Instructions for using IF95 functions, placed as a macro in workbook (version 2.1.0.0 from 23 May 2023).

Calculations of thermodynamic properties of water and steam are programmed according to:

"Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for Generál and Scientific Use"
release authorized by IAPWS in Praha, Czech Republic, 2 - 7.9.2018, document number IAPWS R6-95(2018).

Allowed input data range (in pressure and temperature) is: **10 Pa to 1000 MPa and Ice melting/sublimation temperature (P) to 1000°C**

Program also further calculates:

Dynamic Viscosity according to "Relase on the IAPWS Formulation 2008 for the Viscosity of Ordinary Water Substance", release authorized by IAPWS in Berlin, Germany, 7 - 12.9.2008, doc. number IAPWS R12-08.

Allowed input data range for viscosity calculation is:

10 Pa	<= P <	Triple point pressure	and	0 °C <= T <= 900°C
Triple point pressure	<= P <=	300 MPa	and	Ice melting temperature(P) <= T <= 900°C
300 MPa	< P <=	350 MPa	and	Ice melting temperature(P) <= T <= 600°C
350 MPa	< P <=	500 MPa	and	Ice melting temperature(P) <= T <= 160°C
500 MPa	< P <=	1000 MPa	and	Ice melting temperature(P) <= T <= 100°C

Dynamic viscosity is calculated according to this documentation including relations from paragraph 2.7 for critical region defined by equation (13):

$372{,}76°C < t < 377{,}62°C$ a $245{,}8\ kg/m^3 < \rho < 405{,}3\ kg/m^3$

Thermal conductivity acc. to "Relase on the IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance", rel. authorized by IAPWS in Plzeň, Czech Republic, 4 - 9.9.2011, doc. No. IAPWS R15-11.

Allowed input data range for thermal conductivity calculation is:

10 Pa	<= P <	Triple point pressure	and	0 °C <= T <= 900 °C
Triple point pressure	<= P <=	100 MPa	and	Ice melting temperature(P) <= T <= 900 °C
100 MPa	< P <=	250 MPa	and	Ice melting temperature(P) <= T <= 600.85 °C
250 MPa	< P <=	687 MPa	and	Ice melting temperature(P) <= T <= 299.85 °C
687 MPa	< P <=	785 MPa	and	Ice melting temperature(P) <= T <= 129.85 °C
785 MPa	< P <=	1000 MPa	and	Ice melting temperature(P) <= T <= 74.85 °C

Thermal conductivity is calculated according to this documentation, including relations from paragraph 2.7 for critical region.

Program control:

For proper function it is necessary to have macros enabled in Excel - if macros are not enabled there will be #NAME? error messages in cells with macro references. Excel from 2007 onwards may (depending on macro settings in security centre) ask for macros to be enabled in bar above sheet that appears there when file is opened and macros need to be enabled here. In order for Excel to ask for macros to be enabled when file is opened, you need to have "Disable all macros with notification" option selected in macro security. It is also possible to have "Enable all macros (..." selected in macro settings, but this is not recommended due to viruses. To access macro settings, go to File - Options - Trust Center - Trust Center Settings... - Macro Settings. Administrator rights may be required.

When macros are enabled and working, you can use Excel's bar Formulas - "fx Insert Function" (or f_x button - left next to row of formulas) to select category " Programs L. Ruffer" in window that opens from drop-down list "Or select a category" and there will be among others 5 functions related to IF95:

IF95_IAPWS(P;THS;WhatIsInTHS;Output); IF95SatCurve(TP;WhatIsInTP;Dryness;Output); IF95SatP(T); IF95SatT(P) and IF95IceMeltingT(P).

