IAPWS Working Group Power Cycle Chemistry (PCC)

Minutes of IAPWS PCC WG Meetings

Lucerne Switzerland 27-30 August, 2007

Chairman: Robert Svoboda
Members present See Addendum A

Members attended 4 technical presentation sessions covering topics set out under the agenda, see Addendum B.

1. AGENDA

1.1 Amendments / Adoption of Agenda

The content of the agenda was agreed. The order of consideration of topics was adjusted to enable actions to be placed after full coverage of relevant topics.

1.2 Week program: PCC participation in joint workshops and task groups

It was agreed that the session on sea water properties would provide an opportunity for a further parallel PCC meeting session to be attended by those not wishing to attend the joint meeting.

2. APPOINTMENT OF CLERK OF MINUTES

Geoff Bignold agreed to record the minutes.

3. APPROVAL OF MINUTES OF PCC WG IN WITNEY, ENGLAND, 2006

The minutes were agreed without any corrections or additions.

4. PROGRESS REPORTS ON PCC ACTIVITIES 2006 / 2007

4.1 International Collaboration "Assessment of the State of the Art of sampling Corrosion Products from Water / Steam cycles"

Derek Lister reported that successful progress had been made. Piti Srisukvatananan, a student at New Brunswick University had spent time at Alstom under supervision of Robert Svoboda, and at a Danish plant under supervision of Karol Daucik. He had now produced a draft final report "Assessment of the state of the art of sampling of corrosion products from water/steam cycles":

The draft report will be circulated to PCC members for review with a deadline of 30 September. It will then be submitted for publication.

Action RS.

Derek Lister confirmed that the collaboration had been completed with cost below budget, due to unforeseeable additional resources in Switzerland and Denmark.

Barry Dooley stated that the final report will be retained within IAPWS records and that the Executive Committee need take no action other than to note the successful outcome.

4.2 ICRN

- ICRN 18 "Decomposition of Ion Exchange Resins",

- ICRN 19 "Improved Coolant Sampling and Analysis of Low Concentration Metals (Fe, Cu, Co, etc.),

- ICRN 20 "Sensors for Use at Elevated Temperature in the Plant Cycle of the Power Industry".

Have all been approved and issued.

Work on two other draft ICRNs continues. These are:

"Research of Amines for the Power Industry". Further drafting of this will be coordinated by Jim Bellows.

Action JB.

"Thermophysical Properties Associated with Ultra-supercritical Coal-Fired Steam Generators". Barry Dooley will contact Don Palmer with regard to further drafting of this.

Action BD.

4.3 PCC Guidance Document "Mechanical Carry-Over"

After 16 iterations within the task group, a draft guidance document on this topic has been circulated in PCC. To be discussed under item 10.1

4.4 European Standard EN 12952:12

Severe concerns have been expressed about the technical content of this European Standard. Consideration will be given to setting up a PCC Task Group to lobby for appropriate revisions. See item 10.3.

4.5 PCC Public Relations

Robert Svoboda urged PCC members to give consideration to the need to attract more young members into the working group and to ensure that the efforts of the group are demonstrably valuable to the supporting industry. See item 10.4

4.6 Other Action List Items

There were no reports on other actions at this stage.

5. PROPOSALS FOR INTERNATIONAL COLLABORATION

No new proposals for international collaborations were raised.

6. PRIORITY LIST REVIEW

A full review of the priority list was undertaken. The outcome is covered in Addendum C.

7. ICRN

There is intention for an ICRN on Priority List item #6. ("The relationships between the chemistry of the contaminants and their concentration at point of measurement"). Subject of possible paper for the 15th ICPWS.

Action JB

There is intention for an ICRN 7 on Priority List item #6 ("Quantification of Risk"). Subject of current task group activity, item 10.2

ICRN 13 – Surface Tension. It was agreed that a full formal closure statement is required. Frank Gabrielli has indicated that the interest in the topic has declined and that the closure statement will therefore be quite brief. Robert Svoboda will request that it be prepared.

Action RS.

