2.18 Water(IAPWS Industrial Formulation 1997-ITS 1990)

All equations have been cited from 1999 JSME Steam Tables [1].

2.18.1 Temperature Scale

International temperature scale 1990 (ITS-1990)

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

Name of Substance:	Water, Light Water
Library File for UNIX:	libjh2of97.a
Library File for DOS,Windows95/NT:	JH2OF97.LIB
Single Shot Program for UNIX:	h2of97-ss
Single Shot Program for DOS,Windows95/NT:	H2OF97–SS.EXE

2.18.3 Important Constants and Others

Molecular Formula:	H_2O
Relative Molecular Mass:	18.015268
Gas Constant:	461.526 J/(kg·K)

Critical Constants:

Critical Pressure:	22.064×10^{6}Pa (220.64 bar)
Critical Temperature:	647.096 K (373.946°C)
Critical Specific Volume:	3.10559×10^{-3}m^3/kg

Triple Point:

Pressure:	611.657 Pa (6.11657×10^{-3}bar)
Temperature:	273.16 K (0.01°C)

Reference State:

At the triple point, 0 J/(kg·K) and 0 J/kg are assigned to the specific entropy and the specific enthalpy of saturated liquid, respectively.

2.18.4 Formula

Equation of State:

The function forms of $g = g(P,T)$ and $f = f(v,T)$. Here g=specific free enthalpy, f=specific free energy, P=pressure, T=temperature and ρ=density. The equations, which are divided into five subregions, have been cited from Section 3.1 in chapter 3 in reference [1].

Vapor Pressure:

Equation given at section 3.1 in chapter 3 in reference [1] .

Properties at Vapor-Liquid Equilibrium:

Derived functions given at section 3.1 in chapter 3.1 in reference [1] .

Transport Properties:

Internationally recommended interpolation equations given at sections 3.5 and 3.6 in chapter 3 in reference [1] for dynamic viscosity and thermal conductivity, respectively.

The Other Properties:

Internationally recommended interpolation equations given at sections 3.2, 3.4 and 3.7 in chapter 3 in reference [1] for surface tension, static dielectric constant and ion products, respectively.

References

[1] Japan Society of Mechanical Engineers, 1999 JSME Steam Tables, (1999).

