

**Power Cycle Chemistry Working Group (PCC WG)  
Rotorua, New Zealand, November 27 – December 1<sup>st</sup>**

**1. Adoption of Agenda and Minutes Approval**

IAPWS 2022 PCC WG members were welcomed by David Addison.

Willy Cook requested an addition to the agenda – discussion of radiolysis task group to be formed, possibly by PCC.

The agenda was adopted. The agenda is attached as PCC Attachment A.

Minutes from PCC Virtual/online 2021 were approved with no changes.

**2. Appointment of PCC WG Clerk of Minutes**

Olga Palazhchenko (Canada) was appointed as clerk.

**3. Review of Actions from last PCC WG Meeting**

No significant updates to report on.

**4. IAPWS TGDs Updates**

Session chaired by Executive Secretary Barry Dooley.

Dooley provided background information that 11 TGDs have previously been developed. Dooley emphasized that importance of the TGDs should be shared with the NZ geothermal community, highlighting that TGDs are unique in that they contain a base case and customization aspects for every plant worldwide. Dooley requested that the separate TGD WGs arrange to meet during the ICPWS week to progress activities.

**Progress on Draft TGDs or Whitepapers:**

**Whitepaper: Application of Film Forming Substances (FFS) in Nuclear Power Plants (NPPs)**

Slides from Jorg Fandrich to support this TGD were provided – Dooley gave highlights of slides to PCC

- New reactors under construction and new designs built, highlights importance of FFS for ongoing materials protection
- Highlighted differences of NPPs to fossil units
- Progress has been made overall

Discussion by PCC members on importance of FPPs in nuclear plants due to large number of stations (particularly in North America) undergoing mid-life refurbishment within next 5-10 years.

**TGD: Monitoring of Corrosion Products in Flexible and Two-Shifting Plants**

Additional presentation delivered by Mads Skovbjerg to provide update on round robin process

- IAPWS Round Robin (RR)
  - 10-month endeavour is underway, where Mads has visited 5 plants
  - RR proved necessary QA before IAPWS Collection Campaign
  - Labs that followed protocol for iron analysis performed well, while those that did not saw significant outliers

- Mads will circulate results of round robin to labs with suggestions for improvement
- IAPWS Collection Campaign summary provided by Mads:
  - Measurements of CPs during start-ups
  - Online measurements (preferred) and grab samples
  - Analysis by laboratories at which data were collected
  - Mads will do data analysis of data provided by laboratories in Spring 2023

### **Whitepaper: Flue Gas Condensation**

Monika Nielsen delivered presentation to provide update on first draft of whitepaper and discussion by PCC followed. First draft has been complete.

- Question raised on if materials of construction and corrosion are covered in white paper. They are not currently, but Monika will take this feedback to SIAPWS.
- **ACTION: David Addison will send whitepaper to PCC. One month will be given to PCC to provide feedback.**
  - PCC comments will be sent back to Monika.

### **Retirement of TGDs/Whitepapers:**

#### **TGD: Ensuring Integrity and Reliability of Demin Makeup Water Supply to the Unit Cycle**

- Retired – no further comments from PCC.

#### **Whitepaper: Condensate Polishing for Combined Cycle/HRSG Plants (not a TGD)**

- Retired – no further comments from PCC.

### **Addition of smart alarms to Instrumentation TGD**

- Retired. This was already noted in the 2021 virtual meeting minutes.

### **Refreshment of TGDs:**

David Addison asked for discussion on review of TGDs, importance of refreshing/reviewing previous documents

- E.g., Instrumentation TGD should be refreshed to include geothermal and electrode boilers
- More guidance for more industrial plants – firmer tables would facilitate their use, perhaps in an appendix
- Importance of Instrumentation TGD highlighted – don't want to lose the clear messages or add a lot of extra work for PCC members
- Perhaps formal process that every 3 years refresh is needed for TGDs to make sure current, even if no changes are made.
- Should distinguish if this process is to be formal, updating of technology an issue
- Review process would start the same process as creating a new TGD, locking it into a long process, noting that verification of new technology is required before inclusion
- Most of current documents would need to be reviewed if a frequency of ~3 years was selected. TGDs should be “owned” by someone
- Questionnaire to go to PCC should be generated. After survey results come back, a priority list, review period, etc. will be established. Overall TGD task group will review.

- **ACTION:** David Addison will send out a survey to PCC to provide comments on refreshing and updates needed for each current TGD, then go forward from there: what improvements, advancements, etc. are needed.

