Minutes

IAPWS Thermophysical Properties of Water and Steam WG
IAPWS Subcommittee on Seawater (SC SW)

Boulder, Colorado, USA, October 1-4, 2012

NOTE: These Minutes include many items that were held jointly with the IRS Working Group and/or the Subcommittee on Seawater (SCSW) and/or the Working Group PCAS. Items are listed according to their order on the TPWS agenda, which is Attachment A. **Bold print** denotes significant actions.

1-2. The meeting was opened on Monday morning, October 1 by the TPWS Chair, Allan Harvey. The agenda (Attachment A) was adopted after minor additions (attachment reflects additions). The Chair noted that, in accordance with our procedure, the 2011 Minutes had been circulated and approved with minor corrections shortly after the 2011 meeting. Jan Hrubý was appointed Clerk of Minutes for TPWS. Michael Hiegemann was appointed Clerk for SCSW.

3. M. Kunick (speaker) and H.-J. Kretzschmar demonstrated access to a password-protected website for documents and presentations of the TPWS and IRS Working Groups and the SCSW. The site is accessible from the Working Groups page on www.iapws.org.

4. A. Harvey described the proposed international collaborations. The first proposal concerns the viscosity of ammonia-water mixtures. The proposed project should be carried out by a young Russian scientist hosted in the US. The proposed length of the stay was 6-7 months and IAPWS funding was proposed as USD 20,000. The second proposal concerns work toward a new thermodynamic formulation of the properties of heavy water. The proposed project would be carried out by a young German scientist hosted in the US. The proposed length of the stay was about 4 months with cost 7500 USD**.**

5. R. Feistel reported on the "Guideline on a Low-Temperature Extension of the IAPWS-95 Formulation for Water Vapor". Addition of a few terms allows extension of the ideal-gas part of the IAPWS-95 down to 50 K. The proposed IAPWS has completed Working Group review, review by the Editorial Committee, and it has been circulated to National Committees. No objections were raised. A. Harvey presented a test report prepared by K. Miyagawa and F. Blangetti. The test report confirmed the validity of the suggested low-temperature extension. Sublimation vapor pressures computed using the low-temperature extension and the Revised Release on the Equation of State 2006 for H_2O Ice Ih agree with sublimation pressures obtained from the Revised Release on the Pressure along the Melting and Sublimation Curves of Ordinary Water Substance within the stated uncertainties. **The working Groups TPWS and SCSW voted to approve the Guideline on a Low-Temperature Extension of the IAPWS-95 Formulation for Water Vapor and to recommend its adoption by the EC.**

6. W. Wagner reported on editorial changes to the IAPWS-95 and IAPWS-IF97 documents. First change concerns clarification of the limit of validity of Eq. (18) of the IF-97 describing thermodynamic properties of metastable steam. **The Working Groups TPWS and IRS voted to approve the editorial change.** The second editorial change concerned a statement that the IAPWS-95 formulation can be used for computing the properties of water vapor also in a temperature range

down to 130 K. The ideal-gas part (even without the Low-Temperature Extension) is valid in this range. W. Wagner demonstrated that the second virial coefficient and the compressibility factor at saturation show physically correct behaviors (although they are purely extrapolations). The magnitude of the deviations from the ideal behavior is so small that the IAPWS-95 formulation can be considered as valid also in this region. **The Working Group TPWS voted to approve the proposed editorial changes.**

7. W. Wagner reported on the behavior of the IAPWS-95 formulation in the liquid region of water near the melting line at high pressures. In a recent article, extrapolated behavior of the IAPWS-95 formulation was tested in the range of supercooled water between 200 to 300 K and 0.1 MPa to 400 MPa. It was stated that the behavior of IAPWS-95 in this region is not in accord with recent data by Mishima (2010). However, the supercooled region is not included in the range of validity of IAPWS-95 and, therefore, the IAPWS-95 formulation cannot be blamed of wrong predictions in this region. W.W. further demonstrated that IAPWS-95 agrees with recent data in the vicinity of the melting line within the uncertainties stated in the IAPWS-95 release. Deviations in expansivity and isobaric heat capacity at pressures above 100 MPa will require further analysis.