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
1	AIPPT(P,T)	AIPPT: Ion Product [$(mol/kg)^2$] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$100\times10^3\leq P\leq10\times10^6$ [Pa] $273.15\leq T\leq1273.15$ [K] $10\times10^6\leq P\leq100\times10^6$ [Pa] $273.15\leq T\leq1073.15$ [K] $1\leq P\leq100$ [bar] $0\leq T\leq1000$ [°C] $100\leq P\leq1000$ [bar] $0\leq T\leq800$ [°C]
94	AJTPT(P,T)	AJTPT: Joule-Thomson Coefficient [K/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657\leq P\leq10\times10^6$ [Pa] $273.15\leq T\leq2273.15$ [K] $10\times10^6\leq P\leq100\times10^6$ [Pa] $273.15\leq T\leq1073.15$ [K] $611.657\times10^{-3}\leq P\leq100$ [bar] $0\leq T\leq2000$ [°C] $100\leq P\leq1000$ [bar] $0\leq T\leq800$ [°C]
8A	AKPD(P)	AKPD: Isentropic Exponent of Saturated Liquid [–] P∗: Pressure [Pa], [bar]	$611.657\leq P<22.064\times10^6$ [Pa] $6.11657\times10^{-3}\leq P<220.64$ [bar]
8B	AKPDD(P)	AKPPD: Isentropic Exponent of Saturated Vapor [–] P∗: Pressure [Pa], [bar]	$611.657\leq P<22.064\times10^6$ [Pa] $6.11657\times10^{-3}\leq P<220.64$ [bar]
82	AKPT(P,T)	AKPT: Isentropic Exponent [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657\leq P\leq10\times10^6$ [Pa] $273.15\leq T\leq2273.15$ [K] $10\times10^6\leq P\leq100\times10^6$ [Pa] $273.15\leq T\leq1073.15$ [K] $611.657\times10^{-3}\leq P\leq100$ [bar] $0\leq T\leq2000$ [°C] $100\leq P\leq1000$ [bar] $0\leq T\leq800$ [°C]
8C	AKTD(T)	AKTD: Isentropic Exponent of Saturated Liquid [–] T∗: Temperature [K], [°C]	$273.16\leq T<647.096$ [K] $0.01\leq T<373.946$ [°C]
8D	AKTDD(T)	AKTDD: Isentropic Exponent of Saturated Vapor [–] T∗: Temperature [K], [°C]	$273.16\leq T<647.096$ [K] $0.01\leq T<373.946$ [°C]
2	ALAPP(P)	ALAPP: Laplace Coefficient [m] P∗: Pressure [Pa], [bar]	$611.657\leq P<22.064\times10^6$ [Pa] $6.11657\times10^{-3}\leq P<220.64$ [bar]
3	ALAPT(T)	ALAPT: Laplace Coefficient [m] T∗: Temperature [K], [°C]	$273.16\leq T<647.096$ [K] $0.01\leq T<373.946$ [°C]
4	ALHP(P)	ALHP: Latent Heat of Vaporization [J/kg] P∗: Pressure [Pa], [bar]	$611.657\leq P\leq22.064\times10^6$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	$273.16\leq T\leq647.096$ [K] $0.01\leq T\leq373.946$ [°C]
6	ALMPD(P)	ALMPD: Thermal Conductivity of Saturated Liquid [W/(m·K)] P∗: Pressure [Pa], [bar]	$611.657\leq P<22.064\times10^6$ [Pa] $6.11657\times10^{-3}\leq P<220.64$ [bar]
7	ALMPDD(P)	ALMPDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	$611.657\leq P<22.064\times10^6$ [Pa] $6.11657\times10^{-3}\leq P<220.64$ [bar]
8	ALMPT(P,T)	ALMPT: Thermal Conductivity [W/(m·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657\leq P\leq100\times10^6$ [Pa] $273.15\leq T\leq1073.15$ [K] $6.11657\times10^{-3}\leq P\leq1000$ [bar] $0\leq T\leq800$ [°C]

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
9	ALMTD(T)	ALMTD: Thermal Conductivity of Saturated Liquid [W/(m·K)] T∗: Temperature [K], [°C]	273.16≤T<647.096 [K] 0.01≤T<373.946 [°C]
10	ALMTDD(T)	ALMTDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	273.16≤T<647.096 [K] 0.01≤T<373.946 [°C]
11	AMUPD(P)	AMUPD: Coefficient of Viscosity of Saturated Liquid [Pa·s] P∗: Pressure [Pa], [bar]	611.657≤P≤22.064×10^6 [Pa] 6.11657×10^{-3}≤P≤220.64 [bar]
12	AMUPDD(P)	AMUPDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] P∗: Pressure [Pa], [bar]	611.657≤P≤22.064×10^6 [Pa] 6.11657×10^{-3}≤P≤220.64 [bar]
13	AMUPT(P,T)	AMUPT: Coefficient of Viscosity [Pa·s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.657≤P≤10×10^6 [Pa] 273.15≤T≤1173.15 [K] 10×10^6≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 6.11657×10^{-3}≤P≤100 [bar] 0≤T≤900 [°C] 100≤P≤1000 [bar] 0≤T≤800 [°C]
14	AMUTD(T)	AMUTD: Coefficient of Viscosity of Saturated Liquid [Pa·s] T∗: Temperature [K], [°C]	273.16≤T≤647.096 [K] 0.01≤T≤373.946 [°C]
15	AMUTDD(T)	AMUTDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] T∗: Temperature [K], [°C]	273.16≤T≤647.096 [K] 0.01≤T≤373.946 [°C]
92	BPPT(P,T)	BPPT: Volumetric Coefficient of Expansion [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.657≤P≤10×10^6 [Pa] 273.15≤T≤2273.15 [K] 10×10^6≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 611.657×10^{-3}≤P≤100 [bar] 0≤T≤2000 [°C] 100≤P≤1000 [bar] 0≤T≤800 [°C]
90	BSPT(P,T)	BSPT: Isentropic Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.657≤P≤10×10^6 [Pa] 273.15≤T≤2273.15 [K] 10×10^6≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 611.657×10^{-3}≤P≤100 [bar] 0≤T≤2000 [°C] 100≤P≤1000 [bar] 0≤T≤800 [°C]
91	BTPT(P,T)	BTPT: Isothermal Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.657≤P≤10×10^6 [Pa] 273.15≤T≤2273.15 [K] 10×10^6≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 611.657×10^{-3}≤P≤100 [bar] 0≤T≤2000 [°C] 100≤P≤1000 [bar] 0≤T≤800 [°C]

