

IEEE P2800.2 8th Working Group Meeting

ANDY HOKE, P2800.2 WG CHAIR

MANISH PATEL, SECRETARY

JENS BOEMER, BOB CUMMINGS, DIVYA KURTHAKOTI,

JULIA MATEVOSYAN, MAHESH MORJARIA, STEVE WURMLINGER, VICE CHAIRS

April 30 – May 2, 2024

Some content derived from IEEE 2800 WG and Jens Boemer, 2800 WG Chair

Please record your attendance

- Please record your attendance at:
 - <https://imat.ieee.org/attendance>
 - -> Select “P2800.2 WG meeting”
 - -> Select [PE/EDPG/P2800.2-T&V of BPS-connected IBRs Attendance](#)
- OR
- <https://imat.ieee.org/wg656400043/attendance-log?p=4713000005&t=656400043>
- **Meeting attendance determines eligibility for WG voting membership**
 - Credit for attendance will be given to those who attend at least 2 of 3 days this week
- In lieu of verbal roll call, **please type your name and affiliation in the chat window**
 - IEEE affiliation FAQs: <http://standards.ieee.org/faqs/affiliation.html>

Acknowledgements and disclaimers

- General disclaimer:
 - The views presented in this presentation are the personal views of the individuals presenting it and shall not be considered the official position of the IEEE Standards Association or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of IEEE, in accordance with IEEE Standards Association Standards Board Bylaws 5.2.1.6.
- Draft standard disclaimer:
 - P2800.2 is an unapproved draft of a proposed IEEE Standard. As such, the document is subject to change, any draft requirements and figures shown in this presentation may change.
- For those working group members whose effort on the standard was partially or fully supported by the U.S. DOE's National Renewable Energy Laboratory, the following statement applies:
 - This work was supported in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office and Wind Energy Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.

Working Group Policies and Procedures

- We have the same P&Ps as the 2800 WG, as previously approved by the sponsor, available here:
[https://sagroups.ieee.org/2800/wp-content/uploads/sites/336/2020/08/EDPGC-Sponsored-WG-P-and-PV2Jan2020 IEEE-P2800-WG.pdf](https://sagroups.ieee.org/2800/wp-content/uploads/sites/336/2020/08/EDPGC-Sponsored-WG-P-and-PV2Jan2020%20IEEE-P2800-WG.pdf)
 - Introduced at previous WG meetings
 - Link provided in meeting agenda
- Given ~150 WG members total, we have a quorum if 26 members or more are present

Agenda

- Day 1

- Call to order and welcome
- Roll call and declaration of affiliation
 - (via chat window)
- Approval of agenda and past minutes
- IEEE patent, copyright, and participant policies (Vanessa Lalitte)
 - Call for potentially essential patents
- Introduce IEEE P2800.2 Draft 1.0a and formal commenting process
- Introduction to i2X FIRST
- Subgroup 3: Design Evaluations

- Day 2

- Subgroup 5: Post Commissioning Model Validation, Monitoring, and Periodic Evaluations
- Subgroup 1: General Requirements
- Power Quality Task Force

- Day 3

- Subgroup 2: Type Tests
- Subgroup 4: Commissioning Tests and As-built Evaluations
- Frequency scanning for IBR unit model validation
- Wrap-up and next steps

US ET	US MT	Tuesday April 30	Wednesday May 1	Thursday May 2
11:00	9:00	Introduction	Subgroup 5: Post-commissioning steps	Subgroup 2: Type tests
		New: I2x FIRST (IBR standards forum)	Subgroup 5: Post-commissioning steps	Subgroup 2: Type tests
12:00	10:00	Subgroup 3 - Design evaluation	Subgroup 1 - Overall document	Subgroup 2: Type tests
		Subgroup 3 - Design evaluation	Subgroup 1 - Overall document	Subgroup 2: Type tests
1:00	11:00	Break (recess)	Break (recess)	Subgroup 2: Type tests
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		Subgroup 3 - Design evaluation	Power Quality Task Force	Frequency scanning
3:00	1:00	Subgroup 3 - Design evaluation	Power Quality Task Force	Frequency scanning
		Subgroup 3 - Design evaluation	Power Quality Task Force	Wrap-up and next steps