R. Feistel stated that with respect to the new data for the supercooled water at elevated pressure it was necessary to reconsider the IAPWS-95 properties in the metastable region of seawater freezing point lowering. A task group was formed. Members are: J. Hrubý (chair), M. Anisimov, R. Feistel, O. Hellmuth, V. Holten and W. Wagner

8. Industrial Requirements and Solutions for Steam Property Calculations: **this item is reported on in the Minutes of the WG IRS.**

9. Advisory Note on the Properties of Sea Water for Industrial Use: **This item is reported on in the Minutes of the WG IRS.**

10.1-10.3 Recent Measurements of Seawater Properties (R. Feistel, J. Safarov). New data for density of seawater at high pressures and temperatures (up to S_A=55 and T=195°C) is available. In the discussion it was found necessary to establish a new Task Group with two goals: 1. Extension of the existing Gibbs formulation to higher temperatures, salinities and pressures, 2. Defining the formal position of the extended formulation with respect to the TEOS-10 formulation (either by replacing it with an improved formulation, or the addition of a correction in this new part of parameter space. The members are: R. Feistel (chair), J. Cooper, A. Harvey, M. Hiegemann, J. Hrubý. H.-J. Kretzschmar, R. Pawlowicz.

11.1 R. Feistel presented a report by P. Spitzer concerning a EURAMET Project on the metrology for oceanic salinity and acidification. One of its main topics is establishing SI traceability of practical salinity based on density standards. Further topics are: SI traceability of pH measurements, extension of measurement ranges, in particular for the speed of sound. Refractive index of seawater is not yet considered mature. It is desirable to have a formulation for the refractive index of seawater in IAPWS.

11.2 A. Anderko (speaker) and A. Harvey reported on the activities of the Task Group “Transport Properties of Seawater”. A model for multicomponent salt solutions was developed, applied to seawater and compared with experimental data. During the past year the reference pure-water equation was replaced by the new formulation of thermal conductivity of ordinary water. The plan is to prepare a draft IAPWS guideline for thermal conductivity of seawater about by March 2013. An

Evaluation Task Group was established consisting of K. Miyagawa and F. Blangetti (subject to his acceptance). M. Hiegemann made a comment that it was desirable to develop a model for seawater viscosity in the near future.

11.3 Rich Pawlowicz reported on high temperature and high salinity electrical conductivity of seawater. The PSS-78 standard can be used at high salinities and temperatures with an error of 1 to 2%. (In the Neptunian range less than 0.006%). In response to questions, he mentioned that he felt it would be premature to make an IAPWS recommendation at this stage, since the results were only supported by numerical modelling.

11.4 R. Feistel reported on various definitions of relative humidity: relative vapor mass, mixing ration, relative specific humidity, relative vapor mole fraction, relative fugacity, IUPAC/ASHRAE, pure-vapor, extended/pragmatic. Although the various definitions give similar values, they are all mutually inconsistent. It is still an open question which definition will be adopted by the different communities. There was a debate whether the focus should be on physics (fugacity-based RH) or application-oriented RH definition. Problems may occur in the adoption by certain communities if fugacity-based RH is used. One role for IAPWS may be to provide relations between existing definitions.

11.5 R. Feistel (speaker) and A. Harvey reported on the effect of air dissolution in water and seawater. He proposed an extension of the TEOS-10 by adding an extra term to the Gibbs function reflecting the dissolved air contribution.

11.6 H. Uchida on Reference Materials for Dissolved Oxygen (DO) and S_A (Absolute Salinity). There is a lack of inter-laboratory comparability in DO data. He reported on systematic differences between absolute salinity values calculated based on the practical salinity using different methods. He reported on the development and manufacturing of a new aluminum bottle for sample distribution. Further he reported on sample preparation. Hydrostatic weighing method is being developed.

11.7 R. Pawlowicz (speaker) and R. Feistel reported on the salinity and density of freshwaters. He presented several options for the classification of freshwaters. Typically 8 major ions (plus nitrate and silicic acid) are present in freshwaters. He used numerical modeling for electrical conductivities and densities. He suggested an method whereby the seawater algorithms (TEOS-10) can be adapted for use in freshwaters. Using PSS-78 to remove temperature and pressure dependence of conductivity, scale Sp with respect to the characteristic chemistry of the particular freshwater. After scaling the practical salinity properly, density excess to the pure water density can be estimated using TEOS-10 with an accuracy of 10%.