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
93	BVPT(P,T)	BVPT: Pressure Coefficient [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10\times10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10\times10^6 \leq P \leq 100\times10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657\times10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
16	CPPD(P)	CPPD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar]
17	CPPDD(P)	CPPDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar]
18	CPPT(P,T)	CPPT: Isobaric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10\times10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10\times10^6 \leq P \leq 100\times10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657\times10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
19	CPTD(T)	CPTD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
20	CPTDD(T)	CPTDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
21	CRP('A')	CRP: Critical Constants H: 'A'='H': 2.08755×10^6 [J/kg] Specific Enthalpy P∗: 'A'='P': 22.064×10^6 [Pa], 220.64 [bar] Pressure S: 'A'='S': 4.41202×10^3 [J/(kg·K)] Specific Entropy T∗: 'A'='T': 647.096 [K], 373.946 [°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)	CVPD: Isochoric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar]
76	CVPDD(P)	CVPDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar]
77	CVPT(P,T)	CVPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10\times10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10\times10^6 \leq P \leq 100\times10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657\times10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
7B	CVTD(T)	CVTD: Isochoric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
78	CVTDD(T)	CVTDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
2A	EPSPD(P)	EPSPD: Static Dielectric Constant [–] P∗: Pressure [Pa], [bar]	611.657≤P≤22.064×10^6 [Pa] 6.11657×10^{-3}≤P≤220.64 [bar]
2B	EPSPDD(P)	EPSPD: Static Dielectric Constant [–] P∗: Pressure [Pa], [bar]	611.657≤P≤22.064×10^6 [Pa] 6.11657×10^{-3}≤P≤220.64 [bar]
22	EPSPT(P,T)	EPSPT: Static Dielectric Constant [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.657≤P≤10×10^6 [Pa] 273.15≤T≤1200.15 [K] 10×10^6≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 6.11657×10^{-3}≤P≤100 [bar] 0≤T≤927 [°C] 100≤P≤1000 [bar] 0≤T≤800 [°C]
2C	EPSTD(T)	EPSTD: Static Dielectric Constant [–] T∗: Temperature [K], [°C]	273.16≤T≤647.096 [K] 0.01≤T≤373.946 [°C]
2D	EPSTDD(T)	EPSTDD: Static Dielectric Constant [–] T∗: Temperature [K], [°C]	273.16≤T≤647.096 [K] 0.01≤T≤373.946 [°C]
89	FC('A')	FC: Fundamental Constants M: 'A'='M': 18.015268 Relative Molecular Mass R: 'A'='R': 461.526 [J/(kg·K)] Gas Constant	one of 'M' and 'R'
9A	GAMPD(P)	GAMPD: Ratio of Specific Heats of Saturated Liquid [–] P∗: Pressure [Pa], [bar]	611.657≤P<22.064×10^6 [Pa] 6.11657×10^{-3}≤P<220.64 [bar]
96	GAMPDD(P)	GAMPDD: Ratio of Specific Heats Saturated Vapor [–] P∗: Pressure [Pa], [bar]	611.657≤P<22.064×10^6 [Pa] 6.11657×10^{-3}≤P<220.64 [bar]
95	GAMPT(P,T)	GAMPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	611.657≤P≤10×10^6 [Pa] 273.15≤T≤2273.15 [K] 10×10^6≤P≤100×10^6 [Pa] 273.15≤T≤1073.15 [K] 611.657×10^{-3}≤P≤100 [bar] 0≤T≤2000 [°C] 100≤P≤1000 [bar] 0≤T≤800 [°C]
9B	GAMTD(T)	GAMTD: Ratio of Specific Heats of Saturated Liquid [–] T∗: Temperature [K], [°C]	273.16≤T<647.096 [K] 0.01≤T<373.946 [°C]
97	GAMTDD(T)	GAMTDD: Ratio of Specific Heats Saturated Vapor [–] T∗: Temperature [K], [°C]	273.16≤T<647.096 [K] 0.01≤T<373.946 [°C]
23	HPD(P)	HPD: Specific Enthalpy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	611.657≤P≤22.064×10^6 [Pa] 6.11657×10^{-3}≤P≤220.64 [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	611.657≤P≤22.064×10^6 [Pa] 6.11657×10^{-3}≤P≤220.64 [bar]
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	611.657≤P≤100×10^6 [Pa] 6.11657×10^{-3}≤P≤1000 [bar] The range of the second argument S is the same as the range of the function SPT(P,T). See the range of arguments at SPT(P,T).