Last meeting's minutes

- The minutes of the last WG meeting (December 2023) were [posted](#) on iMeet Central shortly after the meeting
- WG members were notified of an opportunity to review the minutes upon posting
- **Call for comments**
- **Approval of last meeting minutes**

IEEE patent policy and legal notices

- IEEE Patent Policy
 - <https://development.standards.ieee.org/myproject/Public/mytools/mob/slideset.pdf>
 - **Call for potentially essential patents**
- IEEE Copyright Policy:
 - <https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/copyright-policy-WG-meetings.potx>
- IEEE Participant Behavior:
 - <https://standards.ieee.org/wp-content/uploads/import/documents/other/Participant-Behavior-Individual-Method.pdf>
- IEEE Privacy Policy - <https://www.ieee.org/security-privacy.html>
- (Links also provided in meeting agenda)

Status of IEEE 2800-2022

- 94% ballot approval. **Published April 22, 2022.**
- Harmonizes interconnection requirements for large solar, wind, and storage plants (and other inverter-based resources)
- A consensus-based standard developed by over ~175 Working Group participants from utilities, system operators, transmission planners, & OEMs over 2+ years
- IEEE standards are **voluntary until adopted by an appropriate entity**. Such entities are encouraged to consider adoption of 2800 to the extent feasible even before IEEE P2800.2 is complete. Many entities have begun adoption process.

IEEE Std 2800™-2022

IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems

Developed by the
Energy Development & Power Generation Committee, Electric Machinery Committee, and Power System Relaying & Control Committee
of the
IEEE Power and Energy Society

Approved 9 February 2022
IEEE SA Standards Board

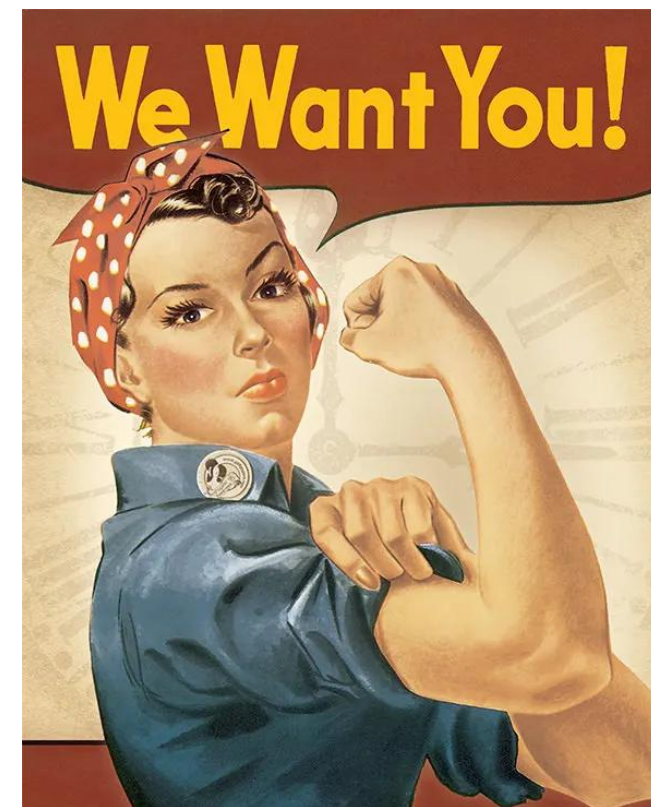
Available at
<https://standards.ieee.org/ieee/2800/10453/>

P2800.2 Overview (from PAR)

- Title:
 - Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems
- Scope:
 - Define **recommended practices** for test and **verification procedures to confirm plant-level conformance** of IBRs interconnecting with bulk power systems in compliance with IEEE Std 2800
 - Applies to IBRs in **transmission** and **sub-transmission systems** (both meshed and radial)
 - May also apply to isolated IBRs interconnected to an AC transmission system via dedicated voltage source converter high-voltage direct current (VSC-HVDC) transmission facilities, e.g., offshore wind farms
 - Specifications for the equipment, conditions, tests, modeling methods, and other verification procedures that should be used to demonstrate conformance with IEEE 2800
- Includes:
 - **Type tests** (unit level, not full compliance)
 - **Design evaluation**, including modeling
 - **As-built evaluation** and **commissioning tests**
 - **Post-commissioning model validation, monitoring, periodic tests, and periodic verifications**
- Recommended practice: Uses “should” language, not “shall” language.

