2.17 Water (IAPS 1984 Formulation for Scientific and General Use)

All equations have been cited from NBS/NRC Steam Tables[1].

2.17.1 Temperature Scale

International temperature scale 1990 (ITS-1990)

2.17.2 The Names of Substance, Library File and Single Shot Program

Name of Substance:	Water (IAPS 1984)
Library File for UNIX:	libjhgk.a
Library File for DOS,Windows95/NT:	JHGK.LIB
Single Shot Program for UNIX:	hgk-ss
Single Shot Program for DOS,Windows95/NT:	HGK–SS.EXE

2.17.3 Important Constants and Others

Molecular Formula:	H_2O
Relative Molecular Mass:	18.0152
Gas Constant:	461.52 J/(kg·K)

Critical Constants:

Critical Pressure:	22.055×10^{6}Pa (220.55 bar)
Critical Temperature:	647.126 K (373.976 °C)
Critical Specific Volume:	3.1056×10^{-3}m^3/kg

Triple Point:

Pressure:	611.731 Pa (6.11731×10^{-3}bar)
Temperature:	273.16 K (0.01 °C)

Reference State:

For the liquid state at the triple point, 0 J/(kg·K) and 0 J/kg are assigned to the specific entropy and the specific internal energy of saturated liquid, respectively.

2.17.4 Formula

Equation of State:

Equations (A.1)-(A.6) in a function form of $A = A(\rho, T)$ in reference [1]. Here A=specific helmholtz function, ρ=density and T=Temperature. However, $\sum_{j=0,1,3,5}$ in equation (A.3) has been corrected to $\sum_{j=0,3,5}$.

Vapor Pressure:

Equations (A.1)-(A.6) for specific Helmholtz function and equation (A.7) for the Gibbs condition for phase equlibrium.

Properties at Vapor-Liquid Equilibrium:

Equations (A.1)-(A.6) and equation (A.7) in reference [1] for specific volume. Equations as functions of density and temperature, which have been derived directly by partial differentiation of the specific Helmholtz function, equations (A.1)-(A.6), for specific entropy, specific enthalpy and isobaric specific heat, respectively.

Transport Properties:

Viscosity and thermal conductivity from equations (C.1) and (C.2) in reference [1], respectively. However,

$$\exp(-A((T^*/T)-1)^2 - B((\rho/\rho^*)-1)^4)$$

in equation (C.2) has been corrected to

$$\exp(-A((T/T^*)-1)^2 - B((\rho/\rho^*)-1)^4)$$

Further the values of a_3=0.0036744 in Table C.1 and $b_{14} = -0.0273093$ in Table C.2 have been corrected as a_3=−0.0036744 and b_{14}=−0.0253093, respectively.

The Other Properties:
Static dielectric constant and surface tension from equations (C.4) and (C.5).

References

[1] L.Haar, J.S.Gallagher and G.S.Kell, NBS/NRC Steam Tables, Hemisphere,N.Y., (1984).