ICRN 22 - Steam Chemistry in Turbine Phase-Transition Zone. A draft, prepared by Miroslav Štastnŷ has been circulated and some comments provided. Further suggestions for modifications, formulation into ICRN format, etc. will be incorporated and the ICRN will be circulated for approval by national committees

Action BD, JB, RH

8. SETTING UP PCC TASK GROUPS

New Task Groups established:

> Task Group on "Assessment of plant lifetime consumption resulting from operation outside of chemistry guideline targets". Karol Daucik (chairman). See item 10.2)
>
> Task Group of European members to lobby for "Review of Standard EN12952:12". Eric Maughan (chairman). See item 10.3

New ad hoc Task Groups established:

> Task Group on defining the role of PCC with regard to future activities and growth of wider support. – All PCC members invited to attend and contribute. See item 10.4.
>
> Task Group on liaison with other IAPWS working groups on chemistry and corrosion issues arising out of the ongoing work on the properties of humid air and humid combustion gases. – Jim Bellows to co-opt members and convene as appropriate.

9. OTHER BUSINESS

None.

10. TASK GROUP PROGRESS REPORTS

10.1 Task Group on PCC Guidance Document "Mechanical Carry-Over"

There was extensive debate about the final draft that had been circulated to members in advance of the meeting. Barry Dooley criticised the concentration on vaporous and mechanical carry over when the plant requirement is to monitor and control total carry-over. Plant operators and manufacturers have different requirements. Manufacturers need to demonstrate that the plant meets specification targets, whereas operators need to be alert to the development of faults. More emphasis on appropriate and sufficiently comprehensive sampling was required.

Despite the issues raised there was general agreement that the document should become a valuable IAPWS PCC product. However, there was not yet sufficient agreement to present it as a final draft for consideration by the Executive Committee at this time. Robert Svoboda agreed to make modifications based on the issues raised and then to invite comments from an editing task group comprising Malcolm Ball, Barry Dooley, Albert Bursik, Jim Bellows, Marc de Wispelaere, Andre Zeitjseink, Geoff Bignold. He would introduce the concept to the Executive Committee and indicate the PCC wish to

issue it under a new suggested category of document called an IAPWS Technical Application Guideline.

Action RS.

10.2 Task Group "Assessment of plant lifetime consumption"

PCC has set up a task group on "Assessment of plant lifetime consumption resulting from operation outside of chemistry guideline targets" (Priority List item # 7: "Quantification of risk of asset damage").

The task group consists of the following members of PCC:
K.Daucik (chairman), M. Rziha, B.Hughes, E.Maughan, A.Zeijseink, A.Rudge, S.-E. Therkildsen, J.Bellows

The goal of the task group is to investigate and to elaborate, as far as possible, the effect of corrosive contaminants, corrosion processes and deposition processes on the life time of the plant, respectively its components in order to provide a decision tool for plant managers and operators to evaluate commercial impacts on plant operation.

The following primary tasks were decided and distributed to the individuals as follows:

Jim Bellows	- Information on deposition rates in steam turbines
Barry Hughes	- Experiences on the application of action levels
Eric Maughan	- Collection and comparison of literature on chemical indices
Andy Rudge	- Information about chem. indices in nuclear industry;
	- Information about risk assessment programs
Andre Zeijseink	- Collection of literature on this topic (starting mid 1990's)

The result of the primary tasks is due to be sent by 1st December 2007 to Karol Daucik who will then define further action.

Action KD

10.3 Task Group on "Review of Standard EN 12952:12"

EN 12952:12 and EN 12953:10 are due for review in 2008. Several PCC WG members from Europe have expressed their concern regarding these Standards that have been adopted by the European Community. The content of the Standards with respect to chemistry is not applicable to all steam generating plants. Considering that work may have begun at least a decade ago, it is feasible to present the CEN with additional views with respect to international plant cycle chemistry guidelines currently in use.

Recognizing the above-mentioned concerns, PCC has set up a task group on review of these guidelines to follow up this issue. The Task Group comprises WG members from European countries. Members of the WG from other countries are welcome to participate in the Task Group activities and to offer opinions.