P2800.2 wants to hear from you

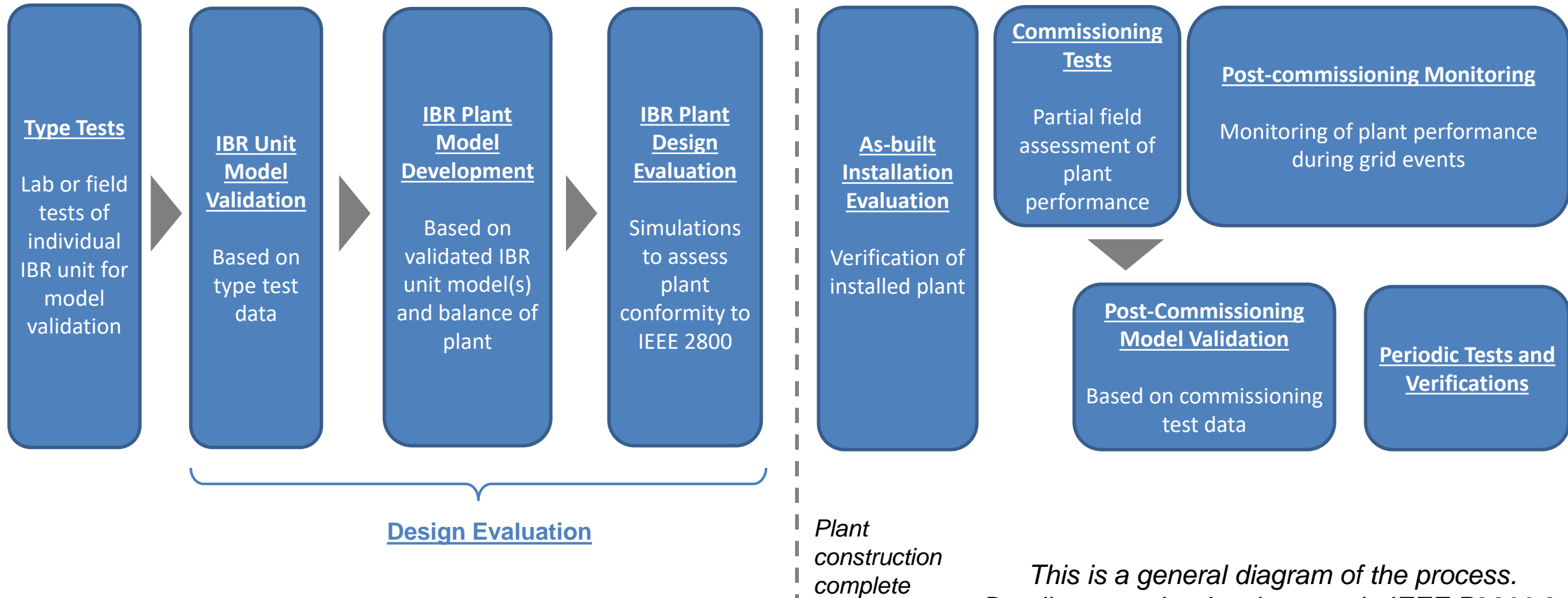
- Several P2800.2 leaders have mentioned that they keep hearing from the same handful of voices
 - This puts us at risk of confirmation bias, or of writing a document that only makes sense to a handful of “experts”
- We want to hear from more of you
- That can be:
 - During this WG meeting
 - Via an email or a call to a WG leader
 - Written comments on D1.0a of P2800.2
 - Out for comment until May 15
 - During a subgroup or task force meeting
- The more people we hear from, the better the standard will be



