IAPWS POWER CYCLE CHEMISTRY (PCC) WORKING GROUP (WG) PROGRAM

FOR IAPWS 2025

HELSINKI, FINLAND,

REVISION 3.0 –UPDATED WORKING DRAFT PROGRAM FOR PCC ISSUE AND COMMENT, 16 APRIL 2025

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Program Notes

1. **This is a revised working draft for circulation to PCC and other IAPWS members and for general circulation**
2. **It includes additional background information as a appendix not previously included in historical PCC programs. This is part of the reset of PCC currently underway**
3. **Feedback is welcomed and encouraged to ensure the best possible PCC program**

1.0 Introduction to PCC - https://iapws.org/wg/PCC.html

The IAPWS Power Cycle Chemistry Group (PCC) is the primary IAPWS Working Group interested in water/steam related chemistry for steam power cycles in conventional fossil, combined cycle, nuclear, solar thermal, and geothermal power cycles, along with other industrial process applications of steam including biomass and electrical boilers and other non-conventional and emerging steam generation technologies.

Membership of PCC is made up of global water/steam experts, researchers, designers, users and other interested persons. Currently over 20 different countries are represented in PCC. The PCC working group was established by IAPWS in 1990.

The key purpose of PCC is to provide technical guidance, obtained by the international consensus of experts working across the whole water/steam industry across all these areas, and to make this technical guidance freely and easily available across the world. The current suite of documents covers the key requirements for the effective management of steam power cycle chemistry, including feedwater and boiler water treatments, steam purity requirements, on-line monitoring instrumentation, corrosion product monitoring and the application of film-forming substances. The documents are written in formats that allow plant operators to customize the guidance for each type of plant. Approved and issued IAPWS PCC Technical Guidance Documents are available to download, for free, from the IAPWS website at https://www.iapws.org/techguide.html.

The PCC working group also produces White Papers that collate and develop the available technical information on particular subjects of interest to the Association as a preliminary stage before a Technical Guidance Document can be developed. Whilst it is emphasized that White Papers have no formal status within IAPWS, they are valuable reference documents for researchers and plant operators.

The IAPWS PCC Working Group also provides an opportunity for industry experts to meet annually and discuss research, emerging industry issues and new technologies and to identify areas of future industry research. The identification of industrial research is via the IAPWS Certified Research Needs (ICRN) process with PCC developing ICRNs to help guide and promote research in the identified areas. IAPWS ICRNs represent the considered opinion of experts in the field that research on a particular subject is needed. They are often developed as a response to a lack of adequate data on a particular issue related to its fundamental understanding and basis for industrial applications. They consist of a statement of the problem, a statement of the industrial need, a contact person, and an expiration date. No funding is available from IAPWS, but the ICRNs may be copied and attached to proposals to funding agencies. Current ICRNs can be reviewed on the IAPWS website at https://www.iapws.org/icrn.html.

In some specific cases, IAPWS can facilitate International Collaboration projects on scientific and technical matters of importance to the Association. These projects must be international in nature and involve at least two Members or Associate Members of the Association. Recent PCC projects include boiler electrochemical corrosion studies and corrosion product monitoring at flexible plants.

As well as meeting at the annual IAPWS meeting to share knowledge and experiences and collaboratively work on future Technical Guidance Documents and ICRNs, PCC members engage throughout the year at other IAPWS supported meetings and conferences, webinars and specific task group meetings and calls. Examples of other IAPWS supported events include the European HRSG

Forum, the International Conference on Film Forming Substances and the Australasian Boiler and HRSG User Group. Details of future IAPWS annual meetings can be found here

Membership of the PCC working group is completely open. Anyone working or who has an interest in water/steam related chemistry for steam power cycles in conventional fossil, combined cycle, nuclear, solar thermal and geothermal power cycles, along with other industrial process applications of steam including biomass and electrical boilers and other non-conventional and emerging steam generation technologies is welcome to attend PCC meetings and to contribute to PCC work.

2.0 Outline of what a IAPWS PCC Annual Meeting Is:

Firstly – it is not a conference with only presentations and a few questions, it's a working meeting and these are subtly different and its worth ensuring potential new attendees are aware of this and as a refresher to previous attendees of PCC.