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10 \times 10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10 \times 10^6 \leq P \leq 100 \times 10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657 \times 10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$611.657 \leq P \leq 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 220.64$ [bar] $0 \leq X \leq 1.0$ [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C] $0 \leq X \leq 1.0$ [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'H2O' Molecular Formula S: 'A'='S': 'WATER(IF97−ITS1990)' 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]	$611.657 \leq P < 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P < 220.64$ [bar]
86	PRPDD(P)	PRPDD: Prandtl Number of Saturated Vapor [–] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P < 220.64$ [bar]
81	PRPT(P,T)	PRPT: Prandtl Number [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 100 \times 10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $6.11657 \times 10^{-3} \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
87	PRTD(T)	PRTD: Prandtl Number of Saturated Liquid [–] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
88	PRTDD(T)	PRTDD: Prandtl Number of Saturated Vapor [–] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
99	PSBT(T)		
30	PST(T)	PST∗: Saturation Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
72	PSTD(T)		
73	PSTDD(T)		
31	SIGP(P)	SIGP: Surface Tension [N/m] P∗: Pressure [Pa], [bar]	$611.657 \leq P \leq 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 220.64$ [bar]
32	SIGT(T)	SIGT: Surface Tension [N/m] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.657 \leq P \leq 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 220.64$ [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$611.657 \leq P \leq 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 220.64$ [bar]

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
35	SPT(P,T)	SPT: Specific Entropy [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10 \times 10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10 \times 10^6 \leq P \leq 100 \times 10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657 \times 10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$611.657 \leq P \leq 22.064 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 220.64$ [bar] $0 \leq X \leq 1.0$ [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C] $0 \leq X \leq 1.0$ [–]
67	TLDP(P)		
69	TMLP(P)		
64	TPH(P,H)	TPH∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] H: Specific Enthalpy [J/kg]	$611.657 \leq P \leq 100 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 1000$ [bar] The range of the second argument H is the same as the range of the function HPT(P,T). See the range of arguments at HPT(P,T).
6H	TPH2(P,H)	TPH2∗: Temperature [K], [°C] calculated using backward functions P∗: Pressure [Pa], [bar] H: Specific Enthalpy [J/kg]	$611.657 \leq P \leq 100 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 1000$ [bar] The range of H is limited in the regions 1 and 2 shown in Fig.3.1.2 in ref.[1].
65	TPS(P,S)	TPS∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$611.657 \leq P \leq 100 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 1000$ [bar] The range of the second argument S is the same as the range of the function SPT(P,T). See the range of arguments at SPT(P,T).
6S	TPS2(P,S)	TPS2∗: Temperature [K], [°C] calculated using backward functions P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$611.657 \leq P \leq 100 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 1000$ [bar] The range of S is limited in the regions 1 and 2 shown in Fig.3.1.2 in ref.[1].
98	TPSEUP(P)		
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$611.657 \leq P \leq 100 \times 10^6$ [Pa] $6.11657 \times 10^{-3} \leq P \leq 1000$ [bar] The range of the second argument V is the same as the range of the function VPT(P,T). See the range of arguments at VPT(P,T).