12. Cooperation with other international bodies

12.1 R. Pawlowicz informed on the adoption of TEOS-10 by scientific community: www.teos-10.org: since October 2010 12,000 visits and 1,600 downloads. The formulation was implemented in visualization software, industry and numerical models, numbers of cited reference to key papers were given from both Web of Science and Google Scholar, anecdotal evidence given about TEOS-10 awareness.

12.2 R. Pawlowicz made a proposal for a "Joint SCOR/IAPSO/IAPWS Committee on the Properties of Seawater". Proposed the Terms of Reference, the executive (R. Pawlowicz, chair, T. McDougall, vice-chair, R. Feistel, vice-chair), and a preliminary member list. He noted that SCOR

may provide a limited financial support to the Committee. **The Working Groups endorsed the proposal and recommend it be approved by the EC.**

12.3-4 R. Feistel reported about contacts with BIPM. He visited BIPM and discussed in particular the climate aspects of standards for water, seawater, ice and humid air. They also discussed the salinity measurements not being traceable to the SI, lack of proper ocean pH measurements. R. Feistel stated that the key process of terrestrial climate is the sea-ice-air interface exchange. Cooperation of several institutions: BIPM and WMO have a Mutual Recognition Agreement (Geneva 2010), further institutions may include IUPAC, IAPWS, IAPWSO. A Task Group was formed in Pilsen. An IAPWS delegation travelled to Paris to discuss the possibilities of future cooperation. The outcome of the visit: A position paper (in preparation) will describe the aims, tasks and benefits of the intended BIPM/IAPWS cooperation. An IAPWS representative will be officially invited to participate in BIPM Consultative Committees. R.F. attended CCQM (Consultation Committee on the Amount of Substance) and CCT (Consultation Committee on Thermometry) meetings – positive response to the cooperation proposal. WG2 (contact thermometry), WG6 (humidity), WG9 (thermophysical quantities). IAPWS sent an Invitation Letter to CCT to the 16ICPWS in 2013. During the workshops, the further procedures will be discussed.

12.5 R. Pawlowicz proposed editorial changes in the Release on the IAPWS Formulation 2008 for the Thermodynamic Properties of Seawater, since recommendations on nomenclature for salinity have been developed since this was released. In particular the term “salinity” should be used only in cases when it is not related to a particular numerical value. Otherwise it must be specified, e.g. Absolute Salinity or Practical Salinity according the definitions which are part of TEOS-10. To clarify the meaning, editorial changes will be done in the Release by a Task Group consisting of R. Feistel, R. Pawlowicz, D. Friend and T. McDougall.

13. Properties of Supercooled Water, joint with PCAS and SC SW.

13.1 V. Holten (speaker), M. Anisimov, J. Sengers presented a report “Towards a Guideline for the thermodynamic properties of supercooled water”. V.H. presented a formulation of thermodynamic properties of supercooled water based on the two-state mixture model of water. The formulation is valid in the region of supercooled water up to pressure of 400 MPa. The formulation included a non-critical background Gibbs function and a mixture part. The proportion of the two states of liquid water – low density and high density – corresponds to the minimum of the Gibbs function. The new formulation was proposed to be matched to the IAPWS-95 near the melting curve, but it would result in jumps in properties, in particular for isobaric heat capacity. A smoother connection is possible at somewhat higher temperatures. The developed equation represents the density data within their uncertainties. For isobaric heat capacity data at atmospheric pressure, the predictions lie between the mutually inconsistent data. V.H. mentioned an unclear uncertainty of the expansivity data by Ter Minassian et al. (1981). Expansivity by Asada et al. (2002) are in accord with Ter Minassian. V.H. suspected that thermodynamic properties (in particular isobaric heat capacity and expansivity) derived by Lin and Trusler from their speed-of-sound data have substantially higher uncertainties than stated by the authors. W. Wagner suggested that the presenters contact Trusler and clarify the uncertainties of their speed of sound measurements and the derived properties. Formation of a Task Group was considered in the discussion. It was found that a Task Group is already established concerting a related topic (item 10). K. Watanabe suggested leaving the clarification of these issues with the Maryland group before proceeding to formulation of an IAPWS Guideline.