Function IF95_IAPWS calculates thermodynamic properties selected by setting variable Output: when **Output = "T"** calculates temperature [°C]; for **"H"** calculates enthalpy [kJ/kg]; **"U"** = internal energy [kJ/kg]; **"S"** = entropy [kJ/kgK]; **"Cp"** = specific heat at const. pressure [kJ/kgK]; **"Cv"** = specific heat at const. volume [kJ/kgK]; **"W"** = speed of sound [m/s]; **"Mi"** = dynamic viscosity [Pa.s]; **"Lam"** = thermal conductivity [W/Km]; **"Kapa"** = isentropic exponent [--]; **"F"** = Helmholtz free energy [kJ/kg], **"G"** = Gibbs free energy [kJ/kg]; **"X"** = dryness (0 is water and 1 is steam) [--] and when content of variable **Output is different** from previous specific volume is calculated [m^3/kg].
Calculation is always from abs. pressure [MPa] which enters in variable **P** and in variable **THS** enters second input variable which is defined by content of variable **WhatIsInTHS:** for **"H"** enters and is calculated from enthalpy [kJ/kg]; for **"S"** enters and is calculated from entropy [kJ/kgK]; for **"K"** enters and is calculated from temperature [°K] and when content of variable **WhatIsInTHS is different** it is entered and calculated from temperature [°C]. Calculations from enthalpy and entropy are performed by iterations.

Function IF95SatCurve calculates thermodynamic properties on saturation curve selected by setting variable Output: when **Output = "H"** calculates enthalpy [kJ/kg]; for **"U"** calculates internal energy [kJ/kg]; **"S"** = entropy [kJ/kgK]; **"Cp"** = specific heat at const. pressure [kJ/kgK]; **"Cv"** = specific heat at const. volume [kJ/kgK]; **"W"** = speed of sound [m/s]; **"Mi"** = = dynamic viscosity [Pa.s]; **"Lam"** = thermal conductivity [W/Km]]; **"Kapa"** = isentropic exponent [--]; **"F"** = Helmholtz free energy [kJ/kg], **"G"** = Gibbs free energy [kJ/kg] and when content of variable **Output is different** from previous specific volume is calculated [m^3/kg].
Input value for calculation is in variable **TP**, what is entered is defined by content of variable **WhatIsInTP** as follows: for **"P"** enters and is calculated from abs. pressure [MPa]; for **"K"** enters and is calculated from temperature [°K] and when content of variable **WhatIsInTP is different** it is entered and calculated from temperature [°C]. Variable **Dryness** determines dryness of mixture which will be calculated as follows: when **Dryness <= 0** so calculates for saturated water; when **Dryness is between 0 and 1** it is calculated for a mixture with a composition according to variable Dryness and when **Dryness >= 1** calculates for saturated steam.

Function IF95SatP calculates absolute saturation pressure [MPa] for specified temperature [°C].
Function IF95SatT calculates absolute saturation temperature [°C] for specified absolute pressure [MPa].
Function IF95IceMeltingT calculates melting or sublimation temperature of ice [°C] for specified abs. pressure [MPa] acc. to **"Revised Release on the Pressure along the Melting and Sublimation Curves of Ordinary Water Substance",** authorized by IAPWS in Plzeň, Czech Republic, 4 - 9.9.2011, doc. No. IAPWS R14-08(2011). This determines lower temperature limit for calculation acc. to pressure where "Ice melting temperature(P)" is mentioned above.

Note: to use IF95 functions, open this example in Excel, delete both sheets "IF9X Check calc. and manual" and either use prepared blank sheet or move necessary sheets here from another open Excel workbook.
(It is possible that after moving sheets here formulas in them will need to be modified for this workbook.)

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Checking calculation and example of using IF95 functions

To check calculations except for dynamic viscosity and thermal conductivity, data from "Revised Release on the IAPWS Industrial Formulation 1995 …", doc. No. IAPWS R6-95(2018) year 2018; from table 7 on page 15 are used.

Calculation of dynamic viscosity and thermal conductivity is for information only, check data are in separate tables.

