Appendix A

Differences between the ITS-90 and the EPT -76, and between the ITS-90 and the IPTS-68.

$(T_{90} - T_{76})$/mK

T_{90}/K	0	1	2	3	4	5	6	7	8	9
0						-0,1	-0,2	-0,3	-0,4	-0,5
10	-0,6	-0,7	-0.8	-1,0	-1,1	-1,3	-1,4	-1,6	-1,8	-2,0
20	-2,2	-2,5	-2,7	-3,0	-3,2	-3,5	-3,8	-4,1		

$(T_{90} - T_{68})$/K

T_{90}/K	0	1	2	3	4	5	6	7	8	9
10					-0,006	-0,003	-0,004	-0 006	-0,008	-0,009
20	-0,009	-0,008	-0,007	-0,007	-0,006	-0,005	-0,004	-0,004	-0,005	-0,006
30	-0,006	-0,007	-0,008	-0,008	-0,008	-0,007	-0,007	-0,007	-0,006	-0,006
40	-0,006	-0,006	-0,006	-0,006	-0,006	-0,007	-0,007	-0,007	-0,006	-0,006
50	-0,006	-0,005	-0,005	-0,004	-0,003	-0,092	-0,001	0,000	0,001	0,002
60	0,003	0,003	0,004	0,004	0,005	0,005	0,006	0,006	0,007	0,007
70	0,007	0,007	0,007	0,007	0,007	0,008	0,008	0,008	0,008	0,008
80	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008
90	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,009	0,009	0,009

T_{90}/K	0	10	20	30	40	50	60	70	80	90
100	0,009	0,011	0,013	0,014	0,014	0,014	0,014	0,013	0,012	0,012
200	0,011	0,010	0,009	0,008	0,007	0,005	0,003	0,001		

$(t_{90} - t_{68})$/°C

t_{90}/°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90
-100	0,013	0,013	0,014	0,014	0,014	0,013	0,012	0,010	0,008	0,008
0	0,000	0,002	0,004	0,006	0,008	0,009	0,010	0,011	0,012	0,012

t_{90}/°C	0	10	20	30	40	50	60	70	80	90
0	0,000	-0,002	-0,005	-0,007	-0,010	-0,013	-0,016	-0,018	-0,021	-0,024
100	-0,026	-0,028	-0,030	-0,032	-0,034	-0,036	-0,037	-0,038	-0,039	-0,039
200	-0,040	-0,040	-0,040	-0,040	-0,040	-0,040	-0,040	-0,039	-0,039	-0,039
300	-0,039	-0,039	-0,039	-0,040	-0,040	-0,041	-0,042	-0,043	-0,045	-0,046
400	-0,048	-0,051	-0,053	-0,056	-0,059	-0,062	-0,065	-0,068	-0,072	-0,075
500	-0,079	-0,083	-0,087	-0,090	-0,094	-0,098	-0,101	-0,105	-0,108	-0,112
600	-0,115	-0,118	-0,122	-0,125	-0,08	-0,03	0,02	0.06	0,11	0,16
700	0,20	0,24	0,28	0,31	0,33	0,35	0,36	0,36	0,36	0,35
800	0,34	0,32	0,29	0,25	0,22	0,18	0,14	0,10	0,06	0,03
900	-0,01	-0,03	-0,06	-0,08	-0,10	-0,12	-0,14	-0,16	-0,17	-0,18
1000	-0,19	-0,20	-0,21	-0,22	-0,23	-0,24	-0,25	-0,25	-0,26	-0,26

t_{90}/°C	0	100	200	300	400	500	600	700	800	900
1000		-0,26	-0,30	-0,35	-0,39	-0,44	-0,49	-0,54	-0,60	-0,66
2000	-0,72	-0,79	-0,85	-0,93	-1,00	-1,07	-1,15	-1,24	-1,32	-1,41
3000	-1,50	-1,59	-1,69	-1,78	-1,89	-1,99	-2,10	-2,21	-2,32	-2,43