P2800.2 – Relationship to the IBR interconnection process

- Defining (or re-defining) an interconnection process is not in the scope of IEEE P2800.2
- Procedures recommended by P2800.2 are intended to be used as part of an interconnection process:
 - P2800.2 type tests can inform interconnection process
 - P2800.2 design evaluation, commissioning tests, and post-commissioning model validation can occur during interconnection process (along with other steps not in scope of P2800.2)
- In an early meeting, we agreed that in P2800.2, our job is (only) to **write procedures to verify that IBRs conform to IEEE 2800**
 - Important discussions related to interconnection that do not relate to *IEEE 2800 conformance verification* can take place *primarily outside* P2800.2
 - By providing standardized procedures, we are taking a major step to improve the interconnection process (without trying to fix everything)

Overview of conformity assessment steps in IEEE P2800.2



*This is a general diagram of the process.
Details are under development in IEEE P2800.2.
Some variations permitted.*

IEEE P2800.2 Subgroup Scopes

SG 1

Overall document and general requirements

Excerpt of
2800 Table 20:
Verification
Methods Matrix

Power
Quality
Task Force

		SG 2 Type tests	SG 3 Design Evals.	SG 4 Commissioning and As-built		SG 5 Post-commissioning model validation, monitoring, etc.			
Requirement	RPA at which requirement applies	IBR unit-level tests (at the POC)		IBR plant-level verifications (at the RPA)					
		Type tests ¹⁵²	Design evaluation (including modeling for most require- ments)	As-built installation evaluation	Commissioning tests	Post- commissioning model validation	Post- commission- ing monitoring	Periodic tests	Periodic verification
		Responsible Entity							
		IBR unit or supplemental IBR device manufacturer	IBR developer / TS owner / TS operator	IBR developer / TS owner / TS operator	IBR developer / TS owner / TS operator	IBR developer / IBR operator / TS owner / TS operator	IBR operator / TS owner / TS operator	IBR operator / TS owner / TS operator	IBR operator / TS owner / TS operator
4.12 Integration with TS grounding	POM	NR	R	R	NR	NR	NR	D	NR
Clause 5 Reactive Power—Voltage Control Requirements within the Continuous Operation Region									
5.1 Reactive power capability	POM	R	R	R	R	R	D	D	D
5.2 Voltage and reactive power control modes	POM	D	R	R	R	R	D	D	D
Clause 6 Active-Power—Frequency Response Requirements									
6.1 Primary Frequency Response (PFR)	POC & POM	NR ¹⁵³	R	R	R	R	D	D	D
6.2 Fast Frequency Response (FFR)	POC & POM	R ¹⁵⁴	R	R	R	R	D	D	D
Clause 7 Response to TS abnormal conditions									
7.2.2 Voltage disturbance ride- through requirements	POC ¹⁵⁵ & POM ¹⁵⁶	R	R	R	NR	R	R	D	D
Clause 8 Power quality									
8.2.2 Rapid voltage changes (RVC)	POM	NR	R	R	R	D	R	D	D
8.2.3 Flicker	POM	NR	NR	NR	R	D	R	N/A	D
8.3.1 Harmonic current distortion	POM	R ¹⁵⁷	R	R	R	D	R	N/A	D
8.3.2 Harmonic-voltage distortion	POM	D	D	D	D	D	D	D	D
8.4.1 Limitation of cumulative instantaneous over-voltage	POM	R	R	R	NR	NR	R	NR	NR
8.4.2 Limitation of over-voltage over one fundamental frequency period	POM	D	R	R	NR	NR	R	NR	NR

Draft 1.0a

- Draft 1.0a [posted on iMeet Central](#) 4/29/2024 for WG member review
 - Changes relative to Draft 1.0 posted 4/25:
 - Updated Annex E (Model Quality Assessment)
 - Fixed minor issue with bookmarks
 - All page and clause numbers are same prior to Annex E
 - Four versions:
 - Redline relative to D0.6 in Word
 - Redline relative to D0.6 in PDF
 - Clean version in Word
 - Clean version in PDF
- Requesting formal comments from WG this round
- Voting on overall direction of draft
 - Not yet voting on sending draft to IEEE-SA for ballot