Input values		Output values										
Pressure	Temperature	Specific volume	Specific density	Specific enthalpy	Specific internal energy	Specific entropy	Specific isobaric heat capacity	Specific isochoric heat capacity	Isentropic exponent	Speed of sound	Dynamic viscosity	Thermal conductivity
P [MPa]	T [K]	v [m^3/kg]	ρ [kg/m^3]	h [kJ/kg]	u [kJ/kg]	s [kJ/kgK]	c_p [kJ/kgK]	c_v [kJ/kgK]	kapa [--]	w [m/s]	mi [μPa.s]	lam [mW/Km]
0,992 418 352E-1	300	0,100 345 590E-2	0,996 556 000E+3	0,112 652 982E+3	0,112 553 397E+3	0,393 062 643E+0	0,418 064 167E+1	0,413 018 112E+1	0,226 395 956E+5	0,150 151 914E+4	853,742741	609,810682
0,200 022 515E+2	300	0,994 720 026E-3	0,100 530 800E+4	0,130 839 813E+3	0,110 943 172E+3	0,387 405 401E+0	0,412 821 768E+1	0,406 798 347E+1	0,118 411 690E+3	0,153 492 501E+4	852,529677	620,626851
0,700 004 704E+3	300	0,841 607 740E-3	0,118 820 200E+4	0,668 517 926E+3	0,793 885 486E+2	0,132 609 616E+0	0,377 321 943E+1	0,346 135 580E+1	0,101 354 355E+2	0,244 357 992E+4	1309,230314	795,644857
0,999 679 423E-1	500	0,229 885 058E+1	0,435 000 000E+0	0,292 855 966E+4	0,269 874 830E+4	0,794 488 271E+1	0,198 124 932E+1	0,150 817 541E+1	0,130 824 045E+1	0,548 314 253E+3	17,299092	36,0317367
0,999 938 125E+0	500	0,220 653 133E+0	0,453 200 000E+1	0,289 122 108E+4	0,267 058 160E+4	0,682 502 725E+1	0,227 945 279E+1	0,166 991 025E+1	0,130 083 826E+1	0,535 739 001E+3	17,053577	38,4725608
0,100 003 858E+2	500	0,119 328 182E-2	0,838 025 000E+3	0,977 181 624E+3	0,965 248 346E+3	0,256 690 919E+1	0,460 222 448E+1	0,322 106 219E+1	0,135 433 363E+3	0,127 128 441E+4	119,828393	646,408561
0,700 000 405E+3	500	0,922 029 498E-3	0,108 456 400E+4	0,141 111 398E+4	0,765 692 960E+3	0,203 237 509E+1	0,367 154 109E+1	0,307 437 693E+1	0,901 393 987E+1	0,241 200 877E+4	Out of range!	Out of range!
0,220 384 756E+2	647	0,279 329 609E-2	0,358 000 000E+3	0,202 850 969E+4	0,196 694 971E+4	0,432 092 307E+1	0,353 179 841E+4	0,618 315 728E+1	0,103 276 727E+1	0,252 145 078E+3	46,363667	1170,96072
0,100 062 559E+0	900	0,414 937 759E+1	0,241 000 000E+0	0,376 497 576E+4	0,334 977 842E+4	0,916 653 194E+1	0,222 164 469E+1	0,175 890 657E+1	0,126 256 905E+1	0,724 027 147E+3	33,680332	82,6467212
0,200 000 690E+2	900	0,190 059 869E-1	0,526 150 000E+2	0,361 278 555E+4	0,323 266 450E+4	0,659 070 225E+1	0,271 928 538E+1	0,193 510 526E+1	0,128 334 476E+1	0,698 445 674E+3	35,027805	100,351901
0,700 000 006E+3	900	0,114 841 020E-2	0,870 769 000E+3	0,286 552 456E+4	0,206 163 741E+4	0,417 223 802E+1	0,358 031 986E+1	0,266 422 350E+1	0,507 250 083E+1	0,201 933 608E+4	Out of range!	Out of range!

Note: in this table, some input values (Pressure or Temperature) are entered to more decimal positions than are visible. This is because they need to be entered values for other decimal positions not listed in source, so that calculated values exactly match values in source tables. However, this is only an optical effect, because deviations caused by not entering non-displayed decimal positions are so small that they are well within the calculation uncertainties given in source.

Checking calculation and example of using IF95 functions - saturation line

Data from "Release on the IAPWS Industrial Formulation 1995 …" from table 8 on page 15 is used for checking.

	T = 275 °K	T = 450 °K	T = 625 °K
Saturation pressure [MPa]	0,698 451 167E-3	0,932 203 564E+0	0,169 082 693E+2
Specific density ρ' [kg/m^3]	0,999 887 406E+3	0,890 341 250E+3	0,567 090 385E+3
Specific density ρ" [kg/m^3]	0,550 664 919E-2	0,481 200 360E+1	0,118 290 281E+3
Specific enthalpy h' [kJ/kg]	0,775 972 202E+1	0,749 161 585E+3	0,168 626 976E+4
Specific enthalpy h" [kJ/kg]	0,250 428 995E+4	0,277 441 078E+4	0,255 071 624E+4
Specific entropy s' [kJ/kgK]	0,283 094 670E-1	0,210 865 845E+1	0,380 194 683E+1
Specific entropy s" [kJ/kgK]	0,910 660 120E+1	0,660 921 221E+1	0,518 506 121E+1

Checking calculation and example using functions for dynamic viscosity in accordance with IAPWS Document No. R12-08

Here are data for checking simplified program when μ_2=1, from table 4. Therefore, calculated viscosity values marked with * exactly do not match because IF95_IAPWS(...;...;...;"Mi") function used here calculates viscosity including μ_2 for critical region, thus μ_2<>1.