Whilst a symposium or a workshop is normally part of the IAPWS week this is a one day event organised by the hosting IAPWS national committee as a separate event to the IAPWS meeting and is normally related to the national committees key areas of interest as is intended to foster collaboration and knowledge sharing between IAPWS and the host national committee members.

Whilst technical presentations by IAPWS PCC members are a part of the meeting these are intended to be

1. Related to ongoing IAPWS PCC work, reporting on progress or findings or providing a opportunity for discussion with peers
2. Outlining back grounds to possible IAPWS Certified Research Needs (ICRNS)projects
3. Introduction of new technical areas or issues that may be of interest to PCC to investigate further
4. Related to possible IAPWS International Collaboration (IC) Projects between IAPWS member national committees.
5. Related report in regards to IAPWS PCC White Papers or Pre-TGDs

The PCC working group meeting also undertakes the following

1. Administration aspects of PCC
2. The formation of possible new PCC Task Groups to investigate and work on specific issues as agreed by PCC
3. Joint working sessions with other IAPWS groups such as PCAS and IRS
4. Direct in person PCC project work and discussion opportunities for PCC members to expedite outputs

PCC attendees are expected to actively participate in the discussions and work streams and all are welcome. It is hoped that any attendees continue to regularly attend and contribute to ongoing PCC activities.

So why should you attend a IAPWS PCC meeting and what are the advantages to you and your organisations?

Some of the key things attendees get out of a IAPWS PCC meeting include

- Networking and knowledge and experience sharing with leading industry and global experts
    - Researchers (Universities/Research Institutes)
    - Equipment suppliers
    - Chemical vendors
    - Utility chemists
    - Consultants
    - Members of other standards organizations (VGB/EPRI etc)
- Exposure to the leading edge of water/steam science, issues, solutions and research taking place as well as the ability to contribute to the discussions associated with these areas
- Obtaining a truly onternational perspectives on water/steam issues occurring in industry
- A chance to work on leading IAPWS guidelines and documents to help lead and influence the world of water/steam chemistry

IAPWS POWER CYCLE CHEMISTRY (PCC) WORKING GROUP (WG) PROGRAM FOR IAPWS 2025 – HELSINKI, FINLAND,

SUNDAY 22 JUNE

6:00 – 8:00 pm Welcome Reception and Registration – Hanaholmen Hotel

MONDAY 23 JUNE

09:00 – 11:00 IAPWS EC initial meeting – (TBC)

11:30 – 12:00 PCC Internal – PCC WG Meeting – (TBC)

1. Introduction to PCC 2025 Meeting
2. Amendments / Adoption of Agenda
3. Appointment of Clerk of Minutes
4. Approval of Minutes of PCC Boulder 2024
5. Review of Actions from last PCC WG Meeting
6. Review of current ICRNs
7. IAPWS TGD's Updates– (Barry Dooley)
    a. TGDs Overview
    b. Corrosion Product Sampling
    c. Flue gas condensation
    d. Geothermal Steam Chemistry
    e. Electrode Boiler Chemistry
    f. Application of FFS in Nuclear Plants
    g. Instrumentation
    h. Steam Purity
    i. Application of Film Forming Substances in Fossil and Combined Cycle Plants Revision with FFS Conference Materials
    j. Carryover

8. PCC TGD Groups working time

12:00 pm to 1:30 pm Lunch

1:30 pm to 4:30 pm PCC and PCAS Joint Meeting (includes afternoon Tea Break

TBC - Ken Yoshida, Tokushima University

Canada/Japan International Collaboration FFA Update Sarita Weerakul , UnB

Ongoing FFS research needs from a PCC perspective– David Addison and Barry Dooley

Does a FFA adsorb under dry steam conditions? -Wolfgang Hater

Electrode Boiler Electrochemistry & Corrosion Update – David Addison, Thermal Chemistry /Monika Nielsen, Orsted

High-resolution X-ray computerized tomography to characterize localized corrosion rates of carbon steel in contaminated steam cycles, Derek Hall, Penn State University

