Minutes of meeting of working group Industrial Requirements & Solutions (IRS)

Santorini, Greece, 3.– 8. July 2005

Note: Items are listed in the order of the agenda (Attachment A), not necessarily in the order they were discussed. Most agenda items were discussed as joint sessions with the TPWS working group (denoted with *). The joint items 4, 8, 9, 10 and 11 of the IRS agenda are covered in the TPWS minutes.

Monday, 4. July 2005
(Item 7 was revisited shortly on Wednesday, 6. July 2005)

1.-3. Opening Remarks, Adoption of Agenda
Chairman Bill Parry welcomed the IRS members. Some revisions were made to the agenda before it was adopted. Ingo Weber was appointed clerk of minutes. The minutes of the Kyoto meeting were approved.

5. *Supplementary release on v(p,T) backward equations in region 3
Kiyoshi Miyagawa outlined the progress of the Evaluation Task Group work since the Kyoto meeting. The supplementary release document was revised and had been approved by the editorial committee during this time frame. The task group tested with regards to reproducibility, accuracy and computing speed and verified that all aspects meet the requirements. The task group recommends that the supplementary release is being accepted by IAPWS. The software code should be handled as the code for the previous supplementary releases, i.e. they will be part of the IAPWS-IF97 authorized code.
The working groups unanimously voted to recommend adoption of the supplementary release to the EC.
Prof. Kretzschmar expressed his thanks for the work of the Evaluation Task Group, especially Kiyoshi Myagawa, not only for this supplementary release but also for all supplementary releases on backwards equations in the past. The backward equations v(p,T) in region 3 complete work on backwards equations since all required backward functions are now available in all regions of IAPWS-IF97 except region 5. The development of these backward equations will be documented in a detailed background paper. Following the procedure of previous publications Prof. Kretzschmar asked if the page charges for the publication would be funded by IAPWS. An estimation for the maximum total charge would be US$ 2000. **The working groups recommend to the EC to provide coverage for the page charges of this paper.**

6. *Amendment of the "Revised Supplementary Release on Backward Equations for the Functions T(p,h), v(p,h) and T(p,s) for Region 3 of the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam"
Katja Knobloch presented a necessary amendment to Tables 12 and 15 of the above mentioned supplementary release document. The tables contain test data for computer program verification. Calculating the temperature with the data listed in the

original document will result in temperatures slightly outside region 3. The proposed corrected tables will contain data which result in temperatures in region 3. The changes are considered editorial changes. **The working groups recommend to the EC to authorize the editorial committee to make the necessary changes without further formal acceptance by the EC.**
A corrected document will be available for the EC meeting. In addition to the corrected tables the top page contains a note stating the date and location of the amendments.

7. *Computing time investigations of IAPWS-IF97 Equations

Kiyoshi Miyagawa presented an investigation on computing speed comparisons between IFC-67 and IAPWS-IF97 in its original form (i.e. without additional backwards equations) on different PCs and operating systems. His findings were that based on the original assumptions on the typical distribution of function calls the computing time ratios (CTR) between IFC-67 and IAPWS-IF97 generally increased with more modern computer systems. With the computer system agreed upon for verification that IAPWS-IF97 meets the requirements (PC 486DX (33MHz)) the CTR value is 5.1 while it increases up to 8.6 (Pentium 4 (1.5GHz)) on modern systems. Apparently modern computer systems are optimized for "simple" computational operations which favors the simpler structure of IAPWS-IF97. Usage of different operating systems showed no relevant influence. Re-evaluation of the CTR values for all backward functions on an up-to-date computer system (Pentium 4 (3.0GHz)) emphasize the fact that backwards equations are very useful in reducing the computing time of applications.
During the discussion it was suggested to make comparisons between IFC-67 and IAPWS-IF97 including all backward equations from supplementary releases.
There was agreement that it was desirable to document the achievements by presenting a paper at suitable occasions, e.g. power industry conferences. This would give IAPWS an opportunity to advertise its work. Kiyoshi Miyagawa agreed to start with the preparation of such a paper.

