.658	6.668	6.678	6.688	6.698	6.707	1120
1130	6.707	6.717	6.727	6.737	6.747	6.757	6.767	6.777	6.786	6.796	6.806	1130
1140	6.806	6.816	6.826	6.836	6.846	6.856	6.866	6.876	6.886	6.896	6.905	1140
1150	6.905	6.915	6.925	6.935	6.945	6.955	6.965	6.975	6.985	6.995	7.005	1150
1160	7.005	7.015	7.025	7.035	7.045	7.055	7.065	7.075	7.085	7.095	7.105	1160
1170	7.105	7.115	7.125	7.135	7.145	7.155	7.165	7.175	7.185	7.196	7.206	1170
1180	7.206	7.216	7.226	7.236	7.246	7.256	7.266	7.276	7.286	7.296	7.306	1180
1190	7.306	7.317	7.327	7.337	7.347	7.357	7.367	7.377	7.387	7.398	7.408	1190

TABLE 2 *Continued*

°F	0	1	2	3	4	5	6	7	8	9	10	°F
Thermoelectric Voltage in Millivolts												
1200	7.408	7.418	7.428	7.438	7.448	7.458	7.469	7.479	7.489	7.499	7.509	1200
1210	7.509	7.519	7.530	7.540	7.550	7.560	7.570	7.581	7.591	7.601	7.611	1210
1220	7.611	7.622	7.632	7.642	7.652	7.662	7.673	7.683	7.693	7.703	7.714	1220
1230	7.714	7.724	7.734	7.745	7.755	7.765	7.775	7.786	7.796	7.806	7.816	1230
1240	7.816	7.827	7.837	7.847	7.858	7.868	7.878	7.889	7.899	7.909	7.920	1240
1250	7.920	7.930	7.940	7.951	7.961	7.971	7.982	7.992	8.002	8.013	8.023	1250
1260	8.023	8.034	8.044	8.054	8.065	8.075	8.085	8.096	8.106	8.117	8.127	1260
1270	8.127	8.137	8.148	8.158	8.169	8.179	8.190	8.200	8.210	8.221	8.231	1270
1280	8.231	8.242	8.252	8.263	8.273	8.284	8.294	8.305	8.315	8.325	8.336	1280
1290	8.336	8.346	8.357	8.367	8.378	8.388	8.399	8.409	8.420	8.430	8.441	1290
1300	8.441	8.451	8.462	8.472	8.483	8.493	8.504	8.515	8.525	8.536	8.546	1300
1310	8.546	8.557	8.567	8.578	8.588	8.599	8.610	8.620	8.631	8.641	8.652	1310
1320	8.652	8.662	8.673	8.684	8.694	8.705	8.715	8.726	8.737	8.747	8.758	1320
1330	8.758	8.768	8.779	8.790	8.800	8.811	8.821	8.832	8.843	8.853	8.864	1330
1340	8.864	8.875	8.885	8.896	8.907	8.917	8.928	8.939	8.949	8.960	8.971	1340
1350	8.971	8.981	8.992	9.003	9.013	9.024	9.035	9.045	9.056	9.067	9.078	1350
1360	9.078	9.088	9.099	9.110	9.120	9.131	9.142	9.153	9.163	9.174	9.185	1360
1370	9.185	9.196	9.206	9.217	9.228	9.239	9.249	9.260	9.271	9.282	9.292	1370
1380	9.292	9.303	9.314	9.325	9.335	9.346	9.357	9.368	9.379	9.389	9.400	1380
1390	9.400	9.411	9.422	9.433	9.443	9.454	9.465	9.476	9.487	9.498	9.508	1390
1400	9.508	9.519	9.530	9.541	9.552	9.563	9.573	9.584	9.595	9.606	9.617	1400
1410	9.617	9.628	9.638	9.649	9.660	9.671	9.682	9.693	9.704	9.715	9.725	1410
1420	9.725	9.736	9.747	9.758	9.769	9.780	9.791	9.802	9.813	9.824	9.834	1420
1430	9.834	9.845	9.856	9.867	9.878	9.889	9.900	9.911	9.922	9.933	9.944	1430
1440	9.944	9.955	9.966	9.977	9.988	9.998	10.009	10.020	10.031	10.042	10.053	1440
1450	10.053	10.064	10.075	10.086	10.097	10.108	10.119	10.130	10.141	10.152	10.163	1450
1460	10.163	10.174	10.185	10.196	10.207	10.218	10.229	10.240	10.251	10.262	10.273	1460
1470	10.273	10.284	10.295	10.306	10.317	10.328	10.339	10.350	10.361	10.372	10.383	1470
