Minutes

IAPWS Thermophysical Properties of Water and Steam WG and Subcommittee on Seawater
Moscow, Russia, 23-26 June 2014

NOTE: These Minutes include many items that were held jointly with the IRS Working Group and/or the Subcommittee on Seawater (SCSW). 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, June 23 by the TPWS Chair, Allan Harvey. The agenda (Attachment A) was adopted. The Chair noted that the 2013 Minutes had been circulated and approved with shortly after the 2013 meeting. J. Hrubý was appointed Clerk of Minutes for TPWS and SCSW. (R. Pawellek was appointed Clerk for IRS)

3. H.-J. Kretzschmar introduced the OPAL Web Space for sharing the working material of WGs. In a continuation of a discussion started at the EC Meeting, WG members expressed various opinions. Some favored abandoning the password protection following a philosophy that IAPWS work should be open to anybody; others suggested that the access should be limited to WG members in order that draft documents are not disseminated and unpublished work can be shared. The resulting opinion was to keep the current state, e.g. password-protected access with a freedom to pass the password to national committee members or other collaborators.

4. No collaborative projects were suggested in TPWS.

5. H.-J. Kretzschmar explained the Revised Advisory Note No. 3 on Thermodynamic Derivatives from IAPWS formulations. The reason for this revision was correcting an incorrect formula and adding formulae for the derivatives of the IAPWS formulation for liquid water for oceanographic use (2009 Release) and the IAPWS industrial formulation for seawater (2013 Advisory Note).

The Working Groups adopted the Revised Advisory Note 3 unanimously.

6. Revised Supplementary Releases on "Backward" equations for IAPWS-IF97 (joint with WG IRS) [See IRS Minutes for this item.]

7. Proposal for an IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using Spline Interpolation, joint with WG IRS
[See IRS Minutes for this item].

8. Metastable Water (joint with SC SW)

8.1 V. Holten explained the background of the supercooled water formulation. The formulation has the form of a Gibbs function of a mixture of a high-density structure and a low-density structure. The equilibrium fraction of these "components" is found by minimizing the Gibbs function for a given pressure and temperature. The model is consistent with the hypothesis of a liquid-liquid critical point. The range of validity of the model is from 300 K down to the homogeneous ice nucleation temperature and up to 400 MPa, which corresponds to the coverage by experimental data.

8.2 J. Hrubý reported on behalf of the Task Group on Supercooled Water formulation (chair J. Hrubý, V. Holten, M. Anisimov, R. Feistel, O. Hellmuth, K. Orlov). The formulation suggested by Holten et al. was found to represent all available experimental data. It was suggested that additional comparisons are performed for the saturation vapor pressure of supercooled water. While the "pure components" of the two-structure model exhibit negative compressibilities and heat capacities, it was explained that this does not indicate anything unphysical and the measurable properties of the "mixture" are correct. It was suggested that the preparation of the IAPWS Guideline for the thermodynamic properties of supercooled water be postponed until comparisons with new density data (cf. 8.4) and other new data are performed.

8.3 Report on Task Group on possible Supercooled Water ICRN. No ICRN has been developed. In a discussion, it was found desirable and **the previously established task group consisting of O. Hellmuth (chair), V. Holten, J. Hrubý, J. Sengers) was asked to prepare a draft ICRN by the end of August**.

8.4 M. Duška and J. Hrubý reported on the progress of measurements of density of supercooled water at elevated pressures. The measurements should cover cold and supercooled water up to 200 MPa. Present measurements up to 35 MPa have shown that uncertainty of 0.01% in density can be achieved. It is likely that the new data will be available before the next meeting.

8.5 In a discussion it was decided that the **IAPWS Guideline on thermodynamic properties of supercooled water will be prepared without waiting for additional data in order to be ready for adoption at the 2015 Meeting**. In a vote, this decision was approved unanimously. The proposers – V. Holten and M. Anisimov – were asked to prepare a draft of the IAPWS Guideline by the end of July. **The Evaluation TG (chair J. Hrubý, O. Hellmuth, R. Feistel, K. Orlov) will prepare an evaluation report by the end of September**.

8.6 Report of Task Group on Superheated liquid water, joint with WG IRS and SCSW (chair H.-J. Kretzschmar, R. Feistel, J. Hrubý, K. Orlov, and B. Rukes). The Task Group had no output. Nevertheless, it was found that this area is of importance and the mandate of the Task Group was continued until the next meeting. The TG should examine the behavior of IAPWS-95 in this region and its agreement with experimental data.