Table II–2.17–1 Water(IAPS 1984) Function

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
1	AIPPT(P,T)		
94	AJTPT(P,T)	AJTPT: Joule-Thomson Coefficient [K/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.15≤T≤423.15 [K] 611.731≤P≤ $100\times(5+(T-273.15)/15)\times10^6$ [Pa] 423.15≤T≤1273.15 [K] 611.731≤P≤1500×10^6 [Pa] 0≤T≤150 [°C] 6.11731×10^{-3}≤P≤ $1000\times(5+T/15)$ [bar] 150≤T≤1000 [°C] 6.11731×10^{-3}≤P≤15000 [bar]
8A	AKPD(P)		
8B	AKPDD(P)		
82	AKPT(P,T)	AKPT: Isentropic Exponent [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.15≤T≤423.15 [K] 611.731≤P≤ $100\times(5+(T-273.15)/15)\times10^6$ [Pa] 423.15≤T≤1273.15 [K] 611.731≤P≤1500×10^6 [Pa] 0≤T≤150 [°C] 6.11731×10^{-3}≤P≤ $1000\times(5+T/15)$ [bar] 150≤T≤1000 [°C] 6.11731×10^{-3}≤P≤15000 [bar]
8C	AKTD(T)		
8D	AKTDD(T)		
2	ALAPP(P)	ALAPP: Laplace Coefficient [m] P∗: Pressure [Pa], [bar]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar]
3	ALAPT(T)	ALAPT: Laplace Coefficient [m] T∗: Temperature [K], [°C]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C]
4	ALHP(P)	ALHP: Latent Heat of Vaporization [J/kg] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
6	ALMPD(P)	ALMPD: Thermal Conductivity of Saturated Liquid [W/(m·K)] P∗: Pressure [Pa], [bar]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar]
7	ALMPDD(P)	ALMPDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar]
8	ALMPT(P,T)	ALMPT: Thermal Conductivity [W/(m·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.731≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 6.11731×10^{-3}≤P≤1000 [bar] 0≤T≤800 [°C]
9	ALMTD(T)	ALMTD: Thermal Conductivity of Saturated Liquid [W/(m·K)] T∗: Temperature [K], [°C]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C]
10	ALMTDD(T)	ALMTDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C]
11	AMUPD(P)	AMUPD: Coefficient of Viscosity of Saturated Liquid [Pa·s] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]
12	AMUPDD(P)	AMUPDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
13	AMUPT(P,T)	AMUPT: Coefficient of Viscosity [Pa·s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.731 \leq P \leq 100 \times 10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $6.11731 \times 10^{-3} \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
14	AMUTD(T)	AMUTD: Coefficient of Viscosity of Saturated Liquid [Pa·s] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.126$ [K] $0.01 \leq T \leq 373.976$ [°C]
15	AMUTDD(T)	AMUTDD: Coefficient of Viscosity Saturated of Vapor [Pa·s] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.126$ [K] $0.01 \leq T \leq 373.976$ [°C]
92	BPPT(P,T)	BPPT: Volumetric Coefficient of Expansion [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \leq T \leq 423.15$ [K] $611.731 \leq P \leq$ $100 \times (5+(T-273.15)/15) \times 10^6$ [Pa] $423.15 \leq T \leq 1273.15$ [K] $611.731 \leq P \leq 1500 \times 10^6$ [Pa] $0 \leq T \leq 150$ [°C] $6.11731 \times 10^{-3} \leq P \leq$ $1000 \times (5+T/15)$ [bar] $150 \leq T \leq 1000$ [°C] $6.11731 \times 10^{-3} \leq P \leq 15000$ [bar]
90	BSPT(P,T)	BSPT: Isentropic Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \leq T \leq 423.15$ [K] $611.731 \leq P \leq$ $100 \times (5+(T-273.15)/15) \times 10^6$ [Pa] $423.15 \leq T \leq 1273.15$ [K] $611.731 \leq P \leq 1500 \times 10^6$ [Pa] $0 \leq T \leq 150$ [°C] $6.11731 \times 10^{-3} \leq P \leq$ $1000 \times (5+T/15)$ [bar] $150 \leq T \leq 1000$ [°C] $6.11731 \times 10^{-3} \leq P \leq 15000$ [bar]
