

**THE INTERNATIONAL ASSOCIATION
FOR THE PROPERTIES OF
WATER AND STEAM**

MEMBERS

Australia
Britain and Ireland
Canada
Czech Republic
Germany
Japan
New Zealand
Russia
Scandinavia (Denmark, Finland, Norway, Sweden)
United States of America

ASSOCIATE MEMBERS

Argentina and Brazil
China
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France
Greece
Italy
Switzerland

EXECUTIVE SECRETARY

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Minutes

of the

General Meeting

of the

International Association for the Properties of Water and Steam

**Prague, Czech Republic
4th September 2018**

Prepared by: Barry Dooley



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**Minutes of the
General Meeting
of the
International Association for the Properties of
Water and Steam**
Prague, Czech Republic
4th September 2018

Tuesday, 4th September 2018. 5:30pm

IAPWS President Kretzschmar opened the General Meeting and welcomed the 55 people in attendance. He explained the background to the General Meeting of IAPWS in that it has always been recognized that it is an opportunity for people attending the ICPWS to observe the workings of the IAPWS organization.

1. Adoption of Agenda

A preliminary agenda had been circulated to all IAPWS members and had been placed on the IAPWS website by the Executive Secretary in May 2018. Copies of this agenda were also available for everybody at the meeting within the booklet of IAPWS activities. There were no suggested changes to the agenda and thus the President requested that it be adopted. It forms Attachment 1 of these minutes.

2. President's Report on Activities of IAPWS 2014 – 2018

President Kretzschmar next provided his report on IAPWS and EC activities since the last General Meeting in London in 2013:

2.1 Membership. IAPWS now has 9 Members and 8 Associate Members. New Zealand became an IAPWS Member. China and Egypt became Associate Members.

2.2 Working Group (WG) Activities. The President introduced the chair people of the four IAPWS Working Groups and Seawater Sub Committee. A short description of the activities of these groups was included within the booklet of IAPWS activities and is included as Attachment 2.

Annual Meetings. Attachment 3 delineates the locations of the annual meetings of the EC and the past presidents.

IAPWS Awards. The fifth IAPWS Gibbs Award was presented to Professor Roberto Fernandez-Prini at the current ICPWS. The following people had been made IAPWS Honorary Fellows since the last General Meeting: Petrova (2014), Nakahara (2015), Harvey (2016) and Weber (2018). The following people had received the Helmholtz Award: Yoshida (2014), Holden (2015), Caupin (2016), Gotovtsev (2017) and Arcis (2018). A full listing of all IAPWS awardees is provided in Attachment.

2.3 IAPWS Products. The President next mentioned the Releases, Supplementary Releases, Guidelines, Advisory Notes, ICRNs and Technical Guidance Documents that were currently in existence and made note of those issued since the last General Meeting. These are provided in Attachments 5 - 10. He also indicated that these products are listed on the IAPWS Web site (www.IAPWS.org).

2.4 Collaborations with Other Organizations. The President mentioned that IAPWS has a number of collaborations with:

- BIPM - International Bureau of Weights and Measures
- IEC - International Electrotechnical Commission
- ASHRAE - American Society of Heating Refrigerating and Air-conditioning Engineers
- ASME - American Society of Mechanical Engineers
- SCOR - Scientific Committee on Oceanic Research
- IAPSO - International Association for the Physical Sciences of the Oceans

There is a Joint SCOR/IAPSO/IAPWS Committee on the Properties of Seawater (JCS).

3. Executive Secretary's Report on Activities of IAPWS 2014 - 2018

The Executive Secretary provided information on the IAPWS financial situation. The record of the IAPWS Bank Account was presented.

The Executive Secretary also indicated that the IAPWS Financial records had been audited and approved each year by VDI in Germany and Professor Safarik in Czech Republic.

The IAPWS Dues Structure had remained the same.

4. Selection of Host Country for the 18th ICPWS

The Executive Secretary indicated that the next country in line to host the 18th ICPWS is the USA followed by Canada, and requested that the head of the US National Committee, Friend, would provide an official answer to the Executive Secretary by the end of 2018.

