

IEEE P2800.2 4th Working Group Meeting

ANDY HOKE, P2800.2 WG CHAIR

MANISH PATEL, SECRETARY

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December 6-8, 2022

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>

or

<https://imat.ieee.org/sp17300043/attendance-log?d=08/24/2022&p=4048500005&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:
 - 2800 and P2800.2 are unapproved drafts of proposed IEEE Standards. As such, the documents are 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.

Agenda

- Day 1
 - Call to order and welcome
 - Roll call and declaration of affiliation (via chat window)
 - P2800.2 Working Group policies and procedures
 - IEEE patent, copyright, and participant policies
 - Approval of agenda and past minutes
 - Subgroup 1: General Requirements
 - Subgroup 2: Type Tests
 - Cross-subgroup coordination
- Day 2
 - External presentation: FGW TR3 Overview – German approach to IBR unit testing and verification
 - Subgroup 3: Design Evaluations
 - Power Quality Task Force
- Day 3
 - External presentation: FGW TR4 Overview – German approach to IBR modeling
 - Subgroup 4: Commissioning Tests and As-built Evaluations
 - Subgroup 5: Post Commissioning Model Validation, Monitoring, and Periodic Evaluations
 - Summary and next steps

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
 - Introduced at previous WG meetings
- Given ~120 WG members total, we have a quorum if 26 members or more are present

IEEE Privacy Policy

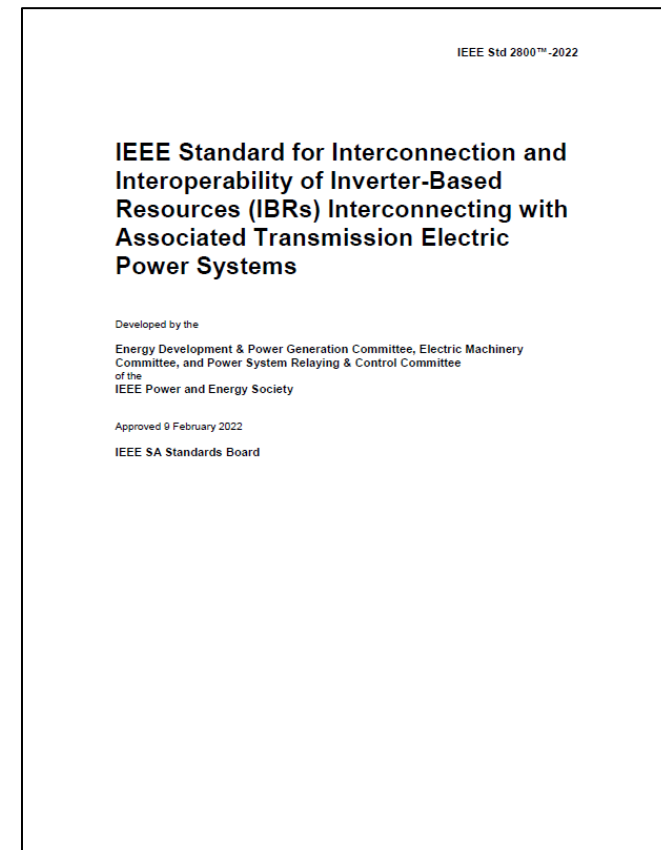
- IEEE Privacy Policy - <https://www.ieee.org/security-privacy.html>
 - Look for an email from IEEE-SA asking you to accept privacy policies (Monday morning)

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>

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.



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

Last meeting's minutes

- The minutes of the last WG meeting (August 2022) 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**

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
 - 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 – Paradigm shift?