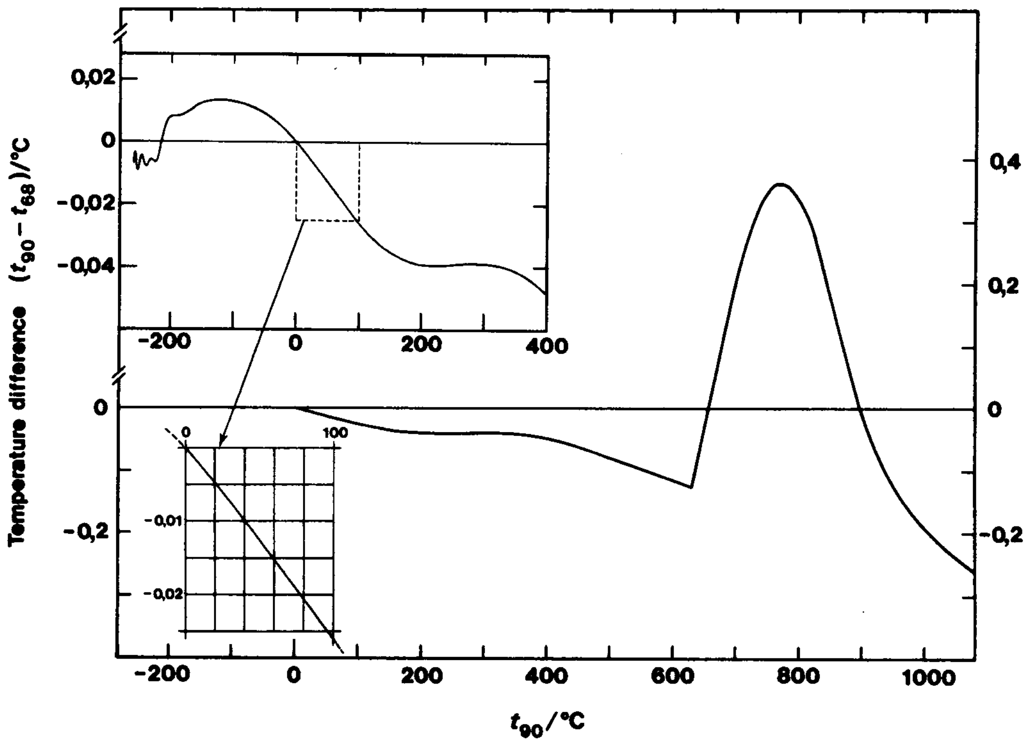

Fig. A.1: Differences between the ITS-90 and the IPTS-68.

The differences (t_{90} - t_{68}) in the temperature range -200 °C to 630 °C in the preceding table can be reproduced to within 1.5 mK below 0 °C and 1 mK above 0 °C by the following polynomial:

$$(t_{90}-t_{68})/°C=\sum_{i=1}^{8} a_i\ (t/630\ °C)^i \qquad \text{(A1)}$$

The values of the coefficients a_i are:

a_1 = -0.148 759

a_2 = -0.267 408

a_3 = 1.080 760

a_4 = 1.269 056

a_5 = -4.089 591

a_6 = -1.871 251

a_7 = 7.438 081

a_8 = -3.536 296.

Appendix B

Addresses of National Standards Laboratories

Amt für Standardisierung
Messwesen und Warenprüfung
Fürstenwalder Damm 388
Postfach 1542
Berlin 1162, DDR
Telex: 112630 ASMW DD

Bureau International des Poids et Mesures
Pavilion de Breteuil
92310 Sèvres, France
Telex: 201067 BIPM F
Fax: (33)(1) 45 342021

Institut National de Metrologie
C.N.A.M.
292, rue St. Martin
75141 Paris 03, France
Telex: 240247 CNAM F
Fax: (33) (1) 42 719329

Istituto di Metrologia "G. Colonnetti"
Strada delle Cacce 73
10135 Torino, Italy
Telex: 212209 IMGCTO I
Fax: (39)(11) 346-761

Kamerlingh Onnes Laboratorium
Rijkuniversiteit te Leiden
Nieuwsteeg 18 - Postbus 9506
2300 RA Leiden
The Netherlands
Telex: 39058 Astro NL
Fax: (31) (71) 275819

National Institute of Standards and Technology
Center for Chemical Technology
Chemical Process Metrology Division
Gaithersburg, Maryland 20899, U.S.A.
Telex: 0023-197674 NBS UT
Fax: (301) 948-4087

National Institute of Metrology
P.O. Box 2112 Beijing
People's Republic of China
Telex: 210028 NIM CN
Fax: (86) (1) 421-8703