5. Proposed Activities during Period to Next ICPWS

The President provided his view of the future IAPWS activities:

- 5.1 Development of new Releases, Supplementary Releases, Guidelines, Advisory Notes, and ICRNs will be dependent on the requirements of industry or science and on the availability of new data and/or new correlation methods.
- 5.2 The Technical Guidance Documents of PCC are penetrating into power plant chemistry and creating worldwide interest, putting IAPWS in a leadership position. PCC is going to produce further Technical Guidance Documents.
- 5.3 The IRS working group will continue its work. Members from industry are very important for IAPWS. Traditionally, requirements for the development of standards come from industry.
- 5.4 Expansion of IAPWS activities to further communities, for example in the fields:
 - Renewables,
 - Solar power
 - Desalination
 - Refrigeration,
 - Air-conditioning
 - Geothermal technology
 - Supply and disposal technology
 - Meteorology, tropospheric and climate Research
- 5.5 Acquisition of new member countries
- 5.6 Activities to make IAPWS more well known in the world

6. New Business

The President requested if there were any items of new business. None were raised.

7. Adjournment

The General Meeting adjourned at 5:55pm.

**AGENDA
for the
GENERAL Meeting
of
IAPWS**

Prague, Czech Republic. 4th September 2018

Tuesday, 4th September 2018. 17:30

Opening Remarks by IAPWS President, Professor Hans-Joachim Kretzschmar

1. Adoption of Agenda by General Assembly
2. President's Report on Activities of IAPWS 2014 - 2018
 - 2.1 Membership
 - 2.2 Working Group Activities
 - 2.3 Annual Meetings
 - 2.4 IAPWS Awards (Gibbs, Helmholtz and Honorary Fellow)
 - 2.5 IAPWS Products (Releases, Guidelines, Advisory Notes, ICRNs and Technical Guidance Documents)
 - 2.6 Collaboration with Other Organizations
 - 2.7 Other
3. Executive Secretary's Report on Activities of IAPWS 2014 - 2018
 - 3.1 Financial, Auditors and Dues
4. Selection of Host Country and Year for the 18th ICPWS – Executive Secretary
5. Proposed Activities during Period to Next ICPWS
6. New Business – General Assembly
7. Adjournment

Barry Dooley
29th August 2018

**IAPWS WORKING GROUP AND SUB-COMMITTEE MAIN ACTIVITIES
SINCE THE 16TH ICPWS IN LONDON, UK IN 2013 (September 2018)**

WORKING GROUP - THERMOPHYSICAL PROPERTIES OF WATER AND STEAM (TPWS)

Chair: Allan Harvey, Vice Chairs: Jan Hruby and Karsten Meier

The Working Group on Thermophysical Properties of Water and Steam has completed a new formulation for the thermodynamic properties of heavy water (D₂O), with improved range, accuracy, and computational stability compared to the previous formulation that was over 35 years old. The new formulation took advantage of some new high quality experimental data and theoretical calculations that were encouraged by IAPWS for purposes of this project. A new Guideline has been completed for the properties of supercooled water, allowing accurate and consistent thermodynamic calculations in this region of major scientific interest. Additional Guidelines have been produced on the calculation of the fugacity of water in humid air, which is important for atmospheric and climate science, and (in collaboration with the PCAS Working Group) on the thermal conductivity of seawater.

Current projects include work to produce new correlations for the transport properties (viscosity and thermal conductivity) of heavy water, work to produce a formulation for the diffusivity of water that covers a wide range of temperature and pressure, production of a new IAPWS formulation for the surface tension of water, and work on the surface tension and the viscosity of seawater.

WORKING GROUP - INDUSTRIAL REQUIREMENTS AND SOLUTIONS (IRS)

Chairman: Nobuo Okita, Vice Chairman: Adam Nový

The mission of the Working Group on Industrial Requirements and Solutions is “To identify and prioritize industrial requirements for water, steam, and aqueous systems, to work with other IAPWS working groups to deliver solutions and to support implementation of solutions”.