An Electrochemical Investigation of Boiler Steel Corrosion Under Chloride and Sulphate Contamination, Summary Presentation of Doctor of Philosophy Dissertation Derived from IAPWS International Collaboration Project (also summary report for IC project), Ben Loder, University of New Brunswick

Use of conductivity versus sodium for steam quality measurement on evaporator distillate BFW in Oil Sand Applicatons - Basil Perdicakis, Suncor Energy

Efficacy improvement of steam generation by a film forming amine product - Wolfgang Hater

3:00 pm to 3:30 pm Coffee/Tea Break

3:30 pm to 4:30 pm PCC and PCAS Joint Meeting - Continued

4:30 pm to 5:30 pm PCC Priority List 2025 Discussion and Update – Led by David Addison – PCC Chair

FFS knowledge and understanding – how does PCC continue to develop this

PCC Mission Statement 2025 Discussion and Update – Led by David Addison – PCC Chair

Evening PCC Social Dinner - TBC

TUESDAY 24TH JUNE

09:00 – 10:00	PCC White Papers/Publication Updates
	IAPWS Corrosion Product Sampling White Paper Update – Barry Dooley
	Other CPS WP related presentations/data collection etc - TBC
	IAPWS Flue Gas Condensate Treatment White Paper – TBC – Ben Loder + Nordic IAPWS - TBC
	IAPWS "Blue Book" Chapter 17 "Water Chemistry in commercial water-steam cycles" possible update and republish as a PCC TGD/White Paper/Other Document – David Addison PCC Chair
	IAPWS PCC Possible Water/Steam Chemistry Benchmarking (and how to use IAPWS TGDs) tool/TGD development – David Addison – PCC Chair
10:00 - 10:15	Coffee Break
10:15 – 10:45	PCC TGD Groups working time
10:45 -12:00 pm	Electrode Boilers/Industrial Boilers
	Nordic IAPWS electrode boiler update – Monika Nielsen
	New Zealand IAPWS electrode boiler update – David Addison
	Japanese spray type electrode boilers - Tomohiko Yoshii
	Revisit the idea of a IAPWS industrial boiler TGD – David Addison
12:00 pm - 1:30 pm	Lunch
1:30 pm - 2:30pm	PCC and PCAS and IRS Joint Meeting
	Geothermal TGD Update – David Addison
	Acid Dew Point White Paper – Nobu Okita
	Chemical cleaning criteria for supercritical power plant – Barry Dooley
2:30 pm – 3:00 pm	PCC Priority List 2025 Discussion and Update Continued if required – Led by David Addison – PCC Chair
3:00 pm to 3:30 pm	Coffee/Tea Break
3:30 pm to 4:00 pm	PCC TGD Groups working time

4:00 pm 5:00 pm Flex Ops Session – chemistry/analysers/layup and storage - TBC

WEDNESDAY 25TH JUNE

08:30 to 4:00 pm – IAPWS/Nordic IAPWS Symposium

"Industrial Boilers, Flue Gas Condensate and Future Technologies"

See separate Symposium program

Includes: IAPWS Helmholtz Award Lecture

5:00 pm	Transport to IAPWS Dinner/Banquet
7:00 pm	IAPWS Dinner/Banquet
	Transport provided to Supmenlinna Sea Fortress

THURSDAY 26TH JUNE

09:00 – 11:30 PCC Internal Session: Continuation of TGDs Related PCC Presentations/Updates

1. Update of PCC Work Flow Chart (2010) to reflect current work practices– Paul McCan
    a. PCC Task Groups
    b. White papers
    c. Webinars
    d. LinkedIn
    e. Etc
2. Possible PCC related ICRNs
3. Possible PCC related future International Collaborations
4. PCC Communications
    a. PCC WG update calls
    b. LinkedIn
    c. Webinars
    d. YouTube
5. Additional PCC internal presentations time
6. IAPWS 2026 Update
7. PCC TGD Groups working time
8. IAPWS TGD's Updates– (Led by Barry Dooley) – progress updates from IAPWS 2025 and progress plans from Task Group Chairs
    a. TGDs Overview
    b. Corrosion Product Sampling
    c. Flue gas condensation
    d. Geothermal Steam Chemistry
    e. Electrode Boiler Chemistry
    f. Application of FFS in Nuclear Plants

g. Instrumentation

h. Steam Purity

i. Application of Film Forming Substances in Fossil and Combined Cycle Plants Revision with FFS Conference Materials

j. Carryover

10:00 - 10:15	Coffee Break
11:30 – 1:00 pm	PCC WG Business - Led by David Addison – PCC Chair