9. Surface Tension of Ordinary Water (joint with WG IRS and SC SW)

9.1 Report (J. Hrubý). Independent measurements of the surface tension of supercooled water have been performed by two laboratories, showing that the IAPWS equation for the surface tension can be safely extrapolated down to −25 °C. The experimental results were presented by V. Vinš and R. Mareš at ICPWS in London and published; a more complete account of the measurements will be forthcoming.

9.2 A Revised Release on Surface Tension of Ordinary Water Substance was prepared, which includes a statement that the equation provides reasonably accurate values when extrapolated into the supercooled region to temperatures as low as −25 °C. The Draft Revised Release was circulated in the WG in February. **The Working Groups recommended the Revised Release for adoption by the EC.**

9.3 Appointment of Task Group for complete revision of formulation. J. Hrubý explained that there are reasons to completely revise the formulations: new data claim uncertainty at 20 and 25 °C which is many times lower than the uncertainties stated by the Release. A noticeable deviation was observed for supercooled water below -25 °C. An up-to-date value for the critical exponent should be used. **A Task Group was established, consisting of V. Vinš (chair), A. Harvey, O. Hellmuth, V. Holten, J. Hrubý, J. Kalová, R. Mareš.** For the next meeting, the TG should prepare a report on the existing experimental data.

10. Possible Improvement of the Uncertainty Estimates of IAPWS-95

10.1 Report of Task Group (A. Harvey, W. Wagner, M. Trusler)

The main basis for reconsideration was the new data for the speed of sound by Lin and Trusler. It has been found that old data by Alexandrov and Larkin (1976) and Alexandrov and Kochetkov (1979, 1980) are of high quality. Based on the differences between IAPWS-95 and experimental data, it was possible to significantly reduce the uncertainties of IAPWS-95 in the speed of sound in some regions. The data situation for C_p at high pressures had not improved. Comparisons with the equation by Holten in the range of overlap show relatively high differences. Consequently, it was proposed that a region near the melting line, which previously was assigned an uncertainty of 6%, is left without uncertainty estimates. As a further improvement, the borders in the uncertainty graphs will be defined mathematically (not just graphically).

10.2 Discussion of density data in the range 0-150 °C to 100 MPa (J. Hrubý, M. Duška). J. Hrubý presented a re-evaluation of the accurate density data by Kell and Whalley (1965, 1975), which is the main density data set in the region of liquid water up to 100 MPa. In their 1965 work, K&W used an erroneous value for the compressibility of stainless steel 304, which was the material of their measuring cell. When it became clear that their density data is not compatible with densities derived from speed of sound measurements, they decided to fit the compressibility of SS304 such that density at 100 MPa for given temperature is equal with density determined from the speed of sound data by Wilson (1959). In this way, K&W 1975 data are not an independent source. To improve this situation, reliable data for the compressibility of SS304 have been found and K&W 1975 data were corrected. The correction is small, its maximum value is about 15 ppm at 100 MPa and 273.15 K. Agreement with the equation by Holten et al. is improved at 273.15 K. It is not necessary to modify the uncertainty statement for IAPWS-95.

10.3 **It was voted to approve the suggestion of the Task Group of a Revised IAPWS-95 Release containing improved uncertainty estimates, and to request that (following Editorial Committee review) it be sent for Postal Ballot by the EC**.

11. Industrial Requirements and Solutions for Steam Property Calculations, joint with WG IRS
[See IRS Minutes for this item.]

12. Report of Task Group on Extension of Range of Formulation for Thermodynamic Properties of Sea Water, joint with WGs IRS and SC SW (R. Feistel, presented by A. Harvey).
J. Safarov has performed measurements of density of seawater as function of pressure, temperature and salinity. Saturation vapor pressure of seawater was measured up to 50 °C. Solubility of CO_2 in seawater as function of salinity was determined. Measurement of vapor pressure up to 200 °C is under development. The Task Group will continue to monitor the data situation to see if new data are sufficient to expand the range of the seawater formulation.

