**IBRWG Meeting Minutes – 02/09/2024**

**IBRWG Leadership Update and ROS Update**

Provided by Julia Matevosyan (IBRWG chair)

* On February 2st ROS Meeting new leadership for IBRWG was approved.
* Julia Matevosyan (ESIG) and Miguel Cova Acosta (Vestas) are IBRWG chair and vice-chair respectively for 2024.
* Julia served as a vice-chair in 2023 and Miguel has previously presented at IBRWG on behalf of Vestas but will introduce himself to the WG at the next meeting.
* Julia thanked Mohammad Albaijat for his two years of services as IBRTF and then IBRWG chair.
* A suggestion has been made for inverter manufacturers to present on their current event reporting capabilities and any future states, similar to today’s Schweitzer presentation on 01/22/24.  Their plans for meeting NOGRR255 and upcoming NERC event reporting compliance. Additional items of interest to cover:
  + Should inverter oscillography be required?  Required to be turned on?  Why or why not?
  + Should ERCOT require that by some date in the future, they be required to be exportable in a more universal format (e.g. COMTRADE) so they can be used more readily in event analysis?
  + Can inverters meet Table 19 IEEE 2800 for Inverter fault codes and dynamic recordings section?  If not, what can they meet?”

We have contacted some OEMs for the presentations in March-April timeframe but welcome others to come forward.

* Additionally, at 1/12 IBRWG meeting David Azari (Invenergy) asked for presentation/report from ERCOT on what has been done in the follow up with resources involved in Odessa events or having same make/model of inverters as the plants that were involved in Odessa events. – ERCOT will provide an update at IBRWG meeting in March
* ROS had the following action item for IBRWG; “Request to conduct a focused review with ERCOT Staff, identifying challenges and recommendations in next steps to implement TSAT, specifically engaging with Resource Owners to provide transparency of the issues and timelines for meeting compliance deadlines and OEM model improvements, and to consider the impacts of the 10% vendor models not submitted/or responsive.” – The requested update was provided by Yunzhi Cheng (ERCOT) at the January IBRWG meeting, and the second part of the request is addressed through the recently updated modelling guideline. ERCOT will provide further updates at March or April IBRWG meetings. Julia will report to ROS in March that this action item can be closed out.

**Advanced Grid Forming for Utility Scale BESS**

This presentation was moved to March IBRWG meeting.

**Update on NOGRR 245 and NOGRR 255**

Provided by Stephen Solis (ERCOT)

* On NOGRR 245 ERCOT is working with stakeholders to find a compromise. Additional stakeholder comments came in before TAC
* ERCOT will ask TAC to table in February (even though TAC rescheduled the meeting specifically for this item)
* NOGRR255 was approved at Februaty ROS meeting, it will be back at in March with IA review
* At ROS meeting there has been a mention that at least one entity may file some comments before IA is filed.
* Seems that now ERCOT is at the version of NOGRR255 that seems to be acceptable for everyone.

**ERCOT Update on the 10/26/23 Solar and LFL Event**

Presented by Julia Hariharan (ERCOT)

* On October 26, 2023, at 10:28 AM CDT, a 138 kV line at a switching station in West Texas experienced an unbalanced (Phase-A to ground) fault, normally cleared in about 4 cycles (about 66ms)
* The event resulted in a loss of approximately 246 MW of IRR generation (all solar), 144 MW of conventional generation, and 179 MW of Large Flexible Load (LFL) consumption (without breaker opening)
* System frequency dropped to 59.972 Hz and returned to 60 Hz within approximately 10 seconds
* Lowest West Texas PMU, voltage recorded was 0.85 pu on a 138 kV line
* This is not a NERC-reportable event, but ERCOT is following up with QSEs of involved resources to get more information.
* RFIs were sent to all involved parties.
* Slide 6 shows comparison with previous event showing some units were repeated performance issues
* Frequency went deeper than expected for this relatively small change in MW, but not that instantaneously higher MW reduction (about 700 MW) was observed
* Got responses from all solar facilities that tripped.
* Three out of the seven impacted facilities had inverters trip on AC overcurrent, these are from KACO that’s out of business and no communication with OEM
* One facility continues to have similar ride-through issues to previous events – ERCOT is following up with them
* Low inverter ramp rate issue has already been addressed by TMEIC and there is ongoing work to fix the issue
* Got responses from 5 out of 6 loads (expecting the last response on 2/9)
* Lowest voltage sag observed by a PMU at these facilities was around 0.85 p.u., LFLs have limited VRT capability (tripping due to small sag in voltage)
* ERCOT will continue working with solar facilities that have KACO inverters to provide whatever information we can to help them ride through future events, keep tracking LFL events as they occur on the system, work with LFL owners to address any questions pertaining to VRT
* Question from Eric Goff: How do you know what kind of loads their were? Julia: there are ways of identifying LFLs in ERCOT systems
* Bob Witmeier: were all LFL same technology? Yes
* Julia Matevosyan: question on TMEIC low ramping issue was it that active power was ramping up slowly after the event. Patric: yes, TMEIC had ramp rates setting low at inverter level instead of 100% per second it’s set at 10% per second; it was identified back in Jan 2023 event, delays are related to PSCAD modelling updates. It seemed like a low hanging fruit fix but is taking unexpectedly long time to implement.
* Julia M: Is this one of those issues where an OEM fixed one performance issue and then the next one was uncovered? Stephen talked about that previously, after the Odessa events. Patrick confirmed that indeed this is a classic case of that happening.
* Julia M: What is happening in terms of model updates? Patric: most of them were resubmitted and approved by this point but a few still remaining, will bring an update to the March meeting together with the rest of Odessa event follow up that David Azari (Invenergy) has asked for.
* Stephen provides few comments:
  + With LFLs it is a bit of a learning curve to understand what information they have that can be used in event analysis. KECO’s inverters’ maintenance has been taken over by Siemens, but there is an extra effort ongoing trying to understand what can be done with these inverters.
  + Dropping active power during the fault and restoring it back after the fault is cleared – we are seeing too much of active power drop for the voltage drop that is happening. NOGRR245 has language in there that should help to address this and make sure that controls are properly tuned. However, when we do the test during interconnection the voltage is reduced all the way to 0 and we miss the performance during more shallow voltage drop events (e.g. down to 0.5-0.8 pu) so this is an area that we need to consider for improvement in MQT. Dropping too much active current during shallow voltage event may eventually lead to UFLS.
* Shawn Wang (Enel): Asking Stephen if he means 0.5 pu voltage right after the fault? Says in the MQT ERCOT does test 0.5 pu scenario during voltage recovery, but tries to clarify if Stephen meant voltage right at the inception of the fault. Stephen confirmed that it’s the latter.
* Patrick comments about active power loss. We have seen three most recent events in South Texas, Nov, Dec, and last one in Jan, where there is a fault and large penetration of wind and event exceeding 700-800 MW for a voltage drop of about 0.85 pu. Wind also takes longer to recover. Shawn comments that active power loss depends on control logic and should be in proportion to the voltage deep but may also depend on system conditions/location. Patrick comments
* Patrick will summarize these three events at the March meeting. We would also like to set some general criteria for smaller drops that plant owners should be following up on. Bigger events where ERCOT engages in analysis take more time to analyze and mitigate.
* Stephen adds: we are trying to prioritize which abnormal performance failures ERCOT with resource entities over. There is still expectation that individual events should be followed up on by REs themselves and reported to ERCOT, so that ERCOT can focus their energy on the bigger ones.

