

Draft IEEE P2800.2 Working Group Meeting Minutes, August 23-25, 2022

IEEE P2800.2 Recommended Practice for Test and Verification Procedures for Inverter-Based Resources Interconnecting with Bulk Power Systems

Chair: Andy Hoke

Secretary: Manish Patel

Vice-Chairs: Jens Boemer, Bob Cummings, Divya Kurthakoti Chandrashekhara,
Julia Matevosyan, Mahesh Morjaria, Steve Wurmlinger

Meeting Date/Time/Location: August 23-25, 2022, 11 am – 3 pm ET, Virtual Meeting

August 23, 2022 Notes:

Andy Hoke kicked-off the meeting with a brief introduction. This meeting was the third meeting of the IEEE P2800.2 Working Group. The meeting was held virtually. In lieu of a roll call, Andy Hoke requested attendees to put their name and affiliation in the chat window. Attendees were also asked to record attendance at <https://imat.ieee.org/attendance>. Attendees interested in joining the P2800.2 WG were asked to send a request to Manish Patel (mpatel@southernco.com) with a copy to Andy Hoke (Andy.Hoke@nrel.gov).

Quorum was achieved. Andy Hoke presented the agenda. Rajat Majumder moved to approve the agenda. Ritwik Chowdhury seconded. No discussion, objection or abstentions were noted. Agenda was approved.

Andy Hoke presented IEEE SA Patents & Copyright policies. A call for potentially essential patents was made, and no potentially essential patents were raised. Malia Zaman presented Participants Behavior Expectations.

Gary Smullin moved to approve meeting minutes for the kick-off meeting. Steve Wurmlinger seconded. No discussion, objection or abstentions were noted. Meeting minutes were approved.

Andy Hoke briefly discussed scope and objective of the IEEE P2800.2 and presented few key strategic questions which would be discussed during the meeting. Andy emphasized that P2800.2's goal is to write procedures to verify that IBRs conform to IEEE 2800. Defining (or re-defining) an interconnection process is not in the scope of IEEE P2800.2. Pouyan Pourbeik & Rajat Majumder agreed. Ratan Das also agreed in concept but asked if interconnection process can be included in an informative annex as an example. Pouyan stated that IEEE document should focus on technical content. Mark Sira suggested to revisit this question as we discuss this further. Jens Boemer agreed with the proposal and suggested that WG could consider specifying multiple alternate verification procedures with different level of scrutiny and complexity to provide a "menu" of verification options from which federal and regional policies can choose their preferred ones into their regional interconnection processes. P2800.2 could intentionally use "may" and "should" language to clarify possible and recommended verification procedures.

Next critical question is then how urgent is it to develop P2800.2? Andy stated that it would take ~3 years to write, ballot, and publish (plus more time for products to be tested and deployed). Based on ESIG interconnection workshop, most OEMs indicated that most (but not all) 2800 requirements can be adopted before 2800.2 is published. This shows the need of urgency to get 2800.2 published.

Pouyan Pourbeik: We should balance between urgency and quality of work.

Timothy Zgonena: If anything new is specified then effort should be made to test such specifications.

Gary Chmiel: Agrees with Pouyan's comments especially ones related to validation. Field testing could be very time consuming and expensive.

Bob Cummings: Basic ride-through capability and modeling needs to improve urgently.

Jens Boemer: Reminded that 2800 is mostly a plant level standard. Urgency topic is a bit moot point and agrees that quality of work shouldn't be compromised.

Few other attendees also had some thoughts. This topic remains important, and Andy Hoke steered away by stating that WG should focus on developing verification procedures.

SG1 Discussion

Andy Hoke presented SG1 Draft Material. It was reemphasized that defining interconnection process is not in the scope of P2800.2. Andy Hoke asked if there is any value in including Figure 1 in Draft 0.2 showing timeline of IBR plant development and operation in P2800.2? Roberto Favela sees a value in including such a time line. Jens Boemer presented a slightly different version 1c of this figure based on discussions in sub-group 3. Ratan Das mentioned that there are too many details in version 1c and consider splitting in two for ease of readability. The references to SGs should also be removed from the final version. Nath Venkit mentioned that updating of models should only be necessary if changes in software update affect the plant performance. Reigh Walling suggested that if material changes are made during construction or commissioning then design evaluation might need to be repeated. Rob O'Keefe noted that NERC MOD 26/27 are going through revision at this time.