Scope of the task group is to formulate a document detailing related issues into a common statement that can be used by the individual national committees to approach CEN via the official channels. If appropriate, the Task Group chairman may also contact CEN directly.

To be successful, the CEN and National Standards' Committees to be approached in each country should be assured that this Task Group is not confronting them but offering international expertise through the IAPWS PCC WG to the Technical Committee who will review and propose changes to the Standard.

Although the PCC WG agree in principle that this could be task for the IAPWS to provide input for the review of this Standard, it is strictly not an official activity but may in future prove to be a product coming from the PCC WG.

It was agreed that Eric Maughan should chair this task group and that he should co-opt all interested members.

Robert Svoboda will inform the Executive Committee of this initiative.

Action RS.

10.4 Ad hoc Task Group "Role, Identity and Public Profile of PCC"

Robert Svoboda opened the discussion by asking for views on what PCC should be undertaking in the future. The options ranged from proactive development of guidelines to merely advising IAPWS on industrial research needs.

Eric Maughan raised the concern that a number of the larger industrial entities (e.g. ESKOM and EdF) no longer attend the working group and that the key staff at VGB were now aware of the work.

Barry Dooley listed many of the achievements of PCC and recommended that they be used to justify the refreshment of the group in future. Discussion of future products of PCC followed, including guidance documents on sampling, on monitoring of concentrations of metals and on practical use of the volatility data.

Pat Coleman suggested a draft mission statement for PCC that was then debated and developed by the group. After significant debate an agreed statement (Addendum D) was prepared.

Robert Svoboda will report this to the Executive Committee.

Action RS.

11. CHANGES IN MEMBERSHIP, ELECTION OF OFFICERS

The group welcomed first time attendance of the following:

Frank Udo Leidich	Germany
K. Balasubranianian	India
K.R. Sanjeev	India
Dimitris Sotiropoulos	Greece
Pangiotis Tsiampas	Greece
Denis Smetanin	Russia

Robert Svoboda explained the route to full membership of PCC and encouraged the expansion of the group.

Andreas Drexler was nominated for membership. Nomination by Robert Svoboda, seconded by Michael Rziha and Jim Bellows and approved unanimously.

Ken McGrath has written retiring from his membership. His past contributions were noted with thanks and best wishes.

Ken Mathur has now retired and will not continue his membership.

Marc de Wispelaere was nominated for recommendation to the Executive Committee as a deputy chairman of PCC. The nomination was approved unanimously.

It was agreed that contact should be sought with a number of members who have not been able to attend in recent years:

W.Allmon	Jim Bellows to contact.
A. Banweg	Robert Svoboda to contact.
J-P.Jensen	Karol Daucik to contact.
L Guinard	Robert Svoboda to contact.
V.Kritski	Tamara Petrova to contact.
P.Saidl	Robert Svoboda to contact.
J.Vosta	Miroslav Štastnŷ to contact.

12. PREPARATION OF ACTION LIST 2007 / 2008, TASK DISTRIBUTION, NEXT YEAR'S AGENDA, ICPWS PROGRAM

Robert Svoboda will circulate the action list to members by e-mail.

13. PREPARATION OF PCC WG REPORT FOR EXECUTIVE MEETING

14. MISCELLANEOUS AND ADJOURNMENT

There was no other business.

ADDENDUM A – Attendees

K. Balasubranianian	India
Malcolm Ball	U.K.
James Bellows	USA
Geoff Bignold	U.K.
Albert Bursik	Germany
Patrick Colman	Ireland
Karol Daucik	Denmark
Marc de Wispelaere	Belgium
Barry Dooley	USA
Andreas Drexler	Germany
Richard Harries	U.K.
J. Barry Hughes	U.K.
Frank Udo Leidich	Germany
Derek Lister	Canada
Kazuo Marugame	Japan
Eric Maughan	Germany
Masamichi Miyajima	Japan
Tamara Petrova	Russia
Michael Rziha	Germany
Andy Rudge	U.K.
K.R. Sanjeev	India
Dimitris Sotiropoulos	Greece
Denis Smetanin	Russia
Miroslav Štastnŷ	Czech Republic
Robert Svoboda	Switzerland
Pangiotis Tsiampas	Greece
Hiroshi Takaku	Japan
Svend-Erik Therkildsen	Denmark
Shunseke Uchida	Japan
Sonia Vidoikovich	Serbia
Masaki Yoshida	Japan
Andre Zeijseink	Netherlands