(1) Progress Reports 2024/2025 and Future PCC Activities
(2) Review, update, rationalization and consolidation of previous PCC actions still outstanding
(3) Proposals for new TGD's summary
(4) International Collaboration
(5) ICRNs – Review and Possible New Additions
(6) PCC Public Relations / Contribution to Press Release
(7) Changes in PCC Membership and Election of Officers
(8) Adjournment

1:00 pm - 2:30 pm	Lunch
2:30 pm – 4 pm	IAPWS Technical Visit – VTT Technical Research Centre of Finland

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FRIDAY, 27TH JUNE

09:00 – 13:00	IAPWS Executive Meeting

APPENDIX 1: 2010 PCC Mission Statement

PCC last had a published mission statement in 2010 that has not been circulated or updated since then. (https://iapws.org/minutes/2010/PCC2010.pdf) which is as per below. As part of PCC 2025 this will be required to be reviewed by the PCC WG and updated.

As developed and published by PCC at the Niagara Falls July 2010 IAPWS meeting

2010 MISSION

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

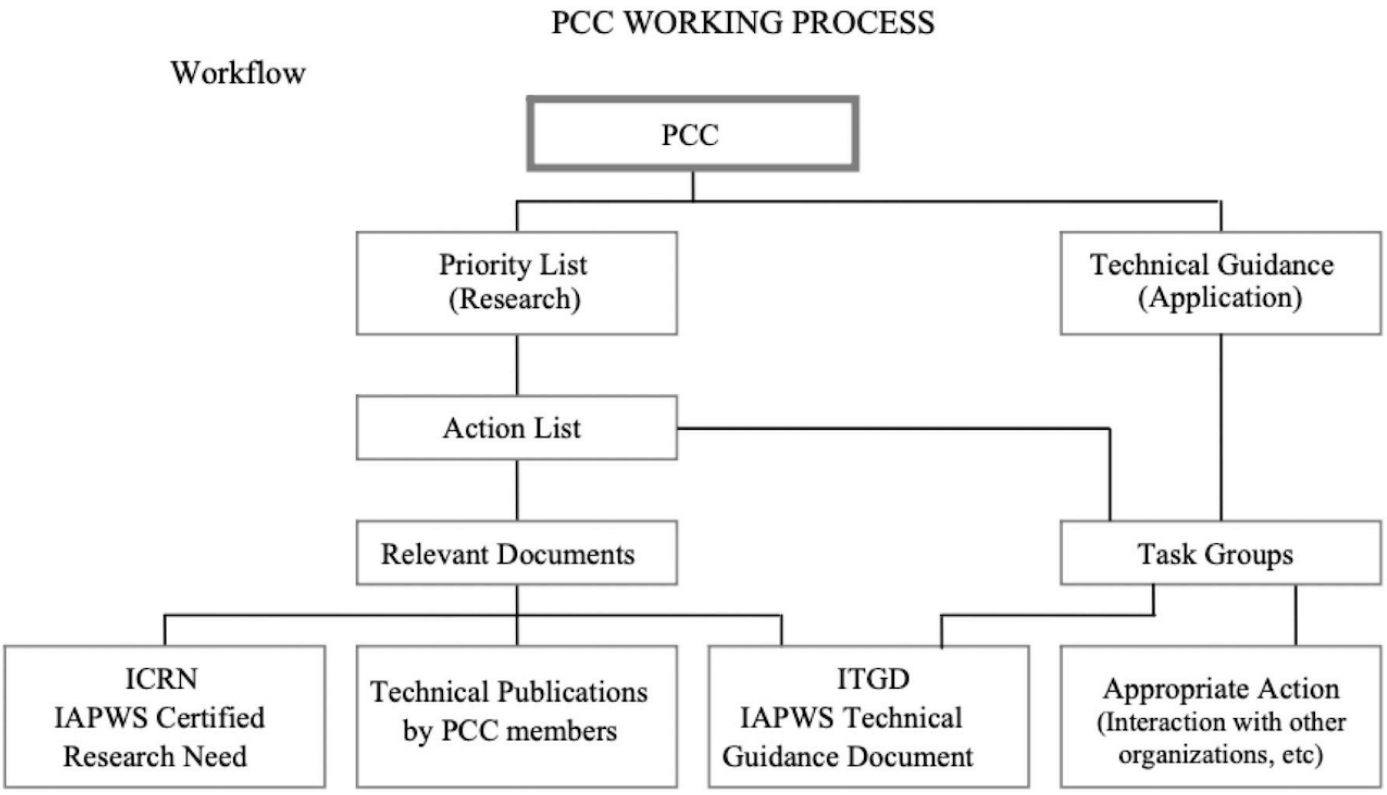
- *Collaborate and share results of scientific and engineering research and experience*
- *Identify gaps in technical information relating to power cycle chemistry*
- *Seek resolution of these gaps through international cooperative projects and the release of appropriate documents*