- Note that:
 - Key interconnection requirement conformity assessment steps occur *before* commissioning
 - Models that accurately represent plant performance are needed *before* plant comes online
- Why?
 - IBR performance and model validation are essential to reliability of evolving power system
 - See Nov 17 FERC [NOPR](#), among many other recent reports
 - Once an IBR is commissioned, it can be costly to fix any issues. Power system is changing fast.
- Is this going to be easy?
 - Probably not
- But if we do a good job, P2800.2 (along with other ongoing industry efforts) can:
 - Offer a standardized industry-wide practice for IBR conformance assessment
 - Minimize future need for costly retrofits
 - Help ensure the near-future, highly renewable grid is at least as reliable as today's

IEEE P2800.2 Subgroup Scopes

SG 1
Overall document and general requirements

Excerpt of 2800 Table 20: Verification Methods Matrix

Power Quality Task Force

| Requirement | RPA at which requirement applies | SG 2 | SG 3 | SG 4 | | SG 5 | | | | | |
|---|---|--|--|--|--|---|---------------------------------------|---------------------------------------|---------------------------------------|--|--|
| | | Type tests | Design Evals. | Commissioning and As-built | | Post-commissioning model validation, monitoring, etc. | | | | | |
| | | IBR unit-level tests (at the POC) | | IBR plant-level verifications (at the RPA) | | | | | | | |
| | | Type tests ¹⁵² | Design evaluation (including modeling for most requirements) | As-built installation evaluation | Commissioning tests | Post-commissioning model validation | Post-commissioning 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 | | |