ADDENDUM B- PCC related Workshops

All WG workshop (Tuesday morning)

"Properties of Humid Air and Humid Combustion Gases" (A.H. Harvey)

- Measurements of the Water Vapor Concentration Enhancement in Compressed Air, Nitrogen, and Argon with FTIR Spectroscopy (M. Wendland)

- First-Principles Calculation of Interaction Second Virial Coefficients Between Water and Common Gases, Including Air (A.H. Harvey)

- Dew Point of Combustion Gas.
  - Report of the Task Group (N. Okita, R. Span, J. Hruby)

- Update for ICRN-14: Thermophysical Properties of Humid Air and Combustion-Gas Mixtures (R. Span)

All WG workshop (Tuesday afternoon)

"Properties of Seawater" (P. Tremaine)

- Activities of the Task Group on Seawater, Liaison with IAPSO, Letters Between the IAPWS President and the President of IAPSO
  - Report of the Task Group (R. Feistel, A.H. Harvey, M. Hiegemann, P.Tremaine)

- Investigation of IAPWS-95 Properties Between the Freezing Points of Pure Water and Seawater- - Report of the Task Group (R. Feistel, M: Anisimov, J. Hruby, W. Wagner)

- Composition of Standard Seawater, Reference Salinity Scale (R. Feistel, F.J. Millero, RSMAS, Miami, FL)

- Development of an Extended Formulation for the Thermodynamic Properties of Seawater (R. Feistel)

- Uncertainty of Conductivity Measurements (P. Spitzer, PTB Braunschweig, Germany)

- Density of Seawater (F.J. Millero, R. Feistel)

- Formulation of an ICRN on the Properties of Seawater (R. Feistel)

- Formula Symbols, e. g. for the Salinity of Seawater (R. Feistel)

PCAS / PCC workshop (Monday afternoon)

Research Presentations on Physical Chemistry for Power Generation (S. Lvov)

PCC contributions:

- S. Uchida: "Radiation Chemistry for Determining Corrosive Conditions in Primary Coolant of Light Water Cooled Nuclear Reactors"
- E. Maughan. "The fate of a water/steam sample from extraction until point of measurement"
- D. Smetanin "Mathematical modelling in cycle chemistry monitoring systems"
- G. Bignold: "Amine dissociation at temperature"
- P. Tremaine: "The Generation IV Supercritical Water Reactor concept and its research challenges"
- S. Lvov: "New experimental system for electrochemical corrosion studies in high temperature water"

PCC workshop (Tuesday morning and Thursday morning)

Presentations on Power Cycle Chemistry Research and Experience (R.Svoboda)

- H. Takaku, M. Miyajima, M. Yoshida: "Essentials of revised guideline for water conditioning for boiler feedwater and boiler water in Japan; JIS-B-8223 published in Oct. of 2006"
- S.Vidojkovic: "Corrosion damages analyses in fossil plant"
- M.Stastny: " Condensation of Flowing Steam with Nucleation in Salt Solution Zone"
- T. Petrova, V. Kashinskiy, P. Nikolaev "Influence filming amines on corrosion rate of carbon steel in water at higher temperatures"
- A.Rudge: "Substantiating an amine for use in our once-through boilers".
- A.Rudge: The second is in a sense a prequel to the one above - how we have used our "Steaming boiler rig to investigate the corrosion risk posed by species that concentrate in the boiler".
- A.Rudge: "Plant trial with amine dimethylamine treatment". (optional)
- S.Uchida: ""Evaluation of Flow Accelerated Corrosion of PWR Secondary Components by Corrosion Analysis Coupled with Flow Dynamics Analysis".