for the benefit of industry. Within IAPWS, it serves as a liaison between industrial needs and related research represented by PCAS Working Group.

APPENDIX 2: PCC Work Flow Chart (2010)

PCC also had a published PCC Working Process in 2010 that has not been circulated or updated since then. (https://iapws.org/minutes/2010/PCC2010.pdf) which is as per below. As part of PCC 2025 this will be required to be reviewed by the PCC WG and updated if required.

As developed and published by PCC at the Niagara Falls July 2010 IAPWS meeting



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*

APPENDIX 3 Last PCC Priority List (Last Updated 2012) – To be Updated 2025

PCC had historically a clear priority list to help provide direction. However, across the 2011-2013 time period this has been misplaced from the PCC agender and has not been updated and published officially since 2012. There is a reference to it being briefly discussed in the 2013 PCC minutes (note that this was a ICPWS year with limited PCC WG time) but no summary was published at that time or afterwards and no further records of it are in the OPAL database.

As part of the 2025 meeting this needs to be refreshed and updated by PCC. All PCC members attending IAPWS 2025 are required to submit two lists of issues (Separate email and instructions to be issued in relation to this) for the following for a list of water/steam chemistry related issues that they feel PCC could assist with in relation to:

1. Their home country and its related issues (e.g. New Zealand is very interested in geothermal steam turbine issues) and
2. Related to their professional work areas

The last published notes from the 2012 PCC meeting (https://iapws.org/minutes/2012/PCC2012.pdf) are provided below for reference.

PCC Minutes, Niagara Falls July 2010

Updated at Plzen, September 2011

Updated at Boulder, October 2012

Not updated or published again at ICPWS in London in 2013

PCC Priority List for Further Research

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)?

Status 2011: Joint PCC/PCAS ICRN #21 is on the IAPWS website Status 2012 : no change

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

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

Status 2010: ICRN #20 has been issued in 2006, some activities known in 2009 (Balashov, Petkin, Lvov), re-formulation in 2010 related to the needs from nuclear industry (Uchida), 2011: still on-

going
Status 2012: ICRN # 20 is approved until Sept. 2014

3. * 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

Status 2011: Geoff Bignold drafted ICRN #25 which should be finalized in 2011 (Bignold, Cook)
Status 2012: ICRN # 25 : Draft for EC

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

Main scope will be the minimum requirements for sampling specifically for Fe, Cu, Co, Oxygen, etc.

Status 2011: ICRN #19 on sampling has been extended to 2012. International collaboration 2006/7 2010/2012. (Uchida, Lister, Daucik, Svoboda). 4 papers by Piti et al. IAPWS Guidance Document on sampling under consideration

PCC Attachment C

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Status 2012: Papers by Lister, Uchida, et al. had been presented focussing on Fe-oxides. Paper is distributed to relevant PCC members for the preparation of the final report. Investigations on other parameters e. g. Oxygen are still of high interest.