National Measurement Laboratory
C.S.I.R.O.
Division of Applied Physics
P.O. Box 218
Lindfield NSW 2070, Australia
Telex: 26296 NATMEASURE SYDNEY
Fax: (61) (2) 467-1902

National Physical Laboratory
Quantum Metrology Division
Teddington, Middlesex
TW11 OLW, England
Telex: 262344
Fax: (44)(81) 943-2155

National Research Council of Canada
Laboratory for Basic Standards
Division of Physics
Ottawa, Ontario, K1A OR6, Canada
Telex: 053-4322
Fax: (613) 952-

National Research Laboratory of Metrology
1-4, 1-Chome, Umezono, Tsukuba
Ibaraki 305, Japan
Telex: 0072-3652570 AIST J
Fax: (81) (298) 54 4135

Nederlands Meetinstituut nv
Schoemakerstraat 97
2628 VJ Dekft, Postbus 654
2600 AR Delft
The Netherlands
Telex: 38373 IJKWZ NL
Fax: (31)(15) 612 971

Physikalish- Technische Bundesanstalt
Bundesallee 100
3300 Braunschweig
Germany
Telex: 952822 PTB D
Fax: (49)(531) 592-7614

Physikalish- Technische Bundesanstalt
Abbestrasse 2-12
D-1000 Berlin 10
Federal Republic of Germany
Fax: (49)(30) 34 81 490

VNIIFTRI Mendeleev
Moscow Region 141 570
USSR
Telex: 411 038 KCSVSU

VNIIM
19, Moskovsky Prospekt
198005 Leningrad
USSR

Appendix C

Some Suppliers of Various Cryogenic Thermometers

Germanium:

CryoCal, Inc.
2303-2W Wycliff St.
St. Paul, Minnesota 55114
U.S.A.

Lake Shore Cryotronics, Inc.
64 East Walnut St.
Westerville, Ohio 43081
U.S.A.

Scientific Instruments, Inc.
1101 25th St.
West Palm Beach, Florida 33407
U.S.A.

All-Union Research Institute for Physical,
Technical, and Radio-Technical Measurement
(VNIIFTRI)
USSR State Committee for Standards
9 Leninsky Prospekt
117049 Moscow M-49
USSR

Rhodium-Iron:

All-Union Research institute for Physical,
Technical, and Radio-Technical Measurement
(VNIIFTRI)
USSR State Committee for Standards
(see entry for germanium)

Cryogenic Consultants Ltd.
The Metrostore Building
231 The Vale
London W3 70S
U.K.

H. Tinsley and Co. Ltd.
Standards House
61 Imperial Way
Croydon CRO 4RR
U.K.

Oxford Instruments Ltd.
Eynsham
Oxford OX8 1 TL, U.K.

Carbon-Glass:	Lake Shore Cryotronics, Inc. (see entry for germanium)
Platinum-Cobalt:	Chino Works, Ltd. Sunshine 60, 19 Fl. 3-1-1 Higashi-ikebukuro, Toshina-ku Tokyo 170 Japan.
Silicon Diodes:	Institute of Cryogenics University of Southampton Southampton S09 SNH U.K.

Appendix D

Calculations Relative to the Filling of a Vapour Pressure Thermometer

Notations

T_a - minimum temperature to be attained. At this temperature the bulb is completely filled with liquid.

T_b - maximum temperature to be attained. The bulb is empty of liquid except for a small quantity v which remains for security and which can be neglected.

Π_a, Π_b - the corresponding saturated vapour pressures.

T_f - temperature used for condensation when filling.

Π_f - corresponding saturated vapour pressure.

T_0 - room temperature.

P_0 - filling pressure at T_0.

T_m - average temperature along the capillary, equal to $\frac{T_0 + T_f}{2}$, $\frac{T_0 + T_a}{2}$, or $\frac{T_0 + T_b}{2}$ as the case may be.

V_b - the bulb volume partially filled with a volume v_c of liquid.

V_c - volume of the capillary.

V_T - volume of the reservoir.

V_0 - totality of volumes of connectors and manometer that remain at room temperature.

M - molar mass of the pure filling substance. N - number of moles to be introduced.

n_1 - number of moles of liquid = $\frac{v_L}{M} \cdot \rho$

n_2 - number of moles of vapour in the bulb = $\frac{P(V_b - v_L)}{RT}$ (p, pressure in the bulb, = p_a, p_b, p_M, or p_0).