#### **ICRN Updates:**

#### **David Addison/Barry Dooley - Film Forming Substances Unknowns/Knowledge gaps for ICRN**

- Still many unknowns and misapplications in the FFS space
- When done correctly, FFS work extremely well; need to do to understand mechanisms
- ICRN is needed – input from PCAS necessary
- ICRN team formed: David Addison (New Zealand), Barry Dooley (UK), Ken Yoshida (Japan), Duncan McAllister (Australia), and David Rodman (Australia)

#### **ICRN 32: Conductivity of Electrolytes in Aqueous Solutions**

**ACTION:** David Addison will circulate ICRN to national committees post IAPWS2022 to prepare for a postal ballot

### **5. Joint PCAS and PCC WG Meeting**

#### **Ben Loder – Boiler Electrochemical Corrosion Studies Test Rig Results– IAPWS Canada/NZ International Collaboration Project**

- This is an update on an international collaboration between Canada (Willy Cook) and New Zealand (David Addison)
- Progress has been made and a lively discussion between Cook, Dooley, Loder, and Addison followed.

#### **Willy Cook – Laboratory study of the impact of ODA on ion exchange resins**

- Good discussion on ODA fouling tests on IX resin completed at UNB, with questions by many PCC members on further plans for testing with commercial filming products and details of procedure to regenerate resin, e.g., brine cleaning. Willy indicated that these are important follow-up tests for future work.

### **6. PCC Presentations**

#### **Taro Ichihara Hydrogen Damage in Power Boiler - A Study of Damage Selectivity and Conditions**

- Good discussion with PCC members on poor welding and re-welding to fix this on previously damaged tubes exacerbating the hydrogen damage and subsequent failure. Suggestions were made to Taro on additions to his work

#### **Mar Nogales – Operational Experience with EDI technology for CACE Measurement**

- Suggestion of backwash of middle component/cartridge as additional R&D direction.

## 7. TPWS/IRS/PCAS/PCC Joint Session

### David Addison – Electrode Boiler Hydrogen Generation from Arcing Events

- Steam hydrogen monitoring should be installed in electrode boilers
- Expressed need for TGD in this area
- Discussion on ratios of oxygen and hydrogen, and suspicious non-stoichiometric ratios
- Either additional oxygen production source or quenching of hydrogen

### David Addison - Geothermal Steam Purity White Paper and Recent Data Collection Update and Discussion

- Progress on whitepaper being made
- A technical paper has been put together
- Some proposed steam chemistry limits for second draft of whitepaper
- Proposed timeline:
  - Draft #2 of whitepaper underway for Jan 2023
  - To circulate to wider IAPWS
  - Draft of TGD for May/June
  - Goal to present TGD at IAPWS Italy 2023

### Report of the joint PCAS/IRC Task Group Wet Steam Data from Operating Turbines:

- Goal of erosion reduction in steam turbine due to coarse water droplets
- 2 remaining issues:
  - Measurement technologies of droplets in steam turbines
  - Modelling – using CFD techniques
- Looking for collaborators to help task group with these issues
  - Barry Dooley indicated that 10-15 years ago an international conference already featured a lot of measurements of droplets – will provide information to task group

### Report of the joint PCAS/IRC Task Group on ICRN for Acid Gas Dew Points:

- Needs are for natural gas GTCCs
- Task group has decided that ICRN is now necessary
- Possible TGD needed to maintain reliability against corrosion for existing plants for newly developed natural gas GTCC
- PCC Chair comment: doesn't currently fit scope of any of the current areas, perhaps additional resources and manpower needed to support this whitepaper/TGD.
- Task group will be formed and revealed to PCC at later date.

### ICRN for Acid Dew Points

**ACTION: David Addison to work with PCAS on draft future TGD**

## 8. PCC WG Business

### a. Gibbs Award 2024 Committee PCC

The Executive Secretary reminded PCC that this is IAPWS' most prestigious award for early career individuals.