The Task Group “Guideline on the Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method (SBTL)” was set up in 2013, and a new guideline IAPWS G13-15 has been released. Revised Supplementary Releases on Backward Equations, IAPWS-SR2-01, SR3-03, SR4-04 and SR5-05 also have been published for reducing computing times further when using IAPWS-IF97. Advisory Note No. 5 has been newly released for industrial calculations of the thermodynamic properties of seawater. Calculations on wet steam properties have been surveyed for defining industrial requirements to low pressure turbines or wet steam turbines such as nuclear, geothermal and solar thermal turbines.

“New Industrial Requirements” and “Future IRS” were discussed and the Task Group “Categories of Industrial Requirements” has been set up to collect, sort and categorize items of industrial interests or issues for the sake of reconsidering IRS missions and/or roles working with other WGs in IAPWS. IRS is focusing not only on calculation methods of industrial use but also on new issues or interests, for example, effects of wet steam with foreign substances on geothermal plants as one of renewable energies to be developed sustainably.

SUBCOMMITTEE ON SEAWATER (SCSW)

Chairman: Rich Pawlowicz, Vice Chairman: Rainer Feistel

In 2013 SCSW joined with the Scientific Committee on Oceanic Research (SCOR) and the International Association for the Physical Sciences of the Oceans (IAPSO) to jointly sponsor a permanent committee to continue developing standards for seawater. This Joint SCOR/IAPSO/IAPWS Committee on the Properties of Seawater (JCS) was formed with terms of reference developed at a series of workshops held at ICPWS16. JCS tasks since then have included maintaining and expanding the TEOS-10 software suite for the properties of seawater, maintaining a TEOS-10 web site (www.teos-10.org), maintaining contacts with the International Bureau of Weights and Measures (BIPM), including participation in meetings of the Consultative Committees on Thermometry (CCT) and Amount of Substance (CCQM), liaising with other groups interested in the properties of seawater and encouraging more research and measurements in this area, and (in 2016) publishing a comprehensive 4-part review paper on metrological challenges for measurements of key climatological observables in the journal *Metrologia*, which was meant to provide a path forwards towards SI traceability of oceanic salinity, seawater pH, and atmospheric relative humidity.

WORKING GROUP - PHYSICAL CHEMISTRY OF AQUEOUS SYSTEMS (PCAS)

Chairman: Andre Anderko, Vice Chairman: Josef Sedlbauer

The activities of PCAS are focused on the fundamental thermodynamic and kinetic properties of aqueous solutions, with particular emphasis on high-temperature systems that are relevant to power generation. Since 2013, the main areas of research have been the speciation and thermodynamic properties of aqueous solutions in power cycle engineering, properties of simple and complex organic solutes in water, transport properties in aqueous systems, reactivity of inorganic and organic species in water, properties of complex aqueous solutions containing rare earth elements, actinides, and transition metals in energy-related industries, and cavitation phenomena.

PCAS has developed a guideline for the thermal conductivity of seawater. A guideline on the self-diffusion in high-temperature water is under preparation.

WORKING GROUP - POWER CYCLE CHEMISTRY (PCC)

Chairman: Michael Rziha, Vice Chairmen: Paul McCann; Frank-Udo Leidich

PCC brings together scientists and engineers from academia and research organizations, power plant operators, equipment manufacturers and other relevant interested parties from around the world. For the benefit of the industry worldwide the main activities and goals in power cycle chemistry are to:

- Collaborate and share results of scientific and engineering research and experience
- Identify gaps in technical information relating to power cycle chemistry
- Seek resolution of these gaps through international cooperative projects and the release of appropriate documents.

Since 2013, PCC has developed and published further Technical Guidance Documents (TGD) for the control and operation of cycle chemistry in fossil and combined cycle plants, and currently there are 8 existing IAPWS TGD.