13. Cooperation with other international bodies, joint with SC SW (O. Hellmuth)
13.1 IAPWS/IAPSO/SCOR Joint Committee on Seawater. Report by R. Pawlowicz was presented by O. Hellmuth. Structure of JCS: Chair: R. Pawlowitz, Vice Chairs: R. Feistel T. McDougall. Taskgroups: Salinity/Density (S. Seitz, H. Uchida, F. Millero, S. Weinreben, Y. Pang), Seawater pH (P. Spitzer, M.F. Camoes, A. Dickson), moist air RH (O. Hellmuth, J. Lovell-Smith, R. Feistel). Subgroups: Thermodynamics (Feistel), numerical modelling (McDougall), software (P. Barker), industry representatives. High number of downloads of TEOS-10 software. Ocean measurements of TEOS-10 salinity anomaly have been carried out. Realized workshop: linearity of the Anton Paar density meter using heavy water and NaCl solutions, definition of a plausible artificial seawater matrix (based on TEOS-10 Reference Composition) for pH measurements. Further plans: best practices for precision density measurements, collective experience about the chemical composition of standard sea water, inter-laboratory comparisons of density measurements, traceability of uncertainties in Pitzer-like models, tasks related to relative humidity (cf. item 14).
13.2 Cooperation with BIPM (CCQM and CCT) (R. Feistel, R. Pawlowicz, P. Spitzer). Pawlowicz attended CCQM/EAWG (Electrochemical Working Group) meetings and CCQM/plenary meetings (April 2014, Sevres, France). Comparisons of NMIs (National Metrology Institutes) for conductivity shows wide variation. Instrument design may be important in seawater practical salinity measurements. Not yet clear how to move forward on salinity/density; also pH issues not yet resolved. R. Feistel attended CCT/WG-6 (now WG-Humidity) and CCT/plenary meetings (May 2014, Sevres, France). When a draft paper on BIPM/IAPWS Cooperation (now under revision) is completed, it is expected that WG-6 will adopt the approach to RH recommended in this paper. R. Feistel is now a member CCT/WG-Humidity and CCT Task Group Environment. **IAPWS is expected to prepare a document on the calculation of fugacity of water in humid air.** CCT/IAPWS will work towards putting RH in the list of quantities with unit 1 in the updated SI brochure.
A motion to ask the EC for support of two people participating in BIPM meetings in the coming year was approved unanimously by SCSW.

14. Report on progress on topics following ICPWS13 Humidity Workshop, joint with SC SW (R. Feistel, J. Lovell-Smith, O. Hellmuth). All items were reported on by O. Hellmuth.
14.1 Virial equation for fugacity of water in humid air and determination of relative fugacity from this equation. ICPWS London workshop. "To support the acceptance of the intended new BIPM/CCT definition of relative humidity, CCT/WG RH is requesting IAPWS to develop a document on the calculation of fugacity and relative fugacity of water in humid air". A draft Guideline has been prepared and a background article submitted (R. Feistel, J. Lovell-Smith, O. Hellmuth), but this only addresses the issue of fugacity in the vapor, not the relative fugacity. The formulation has the form of a virial expansion in terms of pressure and mole fraction which

is expressed using second and third virial coefficients for water by IAPWS-95, second and third coefficients for air by Lemmon et al. (2000), second air-water coefficient by Harvey and Huang (2007), third cross virial coefficients as estimated by Hyland and Wexler (1983).

14.2 Comparison of "relative fugacity" versus "relative humidity". Relative humidity (RH) is defined as a ratio of the water vapor mole fraction to water vapor mole fraction at phase equilibrium for the same temperature and pressure (World Meteorological Organization – WMO). New concept: relative fugacity (RF) is defined as a ratio of fugacity to fugacity at the same temperature and pressure at phase equilibrium. A practical difficulty consists in the necessity of computing the mole fraction at the phase equilibrium. A preliminary approximation function was suggested for the atmospherically relevant range 234.15 K to 325.15 K and 100 hPa to 1060 hPa. Also a high-temperature and pressure (HTP) area was investigated, ranging between 273.15 K to 473.15 K and 1000 hPa to 10 MPa using a similar polynomial fit. A goal of virial formulation for RF was not reached. An eventual formulation needs to also cover the case of ice as the condensed phase. So far the issue of dissolved air in the liquid phase has not been considered, and it was unclear whether that omission is OK.

14.3 Discussion of possible IAPWS Guideline on a Virial Equation for the Fugacity of Water in Humid Air. In a discussion it was recommended that the proposed Guideline contains both equations for computation of fugacity and for computation of the vapor molar fraction at saturation. Also it was suggested that the formulation might be restricted to second virial coefficients to simplify the calculations and to avoid inconsistencies with third virial coefficients obtained from different sources. The proposers should ask CCT about the required ranges of temperatures and pressures, and clarify whether their request to IAPWS is only for the fugacity of water in the vapor phase or if it also includes calculation of relative fugacity. **An evaluation Task Group was established (A. Harvey, H.-J. Kretzschmar, J. Cooper**).