Andy Hoke then briefly reviewed general remarks & limitations section developed by SG1 from Draft 0.2. Nath Venkit suggested that product specific test standards should be referenced for personnel safety. Timothy Zgonena agreed with Nath Venkit. Dave Mueller raised a concern for scenarios when requirement in IEEE 2800 might not be appropriate. Andy Hoke stated that amendment to IEEE 2800 would be required to remedy such issues.

The last topic of discussion was the flow-chart showing sequence of work detailing scope of each SGs that is still under development. All SGs are expected to discuss and revise as appropriate. This flowchart certainly adds clarity and helps sets boundary between scopes of various SGs. Should flow chart be included in P2800.2 remains to be seen? Pouyan Pourbeik sees a value in including such a flow chart in the final document but cautions against making it too complicated. Chip Carter also sees a value in it.

SG2 Discussion

Stephen Wurmlinger and Pramod Ghimire led SG2 discussion. Pramod encouraged interested individuals to join bi-weekly SG2 meetings. SG2 scope as well as definition of type test were reviewed briefly. Pramod also presented some high-level remarks regarding scope of type testing based on existing language in the IEEE 2800. Stephen Wurmlinger presented a worksheet to be used by SG2 to draft type test procedures. In general, where type test is required (or listed as D in Table 20 of IEEE 2800), SG2 will develop a type test general section and then each functional type test will have sections such as: general section

(reference point of applicability, purpose etc.), required equipment, test procedure and test criteria/test results (this section heading may need to be labeled results or something different if criteria is not acceptable for a recommended practice).

WG discussed approach to verify measurement accuracy requirements at the IBR unit level. There were few clarifying questions. For plant level measurements (at high-voltage level), one approach to consider is to state that selection of instrument transformers and metering equipment should be such that accuracy requirements specified in Tables 1&2 of the IEEE 2800 are satisfied. Equipment design standards for instrument transformers and metering equipment could be listed as a reference.

WG also briefly discussed type testing IBR units for harmonics requirements. The Power Quality TF is in early stages. The SG2 to work with the PQ TF to develop test procedures.

The IEEE 2800 states that IBR units and supplemental IBR devices that are too large or have power ratings too high to be practically type test may demonstrate through other means. What is considered too large? Should a threshold be defined? Rajat Majumder mentioned that this statement applied to SVCs, HVDC, FACTS devices. The term “other means” may imply hardware-in-loop testing. There was some discussion about whether the “other means” of testing should have test procedures as the only other means or as one example (not to exclude other means someone might come up with)? Should test procedure be different or same for such large devices. SG2 to continue this discussion in bi-weekly SG meetings.

The WG also briefly discussed type testing IBR unit for voltage ride-through capability requirements. The voltage ride-through requirements in IEEE 2800 applies at POM. How would the IBR unit be tested then as voltage at POC would depend on voltage drop/rise on the collector system. It was concluded that IBR unit to be type tested to determine voltage ride-through capability of an IBR unit. Test results are then used to develop validated unit model. There may not be a need to specify pass/fail criterion for IBR unit. The SG2 to discuss further during bi-weekly SG calls.

The worksheet is available in the SG2 folder on imeet. Non SG2 members are encouraged to review the file from time to time and if there are any comments or input to SG2 on the topics, either: email these to Steve, Mike or Pramod; or join the SG2 call biweekly on Wednesday at 9:30 CT (8:30amMT, 7:30amPT, 10:30amET – with next biweekly meeting starting 7 September 2022).

Meeting in recess @ 3:04 pm ET. WG to reconvene at 11 am ET on August 24, 2022.

August 24, 2022 Notes:

SG3 Discussion

Jens Boemer kicked-off session with SG3 discussion.

After some discussion Jens Boemer summarized that SG3's scope is twofold:

- Develop procedures for equipment and plant model sufficiency validation/model quality verification.
- Develop procedures to assess plant-level performance conformity using these verified plant models prior to commissioning.

It was noted (Rajat M., Julia M., Pouyan P., Divya K.) that aggregated IBR plant level model is validated with a combination of commissioning test and post-commissioning monitoring results and SG5 would address validation procedures and criteria.