13.2 Surface tension of supercooled water. J. Kalová reviewed the existing literature data and correlations for the surface tension of supercooled water. R. Mareš reported on the measurements of the surface tension of supercooled water performed at the University of West Bohemia in Pilsen. The meaurements were performed using the capillary rise method. The measurements extend from 2°C down to -25°C. The liquid meniscus was exposed to air. V. Vinš (speaker) and J. Hrubý reported on independent measurements from -24 to 37°C performed at the Institute of Thermomechanics AS CR in Prague. The liquid meniscus was exposed to helium. Both the Pilsen and Prague data sets almost coincide with extrapolated IAPWS formulation of surface tension of ordinary water. The existence of an inflection point is not supported by the new data.

13.3 Olaf Hellmuth reported on atmospheric ice formation: questions of interest to IAPWS. He applied the classical nucleation theory to heterogeneous nucleation in clouds. At temperatures above 240 K, nucleation of ice is heterogeneous (it occurs about 12-20 K higher than the homogeneous nucleation). Mineral dust or metallic particles (e.g. condensed vapors evaporated from meteorites), serve as heterogeneous nuclei. The rate of heterogeneous nucleation in the supercooled solution depends on many parameters, in particular on the contact angle of the ice nucleus on the heterogeneous particle: "Icephilic" and "Icephobic" substrates. Densities and melting enthalpies and vapor-liquid surface tension are available, problematic estimation of solution/ice, solution/substrate and ice/substrate interface energies. O.H. made a call for collaboration between meteorological community and IAPWS. He suggested establishing a Task Group to work on the interfacial phenomena of aqueous solutions and related subjects; a group of interested people agreed to meet with him later in the week.

14. Molecular Simulation and Modeling: **this item is reported on in the Minutes of PCAS**.

15. Reports on Completed IAPWS Collaborative Projects

15.1 V. Vinš presented a report on "Development of Thermodynamic Models for Hydrates in Water–Carbon Dioxide Mixtures" resulting from a collaboration between the Czech Republic and Germany.

15.2 I. Abdulagatov presented a report on "Experimental Study of the Thermal Conductivity of Ammonia+Water Refrigerant Mixtures at Temperatures from 278 K to 356 K and at Pressures up to 20 MPa resulting from a collaboration between Russia and the US.

16. D. Fuentevilla (speaker), J. Sengers and M. Anisimov reported on the new formulation for the critical locus of aqueous solutions. D.F. presented the phase diagram of water-NaCl system. No new data appeared since the acceptance of the original IAPWS Guideline in 2000. Kim and Fisher (2001) developed a theoretical approach. Their theory was revisited and additional terms were obtained. A. Harvey reported test results by the Evaluation Task Group (K. Miyagawa, A. Harvey). The representation of the experimental data is at least as good as by the previous correlation. The new correlation has a sound theoretical basis in contrast to the original one, which was a purely empirical correlation. **The Working Group TPWS endorsed the Revised Guideline and recommends that the EC sends it for Postal Ballot after review by the Editorial Committee**.

17. R. Span (speaker) and A. Harvey reported on the properties of CO_2/H_2O and related systems relevant in particular to the Carbon Capture and Sequestration. International cooperation including TPWS members as well as colleagues outside IAPWS was established. In preparation are measurements of thermodynamic properties (pvT, w), phase equilibria (VLE, LLE, VLSE), transport

properties (viscosity). Accurate property models for CO_2-rich mixtures and phase equilibria including solid phases will be developed. Phase equilibrium algorithms will be improved, the new property models will be tested for various applications. Relevant systems are mixtures of CO_2, N_2, O_2, Ar, CO, H_2O. Considered components are covered by the GERG equation of state, however the main focus of GERG is natural gas modeling. Further components: SO_2, NO_2, H_2S. Finalization of mixture model needs at least another five years. Workshop is planned in Bochum, R.S. invited interested researchers.