ADDENDUM C

PCC Priority List

1. Interfacial situation in advanced ultra supercritical plants

Formation and exfoliation mechanism of scale (oxide films) in steam lines
effects of chemistry (oxygen, ammonia ?)
Corrosion interactions materials / steam, influence / effect of
supercritical parameters, protective layers, radiation
Faster decomposition of chemicals (TOC, ammonia etc)?

Joint PPC/PCAS ICRN (Palmer, Dooley) to cover some of these topics has been drafted; pending approval

2*. Mechanism of Decomposition of Ion-exchange Resin

Operating conditions, quality control of resin; leak rates are slow, but sulphate is one of the products, organic leachables, oxidation
Additional information has to be researched

ICRN Daucik -> ICRN # 18 has been issued

3*. Development / Application of Sensors (Ambient and High Temperature Sensors)

ECP (nuclear, fossil application), ORP,
problem: abstract parameters, acceptance by plant operators

Joint PPC/PCAS ICRN #20 has been issued

4*. Improved analysis of low concentration of metals (Fe, Cu, Co, etc)

Techniques for analysis are known, but problems with implementation
Additional problems with adequate sampling

Key work on sampling has been done (PCC International Collaboration 2006/7), remaining questions see #6

5*. Corrosion mechanisms that are related to the presence of contaminants in steam/water circuits, particularly in boiler-water

Define critical species / quantify critical quantities of steam generator water impurities, synergy with other species (e.g. oxygen), consideration of the materials

ICRN to be considered for 2008 (Svoboda contact PCC by E-mail)

6*. The relationships between the chemistry of the contaminants and their concentration at point of measurement

Detailed definition of the problem

ICRN: Lister + Daucik; ICRN #19 on sampling of corrosion products has been issued. International collaboration 2006/7 has been performed: Piti S.(Lister, Daucik, Svoboda)

Topic to be considered for a paper at ICPWS 2008,(Bellows, et al)

7*. The quantification of risk of asset damage

problems of getting background data, important long-term issue
need: tool for operators, design engineers & commercial persons
PCC: to provide basic background data, e.g. corrosion / deposition rates
PCC task group has been set up (chair: Karol Daucik), implement results from #10

8*. Method to determine the mechanical carry-over?

Outline established in PPC minutes 2004
Guidance document is needed;
Draft document issued, to be processed by PCC 2007 / 08

9*. Improved understanding of condensation mechanisms

- dropwise vs filmwise condensation in condensers (improve heat transfer)
- heterogenous – homogeneous nucleation models for prediction of condensation in steam turbines (chemistry, electrostatic,...)
- chemistry of the phase transition zone in nuclear turbine systems

ICRN draft to be processed 2007 / 2008 (Stastny with support by RS, BD, RH)

10*. Deposition of contaminants and corrosion products in steam and water circuits

- supersaturation,
- mass transfer,
- adsorption,
- crystal nucleation,
- deposit re-dissolution,
- scouring and exfoliation,
- activation and activity transport in reactor systems
- Mechanism and Influence of Cu Deposition :
  - **(**essentially a solved problem from a scientific viewpoint)
  - mechanism of deposition on a turbine blade is not understood
  - discrepancies in temperature influence on deposition (?)

To be considered in 2008 for ICRN (Bellows)

11. High pressure / high temperature steam and humid air (24 MPa and up, 2000°C), thermophysical properties and chemistry formulation

Long term interest in power industry,

Treated in TPWS

12*. Radiation chemistry of water

Radiolysis

2007 PCAS/PCC presentations have been made

13. Behaviour of Alumnium in the steam / water cycle

- volatile carry-over and deposition in the turbine
- depsoition on boiler tubes
- behaviour in conensate purification

To be considered for ICRN 2007 / 2008 (Rziha, Svoboda)

14. Water cooling of copper in electrical machines

- generator stators
- accelerators

Consider a paper for the 2008 ICPWS (Svoboda)