8. *Revision of Advisory Note #2

Jeff Cooper stated that Advisory Note #2 has to be updated since now an additional supplementary release will be available. Advisory Note #2 explains the proper usage of the various IAPWS releases. Consensus was reached to make the following recommendation to the EC: **The EC is asked to authorize the editorial committee to revise Advisory Note #2 as needed without further formal acceptance by the EC.**

Tuesday, 5. July 2005
(Items 13 and 15 were revisited shortly on Wednesday, 6. July 2005)

13. New Industrial Requirements of the Future

The discussion of future industrial needs was based on the presentation of the Task Group on Environmental Issues by Nobuo Okita covered under item 11. f. of the TPWS minutes. The following areas of interest were identified:

i. High temperature requirements – extension of region 5 of IAPWS-IF97 to higher pressures
For conceptual studies an industrial formulation is not required. For these studies also TTSE could be used to provide fast property values. However if products are being developed an industrial standard is required. In order to use the currently available knowledge of developing such equations should not be delayed for long.

ii. IAPWS release on properties of sea water

iii. H2O – CO2 mixtures, especially steam - CO2 mixtures

iv. Renewed interest in nuclear power generation, here especially two-phase-flow phenomena

v. Metastable steam/water, here especially criteria for existence of the metastable state

vi. H2O dissociation at high temperatures, here especially under which conditions (temperatures, pressures) dissociation occurs

vii. Combustion of H2 and O2, here especially conditions of the steam after combustion (mixtures of steam with H2, O2 and possible other combinations)

viii. Properties of humid air and humid combustion gases

A task group "Future Cycles" was formed chaired by Bill Parry with members Nobuo Okita, Francois Gachon and potential member Michael Hiegemann. The task group will report next year on more precise requirements for future cycles for power generation.

Chairman Bill Parry reported on this discussion in a later joint meeting with TPWS (see TPWS minutes).

14. Extension of Metastable ICRN

As part of the above discussion of future industrial requirements further need for investigations in the metastable regions was identified. **The working group therefore recommends to the EC to extend this ICRN.**

15. Membership

The working group recommends to add the following persons to the membership roster:

Dr.-Ing. Michael Hiegemann, Alstom Power, Switzerland
Francois Gachon, Electricite de France, France

16. Other Business

In the initial EC meeting it was suggested to hold a symposium on new developments in power generation at the 2006 IAPWS meeting in Great Britain. In case the local organizing committee in fact chooses to hold such a symposium IRS will support the organizing efforts. **Chairman Bill Parry will contact the Head of Delegation of the Britain and Ireland National Committee.**

17. Preparation of Report to the Executive Committee

The Chairman and Clerk of Minutes will prepare the report to the EC.

18. Adjournment

The Chairman adjourned the meeting of the IRS working group at 16:30.

Agenda
of
Industrial Requirement and Solutions Working Group
Santorini, Greece July 4th to July 8th, 2005

Monday:

1. Opening Remarks, Adoption of Agenda
2. Appointment of Clerk of Minutes
3. Approval of Minutes of Kyoto Meeting, August/September 2004
4. *Potential International Collaborative Projects

22. *Supplementary release on v(p,T) backward equations in region 3
    - Report of the Evaluation Task group -- Kiyoshi Miyagawa
    - Formal Consideration of Supplementary Release by WGs TPWS and IRS
23. *Computing time investigations of IAPWS-IF97 Equations -- Kiyoshi Miyagawa
24. *Amendment of the "Revised Supplementary Release on Backward Equations for the Functions T(p,h), v(p,h) and T(p,s) for Region 3 of the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam"
25. *Revision of Advisory Note #2
26. *Differential quotients of IAPWS-IF97 and IAPWS-95 –Prof. Kretzschmar
27. *Extension of IAPWS-95 Formulation – Jim Bellows
28. *Requirements for Working Fluids: An Industrial Point of View

Tuesday:

12. *Environmental Task Group Report – Nobuo Okita
13. *New Industrial Requirements of the Future – Bill Parry
14. Extension of Metastable ICRN
15. Membership
16. Other Business
17. Preparation of Report to Executive Committee
18. Adjournment

*Note: The items 4 to 13 will be discussed at a joint session with WG TPWS.