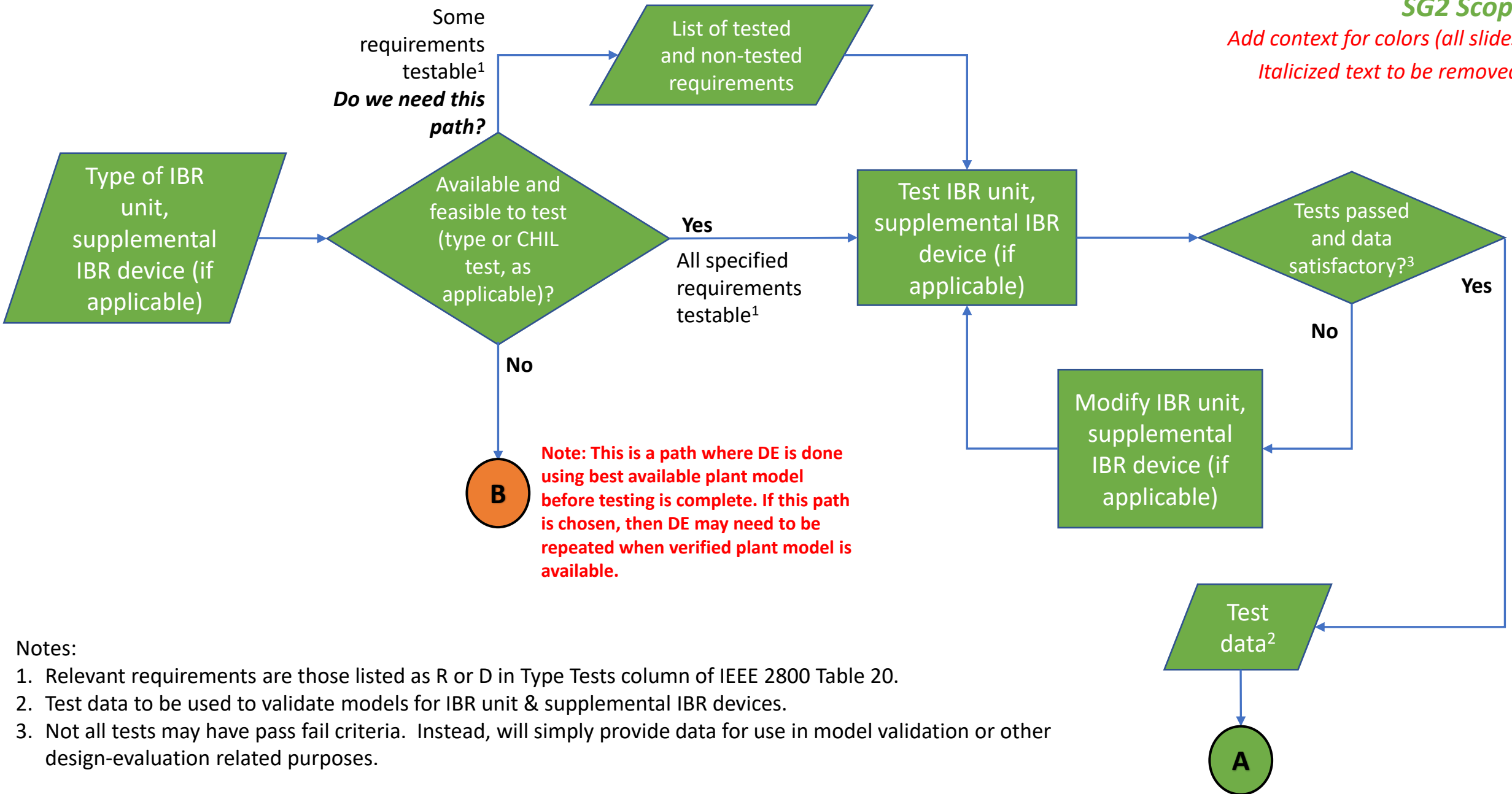
Subgroup 1 new material – Overview

- Flow chart of 2800 conformity verification process
 - Summarizes how the various subgroups' content interrelates
 - Focus is on risk mitigation and early identification of issues
- General comments on:
 - Use of engineering judgement in comparison of traces from tests and/or models
 - Need to iterate P2800.2 steps if changes are made to IBR plant or model