Jens Boemer then briefly reviewed IBR design evaluation (clause 12.2.3) and verification method matrix (clause 12.3.2) and Appendix G (recommendation for modeling data) from the IEEE 2800.

Some key questions need answering are as following:

- What is benchmark for success for unit level model validation?
- Should manufacturer specific EMT models be required?
- Should hardware-in-loop testing of equipment be required?
- What are quality requirements for plant level EMT models?
- What is the procedure for plant level conformity assessment using plant models?
- How to represent grid (single-machine infinite or weak bus)?

There WG discussed need to type test power plant controller and other supplemental IBR devices. More to come on this topic, but majority of attendees who spoke mentioned that it is not necessary to type test power plant controller. This is another topic where coordination between SGs 2 and 3 is needed.

Deepak R. presented comparison of model limitations versus simulation domain limitations. It was emphasized that limitation of model should not be confused with limitation of the simulation domain itself. It was also emphasized that adequate model parameter configuration is needed.

The WG then discussed need of lumped versus detailed plant level models. When to which model remains a question that will depend on which specific performance requirement line item in Table 12 is assessed. The SG3 will continue to discuss in bi-weekly SG meetings for each line item in Table 12.

Jens Boemer presented proposed definitions of verify, verification, conformity assessment etc. followed by performance verification process in Germany. Further discussions on these topics to take place in SG3 bi-weekly calls.

A flowchart showing development of verified IBR plant model leading to design evaluation for conformance of plant with IEEE 2800 was shown. This is the preferred verification path (Path A) as it would minimize the risk for non-conformity of the plant. It was recognized that design evaluation may also be done in "interim" using generic IBR plant model (configurable to conform with IEEE 2800) but presents medium risk (Path B). The highest risk is when no design evaluation is done at all prior to beginning of commissioning (Path C). Some concerns were raised with the sufficiency of Path B and several attendees suggested to strike it from the document. There is a need for further discussion and clarifying the intent of Path B and also a need to clarify how the scope, procedures, and pass/fail criteria of the design evaluation would differ for Path A and Path B. One possible option is to clarify that Path B is "expedited" path and not "interim" path as originally presented: expedited Path B could be an alternate verification path in the scope of P2800.2, whereas interim Path B could be used for early adoption of IEEE 2800-2022 prior to publication of, and outside the scope of P2800.2. Roberto Favela & Sergey Kynev agreed. Nath Venkit mentioned that it is misleading to state that "expedite" path does not use models and is only based on "design checklist". Manish Patel agreed with Nath Venkit and so did Pouyan Pourbeik. Dave Mueller suggested to rename "expedited" path to "proven" path. Robert O'Keefe mentioned that path A (using verified models) is where industry needs to go but recognizes that jumping to Path A right away may not

be practical. Hence, prefers to keep path B as an “interim” path instead of renaming it to “expedited” path. Pouyan Pourbeik and Dave Narang suggested to strike the expedited Path B and rather simplify the recommended Path A to the greatest extent possible. Ratan Das agreed and further suggested that the scope, procedures, and pass/fail criteria of the design evaluation could be adjusted based on the criticality of the plant (size) and the specific performance requirement (line item in Table 12). Manish Patel stated that we might want to take a step back and determine why second path is needed? Depending on the answer, specifics of path B could then be developed. It was concluded that more discussion was necessary with the objective to clarify and focus on what is necessary to include in path B.

Jens Boemer thanked everyone for the valuable feedback and concluded the SG3 discussion.

SG4 Discussion

Divya Kurthakoti kicked-off with a brief review of SG4 scope. Divya mentioned that draft language for commissioning tests to verify reactive power capability, voltage & reactive power control modes, primary/fast frequency response have been received and SG4 is still reviewing/discussing that content. A couple of open issues are as following:

- Does IEEE 2800 require control or energy testing for FFR capability from PV and storage plants? If its control, then there is no difference between PFR and FFR testing for PV and storage plants.
- What does permit service mean? It may be interpreted as “human in the loop communication to allow plant restore operation.
- What does automatic return to service control function mean?

Divya K. presented SG4 content included in Draft 0.2.