The development of additional new TGD is progressing and the following documents are under preparation for finalization in the next two years:

1. Air In-leakage in Steam Water Cycles (Release expected by end of 2018).
2. Ensuring the Integrity and Reliability of Demineralized Makeup Water Supply to the Unit Cycle.
3. Monitoring Corrosion Products in Flexible (cycling and two-shifting) Plants (White Paper)
4. Film Forming Substances (FFS).
 - a. Application of Film Forming Substances in Nuclear Plants (White Paper).
 - b. Application of Film Forming Substances in Industrial Plants.
5. Aspects of Geothermal Steam Chemistry (White Paper).
6. Condensate Polishing (White Paper).
7. Chemistry in Water cooled Generators (Release expected by September 2019)

IAPWS Annual Meetings and ICPWS

<u>Place</u>	<u>Year</u>	<u>ICPWS</u>	<u>President</u>
Giens, France	1974	8th ICPWS	Vodar (France)
Ottawa, Canada	1975		Kestin (USA)
Kyoto, Japan	1976		Kestin (USA)
Moscow, USSR	1977		Bradly (UK)
Washington, USA	1978		Bradly (UK)
Munich, Germany	1979	9th ICPWS	Grigull (Germany)
London, UK	1980		Grigull (Germany)
Prague, Czechoslovakia	1981		Tanashita (Japan)
Ottawa, Canada	1982		Tanashita (Japan)
Tokyo, Japan	1983		Sytchev (USSR)
Moscow, USSR	1984	10th ICPWS	Sytchev (USSR)
Washington, USA	1985		Hill (Canada)
Dusseldorf, Germany	1986		Hill (Canada)
Reading, UK	1987		Grigull (Germany)
Vancouver, Canada	1988		Grigull (Germany)
Prague, Czechoslovakia	1989	11th ICPWS	Pichal (Czechoslovakia)
Buenos Aires, Argentina	1990		Pichal (Czechoslovakia)
Tokyo, Japan	1991		Levelt Sengers (USA)
St. Petersburg, Russia	1992		Levelt Sengers (USA)
Milan, Italy	1993		Cooper (UK)
Orlando, USA	1994	12th ICPWS	Cooper (UK)
Paris, France	1995		Watanabe (Japan)
Fredericia, Denmark	1996		Watanabe (Japan)
Erlangen, Germany	1997		Fernandez-Prini (Argentina)
London, UK	1998		Fernandez-Prini (Argentina)
Toronto, Canada	1999	13th ICPWS	Tremaine (Canada)
Prague, Czech Republic	2000		Tremaine (Canada)
Gaithersburg, USA	2001		Rukes (Germany)
Buenos Aires, Argentina	2002		Rukes (Germany)
Vejle, Denmark	2003		Watanabe (Japan)
Kyoto, Japan	2004	14 th ICPWS	Watanabe (Japan)
Santorini, Greece	2005		Marsik (Czech Republic)
Whitney, UK	2006		Marsik (Czech Republic)
Lucerne, Switzerland	2007		Cooper (BIAPWS)

<u>Place</u>	<u>Year</u>	<u>ICPWS</u>	<u>President</u>
Berlin, Germany	2008	15 th ICPWS	Cooper (BIAPWS)
Doorwerth, The Netherlands	2009		Friend (USA)
Niagara Falls, Canada	2010		Friend (USA)
Plzen, Czech Republic	2011		Daucik (Denmark)
Boulder, USA	2012		Daucik (Denmark)
Greenwich, UK	2013	16 th ICPWS	Petrova (Russia)
Moscow, Russia	2014		Petrova (Russia)
Stockholm, Sweden	2015		Guzonas (Canada)
Dresden, Germany	2016		Kretzschmar (Germany)
Japan	2017		Kretzschmar (Germany)
Czech Republic	2018	17 th ICPWS	Kretzschmar (Germany)
Canada	2019		Hruby (Czech Republic)
	2020		Hruby (Czech Republic)
	2021		

IAPWS AWARDS (September 2018)**IAPWS Gibbs Award**

Year	Gibbs Award
1999	Professor E.U. Franck, University of Karlsruhe (Germany)
2004	Professor R.H. Wood, University of Delaware (USA)
2008	Prof. em. Dr.-Ing. W. Wagner, Ruhr-University Bochum (Germany)
2013	Professor D.D. Macdonald, Berkeley University (USA)
2018	Professor R. Fernández-Prini, CNEA, CONICET and UBA (Argentina)