**** includes input from the nuclear group***

The numbering in the list is made for reference only and does not contain any information on actual priority

In addition, PCC should maintain awareness of the following items

- Chemistry and corrosion related items to future nuclear generation systems (6-best-design-reactor concepts, fusion reactor)

ADDENDUM D

Mission and Working Process of PCC

30 Aug 2007

PCC MISSION

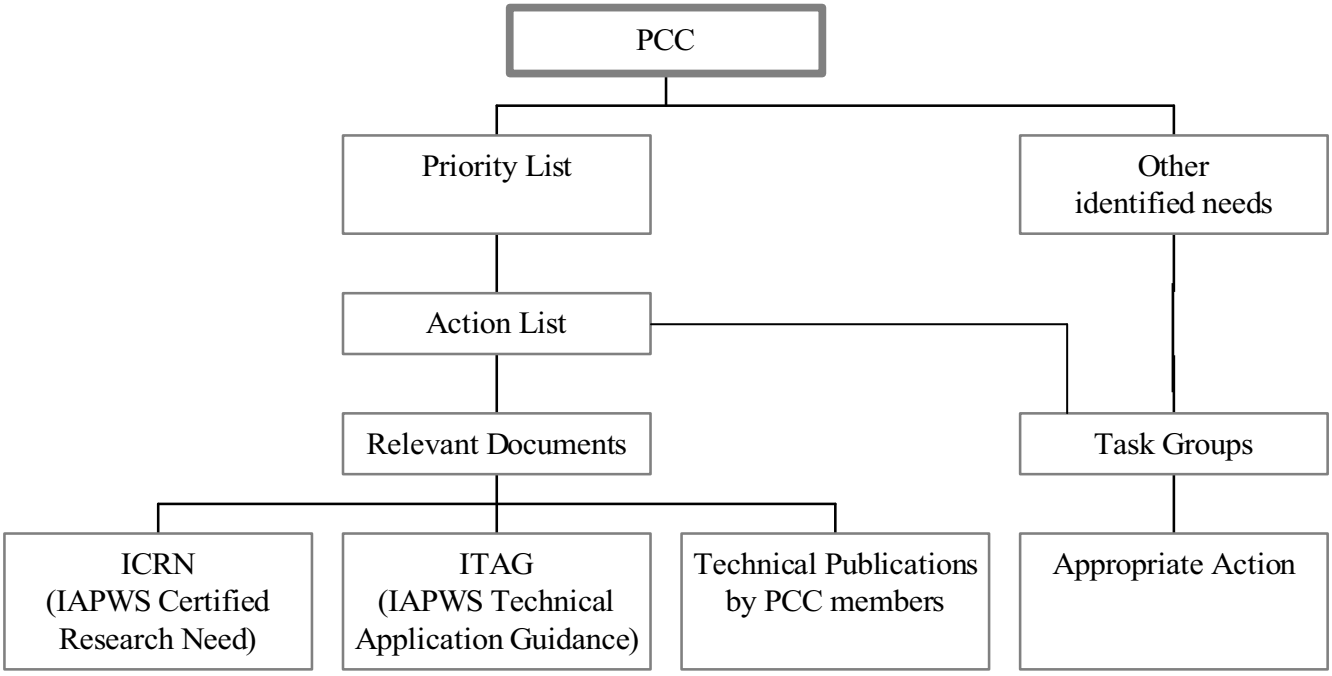
The Power Cycle Chemistry Working Group (PCC) brings together scientists and engineers from academia, research organizations, fossil and nuclear plant operators, equipment manufacturers and other relevant interested parties from around the world with an interest in power cycle chemistry to:

- 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

for the benefit of industry.

PCC WORKING PROCESS

Workflow



(* ITAG: proposal for new type of IAPWS document, to be discussed within PCC)

Working Tools

- Discussions at annual IAPWS meeting (mainly for steering)
- Individual or group work on PCC assigned tasks throughout the year
- IAPWS International Collaboration