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
41	TRPL('A')	TRPL∗: Properties at Triple Point P∗: 'A'='P': 611.657 [Pa], 6.11657×10^{-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]	$611.657\leq P\leq22.064\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$611.657\leq P\leq22.064\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$611.657\leq P\leq22.064\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar]
79	UPS(P,S)	UPS: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$611.657\leq P\leq100\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq1000$ [bar] The range of the second argument S is the same as the range of the function SPT(P,T). See the range of arguments at SPT(P,T)
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657\leq P\leq10\times10^{6}$ [Pa] $273.15\leq T\leq2273.15$ [K] $10\times10^{6}\leq P\leq100\times10^{6}$ [Pa] $273.15\leq T\leq1073.15$ [K] $611.657\times10^{-3}\leq P\leq100$ [bar] $0\leq T\leq2000$ [°C] $100\leq P\leq1000$ [bar] $0\leq T\leq800$ [°C]
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$611.657\leq P\leq22.064\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar] $0\leq X\leq1.0$ [–]
46	UTD(T)	UTD: Specific Internal Energy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$273.16\leq T\leq647.096$ [K] $0.01\leq T\leq373.946$ [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$273.16\leq T\leq647.096$ [K] $0.01\leq T\leq373.946$ [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$273.16\leq T\leq647.096$ [K] $0.01\leq T\leq373.946$ [°C] $0\leq X\leq1.0$ [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	$611.657\leq P\leq22.064\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	$611.657\leq P\leq22.064\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq220.64$ [bar]
80	VPS(P,S)	VPS: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$611.657\leq P\leq100\times10^{6}$ [Pa] $6.11657\times10^{-3}\leq P\leq1000$ [bar] The range of the second argument S is the same as the range of the function SPT(P,T). See the range of arguments at SPT(P,T)

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10\times10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10\times10^6 \leq P \leq 100\times10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657\times10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$611.657 \leq P \leq 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P \leq 220.64$ [bar] $0 \leq X \leq 1.0$ [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$273.16 \leq T \leq 647.096$ [K] $0.01 \leq T \leq 373.946$ [°C] $0 \leq X \leq 1.0$ [–]
8E	WPD(P)	WPD: Velocity of Sound of Saturated Liquid [m/s] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar]
8F	WPDD(P)	WPDD: Velocity of Sound of Saturated Vapor [m/s] P∗: Pressure [Pa], [bar]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar]
83	WPT(P,T)	WPT: Velocity of Sound [m/s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$611.657 \leq P \leq 10\times10^6$ [Pa] $273.15 \leq T \leq 2273.15$ [K] $10\times10^6 \leq P \leq 100\times10^6$ [Pa] $273.15 \leq T \leq 1073.15$ [K] $611.657\times10^{-3} \leq P \leq 100$ [bar] $0 \leq T \leq 2000$ [°C] $100 \leq P \leq 1000$ [bar] $0 \leq T \leq 800$ [°C]
8G	WTD(T)	WTD: Velocity of Sound of Saturated Liquid [m/s] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
8H	WTDD(T)	WTDD: Velocity of Sound of Saturated Vapor [m/s] T∗: Temperature [K], [°C]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C]
56	XPH(P,H)	XPH: Dryness Fraction [–] P∗: Pressure [Pa], [bar] H: Specific Enthalpy of Mixture [J/kg]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [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)]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [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]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [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]	$611.657 \leq P < 22.064\times10^6$ [Pa] $6.11657\times10^{-3} \leq P < 220.64$ [bar] VPD(P)≤V≤VPDD(P) [m^3/kg]
60	XTH(T,H)	XTH: Dryness Fraction [–] T∗: Temperature [K], [°C] H: Specific Enthalpy of Mixture [J/kg]	$273.16 \leq T < 647.096$ [K] $0.01 \leq T < 373.946$ [°C] HTD(T)≤H≤HTDD(T) [J/kg]

Table II–2.18–1 Water(IAPWS IF97−ITS 1990) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
61	XTS(T,S)	XTS: Dryness Fraction [–] T∗: Temperature [K], [°C] S: Specific Entropy of Mixture [J/(kg·K)]	273.16≤T<647.096 [K] 0.01≤T<373.946 [°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<647.096 [K] 0.01≤T<373.946 [°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<647.096 [K] 0.01≤T<373.946 [°C] VTD(T)≤V≤VTDD(T) [m^3/kg]