Input values		Output values	
Pressure	Temperature	Dynamic viscosity	Specific density
P [MPa]	T [K]	mi [μPa.s]	ρ [kg/m^3]
0,221 713 489E+1	298,15	889,735170 *	0,998 000 000E+3
0,760 755 375E+3	298,15	1437,649467	0,120 000 000E+4
0,100 644 962E+3	373,15	307,883636 *	0,100 000 000E+4
0,196 901 583E+0	433,15	14,538324	0,100 000 000E+1
0,214 352 684E+3	433,15	217,685365 *	0,100 000 000E+4
0,402 225 473E+0	873,15	32,619287	0,100 000 000E+1
0,336 086 081E+2	873,15	35,802262	0,100 000 000E+3
0,208 180 810E+3	873,15	77,430195	0,600 000 000E+3
0,541 106 212E+0	1173,15	44,217245	0,100 000 000E+1
0,514 248 931E+2	1173,15	47,640433	0,100 000 000E+3
0,219 723 616E+3	1173,15	64,154608	0,400 000 000E+3

Here are data for checking program from table 5 on page 9, thus for program that calculates viscosity including critical region. Data are for region close to the critical point where here partial viscosity μ_2 is calculated.

Input values		Output values	
Pressure	Temperature	Dynamic viscosity	Specific density
P [MPa]	T [K]	mi [μPa.s]	ρ [kg/m^3]
0,194 596 313E+2	647,35	25,520677	0,122 000 000E+3
0,219 924 624E+2	647,35	31,337589	0,222 000 000E+3
0,221 206 591E+2	647,35	36,228143	0,272 000 000E+3
0,221 318 931E+2	647,35	42,961579	0,322 000 000E+3
0,221 439 770E+2	647,35	45,688204	0,372 000 000E+3
0,223 147 216E+2	647,35	49,436256	0,422 000 000E+3

Checking calculation and example using functions for thermal conductivity according to IAPWS Document No. R15-11

Here are data for check simplified program when λ_2=0, from table 4. Therefore, calculated conductivity values marked with * do not exactly match because IF95_IAPWS(...;...;...;"Lam") function used here calculates conductivity including conductivity λ_2 for critical region, thus λ_2<>0.
Note: since it is not possible to insert here a zero pressure, which would correspond to zero ρ from table, pressure 1E-9 MPa is inserted for first and last row of table, which is miminum that can be inserted, and with it already calculated conductivities correspond to values in table, but ρ is slightly greater than 0.

Input values		Output values	
Pressure	Temperature	Thermal conductivity	Specific density
P [MPa]	T [K]	lam [mW/Km]	ρ [kg/m^3]
0,100 000 000E-8	298,15	0,184 341 883E+2	0,000 000 007
0,221 713 489E+1	298,15	0,608 010 782E+3 *	0,998 000 000E+3
0,760 755 384E+3	298,15	0,799 176 844E+3 *	0,120 000 000E+4
0,100 000 000E-8	873,15	0,791 034 659E+2	0,000 000 002

Here are data for checking program from table 5 on page 10, thus for program that calculates conductivity including critical region. Data are for region close to the critical point where here partial conductivity λ_2 is calculated.