IAPWS Helmholtz Award

Year	Helmholtz Award
2000	Dr. Andrzej Anderko, OLI Systems, Inc.
2001	Dr. Nobuyuki Matubayasi, Kyoto University
2003	Prof. Eric Luijten, University of Illinois
2005	Dr. Valeria Molinero, California Institute of Technology
2006	Dr. Hong-Wei Xiang, Chinese Academy of Sciences
2007	Dr. Karsten Meier, Helmut-Schmidt University
2008	Dr. Noriyuki Yoshii, Himeji Dokkyo University
2010	Ms. Melonie Myszczyzyn, Canadian Natural Resources Limited
2011	Prof. Hertanto Adidharma, University of Wyoming
2012	Prof. Maxim Fedorov, University of Strathclyde
2013	Prof. Henry Ashbaugh, Tulane University
2014	Prof. Ken Yoshida, University of Tokushima
2015	Dr. Vincent Holden, Cornell University
2016	Dr. Frédéric Caupin, Université Claude Bernard Lyon 1 et CNRS
2017	Dr. Pavel Gotovtsev, Kurchatov Institute

Year	Honorary Fellow
1981	Professor S. Beitler Professor H. Hausen Professor J. Juza Professor Sugawara Professor N.B. Vargaftik
1982	Professor B. Vodar
1985	Professor E.J. LeFevre Professor I. Tanishita
1987	Dr. S. Angus Professor U. Grigull Professor J. Kestin Mr. R.C. Spencer
1988	K.R. Schmidt Dr. H.J. White
1990	Dr. G. Bohnsack
1991	Professor O.I. Martynova
1992	Professor A.A. Alexandrov Professor E.U. Franck
1993	Dr. E. Whalley
1994	Dr. J.M.H. Levelt Sengers
1996	Dr. A. Bursik
1997	Professor P.G. Hill Professor J. Straub Professor K. Watanabe
1998	Professor W. Wagner
1999	Mr. J.R. Cooper
2000	Professor B. LeNeindre Professor J.V. Sengers
2001	Professor A. Nagashima Dr. O. Šifner
2002	Dr. R. Fernandez-Prini
2003	Mr. K. Daucik
2004	Mr. K. Miyagawa Professor P. Tremaine
2005	Dr. B. Rukes
2006	Dr. J.C. Bellows Dr. R.B. Dooley
2007	Dr. D.A. Palmer
2008	Dr. R. Svoboda
2010	Dr. G. Bignold

2011	Professor R. Mareš
2012	Dr. D.G. Friend Prof. H.-J. Kretzschmar
2013	Dr. R. Feistel
2014	Professor T. Petrova
2015	Professor M. Nakahara
2016	Dr. A. Harvey
2018	Mr. I. Weber

CURRENT IAPWS RELEASES (September 2018)

- **R16-17.** Release on the IAPWS Formulation 2017 for the Thermodynamic Properties of Heavy Water. September 2017. (This replaces the revised release of 2005 which replaced the original release of 1984).
- **R15-11.** Release on the IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance. September 2011.
- **R14-08(2011).** Revised Release on the Pressure along the Melting and Sublimation Curves of Ordinary Water Substance. September 2011. (This is a minor revision of the 2008 revised release, which replaced the corresponding release of 1993)
- **R13-08.** Release on the IAPWS Formulation 2008 for the Thermodynamic Properties of Seawater. September 2008.
- **R12-08.** Release on the IAPWS Formulation 2008 for the Viscosity of Ordinary Water Substance (September 2008).
- **R11-07.** Release on the Ionization Constant of H₂O (August 2007) (This release replaces the corresponding release of 1980)
- **R10-06(2009).** Revised Release on the Equation of State 2006 for H₂O Ice Ih. September 2009. (This is a minor revision of the 2006 release)
- **R9-97.** Release on the Refractive Index of Ordinary Water Substance as a Function of Wavelength, Temperature and Pressure. September 1997. (This release replaces the corresponding release of 1991)
- **R8-97.** Release on the Static Dielectric Constant of Ordinary Water Substance for Temperatures from 238 K to 873 K and Pressures up to 1000 MPa. September 1997. (This release replaces the corresponding release of 1977)
- **R7-97(2012).** Revised Release on the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam (*The revision only relates to the extension of region 5 to 50 MPa*) (August 2007) (This is a revision of the 1997 release, which replaced the corresponding release of 1967).
NOTE: This release has been supplemented by additional "backward" equations for $p(h,s)$ in Regions 1 and 2, $T(p,h)$, $v(p,h)$, $T(p,s)$, $v(p,s)$ in Region 3, $p(h,s)$ in Region 3 with auxiliary equations for independent variables h and s , and $v(p,T)$ in Region 3.
- **R6-95(2016).** Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use. September 2016. (This is a minor revision of the 1995 release, which replaced the corresponding release of 1984)
- **R5-85(1994).** Release on Surface Tension of Heavy Water Substance. September 1994. (This is a revision of the 1985 Release)
- **R4-84(2007).** Revised Release on Viscosity and Thermal Conductivity of Heavy Water Substance. August 2007. (This is a revision of the 1984 Release)
- **R2-76(2014).** Release on Values of Temperature, Pressure and Density of Ordinary and Heavy Water Substances at their Respective Critical Points. September 1992. (This is a revision of the 1983 Release)
- **R1-76(2014).** Revised Release on Surface Tension of Ordinary Water Substance. June 2014. (This is a minor revision of the 1994 revision of the 1976 Release)