 - When 2800 requirements are not met, need to evaluate why and mitigate
- List of 2800 requirements that may require alignment of expectations
- Statement that *“A requirement outside the scope of IEEE Std 2800 or 2800.2 may supersede some requirements”*

IEEE P2800.2 Flow Chart

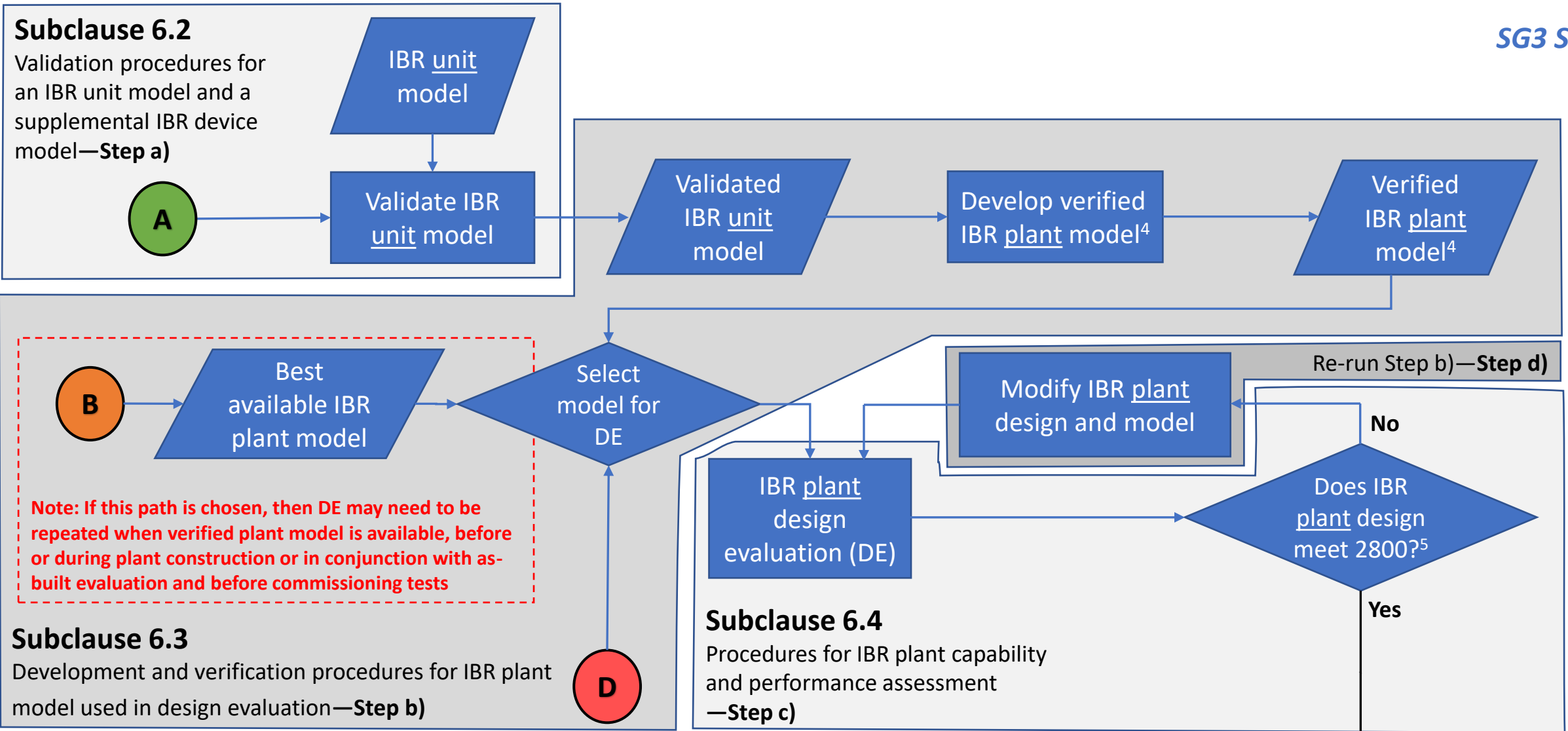
- Flow chart now generally has consensus from SG1 and officer team
 - Expect more edits as subgroups and WG move forward
- Included in clause 4.2 of P2800.2 draft 0.3