1480	10.383	10.395	10.406	10.417	10.428	10.439	10.450	10.461	10.472	10.483	10.494	1480
1490	10.494	10.505	10.516	10.527	10.538	10.549	10.561	10.572	10.583	10.594	10.605	1490
1500	10.605	10.616	10.627	10.638	10.649	10.660	10.671	10.683	10.694	10.705	10.716	1500
1510	10.716	10.727	10.738	10.749	10.760	10.772	10.783	10.794	10.805	10.816	10.827	1510
1520	10.827	10.838	10.850	10.861	10.872	10.883	10.894	10.905	10.916	10.928	10.939	1520
1530	10.939	10.950	10.961	10.972	10.983	10.995	11.006	11.017	11.028	11.039	11.051	1530
1540	11.051	11.062	11.073	11.084	11.095	11.106	11.118	11.129	11.140	11.151	11.162	1540
1550	11.162	11.174	11.185	11.196	11.207	11.219	11.230	11.241	11.252	11.263	11.275	1550
1560	11.275	11.286	11.297	11.308	11.320	11.331	11.342	11.353	11.365	11.376	11.387	1560
1570	11.387	11.398	11.410	11.421	11.432	11.443	11.455	11.466	11.477	11.488	11.500	1570
1580	11.500	11.511	11.522	11.533	11.545	11.556	11.567	11.579	11.590	11.601	11.612	1580
1590	11.612	11.624	11.635	11.646	11.658	11.669	11.680	11.692	11.703	11.714	11.725	1590
1600	11.725	11.737	11.748	11.759	11.771	11.782	11.793	11.805	11.816	11.827	11.839	1600
1610	11.839	11.850	11.861	11.873	11.884	11.895	11.907	11.918	11.929	11.941	11.952	1610
1620	11.952	11.963	11.975	11.986	11.997	12.009	12.020	12.032	12.043	12.054	12.066	1620
1630	12.066	12.077	12.088	12.100	12.111	12.123	12.134	12.145	12.157	12.168	12.179	1630
1640	12.179	12.191	12.202	12.214	12.225	12.236	12.248	12.259	12.271	12.282	12.293	1640
1650	12.293	12.305	12.316	12.328	12.339	12.350	12.362	12.373	12.385	12.396	12.407	1650
1660	12.407	12.419	12.430	12.442	12.453	12.465	12.476	12.487	12.499	12.510	12.522	1660
1670	12.522	12.533	12.545	12.556	12.567	12.579	12.590	12.602	12.613	12.625	12.636	1670
1680	12.636	12.648	12.659	12.670	12.682	12.693	12.705	12.716	12.728	12.739	12.751	1680
1690	12.751	12.762	12.774	12.785	12.797	12.808	12.819	12.831	12.842	12.854	12.865	1690
1700	12.865	12.877	12.888	12.900	12.911	12.923	12.934	12.946	12.957	12.969	12.980	1700
1710	12.980	12.992	13.003	13.015	13.026	13.038	13.049	13.061	13.072	13.084	13.095	1710
1720	13.095	13.107	13.118	13.130	13.141	13.153	13.164	13.176	13.187	13.199	13.210	1720
1730	13.210	13.222	13.234	13.245	13.257	13.268	13.280	13.291	13.303	13.314	13.326	1730
1740	13.326	13.337	13.349	13.360	13.372	13.383	13.395	13.407	13.418	13.430	13.441	1740
1750	13.441	13.453	13.464	13.476	13.487	13.499	13.510	13.522	13.534	13.545	13.557	1750
1760	13.557	13.568	13.580	13.591	13.603	13.615	13.626	13.638	13.649	13.661	13.672	1760
1770	13.672	13.684	13.696	13.707	13.719	13.730	13.742	13.753	13.765	13.777	13.788	1770
1780	13.788	13.800	13.811	13.823	13.835	13.846	13.858	13.869	13.881	13.892	13.904	1780
1790	13.904	13.916	13.927	13.939	13.950	13.962	13.974	13.985	13.997	14.009	14.020	1790