Commenting on Draft 1.0a

- Please **focus on technical and big picture comments**. We are not requesting comments on formatting, grammar, minor wording changes, etc. at this time.
- Please **comment on the clean version** for alignment of clause and page numbers. Use page numbers as printed on the page.
- Please submit comments using the comment spreadsheet (also [on iMeet](#)).
 - (Review comment spreadsheet)
 - In “Proposed Change,” try to be as specific as possible
- **Comments are due May 15**. Email your completed comment spreadsheet to Andy and Manish for submission or submit it on [iMeet here](#). Include your vote in your email.
 - Andy.Hoke@nrel.gov, Manish.P@ieee.org
- The draft is over 200 pages – start early if possible.
- Feel free to focus on clauses or annexes of your interest/expertise if you cannot read the whole thing.
- Per IEEE policy, you must be a member of the WG to access the draft, so only WG members can submit comments.

Voting on Draft 1.0a

- Voting members of WG, please submit a vote responding to the question, “Do you approve of the overall direction of Draft 1.0a of P2800.2?”
- Voting options: Approve, Disapprove, Abstain
- Submit vote via email when sending comments
- “No” votes without comments will not be counted
- Non-voting WG members can comment, but vote will not be counted

Introducing i2X FIRST

- Julia Matevosyan and Cindy Bothwell

Subgroup 3 – Design Evaluations

45 minute break – Back at 12:15 Mountain (2:15 Eastern)

- Subgroup 3 (Design Evaluations) continues next
- Reminder: record your attendance in iMat:

<https://imat.ieee.org/wg656400043/attendance-log?p=4713000005&t=656400043>

Agenda – Day 2

- Day 1

- Call to order and welcome
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Welcome to Day 2 of IEEE P2800.2 WG meeting

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Subgroup 5 – Post-Commissioning Model Validation, Performance Monitoring, and Periodic Tests

Subgroup 1

- Scope: General requirements and overall document
 - Anything that does not fall under other subgroups
- Leads:
 - Andy Hoke, andy.hoke@nrel.gov
 - Manish Patel, Manish.P@ieee.org
- 139 members on SG1 listserv. ~20-30 members typically attend biweekly meetings
- Logistics details on a later slide

Subgroup 1 Content Overview

- Clause 1: Overview, Scope, Purpose, General remarks and limitations
- Clause 2: Normative references (none so far – need to collect from other subgroups and PQ TF)
- Clause 3: Definitions, Acronyms
- Clause 4:
 - General content
 - Overview of conformity assessment process
 - Conformity assessment flow chart
 - Requirements that may require alignment of expectations
 - Requirements for which no verification procedure is provided
 - Power plant controllers
 - Retrofitting/augmentation of IBR plants
- Annexes A (bibliography), B (internal reference table), H (BESS augmentation)

Overview of subgroup 1 edits

- Added and updated several definitions:
 - Modeling related definitions
 - PPC definition
- Added Annex B: Internal reference table
- Added Annex H related to plant retrofitting/augmentation with brief language in clause 4

Clause 3 – Definitions

- Updated definition of power plant controller
- Added and updated model-related definitions
- New protection-related definitions proposed by SG3. Will be reviewed by SG1 after WG meeting

Clause 4 – General content

- Added 4.7 – Retrofitting/augmentation of IBR plants

Next steps in SG1

- Address comments from WG on D1.0
- Incorporate and refine definitions and references as they arise in other subgroups
- As other subgroups complete their content, fill in:
 - References, definitions, acronyms
 - Tables in Clause 4.5 (requirements for which no conformity assessment procedure is provided)
 - Internal reference table (Annex B)
- WG priority is achieving consensus on the conformity assessment procedures in Clauses 5-13 (i.e., SG2-SG5, PQ Task Force)

Subgroup 1 – Overall document: Logistics

- Plan
 - Biweekly meetings (as needed), Mondays, 10am Mountain Time
- Leads
 - Andy Hoke (andy.hoke@nrel.gov)
 - Manish Patel (manish.p@ieee.org)
- How to get involved: Join listserv by sending an email message to listserv@listserv.ieee.org
 - In first line of email body, write: **SUBSCRIBE STDS-P2800-2-SG1 <Your Name>**
 - For example, “**SUBSCRIBE STDS-P2800-2-SG1 Andy Hoke**”