Add context for colors (all slides)
Italicized text to be removed.



Notes:

- 1. Relevant requirements are those listed as R or D in Type Tests column of IEEE 2800 Table 20.
- 2. Test data to be used to validate models for IBR unit & supplemental IBR devices.
- 3. Not all tests may have pass fail criteria. Instead, will simply provide data for use in model validation or other design-evaluation related purposes.

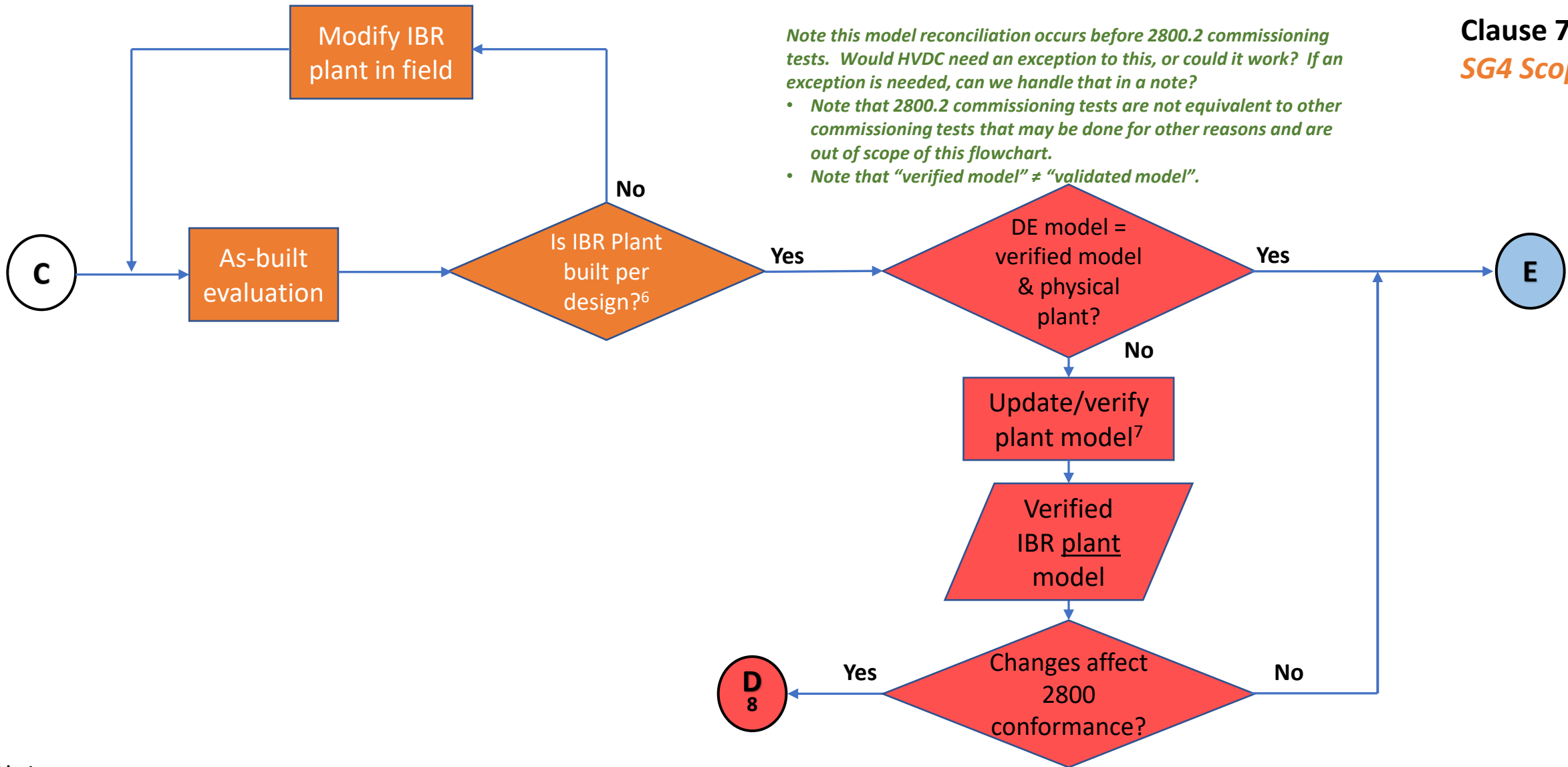


Notes:

4. Verified IBR Plant model is developed using IBR plant design and validated IBR Unit/Supplemental IBR device models. The plant model in this step is not validated.