TABLE 2 *Continued*

°F	0	1	2	3	4	5	6	7	8	9	10	°F
Thermoelectric Voltage in Millivolts												
1800	14.020	14.032	14.043	14.055	14.067	14.078	14.090	14.101	14.113	14.125	14.136	1800
1810	14.136	14.148	14.159	14.171	14.183	14.194	14.206	14.218	14.229	14.241	14.252	1810
1820	14.252	14.264	14.276	14.287	14.299	14.311	14.322	14.334	14.345	14.357	14.369	1820
1830	14.369	14.380	14.392	14.404	14.415	14.427	14.439	14.450	14.462	14.474	14.485	1830
1840	14.485	14.497	14.508	14.520	14.532	14.543	14.555	14.567	14.578	14.590	14.602	1840
1850	14.602	14.613	14.625	14.637	14.648	14.660	14.672	14.683	14.695	14.707	14.718	1850
1860	14.718	14.730	14.742	14.753	14.765	14.777	14.788	14.800	14.812	14.823	14.835	1860
1870	14.835	14.847	14.858	14.870	14.882	14.893	14.905	14.917	14.928	14.940	14.952	1870
1880	14.952	14.963	14.975	14.987	14.998	15.010	15.022	15.033	15.045	15.057	15.069	1880
1890	15.069	15.080	15.092	15.104	15.115	15.127	15.139	15.150	15.162	15.174	15.185	1890
1900	15.185	15.197	15.209	15.220	15.232	15.244	15.256	15.267	15.279	15.291	15.302	1900
1910	15.302	15.314	15.326	15.337	15.349	15.361	15.373	15.384	15.396	15.408	15.419	1910
1920	15.419	15.431	15.443	15.455	15.466	15.478	15.490	15.501	15.513	15.525	15.536	1920
1930	15.536	15.548	15.560	15.572	15.583	15.595	15.607	15.618	15.630	15.642	15.654	1930
1940	15.654	15.665	15.677	15.689	15.701	15.712	15.724	15.736	15.747	15.759	15.771	1940
1950	15.771	15.783	15.794	15.806	15.818	15.829	15.841	15.853	15.865	15.876	15.888	1950
1960	15.888	15.900	15.912	15.923	15.935	15.947	15.958	15.970	15.982	15.994	16.005	1960
1970	16.005	16.017	16.029	16.041	16.052	16.064	16.076	16.087	16.099	16.111	16.123	1970
1980	16.123	16.134	16.146	16.158	16.170	16.181	16.193	16.205	16.217	16.228	16.240	1980
1990	16.240	16.252	16.264	16.275	16.287	16.299	16.310	16.322	16.334	16.346	16.357	1990
2000	16.357	16.369	16.381	16.393	16.404	16.416	16.428	16.440	16.451	16.463	16.475	2000
2010	16.475	16.487	16.498	16.510	16.522	16.534	16.545	16.557	16.569	16.581	16.592	2010
2020	16.592	16.604	16.616	16.628	16.639	16.651	16.663	16.675	16.686	16.698	16.710	2020
2030	16.710	16.722	16.733	16.745	16.757	16.769	16.780	16.792	16.804	16.816	16.827	2030
2040	16.827	16.839	16.851	16.863	16.874	16.886	16.898	16.910	16.921	16.933	16.945	2040
2050	16.945	16.957	16.968	16.980	16.992	17.004	17.015	17.027	17.039	17.051	17.062	2050
2060	17.062	17.074	17.086	17.098	17.109	17.121	17.133	17.145	17.156	17.168	17.180	2060
2070	17.180	17.192	17.203	17.215	17.227	17.239	17.250	17.262	17.274	17.286	17.298	2070
2080	17.298	17.309	17.321	17.333	17.345	17.356	17.368	17.380	17.392	17.403	17.415	2080