91	BTPT(P,T)	BTPT: Isothermal Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \leq T \leq 423.15$ [K] $611.731 \leq P \leq$ $100 \times (5+(T-273.15)/15) \times 10^6$ [Pa] $423.15 \leq T \leq 1273.15$ [K] $611.731 \leq P \leq 1500 \times 10^6$ [Pa] $0 \leq T \leq 150$ [°C] $6.11731 \times 10^{-3} \leq P \leq$ $1000 \times (5+T/15)$ [bar] $150 \leq T \leq 1000$ [°C] $6.11731 \times 10^{-3} \leq P \leq 15000$ [bar]
93	BVPT(P,T)	BVPT: Pressure Coefficient [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \leq T \leq 423.15$ [K] $611.731 \leq P \leq$ $100 \times (5+(T-273.15)/15) \times 10^6$ [Pa] $423.15 \leq T \leq 1273.15$ [K] $611.731 \leq P \leq 1500 \times 10^6$ [Pa] $0 \leq T \leq 150$ [°C] $6.11731 \times 10^{-3} \leq P \leq$ $1000 \times (5+T/15)$ [bar] $150 \leq T \leq 1000$ [°C] $6.11731 \times 10^{-3} \leq P \leq 15000$ [bar]
16	CPPD(P)	CPPD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.731 \leq P < 22.055 \times 10^6$ [Pa] $6.11731 \times 10^{-3} \leq P < 220.55$ [bar]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
17	CPPDD(P)	CPPDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.731 \leq P < 22.055 \times 10^6$ [Pa] $6.11731 \times 10^{-3} \leq P < 220.55$ [bar]
18	CPPT(P,T)	CPPT: Isobaric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \leq T \leq 423.15$ [K] $611.731 \leq P \leq 100 \times (5+(T-273.15)/15) \times 10^6$ [Pa] $423.15 \leq T \leq 1273.15$ [K] $611.731 \leq P \leq 1500 \times 10^6$ [Pa] $0 \leq T \leq 150$ [°C] $6.11731 \times 10^{-3} \leq P \leq 1000 \times (5+T/15)$ [bar] $150 \leq T \leq 1000$ [°C] $6.11731 \times 10^{-3} \leq P \leq 15000$ [bar]
19	CPTD(T)	CPTD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.126$ [K] $0.01 \leq T < 373.976$ [°C]
20	CPTDD(T)	CPTDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.126$ [K] $0.01 \leq T < 373.976$ [°C]
21	CRP('A')	CRP: Critical Constants A: 'A'='H': 2.086×10^6 [J/kg] Specific Enthalpy P∗: 'A'='P': 22.055×10^6 [Pa], 220.55 [bar] Pressure S: 'A'='S': 4.409×10^3 [J/(kg·K)] Specific Entropy T∗: 'A'='T': 647.126 [K], 373.976 [°C] Temperature V: 'A'='V': 3.1056×10^{-3}[m^3/kg] Specific Volume	one of 'H', 'P', 'S', 'T' and 'V'
7A	CVPD(P)		
76	CVPDD(P)	CVPDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.731 \leq P \leq 22.055 \times 10^6$ [Pa] $6.11731 \times 10^{-3} \leq P \leq 220.55$ [bar]
77	CVPT(P,T)	CVPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \leq T \leq 423.15$ [K] $611.731 \leq P \leq 100 \times (5+(T-273.15)/15) \times 10^6$ [Pa] $423.15 \leq T \leq 1273.15$ [K] $611.731 \leq P \leq 1500 \times 10^6$ [Pa] $0 \leq T \leq 150$ [°C] $6.11731 \times 10^{-3} \leq P \leq 1000 \times (5+T/15)$ [bar] $150 \leq T \leq 1000$ [°C] $6.11731 \times 10^{-3} \leq P \leq 15000$ [bar]
7B	CVTD(T)		
78	CVTDD(T)	CVTDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.126$ [K] $0.01 \leq T \leq 373.976$ [°C]
2A	EPSPD(P)		
2B	EPSPDD(P)		
22	EPSPT(P,T)	EPSPT: Static Dielectric Constant [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.731 \leq P \leq 500 \times 10^6$ [Pa] $273.15 \leq T \leq 823.15$ [K] $6.11731 \times 10^{-3} \leq P \leq 5000$ [bar] $0 \leq T \leq 550$ [°C]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
2C	EPSTD(T)		
2D	EPSTDD(T)		
89	FC('A')	FC: Fundamental Constants M: 'A'='M': 18.0152 Relative Molecular Mass R: 'A'='R': 461.52 [J/(kg·K)] Gas Constant	one of 'M' and 'R'
9A	GAMPD(P)		
96	GAMPDD(P)	GAMPDD: Ratio of Specific Heats of Saturated Vapor [–] P∗: Pressure [Pa], [bar]	$611.731 \le P \le 22.055\times10^6$ [Pa] $6.11731\times10^{-3} \le P \le 220.55$ [bar]