15. Reports on miscellaneous TPWS scientific topics

15.1 V. Holten reported on his investigation of the melting curve of Ice III. The present IAPWS formulation is based on Bridgman's data which do not agree with newer data. V. H. based his computation on a simple model for the Gibbs energy of ice III and his formulation of properties of cold and supercooled water (cf. 8.1). Preliminary computations showed agreement with more recent experimental data including metastable regions corresponding to stable ices Ih and V. It has been recommended that a new correlation for this melting line is established. Discussion about the triple point (liquid,Ih,III): The current triple-point temperature and pressure are computed with IAPWS-95, which is not quite accurate in this region. It was recommended that new coordinates are computed using the new equation by V.H. **A Task Group was appointed consisting of V. Holten, A. Harvey, and H.-J. Kretzschmar to consider revision of the IAPWS Release that gives the melting curves of water with various ice forms.**

15.2 N. P. Romanov reported on a New Simple Formula for Saturated Water Steam Pressure from -40 to 350 °C for Liquid Water and from −100 to 0 °C for Ice. The equations are constructed as simple fits of partial ranges. Inverse computation is possible by solving a cubic equation using Cardano's method.

16. Heavy Water Properties, joint with WG IRS

16.1 S. Herrig presented a Report of Task Group on Heavy Water Thermodynamic Properties (R. Span, A. Harvey, S. Herrig). The present formulation by Hill et al. (1982) was adopted in 1984 and adjusted to ITS-90 in 2005. The preliminary new equation has the form of dimensionless Helmholtz energy, it contains 6 terms for ideal gas and 23 terms for the residual function. The equation is valid up to 825 K and 1000 MPa. It shows a plausible extrapolation behavior. The new equation represents much better the speed of sound. High-pressure pvT data by Jůza et al. were decided to be inaccurate based on other data. The ideal-gas part is based on data by Friedman and Haar (1954) who gave values between 0 and 5000 K. Potential improvements: additional measurements for vapor pressures at low temperatures may be performed at NIST if manpower can be made available; additional measurements for sound speeds are considered at University of Bochum. Ideal-gas properties based on recent spectroscopic data and quantum mechanical computations will be available soon (c.f. 17.2).

16.2 **An Evaluation TG for Heavy Water Thermodynamic Properties was established including M. Duska, H.-J. Kretzschmar, and co-opted expert Thomas Beuthe (AECL, Canada)**. The TG Chair will be determined by the WG Chair later.

16.3 Appointment of TG for Heavy Water Transport Properties. Preliminary work started at NIST. **A Task Group was formed incorporating J. Sengers and M. Assael and co-opted expert M. Huber (NIST).** The TG Chair will be determined by the WG Chair later.

17. Joint session with WG PCAS [Thursday morning]

17.1 Report of Task Group on Transport Properties of Seawater, joint with SC SW and WG IRS (A. Anderko, A. Harvey)

The recently developed equation for thermal conductivity of seawater (Wang Anderko 2012) is based on a model of a multicomponent salt solution. Thermal conductivity is expressed as a sum of the pure-water term and a contribution due to electrolytes, where the latter is a sum of contributions of individual ions and an interaction term, which depends on the ionic strength. The parameters of the model are based on a large amount of good quality experimental data for individual salts and for multicomponent systems. Most of the seawater data is not consistent. Comparison of existing seawater data with NaCl solution for the same molality shows an unexpected deviation increasing with pressure. Recent data by Sharqawy (2013) at atmospheric pressure are in an excellent agreement with the multicomponent model. Based on this model, a draft guideline has been proposed and reviewed. It has been found that the multicomponent approach is too complex for application to seawater, because the variability of the chemical composition of seawaters is small to produce noticeable effects in thermal conductivity. Therefore, a simple model in terms of pressure (p), temperature (T), and salinity (S) has been developed based on a matrix of data generated from the multicomponent model. It has been found that the difference from the pure-water thermal conductivity can be expressed as a*S^(1+b), where a and b are simple functions of pressure and temperature. The simplified model is prepared for publication.

In the discussion it was suggested that a new Draft Guideline be prepared along with publishing the paper. The Draft Guideline will contain only the simplified approach (p,T,S). The evaluation task group as nominated in London (R. Feistel, R. Pawlowicz, K. Miyagawa) will review it such that the Guideline is prepared for adoption at the 2015 Meeting.