18. Discussion of 16th ICPWS 2013 in London: No further suggestions were given.

19. Reports on Other TPWS, IRS and SC SW Activities

19.1 A. Harvey reported on the Guideline on Fundamental Constants. Small revisions were done in 2002, 2005, 2008, reflecting the adoption of universal constants and atomic weights. 2012 revision reflects newly recommended values of the fundamental physical constants by Mohr et al. 2012 (simultaneously in Rev. Mod. Phys. and J. Phys. Chem. Ref. Data, in press). **The working groups TPWS, IRS and SCSW adopted the revision.**

19.2 J. Hrubý reported on proper incorporation of systematic experimental uncertainties in thermodynamic models based on regression and realistic uncertainties of predicted values. Systematic uncertainties generate covariances of experimental data. Method of uncertainty estimation using the full covariance matrix and the generalized least squares method were introduced. Their applicability was demonstrated on the saturation pressure equation by Wagner and Saul (1986), which is part of the Revised Supplementary Release on Saturation Properties of Ordinary Water Substance. It was shown that realistic uncertainties of predicted pressures can be obtained when systematic errors are included, whereas considering the uncertainty as purely random leads to unrealistically low uncertainties.

19.3 M. Duška (speaker) and J. Hrubý presented some remarks on re-evaluation of thermodynamic data for steam at low pressures. pvT data, Joule-Thomson coefficient and speed of sound were considered for evaluation of the second virial coefficient. At low temperatures, the experimental uncertainties are too large which makes the extrapolation into the metastable steam region unreliable.

19.4 J. Hrubý (speaker) and A. Harvey reported on the status of ideal-gas properties for ordinary and heavy water. Present formulations for ordinary water are based on data by Woolley (1980) and for the heavy water on Friedman and Haar (1954). There is a space for improvement. Specroscopist groups of J. Tennyson (London) and A. Csaszar were contacted. Preliminary data for isobaric heat capacity of $H_2{}^{16}O$ were provided in the range from 0 to 1199 K. Large differences of the new data from Woolley (1980) below 50 K are due to a different treatment of the ortho and para waters. About above 800 K, deviation is increasing, but it remains within stated uncertainty of the IAPWS-95 formulation. The spectroscopist groups were asked to provide data at least up to 6000 K and also data for other isotopologues forming the ordinary water and heavy water isotopic mixtures.

19.5 A. Harvey (speaker) and E. Lemmon reported on the status of D_2O properties. Current (1984/2005) IAPWS D_2O release is based on IPTS-68 (adjusted in 2005), equation has 50 terms (new fit probably down to 15 or 20 terms), extrapolation to high temperature shows an unphysical behavior, incorrect behavior of cp near the critical point. New data are available. Collaboration project between Ruhr Universität Bochum and NIST was suggested. In the discussion it was suggested that the region of supercooled heavy water should be described in accord with the latest knowledge. A task group dealing with thermophysical properties of D_2O was established: A. Harvey (chair), J. Cooper, V. Holten, E. Lemmon [co-opted expert], R. Span.

19.6 A. Harvey asked whether any changes of IAPWS Statutes and By-Laws were suggested specific for these Working Groups. No suggestions were given.

19.7 V. Ochkov (speaker), K. Orlov, and G. Kondakova reported about live calculations linked from IAPWS website. The linked site provided by Russian National Committee enables online computations using IAPWS formulations. A useful feature for program developers is that intermediate computation results are shown besides the final results. In a short discussion it was reminded that IAPWS by decision of the EC does not provide software. However, it is desirable to have links to web sites allowing online computations and software download.

19.8 M. Kunick (speaker) and H.-J. Kretzschmar reported on Steam Tables for Excel®, Mathcad®, MATLAB, smart phones and Pocket Calculators for Education. A link is provided on the IAPWS Website.

19.9 Task Group concerning the uncertainties of IAPWS 95: W. Wagner was appointed to consider possible changes in estimates of uncertainties of the IAPWS-95.