ρ_a, ρ_b - density of liquid at temperature T_a, T_b respectively.

n_3 - number of moles in the capillary = $\frac{PV_c}{RT_m}$

n_4 - number of moles in the various volumes at room temperature = $\frac{PV_0}{RT_0}$

n_5 - number of moles in the volume of the reservoir = $\frac{PV_T}{RT_0}$

N - total number of moles.

We assume that the vapour phase obeys the perfect gas law.

V_T being generally much larger than the other volumes, we can make some approximations:

1. *At the lowest temperature,* T_a, we have $v_L \sim V_b$

$$n_1 = \frac{V_b}{M}\rho_a$$

$n_2 = 0$; $\quad n_3 = \frac{2\Pi_a V_c}{R(T_0 + T_a)}$; $\quad n_4 = \frac{\Pi_a V_0}{RT_0}$

V_T not connected; $n_5 = 0$

The total number of moles, N, must be ≤ n1 + n3 + n4

$$N \le \frac{\Pi_a}{RT_0}\left[\frac{2V_c T_0}{T_0 + T_a} + V_0\right] + \frac{V_b}{M}\cdot\rho_a \qquad \text{(D1)}$$

2. *At the highest temperature,* T_b, there is only a small volume v of liquid in the bulb

(v - 0).

$n_1 = \frac{v}{M}\rho_b$ $\quad n_2 = \frac{Vb - v}{RT_b}\Pi_b$; $\quad n_3 = \frac{2\Pi_b V_c}{R(T_0 + T_b)}$;

$n_4 = \frac{\Pi b V_0}{RT_0}$; $\quad n_5 = 0$.

The total number of moles, N, must be

$$N \ge \frac{v\rho_b}{M} + \frac{\Pi_b}{RT_0}\left[\frac{T_0}{T_b}(V_b - v) + V_0 + \frac{2V_c T_0}{T_0 + T_b}\right] \qquad \text{(D2)}$$

3. *From relations (D1) and (D2),* we obtain

$$\rho_b\frac{v}{M} + \frac{\Pi_b}{RT_0}\left[\frac{T_0}{T_b}(V_b - v) + V_0 + \frac{2V_c T_0}{T_0 + T_b}\right] \le \frac{\Pi_a}{RT_0}\left[\frac{2V_c T_0}{T_0 + T_a} + V_0\right] + \frac{v_b\rho_a}{M},$$

or

$$v_b\left[\frac{\rho_a}{M} - \frac{\Pi_b}{RT_b}\right] \ge \frac{V_0}{RT_0}\left[\Pi_b - \Pi_a\right] + v\left[\frac{\rho_b}{M} - \frac{\Pi_b}{RT_b}\right] + \frac{2V_c}{R}\left[\frac{\Pi_b}{T_0 + T_b} - \frac{\Pi_a}{T_0 + T_a}\right]. \qquad \text{(D3)}$$

This expression determines the volume V_b of the bulb (to a first approximation, we can neglect the last two terms and overestimate the value).

4. The calculation of the number of moles to introduce:

Knowing V_b, we can determine the number N = n1 + n2 + n3 + n4 of moles to introduce (staying within the limits where inequalities (D1) and (D2) are applicable).

At the time of filling, all of the moles are in the vapour and it is necessary to predict the reservoir volume V_T. P_0 must be chosen so that at T_0 the pure substance is all gaseous.

At the condensation pressure, Π_f. and just before isolating the thermometer, there remains in the reservoir n_5 moles, where $n_5 = \dfrac{\Pi_f V_T}{RT_0}$.

Then N' = N + n_5 moles of pure substance must be introduced. At pressure P_0 and temperature T_0 these N' moles occupy a total volume $V = V_b + V_c + V_0 + V_T = \dfrac{N'RT_0}{P_0}$, from which the following equation allows the determination of the necessary volume V_T, taking account of the chosen pressure P_0:

$$V_T\left[1-\frac{\Pi_f}{P_0}\right]=\frac{NRT_0}{P_0}-\left(V_b+V_c+V_0\right) \quad . \qquad \text{(D 4)}$$

Appendix E

Calculation of the Aerostatic Pressure Correction for a Vapour Pressure Thermometer

The problem is to know the distribution of temperatures along the capillary. By neglecting the contribution by radiation and by conduction across the vapour, we can write:

$$\Delta L_i = \frac{1}{\phi}\int_{T_{i-1}}^{T_i} k(T)\,dT \qquad \text{with} \qquad \phi = \frac{1}{L_n}\int_{T_f}^{T_e} k(T)\,dT$$

where

ΔL_i is a vertical section of the capillary at temperature T between T_i and T_{i-1},

k (T) is the conductivity of the material of the capillary (stainless steel),

L_n is the total length of the capillary,

T_e and T_f are the temperatures of the hot and cold extremeties.