Input values		Output values	
Pressure	Temperature	Thermal conductivity	Specific density
P [MPa]	T [K]	lam [mW/Km]	ρ [kg/m^3]
0,297 424 666E+0	647,35	0,519 298 924E+2	0,100 000 000E+1
0,194 596 313E+2	647,35	0,130 922 885E+3	0,122 000 000E+3
0,219 924 624E+2	647,35	0,367 787 459E+3	0,222 000 000E+3
0,221 206 591E+2	647,35	0,757 959 776E+3	0,272 000 000E+3
0,221 318 931E+2	647,35	0,144 375 556E+4	0,322 000 000E+3
0,221 439 770E+2	647,35	0,650 319 402E+3	0,372 000 000E+3
0,223 147 216E+2	647,35	0,448 883 487E+3	0,422 000 000E+3
0,117 733 755E+3	647,35	0,600 961 346E+3	0,750 000 000E+3

Checking calculation and example of using IF95 functions - calculation by iterations from P and H

To check calculations except for dynamic viscosity and thermal conductivity, data from "Revised Release on the IAPWS Industrial Formulation 1995 …", doc. No. IAPWS R6-95(2018) year 2018; from table 7 on page 15 are used, with that, input enthalpy was taken from pressure and temperature calculations, because enthalpy is not in Table 7. Calculation of dynamic viscosity and thermal conductivity is for information only, check data are in separate tables.

Input values		Output values										
Pressure	Specific enthalpy	Specific volume	Specific density	Temperature	Specific internal energy	Specific entropy	Specific isobaric heat capacity	Specific isochoric heat capacity	Isentropic exponent	Speed of sound	Dynamic viscosity	Thermal conductivity
P [MPa]	h [kJ/kg]	v [m^3/kg]	ρ [kg/m^3]	[K]	u [kJ/kg]	s [kJ/kgK]	c_p [kJ/kgK]	c_v [kJ/kgK]	kapa [--]	w [m/s]	mi [μPa.s]	lam [mW/Km]
0,992 418 352E-1	0,112 652 982E+3	0,100 345 590E-2	0,996 556 000E+3	0,300 000 000E+3	0,112 553 397E+3	0,393 062 643E+0	0,418 064 167E+1	0,413 018 112E+1	0,226 395 956E+5	0,150 151 914E+4	853,742741	609,810682
0,200 022 515E+2	0,130 839 813E+3	0,994 720 026E-3	0,100 530 800E+4	0,300 000 000E+3	0,110 943 172E+3	0,387 405 401E+0	0,412 821 768E+1	0,406 798 347E+1	0,118 411 690E+3	0,153 492 501E+4	852,529677	620,626851
0,700 004 704E+3	0,668 517 926E+3	0,841 607 740E-3	0,118 820 200E+4	0,300 000 000E+3	0,793 885 486E+2	0,132 609 616E+0	0,377 321 943E+1	0,346 135 580E+1	0,101 354 355E+2	0,244 357 992E+4	1309,230314	795,644857
0,999 679 423E-1	0,292 855 966E+4	0,229 885 058E+1	0,435 000 000E+0	0,500 000 000E+3	0,269 874 830E+4	0,794 488 271E+1	0,198 124 932E+1	0,150 817 541E+1	0,130 824 045E+1	0,548 314 253E+3	17,299092	36,0317367
0,999 938 125E+0	0,289 122 108E+4	0,220 653 133E+0	0,453 200 000E+1	0,500 000 000E+3	0,267 058 160E+4	0,682 502 725E+1	0,227 945 279E+1	0,166 991 025E+1	0,130 083 826E+1	0,535 739 001E+3	17,053577	38,4725608
0,100 003 858E+2	0,977 181 624E+3	0,119 328 182E-2	0,838 025 000E+3	0,500 000 000E+3	0,965 248 346E+3	0,256 690 919E+1	0,460 222 448E+1	0,322 106 219E+1	0,135 433 363E+3	0,127 128 441E+4	119,828393	646,408561
0,700 000 405E+3	0,141 111 398E+4	0,922 029 498E-3	0,108 456 400E+4	0,500 000 000E+3	0,765 692 960E+3	0,203 237 509E+1	0,367 154 109E+1	0,307 437 693E+1	0,901 393 987E+1	0,241 200 877E+4	Out of range!	Out of range!
0,220 384 756E+2	0,202 850 969E+4	0,279 329 609E-2	0,358 000 000E+3	0,647 000 000E+3	0,196 694 971E+4	0,432 092 307E+1	0,353 179 841E+4	0,618 315 728E+1	0,103 276 727E+1	0,252 145 078E+3	46,363667	1170,96072
0,100 062 559E+0	0,376 497 576E+4	0,414 937 759E+1	0,241 000 000E+0	0,900 000 000E+3	0,334 977 842E+4	0,916 653 194E+1	0,222 164 469E+1	0,175 890 657E+1	0,126 256 905E+1	0,724 027 147E+3	33,680332	82,6467212
0,200 000 690E+2	0,361 278 555E+4	0,190 059 869E-1	0,526 150 000E+2	0,900 000 000E+3	0,323 266 450E+4	0,659 070 225E+1	0,271 928 538E+1	0,193 510 526E+1	0,128 334 476E+1	0,698 445 674E+3	35,027805	100,351901
0,700 000 006E+3	0,286 552 456E+4	0,114 841 020E-2	0,870 769 000E+3	0,900 000 000E+3	0,206 163 741E+4	0,417 223 802E+1	0,358 031 986E+1	0,266 422 350E+1	0,507 250 083E+1	0,201 933 608E+4	Out of range!	Out of range!