40 minute break – Back at 12:05pm MT, 2:05pm ET

- Power Quality Task Force is next
- Reminder: record your attendance in iMat:

<https://imat.ieee.org/wg500900043/attendance-log?p=4471000005&t=500900043>

Power Quality Task Force

Excerpt of
2800 Table 20:

Verification
Methods Matrix

**PQ Task
Force**

Force		SG 2	SG 3	SG 4		SG 5			
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Subgroup 2

- Discussion led by Steve Wurmlinger, Pramod Ghimire, Mike Ropp

33 minute break – Back at 12:10pm MT, 2:10pm ET

- Subgroup 4 (commissioning) is next
- Reminder: record your attendance in iMat:

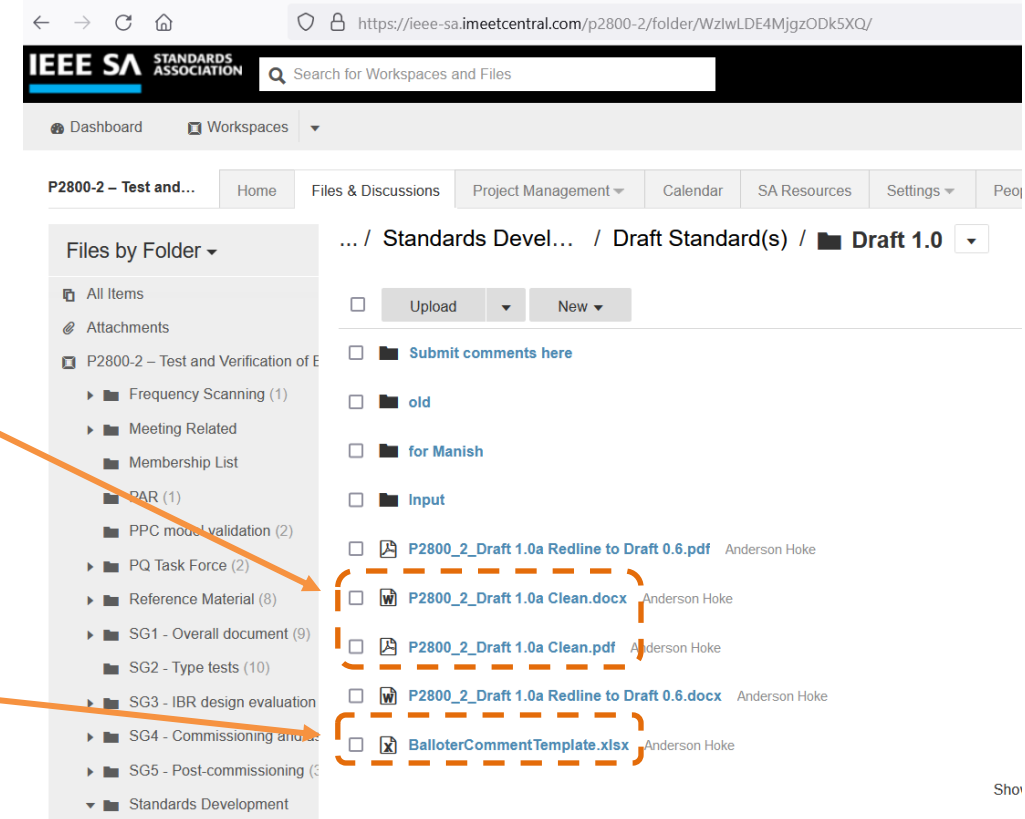
<https://imat.ieee.org/wg656400043/attendance-log?p=4713000005&t=656400043>

Subgroup 4 – Commissioning and As-Built

Frequency scanning for IBR unit model validation

Wrap-up and Next Steps

- Draft 1.0a available for comment by WG members until **May 22**
 - <https://ieee-sa.imeetcentral.com/p2800-2/folder/WzlwLDE4MjgzODk5XQ/>
- Prioritize directional comments and technical comments. Editorial comments not requested at this time.
- Use comment spreadsheet. **Use page/line numbers from D1.0a Clean**
- Email the following to Manish and Andy (Manish.P@ieee.org, Andy.Hoke@nrel.gov):
 - Completed comment spreadsheet
 - Vote: “Do you approve of the overall direction of Draft 1.0a of P2800.2?”
- Alternatively, comment spreadsheet can be submitted on [iMeet here](#)
- Voting options: Approve, Disapprove, Abstain