Knowing ΔL_i and the corresponding T_i, the pressure correction is

$$\Delta P = g\sum_{i=1}^{n} \rho_i \Delta L_i \quad ,$$

where g is the acceleration of gravity,

and ρ_i is the density of vapour at temperature T_i.

The temperature correction is calculated from the pressure correction and the sensitivity of the thermometer.

Appendix F

Interpolation Polynomials for Standard Thermocouple Reference Tables.*
All tables are for a reference temperature of 0 °C.

1. Interpolation polynomial for type T thermocouples
   (E in mV, t_{68} in °C)

- temperature range from -270 °C to 0 °C:

$$E = \sum_{i=0}^{14} d_i \cdot t_{68}^i$$

where:

$d_0 = 0$;
$d_1 = 3.8740773840 \times 10^{-2}$;
$d_2 = 4.4123932482 \times 10^{-5}$;
$d_3 = 1.1405238498 \times 10^{-7}$;
$d_4 = 1.9974406568 \times 10^{-8}$;
$d_5 = 9.0445401187 \times 10^{-10}$;
$d_6 = 2.2766018504 \times 10^{-1\,1}$;
$d_7 = 3.6247409380 \times 10^{-13}$;
$d_8 = 3.8648924201 \times 10^{-15}$;
$d_9 = 2.8298678519 \times 10^{-17}$;
$d_{10} = 1.4281383349 \times 10^{-19}$;
$d_{11} = 4.8833254364 \times 10^{-22}$;
$d_{12} = 1.0803474683 \times 10^{-24}$;
$d_{13} = 1.3949291026 \times 10^{-27}$;
$d_{14} = 7.9795893156 \times 10^{-31}$;

- temperature range from 0 °C to 400 °C:

$$E = \sum_{i=0}^{8} d_i \cdot t_{68}^i$$

where:

$d_0 = 0$;
$d_1 = 3.8740773840 \times 10^{-2}$;
$d_2 = 3.3190198092 \times 10^{-5}$;
$d_3 = 2.0714183645 \times 10^{-7}$;
$d_4 = -2.1945834823 \times 10^{-9}$;
$d_5 = 1.1031900550 \times 10^{-11}$;
$d_6 = -3.0927581898 \times 10^{-14}$;
$d_7 = 4.5653337165 \times 10^{-17}$;
$d_8 = -2.7616878040 \times 10^{-20}$.

---

* These polynomials relate to the IPTS-68. In due course they will be reformulated so as to relate to the ITS-90.

2. Interpolation polynomial for type J thermocouples
(E in mV, t_{68} in °C)

- temperature range from -200 °C to 760 °C:

$$E = \sum_{i=0}^{7} d_i \cdot t_{68}^{i}$$

where:

$d_0 = 0;$

$d_1 = 5.0372753027 \times 10^{-2};$

$d_2 = 3.0425491284 \times 10^{-5};$

$d_3 = -8.5669750464 \times 10^{-8};$

$d_4 = 1.3348825735 \times 10^{-10};$

$d_5 = -1.7022405966 \times 10^{-13};$

$d_6 = 1.9416091001 \times 10^{-16};$

$d_7 = -9.6391844859 \times 10^{-20};$

- temperature range from 760 °C to 900 °C:

$$E = \sum_{i=0}^{5} d_i \cdot t_{68}^{i}$$

where:

$d_0 = 2.9721751778 \times 10^{2};$

$d_1 = -1.5059632873 \times 10^{0};$

$d_2 = 3.2051064215 \times 10^{-3};$

$d_3 = -3.2210174230 \times 10^{-6};$

$d_4 = 1.5949968788 \times 10^{-9};$

$d_5 = -3.1239801752 \times 10^{-13}.$

3. Interpolation polynomial for type E thermocouples (E in mV, t_{68} in °C)

- temperature range from -270 °C to 0 °C:
-

$$E = \sum_{i=0}^{13} d_i \cdot t_{68}^{i}$$

where:

$d_0 = 0;$

$d_1 = 5.8695857799 \times 10^{-2};$

$d_2 = 5.1667517705 \times 10^{-5};$

$d_3 = -4.4652683347 \times 10^{-7};$

$d_4 = -1.7346270905 \times 10^{-8};$

$d_5 = -4.8719368427 \times 10^{-10};$

$d_6 = -8.8896550447 \times 10^{-12};$

$d_7 = -1.0930767375 \times 10^{-13};$

$d_8 = -9.1784535039 \times 10^{-16};$

$d_9 = -5.2575158521 \times 10^{-18};$

$d_{10} = -2.0169601996 \times 10^{-20};$

$d_{11} = -4.9502138782 \times 10^{-23};$

$d_{12} = -7.0177980633 \times 10^{-26};$

$d_{13} = -4.3671808488 \times 10^{-29};$

- temperature range from 0 °C to 1000 °C:

$$E = \sum_{i=0}^{9} d_i \cdot t_{68}^i$$

where: $d_0 = 0$; $d_1 = 5.8695857799 \text{ X } 10^{-2}$; $d_2 = 4.3110945462 \text{ X } 10^{-5}$; $d_3 = 5.7220358202 \times 10^{-8}$; $d_4 = -5.4020668025 \times 10^{-10}$; $d_5 = 1.5425922111 \times 10^{-12}$; $d_6 = -2.4850089136 \times 10^{-15}$; $d_7 = 2.3389721459 \times 10^{-18}$; $d_8 = -1.1946296815 \text{ X } 10^{-21}$; $d_9 = 2.5561127497 \times 10^{-25}$.

4. Interpolation polynomial for type K thermocouples
(E in mV,1Gs in °C)

- temperature range from -270 °C to 0 °C:

$$E = \sum_{i=0}^{10} d_i \cdot t_{68}^i$$

where: $d_0 = 0$; $d_1 = 3.9475433139 \text{ X } 10^{-2}$; $d_2 = 2.7465251138 \text{ X } 10^{-5}$; $d_3 = -1.6565406716 \times 10^{-7}$; $d_4 = -1.5190912392 \times 10^{-9}$; $d_5 = -2.4581670924 \times 10^{-11}$; $d_6 = -2.4757917816 \times 10^{-13}$; $d_7 = -1.5585276173 \times 10^{-15}$; $d_8 = -5.9729921255 \times 10^{-18}$; $d_9 = -1.2688801216 \times 10^{-20}$; $d_{10} = -1.1382797374 \times 10^{-23}$;

- temperature range from 0 °C to 1372 °C:

$$E = \sum_{i=0}^{8} d_i \cdot t_{68}^i + 0.125 \exp\left[-\frac{1}{2}\left(\frac{t_{68} - 127}{65}\right)^2 \right]$$

where: $d_0 = -1.8533063273 \text{ X } 10^{-2}$; $d_1 = 3.8918344612 \times 10^{-2}$; $d_2 = 1.6645154356 \times 10^{-5}$; $d_3 = -7.8702374448 \times 10^{-8}$; $d_4 = 2.2835785557 \times 10^{-10}$; $d_5 = -3.5700231258 \times 10^{-13}$; $d_6 = 2.9932909136 \times 10^{-16}$; $d_7 = -1.2849848798 \times 10^{-19}$; $d_8 = 2.2239974336 \times 10^{-23}$.

5. Interpolation polynomial for type S thermocouples
(E in mV, t_{68} in °C)

- temperature range from -50 °C to 630.74 °C:
-

$$E = \sum_{i=0}^{6} a_i \cdot t_{68}^i$$

where:

$a_0 = 0;$

$a_1 = 5.3995782346 \times 10^{-3};$

$a_2 = 1.2519770000 \times 10^{-5};$

$a_3 = -2.2448217997 \times 10^{-8};$

$a_4 = 2.8452164949 \times 10^{-11};$

$a_5 = -2.2440584544 \times 10^{-14};$

$a_6 = 8.5054166936 \times 10^{-18};$

- temperature range from 630.74 °C to 1064.43 °C:

$$E = \sum_{i=0}^{2} g_i \cdot t_{68}^i$$

where:

$g_0 = -2.9824481615 \times 10^{-1};$

$g_1 = 8.2375528221 \times 10^{-3};$

$g_2 = 1.6453909942 \text{ X } 10^{-6};$

- temperature range from 1064.43 °C to 1665 °C:

$$E = \sum_{i=0}^{3} b_i \left(\frac{t_{68} - 1365}{300} \right)^i$$

where:

$b_0 = 1.3943438677 \times 10^{1};$

$b_1 = 3.6398686553;$

$b_2 = -5.0281206140 \times 10^{-3};$

$b_3 = -4.2450546418 \times 10^{-2}.$

6. Interpolation polynomial for type B thermocouples
(E in mV, t_{68} in °C)

- temperature range from 0 °C to 1820 °C:

$$E = \sum_{i=0}^{8} d_i \cdot t_{68}^i$$

where: $d_0 = 0$; $d_1 = -2.4674601620 \times 10^{-4}$; $d_2 = 5.9102111169 \times 10^{-6}$; $d_3 = -1.4307123430 \times 10^{-9}$; $d_4 = 2.1509149750 \times 10^{-12}$; $d_5 = -3.1757800720 \times 10^{-15}$; $d_6 = 2.4010367459 \times 10^{-18}$; $d_7 = -9.0928148159 \times 10^{-22}$; $d_8 = 1.3299505137 \times 10^{-25}$;

7. Interpolation polynomial for type N thermocouples
(E in mV, t_{68} in °C, wire diameter 1.6 mm)

- temperature range from 0 °C to 1300 °C: .

$$E = \sum_{i=0}^{9} d_i \cdot t_{68}^{i}$$

where: $d_0 = 0$; $d_1 = 2.589\,779\,8582 \times 10^{-2}$; $d_2 = 1.665\,612\,7713 \times 10^{-5}$; $d_3 = 3.123\,496\,2101 \times 10^{-8}$; $d_4 = -1.724\,813\,0773 \times 10^{-10}$; $d_5 = 3.652\,666\,5920 \times 10^{-13}$; $d_6 = -4.439\,083\,3504 \times 10^{-16}$; $d_7 = 3.155\,338\,2729 \times 10^{-19}$; $d_8 = -1.215\,087\,9468 \times 10^{-22}$; $d_9 = 1.955\,719\,7559 \times 10^{-26}$.

8. Interpolation polynomial for type R thermocouples
(E in mV, t_{68} in °C)

- temperature range from -50 °C to 630.74 °C:

$$E = \sum_{i=0}^{7} a_i \cdot t_{68}^{i}$$

where.
$a_0 = 0$
$a_1 = 5.289\,139\,5059 \times 10^{-3}$
$a_2 = 1.391\,110\,9947 \times 10^{-5}$
$a_3 = -2.400\,523\,8430 \times 10^{-8}$
$a_4 = 3.620\,141\,0595 \times 10\text{-}^{11}$
$a_5 = -4.464\,501\,9036 \times 10^{-14}$
$a_6 = 3.849\,769\,1865 \times 10^{-17}$
$a_7 = -1.537\,264\,1559 \times 10^{-20}$

- temperature range from 630.74 °C to 1064.43 °C:

$$E = \sum_{i=0}^{3} g_i \cdot t_{68}^i$$

where: $g_0 = -2.641\ 800\ 7025 \times 10^{-1}$

$g_1 = 8.046\ 868\ 6747 \times 10^{-3}$

$g_2 = 2.989\ 229\ 3723 \times 10^{-6}$

$g_3 = -2.687\ 605\ 8617 \times 10^{-10}$

- temperature range from 1064.43 °C to 1665 °C:

$$E = \sum_{i=0}^{3} b_i \cdot t_{68}^i$$

where: $b_0 = 1.490\ 170\ 2702 \times 10^{0}$

$b_1 = 2.863\ 986\ 7552 \times 10^{-3}$

$b_2 = 8.082\ 363\ 1189 \times 10^{-6}$

$b_3 = -1.933\ 847\ 7638 \times 10^{-9}$

- temperature range from 1665 °C to 1769 °C:

$$E = \sum_{i=0}^{3} d_i \cdot t_{68}^i$$

where: $d_0 = 9.544\ 555\ 9010 \times 10^{1}$

$d_1 = -1.664\ 250\ 0359 \times 10^{-1}$

$d_2 = 1.097\ 574\ 3239 \times 10^{-4}$

$d_3 = -2.228\ 921\ 6980 \times 10^{-8}$.