5. Passes IBR Plant design evaluation steps listed as R or D in Design Evaluation column of IEEE 2800 Table 20

Clause 7
SG4 Scope

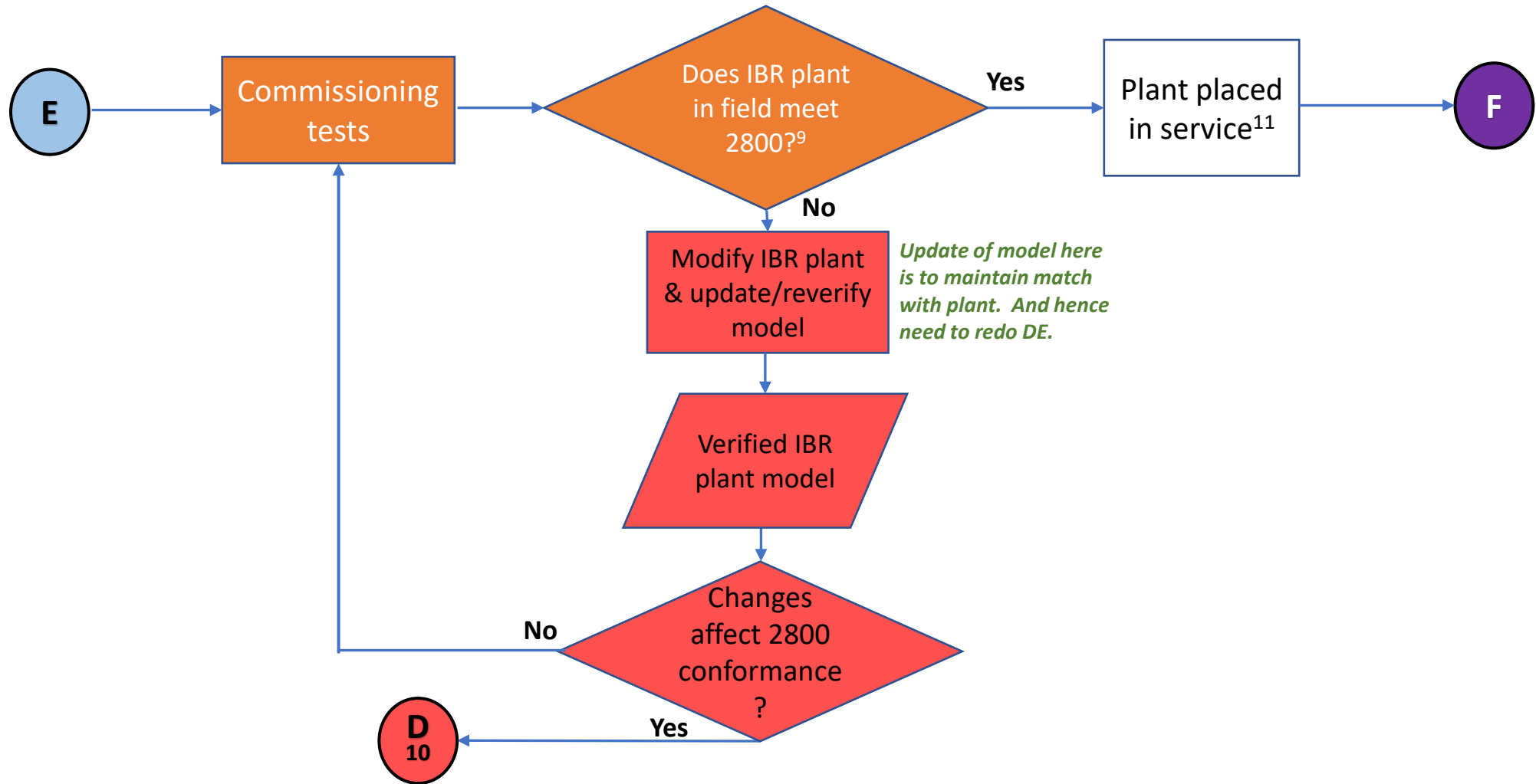


Notes:

6. Passes as-built evaluation steps listed as R or D in As-built Evaluation column of IEEE 2800 Table 20

7. Follow model verification procedure in Clause 6. Could also modify physical plant.

8. On path D, only steps relevant to change need to be repeated



Notes:

9. Passes commissioning steps listed as R or D in Commissioning Tests column of IEEE 2800 Table 20.

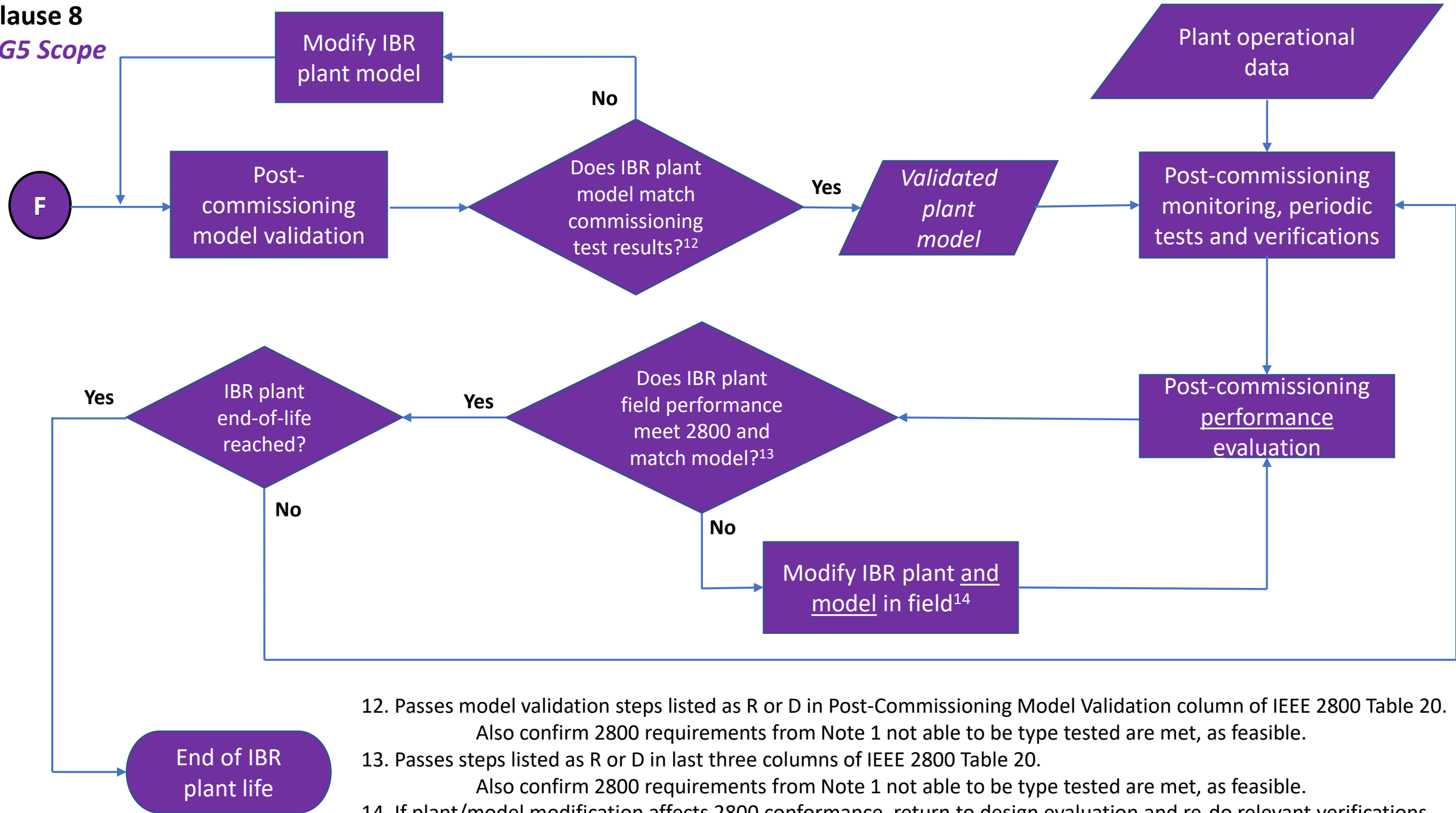
Also confirm 2800 requirements from Note 1 not able to be type tested are met, as feasible.