**ACTION: Nominations to the Executive Secretary are due by January 2023.**

**b. Progress Reports 2021/2022 and Future PCC Activities**

- No new TGDs underway
- Geothermal whitepaper – progress being made
- Revision to flexible/two shifting plants TGD underway
- Face to face meeting in 2023 Turin for updates on international collaborations
- Task group for electrode boilers: Monika Nielsen (Denmark), Willy Cook (Canada), and David Addison (New Zealand) will begin work on this
- Pathway for updating TGDs discussed, and survey will be provided to PCC
- IAPWS Radiolysis Database collaboration
  - Pam Yakabuskie expressed need for centralized and updated location for kinetic rate constants necessary to model radiolysis processes
  - This used to be managed by University of Notre Dame, later moving to NIST, but is difficult to access and has not been updated since 1995. Either NIST radiolysis kinetics information needs updating or a new platform is required
  - Barry Dooley indicated that PCAS and TPWS already have an existing proposal in this area, or something adjacent. This work doesn't fit PCC's mandate, but PCC will support and is in general agreement of importance of this work
  - **ACTION: Pam Yakabuskie to interface with PCAS on existing radiation chemistry activities and will propose a collaboration specific to radiolysis.**
  - **ACTION: on request by Willy Cook, David Addison or Barry Dooley will circulate existing PCAS proposal submission to PCC**

**c. Future Direction of PCC Discussion**

- Management/actions for remote chemistry support, particularly when station event/accident takes place - likely not technical enough for TGD, but important topic to consider
- More PCC focus at ICPWS
  - PCC Chair noted that structure of ICPWS makes it difficult to get regular PCC business done – may need to commit 1 afternoon during the week just for PCC WG work.
- More paper submissions to PPCHEM are needed – PCC to keep this in mind
- PCC webinars will be delivered
  - **ACTION: David Addison to organize two webinars (quarter 1 of 2023 and quarter 3 of 2023)**
  - Efficacy of webinars will be reported on and assessed in Turin 2023.
- Suggestions provided by Kirk Buecher on new directions for IAPWS, e.g., biomass and hydrogen generation
  - PCC Chair expressed some concerns that PCC does not currently have sufficient expertise nor is the direction of the technology mature enough (scope is too broad) for concrete actions to be taken on this by PCC/IAPWS

- **ACTION: Kirk Buecher to assess scope and cross-over of hydrogen generation space with PCC and other WGs' mandates. To present his findings (perhaps reaching out to his contacts) in Turin 2023.**
- PCC will continue to think about other web-based activities, e.g., LinkedIn activity.
- **ACTION: David Addison will update IAPWS website with more details and a refresh on the mandate of PCC**

#### d. International Collaboration

- No international collaborations put forward this year.
- **ACTION: PCC members to submit plans or paperwork for desired upcoming collaborations before Italy ICPWS 2023.**
  - Potential new collaboration for electrode boilers

#### e. ICRNs – Review and Possible New Additions

- ICRNS to be sent out for review:
  - ICRN 32 Conductivity of Electrolytes in Aqueous Solutions to be sent out by David Addison
- Needed Future ICRNS:
  - ICRN for electrode boilers needed, will be put together by Monika Nielsen (Denmark), Willy Cook (Canada), and David Addison (New Zealand)
  - ICRN for FFS needed Barry Dooley (UK) and David Addison (New Zealand)
- Closing of ICRNS:
  - ICRN 19: Improved Coolant Sampling and Analysis of Low Concentration Metals (Fe, Cu, Co, etc.). Issued September 2006. Expired September 2009. Derek Lister

Possibly a misnomer as ICRN 29 in IAPWS records. No progress has been made on this in a while.

**ACTION: David Addison will follow up with Derek Lister on details about this ICRN.**

- ICRN 22: Steam Chemistry in the Turbine Phase-Transition Zone. Issued July 2010. Expires September 2015. M. Stastny  
**ACTION: Barry Dooley will write a closing statement for this ICRN and provide to PCC Chair before EC on Friday.**
- ICRN 26: Behavior of Aluminum in the Steam Water Cycle of Power Plants. Issued September 2011. Renewed June 2014. Expires June 2019. Bobby Svoboda  
**ACTION: David Addison to ask Bobby Svoboda for closing statement.**

- Renewal of ICRNS:
  - ICRN 25: Corrosion mechanisms related to the presence of contaminants in steam/water circuits, particularly in boiler water. Issued June 2014. Expires June 2019. Willy Cook
  - **ACTION: David Addison to extend ICRN 25 until September 2025**

#### **f. PCC Public Relations**

**ACTION: Willy Cook and David Addison will put together press release for 2022 NZ Meeting.**

#### **g. Changes in PCC Membership and Election of Officers**

The Executive Secretary emphasized that being a member of PCC requires active participation and that membership should be taken as a meaningful responsibility

This was seconded by the PCC Chair, highlighting that only attending IAPWS events is not “active” participation, and contribution via partaking in task groups, working on documents (whitepapers or TGDs), etc. is also very important.