Meeting in recess @ 2:55 pm ET. WG to reconvene at 11 am ET on August 25, 2022.

August 25, 2022 Notes:

Andy kicked off with a brief greetings message.

Divya K. presented proposed language (by Pouyan Pourbeik) for commissioning tests to verify reactive capability, voltage control mode, and frequency response (fast and primary) requirements. WG discussed that commissioning tests should be done when roughly 90% of IBR units are online. These tests are to be done at the end of test-energy period and just before the plant enters commercial operation date.

Test to verify reactive power capability: It was noted that it is not possible to run commissioning test to verify all corner points. Reigh Walling mentioned that test results could be used to validate model, which is in SG5’s scope.

In interest of time, tests to verify voltage and reactive power control modes, frequency response tests were discussed very briefly. For frequency response test, when control is done by IBR units, then need to figure out how to send frequency step signal to all IBR units at the same time. Divya concluded that for fast frequency response tests, some high-level questions remain and will be discussed by SG4.

SG5 Discussion

Julia M. presented scope of SG5 and then reviewed SG5 content that is included in the Draft 0.2. The SG5 is reviewing content in Annex G of IEEE 2800 to see if data and parameters listed there are sufficient for

validation. There was some discussion regarding meaning of “post-commissioning model validation”. Does it occur before or after the commercial operation date? Andy H mentioned that such details are not in the scope of P2800.2. Manish P mentioned that clause 12.2.6 in IEEE 2800 defines “post-commissioning model validation”.

Julia briefly summarized ongoing SG5 discussions (data processing and passing results). The SG5 is discussing what constitutes passing results for the model validation. This could be based on engineering judgement or quantitative pass/fail criterion. SG5 may include some examples in an informative annex. Rajat M leans toward using engineering judgement. Pouyan Pourbeik agrees with Rajat M. Reigh Walling raised a point that if model does not match commissioning test results, then there might be a need to re-do design evaluation. Nath Venkit noted that model response may not match actual test results because the system conditions (in field) versus in simulations may not be same. For example, short circuit strength, nearby plants online or offline etc. does affect results. Pouyan Pourbeik noted that engineering judgment should be inclusive of these factors. There appears to be strong support for using an engineering judgement approach, but it was also recognized that some examples in informative annex would be very valuable.

Rob O’Keefe asked if large disturbance should be covered in SG5. Julia clarified that SG3 is developing procedures for verifying plant capability for large disturbances. If there is a need to verify those capabilities post-commissioning, then procedures developed by SG3 still can be used.

Power Quality TF Discussion

Dave Mueller summarized scope of the Power Quality TF and how their work ties into other sub-groups.

Eugen Starschich brief overview of harmonic voltage distortion requirements (including Annex E) in IEEE 2800. It was noted that specifying voltage harmonic limits is outside of the scope of p2800.2. Then the question is: should PQ TF define testing requirements for harmonic voltage limits? The PQ TF will consider providing procedures to verify harmonic voltage limits (to be used if TO specifies harmonic voltage limits).

Coordination with SG2: PQ TF do not anticipate any type test procedures for rapid voltage change, flicker, and limitation of over-voltage requirements. However, type testing for harmonic current distortion is necessary to derive information needed for harmonics modeling. Reigh Walling mentioned that type testing should be done to benchmark an EMT model. There was some resistance to this idea. The PQ taskforce will discuss further.

Coordination with SG3: Except of flicker, design evaluation would be needed for rapid voltage changes, harmonic current distortion, limitation of over-voltage requirements.

Coordination with SG4: Commissioning tests not needed for rapid voltage change, flicker, and over-voltage limitation requirements. Commissioning tests are needed to verify harmonic current distortions requirements. Staged switching tests should be considered during commissioning. Details to be discussed by PQ TF.

Coordination with SG5: All power quality aspects should be monitored post-commissioning.

Dave and Eugen concluded with call for participation.

Andy Hoke reminded of criterion to become a WG member and instructions to join various listservs. Also, noted that FGW TR 8 and 9 are available on iMeet Central workspace. A few more reference documents will be added in the near future. The tentative date for the next WG meeting is December 6-8, 2022. The tentative timeline was presented, looking at publication in late 2024.

Meeting adjourned at 2:45 pm ET.