20. Other Business

20.1 Report on International Collaborative Projects

V. Holten presented a preliminary report (item 13.1.)

V. Vinš presented his final report (item 15.1) and a short written report was sent to the Executive Secretary.

I. Abdualgatov presented his final report (item 15.2) and a short written report was sent to the Executive Secretary.

20.2 Report on ICRNs

The status of existing ICRNs was reviewed.

ICRN 21 (Properties for ultra supercritical power plants) is expiring and it was recommended that it be closed.

ICRN 24 (High temperature thermal conductivity of water vapor) was recommended to be extended for another 3 years after a minor revision.

During 2012, a new ICRN 28 (Metastable steam and nucleation) was adopted.

21. Membership and chairmanship

21.1 **Prof. Maxim Fedorov** (University of Strathclyde) and **Dr. Vincent Holten** (University of Maryland) were **adopted as TPWS members unanimously**.

22.2 **Reiner Feistel stepped down from the chair of the SCSW and will remain a vice-chair. Rich Pawlowicz was elected the new chair. M. Hiegemann remains as another vice-chair.**

22. Contribution to Press Release

The chair and the clerk of minutes were assigned to prepare the contribution to the Press Release.

23. Preparation of the Formal Motion to the EC

The chair and the clerk of minutes were assigned to prepare the Formal Motion to the EC.

24. Adjournment

The meeting was adjourned at 4:15 p.m. Thursday October 4.

Agenda for the IAPWS Working Group Thermophysical Properties of Water and Steam (TPWS) Boulder, Colorado, USA, 01-05 October 2012

1. Opening Remarks; Adoption of Agenda
2. Appointment of Clerk of Minutes
3. OPAL Web Space for Working Material for WGs TPWS, IRS, and SC SW, joint with WG IRS and SC SW (H.-J. Kretzschmar)
4. Potential International Collaborative Projects
5. Guideline on a Low-Temperature Extension of the IAPWS-95 Formulation for Water Vapor, joint with SCSW
   - Report (R. Feistel, W. Wagner)
   - Test Report (K. Miyagawa, F. Blangetti)
   - Formal consideration of the Guideline
6. Editorial changes to the IAPWS-95 and IAPWS-IF97 documents, joint with WG IRS
   - Report (W. Wagner, I. Weber)
   - Formal consideration of the editorial changes
7. Report on behavior of the IAPWS-95 Formulation in the Liquid Region of Water near the Melting Line at High Pressures (W. Wagner) [Monday PM]
8. Industrial Requirements and Solutions for Steam Property Calculations, joint with WG IRS [Monday PM]
   - 8.1 Report of the New Industrial Requirements Task Group (I. Weber)
   - 8.2 Report of the Industrial Survey Task Group (A. Singh)
   - 8.3 Report of the Task Group "Advisory Notes" (M. Hiegemann, W. Parry, B. Rukes, P. Murphy)
   - 8.4 Usage of thermal property calculations in power plant simulations and performance monitoring (R. Pawellek, STEAG Energy Services)
   - 8.5 Modernization Efforts in Steam Properties Modeling for Enhanced Flexibility & Scalability (A. Singh)
   - 8.6 Report of Task Group "CFD Steam Property Formulations" (J. Hrubý, H.-J. Kretzschmar, A. Singh)
   - 8.7 Steam Property Calculations for CFD Applications (A. Singh)
   - 8.8 Formulation of thermodynamic properties of steam for CFD computations based on a global function $s(u,\rho)$ (J. Hrubý, M. Duška, J. Pátek)
   - 8.9 Fast and Accurate Calculation of Thermodynamic Properties Using a Spline-based Table Look-up Method (M. Kunick, H.-J. Kretzschmar, and U. Gampe)
9. Advisory Note on the Properties of Sea Water for Industrial Use, joint with WGs IRS and SC SW
   - Report of the Task Group (H.-J. Kretzschmar)