2090	17.415	17.427	17.439	17.450	17.462	17.474	17.486	17.497	17.509	17.521	17.533	2090
2100	17.533	17.544	17.556	17.568	17.580	17.591	17.603	17.615	17.627	17.638	17.650	2100
2110	17.650	17.662	17.674	17.685	17.697	17.709	17.721	17.732	17.744	17.756	17.768	2110
2120	17.768	17.780	17.791	17.803	17.815	17.827	17.838	17.850	17.862	17.874	17.885	2120
2130	17.885	17.897	17.909	17.921	17.932	17.944	17.956	17.968	17.979	17.991	18.003	2130
2140	18.003	18.015	18.026	18.038	18.050	18.062	18.073	18.085	18.097	18.109	18.120	2140
2150	18.120	18.132	18.144	18.156	18.167	18.179	18.191	18.203	18.214	18.226	18.238	2150
2160	18.238	18.250	18.261	18.273	18.285	18.297	18.308	18.320	18.332	18.344	18.355	2160
2170	18.355	18.367	18.379	18.391	18.402	18.414	18.426	18.438	18.449	18.461	18.473	2170
2180	18.473	18.485	18.496	18.508	18.520	18.532	18.543	18.555	18.567	18.579	18.590	2180
2190	18.590	18.602	18.614	18.625	18.637	18.649	18.661	18.672	18.684	18.696	18.708	2190
2200	18.708	18.719	18.731	18.743	18.755	18.766	18.778	18.790	18.802	18.813	18.825	2200
2210	18.825	18.837	18.849	18.860	18.872	18.884	18.895	18.907	18.919	18.931	18.942	2210
2220	18.942	18.954	18.966	18.978	18.989	19.001	19.013	19.025	19.036	19.048	19.060	2220
2230	19.060	19.071	19.083	19.095	19.107	19.118	19.130	19.142	19.154	19.165	19.177	2230
2240	19.177	19.189	19.200	19.212	19.224	19.236	19.247	19.259	19.271	19.282	19.294	2240
2250	19.294	19.306	19.318	19.329	19.341	19.353	19.364	19.376	19.388	19.400	19.411	2250
2260	19.411	19.423	19.435	19.446	19.458	19.470	19.482	19.493	19.505	19.517	19.528	2260
2270	19.528	19.540	19.552	19.564	19.575	19.587	19.599	19.610	19.622	19.634	19.646	2270
2280	19.646	19.657	19.669	19.681	19.692	19.704	19.716	19.727	19.739	19.751	19.763	2280
2290	19.763	19.774	19.786	19.798	19.809	19.821	19.833	19.844	19.856	19.868	19.880	2290
2300	19.880	19.891	19.903	19.915	19.926	19.938	19.950	19.961	19.973	19.985	19.996	2300
2310	19.996	20.008	20.020	20.031	20.043	20.055	20.067	20.078	20.090	20.102	20.113	2310
2320	20.113	20.125	20.137	20.148	20.160	20.172	20.183	20.195	20.207	20.218	20.230	2320
2330	20.230	20.242	20.253	20.265	20.277	20.288	20.300	20.312	20.323	20.335	20.347	2330
2340	20.347	20.358	20.370	20.382	20.393	20.405	20.417	20.428	20.440	20.452	20.463	2340
2350	20.463	20.475	20.487	20.498	20.510	20.522	20.533	20.545	20.557	20.568	20.580	2350
2360	20.580	20.592	20.603	20.615	20.627	20.638	20.650	20.661	20.673	20.685	20.696	2360
2370	20.696	20.708	20.720	20.731	20.743	20.755	20.766	20.778	20.790	20.801	20.813	2370
2380	20.813	20.824	20.836	20.848	20.859	20.871	20.883	20.894	20.906	20.918	20.929	2380
2390	20.929	20.941	20.952	20.964	20.976	20.987	20.999	21.011	21.022	21.034	21.045	2390