5. * 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: K.Daucik)

Status 2011: available information has been compiled, although insufficient for being basis of an IAPWS document, a publication on the existing results will be made (Daucik, 2012)
Status 2012: ongoing until next meeting in London 2013.

6. 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
- development of liquid films on surfaces in saturated steam environments

(especially with regard to Flow Accelerated Corrosion)

ICRN #22 is on the IAPWS website; Status 2012: ongoing

7. 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 and Al Deposition :

(Cu essentially a solved problem from a scientific viewpoint) - mechanism of deposition on a turbine blade is not understood - discrepancies in temperature influence on deposition (?)

Status 2011: wide range of information available and research ongoing, opportunity for several ICRN

PCC Attachment C

Status 2012: Topic is actually partly covered by ICRN #22 and ICRN #26
Paper by Uchida and Lister et al. had been presented on transport and deposition of Fe-oxides.

8. Radiation chemistry of water

Radiolysis, main importance for nuclear generation

2007 PCAS/PCC presentations have been made

Status 2011: major issue for supercritical water reactors. Workshops held regularly in connection to the bi-annual International Conference on Water Chemistry in Nuclear Reactor Systems
Status 2012: update will presented at the 16th ICPWS in London 2013 – considering moving to watch list.

9. * Behaviour of Aluminium in the steam / water cycle

- Al release under various water treatment regimes - volatile carry-over and deposition in the turbine
- depsoition on boiler tubes,
- solubility in water and steam

- behaviour in condensate purification
- interaction of Al with boiler chemistry
- specfication values for Al in feedwater, boilerwater, steam
- impact of the use of Al on materials and cycle chemistry of the rest of the cycle

Status 2011: ICRN #26 in processing, final draft is available (Rziha, Svoboda) Status 2012: additional input to ICRN #26 by Gary Joy. Draft to EC

10. Water cooling of copper in electrical machines

- generator stators - accelerators

Status 2011: paper at ICPWS 2008;EPRI guideline 2008, CIGRE guidance document to be published (draft document approved), new investigations Palmer/Svoboda considered Status 2012: remains of interest. Update during 16th ICPWS

11. Water use outside the steam / water cycle

- - cooling water
- - waste water
- - external process
- - recycling for use as make-up
- - etc.

For further consideration for 2012, possibly new IAPWS sub-committee. PCC does not have the resources to take leadership on these items.

PCC Attachment C

Status 2012: ongoing. Position paper in preparation (task group: ***Stephanie Marais****, Andy Howell, David Moed, Gary Joy, Pavel, et. Al)*

12. Chemistry in geothermal and oil / sand cycles

Behaviour of water constituents, effects on system materials, geochemical and waste water issues, including behaviour of radionuclides in these waters.

Status 2011: ICRN to be considered for 2012 (Leidich, Rziha, Myszczyszyn) Status 2012: ICRN still to be drafted. (Leidich, Rziha, Myszczyszyn, Addison)

13. Chemistry aspects in solar thermal generation

Status 2012: ICRN is under preparation (Gary Joy)

14. Chemistry of Desalination Systems

Status 2012: “White paper” by Stephanie Marais, David Moed, Pavel Gotovtsev, Gary Joy, Andrew Howell, Paul McCann, describing the needs and recommendation is available. ICRN will be prepared until 2013. Elaboration of TGD is proposed and accepted by WG. Task Group for TGD will be set up at annual meeting 2013.

15. Chemistry of Filming Amines

Status 2012: A “white paper” by Stephanie Marais, David Moed, James Bellows and Tamara Petrova, describing the needs is available. It is recommended to create a separate ICRN beside ICRN #17. The draft will be prepared in advance to the annual meeting 2013.

**** urgent priority***

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, Generation IV reactor plants, ITER)
- 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)

APPENDIX 5 PCC File Access - OPAL

Final PCC files are currently stored on the OPAL file storage system hosted by the Zittau/Görlitz University of Applied Sciences in Germany. This system has recently been changed and a new username and password has been issued.

https://bildungsportal.sachsen.de/opal

A separate email will be sent to all PCC members with the updated access details to this system