CURRENT IAPWS SUPPLEMENTARY RELEASES (September 2018)

- **SR7-09.** Supplementary Release on a Computationally Efficient Thermodynamic Formulation for Liquid Water for Oceanographic Use. September 2009.
- **SR6-08(2011).** Revised Supplementary Release on Properties of Liquid Water at 0.1 MPa. September 2011). (This is a revision of the 2008 Supplementary Release).
- **SR5-05(2016).** Revised Supplementary Release on Backward Equations for Specific Volume as a Function of Pressure and Temperature $v(p,T)$ for Region 3 of the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam. June 2014. (This is a revision of the 2005 Supplementary Release).
NOTE: This Supplementary Release provides additional "backward" equations designed to accompany the IAPWS Industrial Formulation 1997.
- **SR4-04(2014).** Revised Supplementary Release on Backward Equations $p(h,s)$ for Region 3, Equations as a Function of h and s for the Region Boundaries, and an Equation $T_{\text{sat}}(h,s)$ for Region 4 of the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam. June 2014. (This is a revision of the 2004 Supplementary Release).
NOTE: This Supplementary Release provides additional "backward" equations designed to accompany the IAPWS Industrial Formulation 1997.
- **SR3-03(2014).** Revised Supplementary Release on Backward Equations for the Functions $T(p,h)$, $v(p,h)$, and $T(p,s)$, $v(p,s)$ for Region 3 of the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam. June 2014. (This is a revision of the 2004 Revised Supplementary Release).
NOTE: This Supplementary Release provides additional "backward" equations designed to accompany the IAPWS Industrial Formulation 1997.
- **SR2-01(2014).** Revised Supplementary Release on Backward Equations for Pressure as a Function of Enthalpy and Entropy $p(h,s)$ to the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam. June 2014. (This is a revision of the 2001 Supplementary Release).
NOTE: This Supplementary Release provides additional "backward" equations designed to accompany the IAPWS Industrial Formulation 1997.
- **SR1-86(1992).** Revised Supplementary Release on Saturation Properties of Ordinary Water Substance. September 1992. (This is a revision of the 1986 Release).

CURRENT IAPWS GUIDELINES (September 2018)