95	GAMPT(P,T)	GAMPT: Ratio of Specific Heats [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \le T \le 423.15$ [K] $611.731 \le P \le$ $100\times(5+(T-273.15)/15)\times10^6$ [Pa] $423.15 \le T \le 1273.15$ [K] $611.731 \le P \le 1500\times10^6$ [Pa] $0 \le T \le 150$ [°C] $6.11731\times10^{-3} \le P \le$ $1000\times(5+T/15)$ [bar] $150 \le T \le 1000$ [°C] $6.11731\times10^{-3} \le P \le 15000$ [bar]
9B	GAMTD(T)		
97	GAMTDD(T)	GAMTDD: Ratio of Specific Heats of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$273.16 \le T \le 647.126$ [K] $0.01 \le T \le 373.976$ [°C]
23	HPD(P)	HPD: Specific Enthalpy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$611.731 \le P \le 22.055\times10^6$ [Pa] $6.11731\times10^{-3} \le P \le 220.55$ [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$611.731 \le P \le 22.055\times10^6$ [Pa] $6.11731\times10^{-3} \le P \le 220.55$ [bar]
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$611.731 \le P \le 500\times10^6$ [Pa] $SPT(P,273.15K) \le S \le$ $SPT(P,1273.15K)$ [J/(kg·K)] $500\times10^6 \le P \le 1500\times10^6$ [Pa] $SPT(P,T_0) \le S \le$ $SPT(P,1273.15K)$ [J/(kg·K)] where $T_0=(P\times10^{-8}-5)\times15+273.15$ [K] $6.11731\times10^{-3} \le P \le 5000$ [bar] $SPT(P,0°C) \le S \le$ $SPT(P,1000°C)$ [J/(kg·K)] $5000 \le P \le 15000$ [bar] $SPT(P,T_0) \le S \le$ $SPT(P,1000°C)$ [J/(kg·K)] where $T_0=(P\times10^{-3}-5)\times15$ [°C]
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.15 \le T \le 423.15$ [K] $611.731 \le P \le$ $100\times(5+(T-273.15)/15)\times10^6$ [Pa] $423.15 \le T \le 1273.15$ [K] $611.731 \le P \le 1500\times10^6$ [Pa] $0 \le T \le 150$ [°C] $6.11731\times10^{-3} \le P \le$ $1000\times(5+T/15)$ [bar] $150 \le T \le 1000$ [°C] $6.11731\times10^{-3} \le P \le 15000$ [bar]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar] 0≤X≤1.0 [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C] 0≤X≤1.0 [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'H2O' Molecular Formula S: 'A'='S': 'WATER(IAPS 1984)' Name of Substance V: 'A'='V': '10.1' Version Number	one of 'C', 'S' and 'V'
66	PLDT(T)		
68	PMLT(T)		
85	PRPD(P)	PRPD: Prandtl Number of Saturated Liquid [–] P∗: Pressure [Pa], [bar]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar]
86	PRPDD(P)	PRPDD: Prandtl Number of Saturated Vapor [–] P∗: Pressure [Pa], [bar]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar]
81	PRPT(P,T)	PRPT: Prandtl Number [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.731≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 6.11731×10^{-3}≤P≤1000 [bar] 0≤T≤800 [°C]
87	PRTD(T)	PRTD: Prandtl Number of Saturated Liquid [–] T∗: Temperature [K], [°C]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C]
88	PRTDD(T)	PRTDD: Prandtl Number of Saturated Vapor [–] T∗: Temperature [K], [°C]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C]
99	PSBT(P)		
30	PST(T)	PST∗: Saturation Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
72	PSTD(P)		
73	PSTDD(T)		
31	SIGP(P)	SIGP: Surface Tension [N/m] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]
32	SIGT(T)	SIGT: Surface Tension [N/m] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
35	SPT(P,T)	SPT: Specific Entropy P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.15≤T≤423.15 [K] 611.731≤P≤ $100\times(5+(T-273.15)/15)\times10^6$ [Pa] 423.15≤T≤1273.15 [K] 611.731≤P≤1500×10^6 [Pa] 0≤T≤150 [°C] 6.11731×10^{-3}≤P≤ $1000\times(5+T/15)$ [bar] 150≤T≤1000 [°C] 6.11731×10^{-3}≤P≤15000 [bar]
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar] 0≤X≤1.0 [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C] 0≤X≤1.0 [–]
67	TLDP(P)		
69	TMLP(P)		