10. Extension of Range of Formulation for Thermodynamic Properties of Sea Water, joint with WGs IRS and SC SW
    - 10.1 New Seawater Measurements (R. Feistel, J. Safarov)
    - 10.2 Discussion of data situation
    - 10.3 Discussion of steps toward an extended formulation
11. Additional Seawater-related Topics (R. Feistel), joint with SC SW and partly with WG IRS
    - 11.1 EURAMET Project Ocean Metrology on seawater salinity, pH and dissolved oxygen (P. Spitzer)
    - 11.2 Task Group Report "Transport Properties" (A. Anderko, A.H. Harvey)
      Report on future Guideline for seawater thermal conductivity
      Appointment of Evaluation Task Group and setting target dates for steps in IAPWS process for 2013 approval
    - 11.3 Electrical Conductivity of Seawater (R. Pawlowicz, R. Feistel)
    - 11.4 On the Definition of Relative Humidity (J. Lovell-Smith, R. Feistel)
    - 11.5 Air saturation of water and seawater – effect on properties (A. Harvey, R. Feistel)
    - 11.6 pH of seawater (P. Spitzer)
    - 11.7 Electrical conductivity and density of Lake and River Waters (R. Pawlowicz, R. Feistel)
12. Cooperation with other international bodies, joint with SC SW
    - 12.1 Report on TEOS-10 acceptance by user community (T. McDougall?)
    - 12.2 IAPWS/IAPSO/SCOR Joint Committee on Seawater (R. Pawlowicz)
    - 12.3 Cooperation with BIPM (CCQM and CCT) (R. Feistel, D. Friend, P. Spitzer)
    - 12.4 ICPWS workshops for IAPWS-BIPM cooperation at ICPWS (J. Cooper)
    - 12.5 Cooperation with WMO (P. Dexter?)
13. Properties of Supercooled Water, joint with PCAS and SC SW [Tuesday PM]
    - 13.1 Towards a Guideline for the thermodynamic properties of supercooled water (V. Holten (speaker), M. Anisimov, J. Sengers)
    - 13.2 Surface tension of supercooled water (J. Kalova, R. Mareš, V. Vinš)
    - 13.3 Atmospheric freezing processes: Questions of interest for IAPWS (O. Hellmuth)
14. Molecular Simulation and Modeling, joint with PCAS [Thursday AM]
    - Valeria Molinero (University of Utah), "Structural transformation in supercooled water controls the crystallization rate of ice"
    - Amadeu K. Sum (Colorado School of Mines), "The structuring of water in the nucleation of clathrate hydrates"
    - Kenji Yasuoka (Keio University), "Melting and Freezing point of rigid water models"
15. Reports on Completed IAPWS Collaborative Projects, joint with PCAS [Thursday AM]
    - 15.1 Development of Thermodynamic Models for Hydrates in Water–Carbon Dioxide Mixtures (V. Vinš (speaker), J. Hrubý, R. Span)
    - 15.2 Experimental Study of the Thermal Conductivity of Ammonia+Water Refrigerant Mixtures at Temperatures from 278 K to 356 K and at Pressures up to 20 MPa (I. Abdulagatov (speaker), M.L. Huber, F.N. Shamsetdinov)

16. Critical locus of aqueous solutions of sodium chloride, joint with PCAS [Tuesday PM]
    - Report (D. Fuentevilla (speaker), J. Sengers, M. Anisimov)
    - Test Report (K. Miyagawa, A. Harvey)
    - Formal consideration of the Guideline
17. Properties of CO_2/H_2O and related systems, joint with WG IRS (R. Span, A. Harvey)
18. Discussion of 16th ICPWS 2013 in London, joint with WG IRS and SC SW (J. Cooper and WG Chairs)
19. Reports on Other TPWS, IRS and SC SW Activities
    - 19.1 Guideline on Fundamental Constants (A. Harvey), joint with WG IRS and SC SW
    - 19.2 Proper incorporation of systematic experimental uncertainties in thermodynamic models based on regression and realistic uncertainties of predicted values (J. Hrubý)
    - 19.3 Remarks on new data and re-evaluation of older data for steam at low pressures (J. Hrubý and M. Duška)
    - 19.4 Status of ideal-gas properties for ordinary and heavy water (A. Harvey, J. Hrubý)
    - 19.5 Status of D_2O Thermodynamic Properties (A. Harvey, E. Lemmon), joint with IRS
    - 19.6 Changes of IAPWS Statutes and By-Laws (A. Harvey)
    - 19.7 Live calculations linked from IAPWS website (V. Ochkov [speaker], K. Orlov, and G. Kondakova)
    - 19.8 Steam Tables for Excel®, Mathcad®, MATLAB, smart phones and Pocket Calculators for Education on the IAPWS Website (H.-J. Kretzschmar, M. Kunick), joint with WG IRS
    - 19.9 Possibility of improving uncertainty estimates of IAPWS-95
20. Other Business
    - 20.1 Report on International Collaborative Projects
    - 20.2 Report on ICRNs [Monday or Tuesday]
21. Membership
22. Contribution to Press Release
23. Preparation of the Formal Motion to the EC
24. Adjournment