- **G13-15.** Guideline on the Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method (SBTL). July 2015.
- **G12-15.** Guideline on Thermodynamic Properties of Supercooled Water. July 2015.
- **G11-15.** Guideline on a Virial Equation for the Fugacity of H₂O in Humid Air. July 2015.
- **G10-15.** Guideline on the Thermal Conductivity of Seawater Vapor. July 2015.
- **G9-12.** Guideline on a Low-Temperature Extension of the IAPWS-95 Formulation for Water Vapor. October 2012.
- **G8-10.** Guideline on an Equation of State for Humid Air in Contact with Seawater and Ice, Consistent with the IAPWS Formulation 2008 for the Thermodynamic Properties of Seawater. July 2010.
- **G7-04.** Guideline on the Henry's Constant and Vapor-Liquid Distribution Constant for Gases in H₂O and D₂O at High Temperatures. September 2004. (This guideline replaces a gas solubility guideline issued in 1993 and a distribution constant guideline issued in 1998.)
- **G6-03.** Guideline on the Tabular Taylor Series Expansion (TTSE) Method for Calculation of Thermodynamic Properties of Water and Steam Applied to IAPWS-95 as an Example. August 2003.
- **G5-01(2106).** Guideline on the Use of Fundamental Physical Constants and Basic Constants of Water. September 2001.
NOTE: This Guideline is reviewed annually and updated as necessary. Latest update September 2016.
- **G4-01.** Guideline on the IAPWS Formulation 2001 for the Thermodynamic Properties of Ammonia-Water Mixtures. September 2001.
- **G3-00(2012).** Revised Guideline on the Critical Locus of Aqueous Solutions of Sodium Chloride. (This is a revision of the 2000 Guideline). October 2012.
- **G2-90(1994).** Guideline: "Solubility of Sodium Sulfate in Aqueous Mixtures of Sodium Chloride and Sulfuric Acid from Water to Concentrated Solutions, from 250°C to 350°C". (This is a revision of the 1990 Guideline). September 1994.
- **G1-90.** Guideline: "Electrolytic Conductivity (Specific Conductance) of Liquid and Dense Supercritical Water from 0°C to 800°C and Pressures up to 1000 MPa". May 1990.

CURRENT IAPWS ADVISORY NOTES (September 2018)

- **AN6-16.** Advisory Note No. 6: Relationship between Various IAPWS Documents and the International Thermodynamic Equation of Seawater – 2010 (TEOS – 10). September 2016.
- **AN5-13(2016).** Advisory Note No. 5: Industrial Calculation of the Thermodynamic Properties of Seawater. September 2013.
- **AN4-09.** Advisory Note No. 4: Roles of IAPWS and CIPM Standards for the Density of Water. September 2009.
- **AN3-07(2014).** Revised Advisory Note No. 3: Thermodynamic Derivatives from IAPWS Formulations. June 2014. (This is a revision of the 2007 Advisory Note)
- **AN2-04(2013).** Advisory Note No. 2: Role of Various IAPWS Documents Concerning the Thermodynamic Properties of Ordinary Water Substance (September 2004)
NOTE: This Advisory Note is reviewed annually and updated as necessary. Latest update September 2013.
- **AN1-03.** Advisory Note No. 1: Uncertainties in Enthalpy for the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (IAPWS-95) and the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam (IAPWS-IF97). August 2003).

IAPWS CERTIFIED RESEARCH NEEDS (ICRNS) (September 2018)

Active ICRNs

16. Thermophysical Properties of Seawater. Issued August 2007. Revised July 2011 and June 2014. Expires June 2019. IAPWS Contact: R. Pawlowicz.
22. Steam Chemistry in Turbine Phase Transition Zone. Issued July 2010. Expires September 2013. At 2014 Meetings EC approved extension for one year to June 2015. At 2017 meeting ICRN was finalized with an expiration date of September 2019. Needs an Editorial Committee review and then be sent for Postal Ballot. IAPWS Contacts: M. Stastny.
25. Corrosion Mechanisms that are Related to the Presence of Contaminants in Steam/Water Circuits Particularly Boiler Water. Issued June 2014. Expires June 2019. IAPWS Contact: W. Cook.
26. Behaviour of Aluminum in the Steam/Water Cycle of Power Plants. Issued September 2011 and June 2014. Expires June 2019. Contacts: R. Svoboda and M. Rziha.
28. Thermophysical Properties of Metastable Steam and Homogeneous Nucleation. Issued September 2011 and June 2014. Expires June 2019. Contact: J. Hruby.
29. Resolving Uncertainties in Coolant Sampling for Low-Concentration Metals (Fe, Cu, Co, etc.). Planned issue date: 2014. At 2017 meeting ICRN was finalized with an expiration date of September 2021. Needs an Editorial Committee review and then be sent for Postal Ballot. Contact: D. Lister.
30. Thermodynamic Properties of Supercooled Water. Issued July 2015. Expires July 2020. Contact: O. Hellmuth.