10. On path D, only steps relevant to change need to be repeated

11. Following commissioning tests, the validated IBR plant model should be provided to TS owner and TS operator according to a schedule determined by the TS owner/TS operator.

Clause 8

SG5 Scope



12. Passes model validation steps listed as R or D in Post-Commissioning Model Validation column of IEEE 2800 Table 20. Also confirm 2800 requirements from Note 1 not able to be type tested are met, as feasible.

13. Passes steps listed as R or D in last three columns of IEEE 2800 Table 20.

Also confirm 2800 requirements from Note 1 not able to be type tested are met, as feasible.

14. If plant/model modification affects 2800 conformance, return to design evaluation and re-do relevant verifications.

Next steps

- Incorporate definitions as they arise in other subgroups
- Address topics that cut across multiple subgroups
- Develop any general content needed (Clause 4)
- Expect fewer SG1 meetings for a few months
 - Priority is filling in the details of the conformity assessment procedures in Clauses 5-10

Subgroup 1 – Overall document: Logistics

- Plan
 - Biweekly meetings (as needed), Mondays, 10am Mountain Time
- Leads
 - Andy Hoke (andy.hoke@nrel.gov)
 - Manish Patel (mpatel@southernco.com)
- How to get involved, join listserv, send 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**”

15 minute break – Back at top of hour

- Subgroup 2 (Type Tests) continues next
- Reminder: record your attendance in iMat:
 - <https://imat.ieee.org/sp17300043/attendance-log?p=4048500005&t=656400043>

Subgroup 2

- Discussion led by Steve Wurmlinger

Agenda – Wednesday and Thursday

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Welcome to Day 2 of IEEE P2800.2 WG meeting

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FGW TR3 presentation: German approach to IBR unit testing and verification

Subgroup 3 – Design Evaluations

10 minute break – Back 15 minutes past hour

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Power Quality Task Force

Excerpt of
2800 Table 20:
Verification
Methods Matrix

**PQ Task
Force**

| Requirement | RPA at which requirement applies | SG 2 | SG 3 | SG 4 | | SG 5 | | | | |
|---|---|--|--|--|--|---|---------------------------------------|---------------------------------------|---------------------------------------|--|
| | | IBR unit-level tests (at the POC) Type tests ¹⁵² | Design evaluation (including modeling for most requirements) | As-built installation evaluation | Commissioning tests | IBR plant-level verifications (at the RPA) | | | | |
| | | | | | | Post-commissioning model validation | Post-commissioning 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 | |

Agenda –Thursday

- Day 1
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 - Subgroup 5: Post Commissioning Model Validation, Monitoring, and Periodic Evaluations
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Welcome to Day 3 of IEEE P2800.2 WG meeting