17.2 Progress toward improved ideal-gas properties of ordinary and heavy water (J. Hrubý). The ideal-gas parts of the formulations of thermodynamic properties for ordinary water is based on data by Woolley (1980) and for heavy water on data by Friedman and Haar (1954). In 2012, a loose collaboration was established with J. Tennyson (London) and A. Csaszar (Budapest) who participated in an IUPAC project to develop a comprehensive spectroscopic database for the 9 important water isotopologues (various combinations of isotopes H, D, ^{16}O, ^{17}O, and ^{18}O). This work has been recently finished. Based on the evaluated energy levels, the ideal-gas properties can be computed with a high accuracy. First data for C_p of $H_2{}^{16}O$ in a limited temperature range were obtained in 2012. Consequent discussions concerned primarily the uncertainty of the results. For high temperatures (approximately above 1000 K), high energy levels become important which are not covered by spectroscopic data. These are presently being computed quantum mechanically. The temperature should range up to 6000 K or perhaps even higher as long as the uncertainty in C_p remains in useful limits (say 20%). It has been noted that below about 60 K it is necessary to distinguish the "ortho" and "para" states of the water molecule. Data relevant to heavy water should be delivered very soon (summer 2014).

18. IAPWS Certified Research Needs (ICRNs)

18.1 **ICRN-16 on Thermophysical Properties of Seawater (joint with SCSW) was extended until 2019.** The motion passed unanimously.

18.2 ICRN-27 on Humid Gases and CO_2-Rich Mixtures (R. Span, A. Harvey)

It was decided to close this ICRN. R. Span and A. Harvey will prepare a closing statement. They will also consider the possibility of a new ICRN for properties relevant to carbon capture and sequestration.

18.3 ICRN-28 on Metastable Steam

J. Hrubý explained the importance of metastable steam for power generation. The situation in experimental data has not improved. Significant improvement is possible also from the side of molecular simulation of virial coefficients and the nucleation process. **The Working Group agreed to extend ICRN-28 to 2019 without modification.**

19. Reports on other TPWS activities

19.1 Guideline on Fundamental Constants (A. Harvey)

No new information relevant to IAPWS documents was found.

19.2 Advisory Note 2 on the Role of Various IAPWS Documents Concerning the Thermodynamic Properties of Ordinary Water Substance. (J. Cooper, A. Harvey). **Harvey and Cooper were authorized to make minor revisions to the Advisory Note to reflect recent updates**. When the SBTL Guideline is approved, a note on its role will be added.

19.3 IAPWS formulation on the Elsevier site (V. Ochkov)

On Tuesday, V. Ochkov presented plans for incorporating calculations based on IAPWS formulations via the SMath tool on the site of Knovel (owned by Elsevier) which provides web-based science and engineering information. It was requested that IAPWS endorse this project by letter. A copy of the letter was circulated. Further discussion on Thursday primarily concerned the question that the letter might be understood as promotion of a specific company, which would not be compatible with IAPWS Statutes. An option was suggested that IAPWS develops a general letter which can be sent to companies for such purposes. The letter would inform about the position of IAPWS, its main documents and would contain an offer for feedback. It has been recognized that the decision about the letter is a question for the EC, not for any Working Group. **The WG Chair will bring the question to the EC.**

20. Other Business

20.1 Report on International Collaborative Projects. Nothing to report

21. Membership

Two proposals were submitted for TPWS membership: Dr. Henning Wolf (PTB Braunschweig) and Mr. Stefan Herrig (Ruhr Universität Bochum). Both candidates were approved unanimously.

No proposal was submitted for SCSW membership.

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 11:10 a.m on Thursday, June 26.

Agenda for the IAPWS Working Group

Thermophysical Properties of Water and Steam (TPWS)