64	TPH(P,H)	TPH∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] A: Specific Enthalpy [J/kg]	611.731≤P≤500×10^6 [Pa] HPT(P,273.15K)≤H≤ HPT(P,1273.15K) [J/kg] 500×10^6≤P≤1500×10^6 [Pa] HPT(P,T_0)≤H≤ HPT(P,1273.15K) [J/kg] where $T_0=(P\times10^{-8}-5)\times15+273.15$[K] 6.11731×10^{-3}≤P≤5000 [bar] HPT(P,0°C)≤H≤ HPT(P,1000°C) [J/kg] 5000≤P≤15000 [bar] HPT(P,T_0)≤H≤ HPT(P,1000°C) [J/kg] where $T_0=(P\times10^{-3}-5)\times15$ [°C]
6H	TPH2(P,H)		
65	TPS(P,S)	TPS∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	611.731≤P≤500×10^6 [Pa] SPT(P,273.15K)≤S≤ SPT(P,1273.15K) [J/(kg·K)] 500×10^6≤P≤1500×10^6 [Pa] SPT(P,T_0)≤S≤ SPT(P,1273.15K) [J/(kg·K)] where $T_0=(P\times10^{-8}-5)\times15+273.15$ [K] 6.11731×10^{-3}≤P≤5000 [bar] SPT(P,0°C)≤S≤ SPT(P,1000°C) [J/(kg·K)] 5000≤P≤15000 [bar] SPT(P,T_0)≤S≤ SPT(P,1000°C) [J/(kg·K)] where $T_0=(P\times10^{-3}-5)\times15$ [°C]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
6S	TPS2(P,S)		
98	TPSEUP(P)		
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$611.731 \le P \le 500\times10^6$ [Pa] VPT(P,273.15K)≤V≤ VPT(P,1273.15K) [m^3/kg] $500\times10^6 \le P \le 1500\times10^6$ [Pa] VPT(P,T_0)≤V≤ VPT(P,1273.15K) [m^3/kg] where $T_0=(P\times10^{-8}-5)\times15+273.15$[K] $6.11731\times10^{-3} \le P \le 5000$ [bar] VPT(P,0°C)≤V≤ VPT(P,1000°C) [m^3/kg] $5000 \le P \le 15000$ [bar] VPT(P,T_0)≤V≤ VPT(P,1000°C) [m^3/kg] where $T_0=(P\times10^{-3}-5)\times15$[°C]
41	TRPL('A')	TRPL∗: Properties at Triple Point P∗: 'A'='P': 611.731 [Pa], 6.11731×10^{-3} [bar] Pressure T∗: 'A'='T': 273.16 [K], 0.01 [°C] Temperature	one of 'P' and 'T'
100	TSBP(P)		
40	TSP(P)	TSP∗: Saturation Temperature [K], [°C] P∗: Pressure [Pa], [bar]	$611.731 \le P \le 22.055\times10^6$ [Pa] $6.11731\times10^{-3} \le P \le 220.55$ [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$611.731 \le P \le 22.055\times10^6$ [Pa] $6.11731\times10^{-3} \le P \le 220.55$ [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$611.731 \le P \le 22.055\times10^6$ [Pa] $6.11731\times10^{-3} \le P \le 220.55$ [bar]
79	UPS(P,S)	UPS: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$611.731 \le P \le 500\times10^6$ [Pa] SPT(P,273.15K)≤S≤ SPT(P,1273.15K) [J/(kg·K)] $500\times10^6 \le P \le 1500\times10^6$ [Pa] SPT(P,T_0)≤S≤ SPT(P,1273.15K) [J/(kg·K)] where $T_0=(P\times10^{-8}-5)\times15+273.15$ [K] $6.11731\times10^{-3} \le P \le 5000$ [bar] SPT(P,0°C)≤S≤ SPT(P,1000°C) [J/(kg·K)] $5000 \le P \le 15000$ [bar] SPT(P,T_0)≤S≤ SPT(P,1000°C) [J/(kg·K)] where $T_0=(P\times10^{-3}-5)\times15$ [°C]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.15≤T≤423.15 [K] 611.731≤P≤ 100×(5+(T−273.15)/15)×10^6 [Pa] 423.15≤T≤1273.15 [K] 611.731≤P≤1500×10^6 [Pa] 0≤T≤150 [°C] 6.11731×10^{-3}≤P≤ 1000×(5+T/15) [bar] 150≤T≤1000 [°C] 6.11731×10^{-3}≤P≤15000 [bar]
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar] 0≤X≤1.0 [–]
46	UTD(T)	UTD: Specific Internal Energy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C] 0≤X≤1.0 [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar]
80	VPS(P,S)	VPS: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	611.731≤P≤500×10^6 [Pa] SPT(P,273.15K)≤S≤ SPT(P,1273.15K) [J/(kg·K)] 500×10^6≤P≤1500×10^6 [Pa] SPT(P,T_0)≤S≤ SPT(P,1273.15K) [J/(kg·K)] where T_0=(P×10^{-8}–5)×15+273.15 [K] 6.11731×10^{-3}≤P≤5000 [bar] SPT(P,0°C)≤S≤ SPT(P,1000°C) [J/(kg·K)] 5000≤P≤15000 [bar] SPT(P,T_0)≤S≤ SPT(P,1000°C) [J/(kg·K)] where T_0=(P×10^{-3}–5)×15 [°C]
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.15≤T≤423.15 [K] 611.731≤P≤ 100×(5+(T−273.15)/15)×10^6 [Pa] 423.15≤T≤1273.15 [K] 611.731≤P≤1500×10^6 [Pa] 0≤T≤150 [°C] 6.11731×10^{-3}≤P≤ 1000×(5+T/15) [bar] 150≤T≤1000 [°C] 6.11731×10^{-3}≤P≤15000 [bar]