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 - IEEE affiliation FAQs: <http://standards.ieee.org/faqs/affiliation.html>

FGW TR4 presentation: German approach to IBR modeling

Subgroup 4 – Commissioning and As-Built

10 minute break – Back 20 minutes past hour

- Subgroup 5 is next
- Reminder: record your attendance in iMat:
 - <https://imat.ieee.org/sp17300043/attendance-log?p=4048500005&t=656400043>

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

Wrap-up and Next Steps

- Please 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 – that's how we move this forward

To get involved in IEEE P2800.2:

- To join Working Group:
 - If have attended two WG meetings and want to be a WG member, email Manish Patel: Mpatel@southernco.com; 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://ieeesa.imeetcentral.com/p2800-2/home>
 - Contains draft documents, subgroup documents, references, etc
- Public website: <https://sagroups.ieee.org/2800-2/>

Related international standards update

- Four FGW (German interconnection-related documents) are now available to WG on [iMeet site](#), for use (only) in P2800.2 development. (Thank you Jens for arranging!)
 - FGW TG 3
 - FGW TG 4
 - FGW TG 8 - Certification of the electrical characteristics of power generating units and systems in low-, medium-, high- and extra-high voltage grids – Rev 9 (01.02.2019) / EN
 - FGW TG 9 - Determination of high frequency emissions from renewable power generating units – Rev 1 (18.04.2016) / EN
- Request from IEEE for various IEC standards is (still) pending.
- If you identify a standard we should refer to, notify the appropriate subgroup/task force lead.

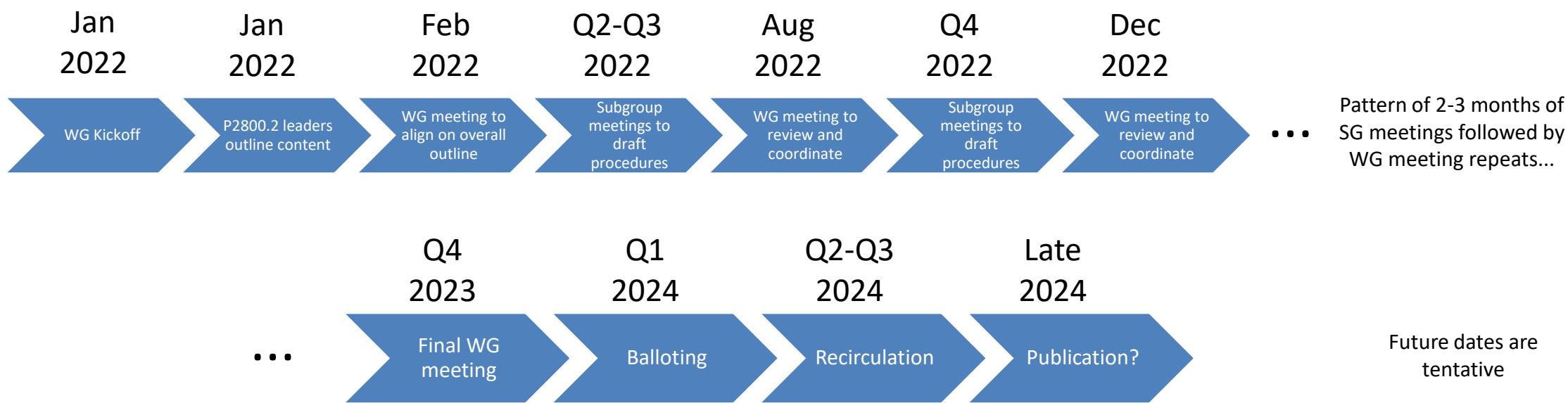
IEEE P2800.2 Email Listservs

- Overall listserv “P2800-2” will be used to communicate meeting dates, agendas, etc.
- Each subgroup and PQ task force each 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**”

Future P2800.2 meetings

- **Next meeting (tentatively, pending confirmation): April 2022**
- 3-4 per year
- Currently still online only
- Will consider in-person meetings with remote option if conditions allow
 - Anyone want to host at their organization? Need meeting room for ~100 people



Anticipated Timeline