TABLE 2 *Continued*

°F	0	1	2	3	4	5	6	7	8	9	10	°F
Thermoelectric Voltage in Millivolts												
3600	33.744	33.753	33.762	33.771	33.781	33.790	33.799	33.808	33.817	33.826	33.835	3600
3610	33.835	33.844	33.853	33.862	33.871	33.880	33.889	33.898	33.907	33.916	33.925	3610
3620	33.925	33.934	33.943	33.952	33.961	33.970	33.979	33.988	33.997	34.006	34.015	3620
3630	34.015	34.024	34.033	34.042	34.051	34.060	34.069	34.078	34.087	34.096	34.105	3630
3640	34.105	34.114	34.123	34.132	34.141	34.150	34.159	34.168	34.177	34.186	34.195	3640
3650	34.195	34.204	34.213	34.222	34.230	34.239	34.248	34.257	34.266	34.275	34.284	3650
3660	34.284	34.293	34.302	34.311	34.319	34.328	34.337	34.346	34.355	34.364	34.373	3660
3670	34.373	34.382	34.390	34.399	34.408	34.417	34.426	34.435	34.444	34.452	34.461	3670
3680	34.461	34.470	34.479	34.488	34.497	34.505	34.514	34.523	34.532	34.541	34.549	3680
3690	34.549	34.558	34.567	34.576	34.585	34.593	34.602	34.611	34.620	34.629	34.637	3690
3700	34.637	34.646	34.655	34.664	34.672	34.681	34.690	34.699	34.707	34.716	34.725	3700
3710	34.725	34.734	34.742	34.751	34.760	34.768	34.777	34.786	34.795	34.803	34.812	3710
3720	34.812	34.821	34.829	34.838	34.847	34.855	34.864	34.873	34.881	34.890	34.899	3720
3730	34.899	34.908	34.916	34.925	34.933	34.942	34.951	34.959	34.968	34.977	34.985	3730
3740	34.985	34.994	35.003	35.011	35.020	35.029	35.037	35.046	35.054	35.063	35.072	3740
3750	35.072	35.080	35.089	35.097	35.106	35.115	35.123	35.132	35.140	35.149	35.157	3750
3760	35.157	35.166	35.175	35.183	35.192	35.200	35.209	35.217	35.226	35.234	35.243	3760
3770	35.243	35.251	35.260	35.269	35.277	35.286	35.294	35.303	35.311	35.320	35.328	3770
3780	35.328	35.337	35.345	35.354	35.362	35.371	35.379	35.388	35.396	35.404	35.413	3780
3790	35.413	35.421	35.430	35.438	35.447	35.455	35.464	35.472	35.481	35.489	35.497	3790
3800	35.497	35.506	35.514	35.523	35.531	35.540	35.548	35.556	35.565	35.573	35.582	3800
3810	35.582	35.590	35.598	35.607	35.615	35.623	35.632	35.640	35.649	35.657	35.665	3810
3820	35.665	35.674	35.682	35.690	35.699	35.707	35.715	35.724	35.732	35.740	35.749	3820
3830	35.749	35.757	35.765	35.774	35.782	35.790	35.799	35.807	35.815	35.824	35.832	3830
3840	35.832	35.840	35.848	35.857	35.865	35.873	35.882	35.890	35.898	35.906	35.915	3840
3850	35.915	35.923	35.931	35.939	35.948	35.956	35.964	35.972	35.981	35.989	35.997	3850
3860	35.997	36.005	36.013	36.022	36.030	36.038	36.046	36.054	36.063	36.071	36.079	3860
3870	36.079	36.087	36.095	36.104	36.112	36.120	36.128	36.136	36.144	36.153	36.161	3870
3880	36.161	36.169	36.177	36.185	36.193	36.201	36.210	36.218	36.226	36.234	36.242	3880
3890	36.242	36.250	36.258	36.266	36.275	36.283	36.291	36.299	36.307	36.315	36.323	3890
3900	36.323	36.331	36.339	36.347	36.355	36.363	36.371	36.380	36.388	36.396	36.404	3900
3910	36.404	36.412	36.420	36.428	36.436	36.444	36.452	36.460	36.468	36.476	36.484	3910
3920	36.484	36.492	36.500	36.508	36.516	36.524	36.532	36.540	36.548	36.556	36.564	3920
3930	36.564	36.572	36.580	36.588	36.596	36.604	36.612	36.619	36.627	36.635	36.643	3930
3940	36.643	36.651	36.659	36.667	36.675	36.683	36.691	36.699	36.707	36.715	36.722	3940
3950	36.722	36.730	36.738	36.746	36.754	36.762	36.770	36.778	36.785	36.793	36.801	3950
3960	36.801	36.809	36.817	36.825	36.833	36.840	36.848	36.856	36.864	36.872	36.880	3960
3970	36.880	36.887	36.895	36.903	36.911	36.919	36.926	36.934	36.942	36.950	36.958	3970
3980	36.958	36.965	36.973	36.981	36.989	36.996	37.004	37.012	37.020	37.028	37.035	3980
3990	37.035	37.043	37.051	37.058	37.066	37.074	37.082	37.089	37.097	37.105	37.113	3990
4000	37.113	37.120	37.128	37.136	37.143	37.151	37.159	37.166	37.174	37.182	37.189	4000
4010	37.189	37.197	37.205	37.212	37.220	37.228	37.235	37.243	37.251	37.258	37.266	4010
4020	37.266	37.274	37.281	37.289	37.296	37.304	37.312	37.319	37.327	37.334	37.342	4020
4030	37.342	37.350	37.357	37.365	37.372	37.380	37.388	37.395	37.403	37.410	37.418	4030
4040	37.418	37.425	37.433	37.440	37.448	37.456	37.463	37.471	37.478	37.486	37.493	4040
4050	37.493	37.501	37.508	37.516	37.523	37.531	37.538	37.546	37.553	37.561	37.568	4050
4060	37.568	37.576	37.583	37.590	37.598	37.605	37.613	37.620	37.628	37.635	37.643	4060
4070	37.643	37.650	37.658	37.665	37.672	37.680	37.687	37.695	37.702	37.709	37.717	4070
4080	37.717	37.724	37.732	37.739	37.746	37.754	37.761	37.768	37.776	37.783	37.791	4080
4090	37.791	37.798	37.805	37.813	37.820	37.827	37.835	37.842	37.849	37.857	37.864	4090
4100	37.864	37.871	37.879	37.886	37.893	37.900	37.908	37.915	37.922	37.930	37.937	4100
4110	37.937	37.944	37.951	37.959	37.966	37.973	37.980	37.988	37.995	38.002	38.009	4110
4120	38.009	38.017	38.024	38.031	38.038	38.046	38.053	38.060	38.067	38.074	38.082	4120
4130	38.082	38.089	38.096	38.103	38.110	38.118	38.125	38.132	38.139	38.146	38.153	4130
4140	38.153	38.161	38.168	38.175	38.182	38.189	38.196	38.203	38.210	38.218	38.225	4140
4150	38.225	38.232	38.239	38.246	38.253	38.260	38.267	38.274	38.281	38.289	38.296	4150
4160	38.296	38.303	38.310	38.317	38.324	38.331	38.338	38.345	38.352	38.359	38.366	4160
4170	38.366	38.373	38.380	38.387	38.394	38.401	38.408	38.415	38.422	38.429	38.436	4170