Wrap-up and Next Steps

- Subgroups and power quality task force will address comments
- You can still join any subgroup or task force aligned with your interest/knowledge
 - Join listserv, and send a note to the lead so they are aware
 - Consider volunteering to draft procedures/content in that subgroup

Next WG meeting

- Date will be determined once we can estimate how long subgroups will need to address comments on D1.0a

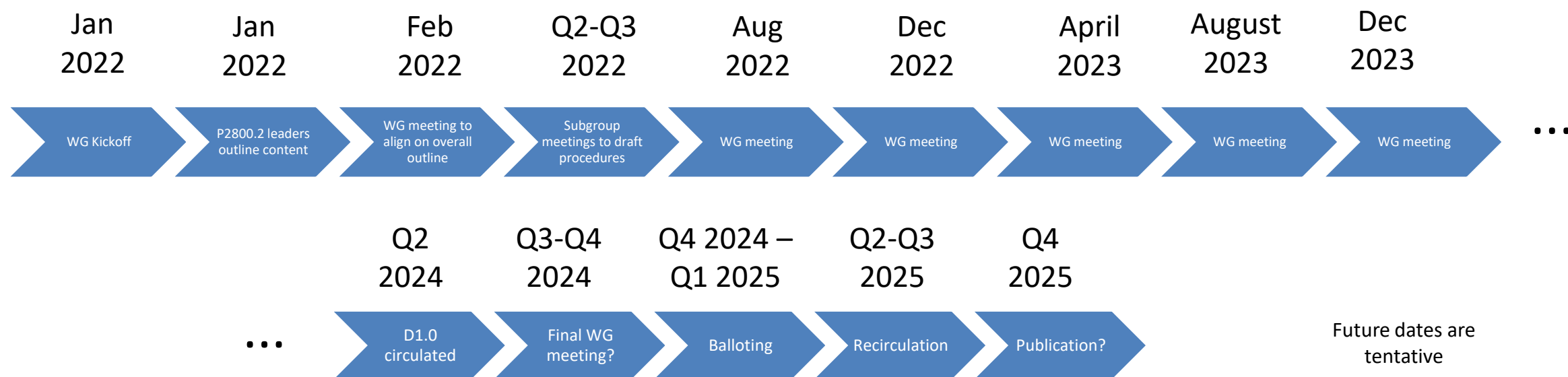
To get involved in IEEE P2800.2:

- To join Working Group:
 - If you have attended two WG meetings and want to be a WG voting member, email Manish Patel: Manish.P@ieee.org; CC Andy.Hoke@nrel.gov
 - If not, attend two meetings and request membership
- Join listserv for any subgroup or task force of interest
- WG member iMeet site: <https://ieee-sa.imeetcentral.com/p2800-2/home>
 - Contains draft documents, subgroup documents, references, etc.
- Public website: <https://sagroups.ieee.org/2800-2/>

IEEE P2800.2 Email Listservs

- Overall listserv “P2800-2” will be used to communicate meeting dates, agendas, etc.
- Each subgroup and PQ task force have listserv – sign up to get involved in that group:
 - Overall Working Group: P2800-2
 - Subgroup 1 (overall document): STDS-P2800-2-SG1
 - Subgroup 2 (type tests): STDS-P2800-2-SG2
 - Subgroup 3 (design evaluation): STDS-P2800-2-SG3
 - Subgroup 4 (commissioning and as-built): STDS-P2800-2-SG4
 - Subgroup 5 (post-commissioning): STDS-P2800-2-SG5
 - Power quality task force: STDS-P2800-2-PQTF
- To join a listserv, send an email message to listserv@listserv.ieee.org
 - In first line of email body, write: **SUBSCRIBE <list name> <Your Name>**
 - For example, “**SUBSCRIBE STDS-P2800-2-SG1 Andy Hoke**”

P2800.2 WG Timeline



Potential Adoption Timeline