Table II–2.17–1 Water(IAPS 1984) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	611.731≤P≤22.055×10^6 [Pa] 6.11731×10^{-3}≤P≤220.55 [bar] 0≤X≤1.0 [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	273.16≤T≤647.126 [K] 0.01≤T≤373.976 [°C] 0≤X≤1.0 [–]
8E	WPD(P)		
8F	WPDD(P)		
83	WPT(P,T)	WPT: Velocity of Sound [m/s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	273.15≤T≤423.15 [K] 611.731≤P≤ 100×(5+(T−273.15)/15)×10^6 [Pa] 423.15≤T≤1273.15 [K] 611.731≤P≤1500×10^6 [Pa] 0≤T≤150 [°C] 6.11731×10^{-3}≤P≤ 1000×(5+T/15) [bar] 150≤T≤1000 [°C] 6.11731×10^{-3}≤P≤15000 [bar]
8G	WTD(T)		
8H	WTDD(T)		
56	XPH(P,H)	XPH: Dryness Fraction [–] P∗: Pressure [Pa], [bar] H: Specific Enthalpy of Mixture [J/kg]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar] HPD(P)≤H≤HPDD(P) [J/kg]
57	XPS(P,S)	XPS: Dryness Fraction [–] P∗: Pressure [Pa], [bar] S: Specific Entropy of Mixture [J/(kg·K)]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar] SPD(P)≤S≤SPDD(P) [J/(kg·K)]
58	XPU(P,U)	XPU: Dryness Fraction [–] P∗: Pressure [Pa], [bar] U: Specific Internal Energy of Mixture [J/kg]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar] UPD(P)≤U≤UPDD(P) [J/kg]
59	XPV(P,V)	XPV: Dryness Fraction [–] P∗: Pressure [Pa], [bar] V: Specific Volume of Mixture [m^3/kg]	611.731≤P<22.055×10^6 [Pa] 6.11731×10^{-3}≤P<220.55 [bar] VPD(P)≤V≤VPDD(P) [m^3/kg]
60	XTH(T,H)	XTH: Dryness Fraction [–] T∗: Temperature [K], [°C] A: Specific Enthalpy of Mixture [J/kg]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C] HTD(T)≤H≤HTDD(T) [J/kg]
61	XTS(T,S)	XTS: Dryness Fraction [–] T∗: Temperature [K], [°C] S: Specific Entropy of Mixture [J/(kg·K)]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C] STD(T)≤S≤STDD(T) [J/(kg·K)]
62	XTU(T,U)	XTU: Dryness Fraction [–] T∗: Temperature [K], [°C] U: Specific Internal Energy of Mixture [J/kg]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C] UTD(T)≤U≤UTDD(T) [J/kg]
63	XTV(T,V)	XTV: Dryness Fraction [–] T∗: Temperature [K], [°C] V: Specific Volume of Mixture [m^3/kg]	273.16≤T<647.126 [K] 0.01≤T<373.976 [°C] VTD(T)≤V≤VTDD(T) [m^3/kg]