Note: in this table, some input values (Pressure or Enthalpy) are entered to more decimal positions than are visible. This is because they need to be entered values for other decimal positions not listed in source, so that calculated values exactly match values in source tables. However, this is only an optical effect, because deviations caused by not entering non-displayed decimal positions are so small that they are well within the calculation uncertainties given in source.

Checking calculation and example of using IF95 functions - calculation by iterations from P and S

To check calculations except for dynamic viscosity and thermal conductivity, data from "Revised Release on the IAPWS Industrial Formulation 1995 …", doc. No. IAPWS R6-95(2018) year 2018; from table 7 on page 15 are used. Calculation of dynamic viscosity and thermal conductivity is for information only, check data are in separate tables.

Input values		Output values										
Pressure	Specific entropy	Specific volume	Specific density	Specific enthalpy	Specific internal energy	Temperature	Specific isobaric heat capacity	Specific isochoric heat capacity	Isentropic exponent	Speed of sound	Dynamic viscosity	Thermal conductivity
P [MPa]	s [kJ/kgK]	v [m^3/kg]	ρ [kg/m^3]	h [kJ/kg]	u [kJ/kg]	[K]	c_p [kJ/kgK]	c_v [kJ/kgK]	kapa [--]	w [m/s]	mi [μPa.s]	lam [mW/Km]
0,992 418 352E-1	0,393 062 643E+0	0,100 345 590E-2	0,996 556 000E+3	0,112 652 982E+3	0,112 553 397E+3	0,300 000 000E+3	0,418 064 167E+1	0,413 018 112E+1	0,226 395 956E+5	0,150 151 914E+4	853,742741	609,810682
0,200 022 515E+2	0,387 405 401E+0	0,994 720 026E-3	0,100 530 800E+4	0,130 839 813E+3	0,110 943 172E+3	0,300 000 000E+3	0,412 821 768E+1	0,406 798 347E+1	0,118 411 690E+3	0,153 492 501E+4	852,529677	620,626851
0,700 004 704E+3	0,132 609 616E+0	0,841 607 740E-3	0,118 820 200E+4	0,668 517 926E+3	0,793 885 486E+2	0,300 000 000E+3	0,377 321 943E+1	0,346 135 580E+1	0,101 354 355E+2	0,244 357 992E+4	1309,230314	795,644857
0,999 679 423E-1	0,794 488 271E+1	0,229 885 058E+1	0,435 000 000E+0	0,292 855 966E+4	0,269 874 830E+4	0,500 000 000E+3	0,198 124 932E+1	0,150 817 541E+1	0,130 824 045E+1	0,548 314 253E+3	17,299092	36,0317367
0,999 938 125E+0	0,682 502 725E+1	0,220 653 133E+0	0,453 200 000E+1	0,289 122 108E+4	0,267 058 160E+4	0,500 000 000E+3	0,227 945 279E+1	0,166 991 025E+1	0,130 083 826E+1	0,535 739 001E+3	17,053577	38,4725608
0,100 003 858E+2	0,256 690 919E+1	0,119 328 182E-2	0,838 025 000E+3	0,977 181 624E+3	0,965 248 346E+3	0,500 000 000E+3	0,460 222 448E+1	0,322 106 219E+1	0,135 433 363E+3	0,127 128 441E+4	119,828393	646,408561
0,700 000 405E+3	0,203 237 509E+1	0,922 029 498E-3	0,108 456 400E+4	0,141 111 398E+4	0,765 692 960E+3	0,500 000 000E+3	0,367 154 109E+1	0,307 437 693E+1	0,901 393 987E+1	0,241 200 877E+4	Out of range!	Out of range!
0,220 384 756E+2	0,432 092 307E+1	0,279 329 609E-2	0,358 000 000E+3	0,202 850 969E+4	0,196 694 971E+4	0,647 000 000E+3	0,353 179 841E+4	0,618 315 728E+1	0,103 276 727E+1	0,252 145 078E+3	46,363667	1170,96072
0,100 062 559E+0	0,916 653 194E+1	0,414 937 759E+1	0,241 000 000E+0	0,376 497 576E+4	0,334 977 842E+4	0,900 000 000E+3	0,222 164 469E+1	0,175 890 657E+1	0,126 256 905E+1	0,724 027 147E+3	33,680332	82,6467212
0,200 000 690E+2	0,659 070 225E+1	0,190 059 869E-1	0,526 150 000E+2	0,361 278 555E+4	0,323 266 450E+4	0,900 000 000E+3	0,271 928 538E+1	0,193 510 526E+1	0,128 334 476E+1	0,698 445 674E+3	35,027805	100,351901
0,700 000 006E+3	0,417 223 802E+1	0,114 841 020E-2	0,870 769 000E+3	0,286 552 456E+4	0,206 163 741E+4	0,900 000 000E+3	0,358 031 986E+1	0,266 422 350E+1	0,507 250 083E+1	0,201 933 608E+4	Out of range!	Out of range!