TABLE 2 *Continued*

°F	0	1	2	3	4	5	6	7	8	9	10	°F
Thermoelectric Voltage in Millivolts												
4180	38.436	38.443	38.450	38.457	38.464	38.471	38.478	38.485	38.492	38.499	38.506	4180
4190	38.506	38.513	38.520	38.527	38.534	38.540	38.547	38.554	38.561	38.568	38.575	4190
4200	38.575											4200

Coefficients and temperature ranges of equations used to compute the above ITS–90 based table for Tungsten versus Tungsten – 26% Rhenium thermocouples.

32 °F to 1167.107 °F	1167.107 °F to 4200 °F
$c_0 = -1.583\ 958\ 522 \times 10^{-02}$ $c_1 = 2.772\ 681\ 020 \times 10^{-04}$ $c_2 = 6.867\ 532\ 076 \times 10^{-06}$ $c_3 = -2.007\ 966\ 008 \times 10^{-09}$ $c_4 = 4.321\ 850\ 871 \times 10^{-13}$ $c_5 = -9.043\ 972\ 880 \times 10^{-17}$	$c_0 = -1.276\ 594\ 726$ $c_1 = 5.364\ 619\ 207 \times 10^{-03}$ $c_2 = -1.661\ 183\ 970 \times 10^{-06}$ $c_3 = 5.824\ 006\ 857 \times 10^{-09}$ $c_4 = -3.889\ 648\ 278 \times 10^{-12}$ $c_5 = 1.345\ 592\ 929 \times 10^{-15}$ $c_6 = -2.709\ 518\ 871 \times 10^{-19}$ $c_7 = 2.995\ 846\ 596 \times 10^{-23}$ $c_8 = -1.409\ 677\ 575 \times 10^{-27}$

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