Moscow, Russia, 23-26 June 2014

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. Revised Advisory Note No. 3 on Thermodynamic Derivatives from IAPWS formulations, joint with WG IRS and SC SW
    - Report of the proposers (H.-J. Kretzschmar)
    - Formal consideration of the Revised Advisory Note by the Working Groups
6. Revised Supplementary Releases on “Backward” equations for IAPWS-IF97 (joint with WG IRS)
    - 6.1 Report of the proposers (H.-J. Kretzschmar)
    - 6.2 Formal consideration of the Revised Supplementary Releases by the Working Groups
7. Proposal for an IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using Spline Interpolation, joint with WG IRS (H.-J. Kretzschmar, M. Kunick, J. Hrubý, M. Duška, V. Vinš, F. di Mare, A. Singh)
    - 7.1 Report of Evaluation Task Group (A. Novy)
    - 7.2 Specification of path forward for Guideline
8. Metastable Water (joint with SC SW)
    - 8.1 Background of supercooled water formulation (V. Holten)
    - 8.2 Report of Task Group on Supercooled Water formulation (J. Hrubý)
    - 8.3 Report on Task Group on possible Supercooled Water ICRN (V. Holten, J. Sengers, O. Hellmuth)
    - 8.4 Progress of measurements of density of supercooled water at elevated pressures (M. Duška, J. Hrubý)
    - 8.5 Discussion of IAPWS path forward for supercooled water
    - 8.6 Report of Task Group on Superheated liquid water, joint with WG IRS and SCSW (H.-J. Kretzschmar)
9. Surface Tension of Ordinary Water (joint with WG IRS and SC SW)
    - 9.1 Report (J. Hrubý)
    - 9.2 Formal consideration of the Revised Release by the Working Groups

9.3 Appointment of Task Group for complete revision of formulation

10. Possible Improvement of the Uncertainty Estimates of IAPWS-95
    10.1 Report of Task Group (A. Harvey, W. Wagner, M. Trusler)
    10.2 Discussion of density data in the range 0-150 °C to 100 MPa (J. Hrubý, M. Duška)
    10.3 Discussion of next steps, including formal consideration of Revised Release

11. Industrial Requirements and Solutions for Steam Property Calculations, joint with WG IRS
    11.1 Report of the New Industrial Requirements Task Group (I. Weber)
    11.2 Report of the Task Group "Industrial Advisory Note" (M. Hiegemann, B. Rukes, A. Singh, A. Harvey)

12. Report of Task Group on Extension of Range of Formulation for Thermodynamic Properties of Sea Water, joint with WGs IRS and SC SW (R. Feistel)

13. Cooperation with other international bodies, joint with SC SW (O. Hellmuth)
    13.1 IAPWS/IAPSO/SCOR Joint Committee on Seawater (R. Pawlowicz)
    13.2 Cooperation with BIPM (CCQM and CCT) (R. Feistel, R. Pawlowicz, P. Spitzer)

14. Report on progress on topics following ICPWS13 Humidity Workshop, joint with SC SW (R. Feistel, J. Lovell-Smith, O. Hellmuth)
    14.1 Virial equation for fugacity of water in humid air and determination of relative fugacity from this equation
    14.2 Comparison of "relative fugacity" versus "relative humidity"
    14.3 Discussion of possible IAPWS Guideline on a Virial Equation for the Fugacity of Water in Humid Air

15. Reports on miscellaneous TPWS scientific topics
    15.1 Investigation of the melting curve of Ice III (V. Holten)
    15.2 A New Simple Formula for Saturated Water Steam Pressure from –40 to 350 °C for Liquid Water and from –100 to 0 °C for Ice (N.P. Romanov)

16. Heavy Water Properties, joint with WG IRS
    16.1 Report of Task Group on Heavy Water Thermodynamic Properties (R. Span, A. Harvey, S. Herrig)
    16.2 Appointment of Evaluation TG for Heavy Water Thermodynamic Properties
    16.3 Appointment of TG for Heavy Water Transport Properties

17. Joint session with WG PCAS [Thursday morning]
    17.1 Report of Task Group on Transport Properties of Seawater, joint with SC SW and WG IRS (A. Anderko, A. Harvey)
    17.2 Progress toward improved ideal-gas properties of ordinary and heavy water (J. Hrubý)

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    18.1 ICRN-16 on Thermophysical Properties of Seawater (joint with SCSW)
    18.2 ICRN-27 on Humid Gases and CO2-Rich Mixtures (R. Span, A. Harvey)
    18.3 ICRN-28 on Metastable Steam (J. Hrubý)

19. Reports on other TPWS activities
    19.1 Guideline on Fundamental Constants (A. Harvey)
    19.2 Advisory Note 2 (J. Cooper, A. Harvey)
    19.3 IAPWS formulation on the Elsevier site (V. Ochkov) [Tuesday]

20. Other Business
    20.1 Report on International Collaborative Projects

21. Membership

22. Contribution to Press Release

23. Preparation of the Formal Motion to the EC

24. Adjournment

June 19, 2014

A.H. Harvey (Chair), J. Hrubý (Vice-Chair)