The following WG members were nominated to join PCC:

1. Benjamin Loder, University of New Brunswick, Canada
2. Mads Skovbjerg, VTT Technical Research Centre of Finland, Finland
3. Duncan McAllister, Loy Yang B Power Station, Australia
4. David Rodman, Nalco Water, Australia
5. Pam Yakabuskie, Canadian Nuclear Laboratories, Canada
6. Harold Stansfield, Waltron Bull and Roberts, United States

New members should provide the PCC Chair or the Executive Secretary with their contact information before the EC meeting on Friday.

Previous meeting (2021) established that the vice chair position would expire in one year. Two vice chair positions need to be filled to replace Michael Rziha and Paul McCann.

- Barry Dooley nominated Kirk Buecher (USA) and Willy Cook seconded the nomination.
- PCC accepted Kirk as new vice chair unanimously.
- **ACTION: PCC Chair David Addison will make recommendation to EC on Friday to introduce one new vice chair**
  
- Barry Dooley nominated Taro Ichihara (Japan) as the second vice chair.
- Taro Ichihara requested a letter for his employer outlining the responsibilities of this position before he can accept the nomination
- **ACTION: PCC Chair David Addison will provide Taro with requested information for his manager.**

#### **h. Adjournment**

Meeting adjourned 5:03 PM November 29<sup>th</sup>, 2022.

## Summary of Actions from PCC 2022

#	PCC Area	Action	Whom By	Due Date
1	Flue Gas Condensation	Flue Gas Condensation whitepaper to be sent to PCC	David Addison	PCC will need 1 month to provide comments, send ASAP
2	Updates to TGDs	Send survey to PCC to provide comments on updates needed for each current TGD	David Addison	Before Turin 2023
3	ICRN 32: Conductivity of Electrolytes in Aqueous Solutions	Circulate ICRN to national committees during the week so decision can be made by EC at end of week	David Addison	Before Dec. 2 <sup>nd</sup> 2022
4	Future PCC directions	Organize two webinars	David Addison	Webinar 1: Q1 of 2023 and Webinar 2: Q3 of 2023
5	Future PCC directions	Assess scope and cross-over of hydrogen generation space with PCC and other WGs' mandates. To present his findings in Turin	Kirk Buecher	Turin 2023
6	International collaborations	Submit plans or paperwork for desired upcoming international collaborations	PCC Members	Before Turin 2023
7	PCC description on IAPWS website	Update IAPWS website with more details and a refresh on the mandate of PCC	David Addison	Before Turin 2023
8	Status of ICRN 19: Improved Coolant Sampling and Analysis of Low Concentration Metals	Follow up with Derek Lister on details about ICRN 19 (potential misnomer as ICRN 29 in PCC records)	David Addison	
9	Status of ICRN 22: Steam Chemistry in the Turbine Phase-Transition Zone	Write closing statement for ICRN 22, and provide to PCC Chair	Barry Dooley	December 2 <sup>nd</sup> , 2022 EC meeting
10	Status of ICRN 26: Behavior of Aluminum in the Steam Water Cycle of Power Plants	Obtain closing statement from Bobby Svoboda	David Addison	



11	Status of ICRN 25: Corrosion mechanisms related to the presence of contaminants in steam/water circuits	Extension of ICRN 25 until Sept. 2025	David Addison	
12	Press Release	Put together press release for 2022 NZ Meeting	Willy Cook David Addison	December 2 <sup>nd</sup> , 2022 EC meeting
13	Vice chair replacement	Recommendation to EC on to introduce one new vice chair: Kirk Buecher	David Addison	December 2 <sup>nd</sup> , 2022 EC meeting
14	Vice chair replacement	Provide Taro Ichihara with requested information for his manager on duties of vice chair position	David Addison	
15	Future PCC directions: radiation chemistry and radiolysis collaboration	Interface with PCAS on existing radiation chemistry activities and will propose a collaboration specific to radiolysis.	Pam Yakabuskie	Prior to Turin 2023 meeting
16	Future PCC directions: radiation chemistry and radiolysis collaboration	Circulate existing PCAS proposal submission on radiation chemistry task group to PCC	David Addison or Barry Dooley	