Note: in this table, some input values (Pressure or Entropy) are entered to more decimal positions than are visible. This is because they need to be entered values for other decimal positions not listed in source, so that calculated values exactly match values in source tables. However, this is only an optical effect, because deviations caused by not entering non-displayed decimal positions are so small that they are well within the calculation uncertainties given in source.

Checking calculation to compare IF95 and IF97 and example of using their functions - equations for saturation line

For checking calculations, data from "Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use", document No. IAPWS R6-95(2018) year 2018; from table 8 on page 15 as input.

Values calculated by IF97 equations :

	T = 275 °K	T = 450 °K	T = 625 °K
Specific density ρ' [kg/m^3]	0,999 888 397E+3	0,890 346 801E+3	0,567 062 014E+3
Specific density ρ" [kg/m^3]	0,550 647 310E-2	0,481 150 942E+1	0,118 308 455E+3
Specific enthalpy h' [kJ/kg]	0,775 955 758E+1	0,749 293 340E+3	0,168 627 331E+4
Specific enthalpy h" [kJ/kg]	0,250 429 111E+4	0,277 441 019E+4	0,255 065 140E+4
Specific entropy s' [kJ/kgK]	0,283 088 058E-1	0,210 894 620E+1	0,380 191 134E+1
Specific entropy s" [kJ/kgK]	0,910 661 682E+1	0,660 922 243E+1	0,518 491 640E+1

Selected values from table 8 on page 15 in IF95 (values are calculated using IF95 equations):

Thermodynamic property values in the two-phase region for selected values of temperature

	T = 275 °K	T = 450 °K	T = 625 °K
Specific density ρ' [kg/m^3]	0,999 887 406E+3	0,890 341 250E+3	0,567 090 385E+3
Specific density ρ" [kg/m^3]	0,550 664 919E-2	0,481 200 360E+1	0,118 290 281E+3
Specific enthalpy h' [kJ/kg]	0,775 972 202E+1	0,749 161 585E+3	0,168 626 976E+4
Specific enthalpy h" [kJ/kg]	0,250 428 995E+4	0,277 441 078E+4	0,255 071 624E+4
Specific entropy s' [kJ/kgK]	0,283 094 670E-1	0,210 865 845E+1	0,380 194 683E+1
Specific entropy s" [kJ/kgK]	0,910 660 120E+1	0,660 921 221E+1	0,518 506 121E+1

Deviations [%] of values calculated according to IF97 from values calculated according to IF95 :

(IF95 values are taken as 100%)

	T = 275 °K	T = 450 °K	T = 625 °K
Specific density ρ' [%]	-0,0001	-0,0006	0,0050
Specific density ρ" [%]	0,0032	0,0103	-0,0154
Specific enthalpy h' [%]	0,0021	-0,0176	-0,0002
Specific enthalpy h" [%]	0,0000	0,0000	0,0025
Specific entropy s' [%]	0,0023	-0,0136	0,0009
Specific entropy s" [%]	-0,0002	-0,0002	0,0028