IAPWS CERTIFIED RESEARCH NEEDS (ICRNS) (September 2018)

Closed and Expired ICRNs

1. Evaluation of Binary Nucleation Models. Issued September 1993. Closed August 2004. Closing Statement November 2005. IAPWS Contact: F. Signon.
2. Solubility of Sodium Sulphate in Superheated Steam. Issued September 1993. Expired September 2001. IAPWS Contact: K. Dacic. Closing Statement, October 2001.
3. Solubility of Spinel in the Chemical Conditions of Nuclear Reactors. Issued September 1993. Expired September 1996. Closing statement prepared. IAPWS Contacts: D. You.
4. Interaction Between Sodium Salts (Phosphates, Sulfates, Silicates, Borates) and Transition Metal Oxides. Issued September 1993. Closed September 1996. IAPWS Contact: J. Stodola.
5. Origin, Behaviour, and Fate of Organics in the Power Cycle. Issued September 1993. Closing Statement September 2006. IAPWS Contact: E. Maughan.
6. Thermophysical Properties of Ammonia-Water Mixtures. Issued June 1994. Closed September 2002. IAPWS Contact: W. Parry. Closing Statement, July 2002.
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11. Properties of Salts in Steam. Issued May 1996. Closed September 2001. IAPWS Contacts: D. Palmer and R. Fernandez-Prini. No Closing Statement.
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13. Surface Tension of Aqueous Solutions. Issued September 1998. Extended to September 2009. Closing Statement: September 2009. IAPWS Contacts: T. Nemecek and F. Marsik.
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17. Research on Amines for the Power Industry. Originally issued July 2010. Expired September 2013.

18. Decomposition of Ion Exchange Resins. Issued September 2006. Expires September 2009. IAPWS Contact: K. Daucik. Closing Statement 22nd July 2010.
19. Improved Coolant Sampling and Analysis of Low Concentration Metals (Fe, Cu, Co, etc.). Issued September 2006. Expired September 2009. ICRN extended to 2014. Expired October 2014. Closing Statement October 2014. IAPWS Contact: D. Lister.
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21. Thermophysical Properties Associated with Ultra-supercritical Coal-Fired Steam Generators. Issued September 2009. Expired September 2012. Closing statement October 2012. IAPWS Contact: D. Palmer, B. Dooley and A. Harvey.
23. Dew Point for Flue Gas of Power Plant Exhaust. Issued September 2008. Expires September 2011. Revision September 2011, Expired September 2012. Closing statement October 2012. IAPWS Contact: N. Okita.
24. Thermal Conductivity of H₂O at Low Pressures and High Temperatures. Issued September 2009. Extended and Expired June 2015. IAPWS Contacts: A. Harvey.
27. Thermodynamic Properties of Humid Gases and CO₂-Rich Mixtures. Issued September 2011. Expired September 2014. IAPWS Contacts: R. Span and A. Harvey

CURRENT IAPWS TECHNICAL GUIDANCE DOCUMENTS (TGD) (September 2018)

- **TGD8-16.** Application of Film Forming Amines in Fossil, Combined Cycle, and Biomass Power Plants. September 2016.
- **TGD7-16.** HRSG High Pressure Evaporator Sampling for Internal Deposit Identification and Determining the Need to Chemical Clean. September 2016.
- **TGD6-13(2014).** Corrosion Product Sampling and Analysis. November 2013. (This 2014 TGD includes editorial revisions of the 2013 TGD].
- **TGD5-13.** Steam Purity for Turbine Operation. September 2013.
- **TGD4-11(2015).** Phosphate and NaOH Treatments for the Steam-Water Circuits of Drum Boilers of Fossil and Combined Cycle/HRSG Power Plants. September 2015. (This is a revision of the 2011 TGD].
- **TGD3-10(2015).** Volatile Treatments for the Steam-Water Circuits of Fossil and Combined Cycle/HRSG Power Plants. July 2015. (This is a revision of the 2010 TGD].
- **TGD2-09(2015).** Instrumentation for Monitoring and Control of Cycle Chemistry for the Steam-Water Circuits of Fossil-Fired and Combined Cycle Power Plants. July 2015. (This is a minor revision of the 2009 TGD].
- **TGD1-08.** Procedures for the Measurement of Carryover of Boiler Water and Steam (September 2008).