Draft Agenda for the Subcommittee on Seawater (SC SW)
Boulder, Colorado, USA, 01-05 October 2012

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      Presentation of draft Guideline for seawater thermal conductivity
      Appointment of Evaluation Task Group and setting target dates for steps in IAPWS process for 2013 approval
    - 10.3 Electrical Conductivity of Seawater (R. Pawlowicz, R. Feistel)
    - 10.4 On the Definition of Relative Humidity (J. Lovell-Smith, R. Feistel)
    - 10.5 Air Saturation of Water and Seawater – effect on properties (A. Harvey, R. Feistel)
    - 10.6 pH of Seawater (P. Spitzer)
    - 10.7 Electrical conductivity and density of Lake and River Waters (R. Pawlowicz, R. Feistel)

11. Cooperation with other international bodies, joint with TPWS
    - 11.1 Report on TEOS-10 acceptance by user community (T. McDougall/R. Pawlowicz)
    - 11.2 IAPWS/IAPSO/SCOR Joint Committee on Seawater (R. Pawlowicz)
    - 11.3 Cooperation with BIPM (CCQM and CCT) (R. Feistel, D. Friend, P. Spitzer)
    - 11.4 ICPWS workshops for IAPWS-BIPM cooperation at ICPWS (J. Cooper, R. Pawlowicz, P. Spitzer, O. Hellmuth)
    - 11.5 Cooperation with WMO (P. Dexter?)
12. Properties of Supercooled Water, joint with PCAS, TPWS [Tuesday PM]
    - 12.1 Towards a Guideline on thermodynamic properties of supercooled water (V. Holton, M. Anisimov, J. Sengers)
    - 12.2 Ice nucleation (J. Kalova, R. Mareš, V. Vinš)
    - 12.3 Atmospheric freezing processes: Questions of interest for IAPWS (O. Hellmuth)
13. Critical locus of aqueous solutions of sodium chloride, joint with TPWS, PCAS (D. Fuentevilla, J. Sengers, M. Anisimov) [Tuesday PM]
14. Properties of CO_2/H_2O and related systems (R. Span, A. Harvey), joint with TPWS
15. Discussion of 16th ICPWS 2013 in London, joint with WG IRS and TPWS (J. Cooper, WG Chairs)
16. Reports on Other TPWS, IRS and SC SW Activities, joint with WG IRS and TPWS
    - 16.1 Guideline on Fundamental Constants (A. Harvey)
    - 16.2 Proper incorporation of systematic experimental uncertainties in thermodynamic models based on regression and realistic uncertainties of predicted values (J. Hrubý)
    - 16.3 Remarks on new data and re-evaluation of older data for steam at low pressures (J. Hrubý and M. Duška)
    - 16.4 Status of Ideal-Gas properties for ordinary and heavy water (A. Harvey, J. Hrubý)
    - 16.5 Status of D_2O Thermodynamic Properties (A. Harvey, E. Lemmon)
    - 16.6 Changes of IAPWS Statutes and By-Laws (A. Harvey)
    - 16.7 Live calculations linked from IAPWS website (V. Ochkov, K. Orlov, G. Kondakova)
17. Other Business
    - Report on International Collaborative Projects
18. Membership
19. Contribution to Press Release
20. Preparation of the Formal Motion to the EC
21. Adjournment

Sept. 28, 2012, R. Feistel (Chair), R. Pawlowicz (Vice-Chair), M. Hiegemann (Vice-Chair)