**DWG and IBRWG Collaboration Update**

Provided by John Schmall (ERCOT), verbal update, no slides

* At the January meeting a need for collaboration between DWG and IBRWG brought up by Paul Koberlein (DWG vice-chair), slides are posted on 1/12/24 meeting page. There were some open questions that John will cover here.
* Reached out to Market Rules and it’s really up to DWG and IBRWG if we want to handle this as an informal collaboration rather than spinning off another Task Force. We can then report from this collaboration to ROS as a part of IBRWG updates and they will direct if a different approach is preferred.
* This collaboration will be looking to review if any updates are needed to modeling and MQT tests to assess performance proposed in NOGRR245. It would be within DWG purview, normally, but they can appreciate input from IBRWG and particularly OEMs to inform this process in an open forum.
* Moving forward there is a challenge with uncertainty around NOGRR245 language as Stephen mentioned until there is good consensus. But this group can already start with review of existing procedure manual and model testing and has some ideas of where the changes may be needed, e.g. the shallower voltage ride through test that Stephen mentioned. ERCOT can bring this to the first meeting to get started. Also open to OEM’s ideas with regard to what testing should be included.
* Another admin point is where to meet. We could add it to IBRWG meeting, for example, after a lunch break. This is more practical than finding additional time.
* Last remaining item if there is something that goes beyond existing modeling procedure manual that may require bigger change or a NOGRR then it can be sponsored by either IBRWG or DWG but changes on procedure manual IBRWG and DWG can simply work on together.
* Julia M: confirmed that IBRWG will start with standing item on IBRWG/DWG collaboration and then if the agenda extends for too long, we’ll add a lunch break and continue after. Any additional feedback about the format of scope is very welcome!
* Julia M: As grid forming (GFM) requirements are being developed there may be additional modeling requirements and testing requirements that may need to be added for GFM to modeling procedures and modeling guide updates will this come to this collaboration between IBRWG/DWG
* John: Yes, initially we’ll focus on changes needed for NOGRR245 but yes grid forming will be the next priority. A normal set of test is expected to apply even to GFM but there may be other additional test to verify if GFM or not.
* Julia: Another topic could be on how to include energy augmentation that Tesla has presented at the January meeting. Power augmentation is adding more inverters on the AC side and controlling power output to the level of SGIA. The question then is when modeling updates are needed (with what periodicity) and are the any additional tests or studies that are needed. This is currently discussed in IEEE2800.2 but also relevant for this group. – this could be another topic to pick up by IBRWG/DWG collaboration.
* John: yes it’s an important topic, may be we can bring something from IEEE2800.2 discussion for this group to provide more details.

**NERC Work Plan in Response to FERC Order 901**

Mark Henry and David Penny (Texas RE)

* FERC Order 901 was issued in October 19, 2003 directing NERC to submit a detailed standards development plan to address IBR reliability gaps in four areas
  + Data sharing
  + Model validation
  + Planning and operational studies
  + Performance requirements
* An additional item is registration of smaller IBRs, it’s still above 10 MW registration that’s required at ERCOT but the NERC rules over time are going to apply to the smaller units.
* Informational filing was due within 90 days (by January 17, 2024), posted here <https://www.nerc.com/news/Pages/NERC-Submits-Comprehensive-Work-Plan-Addressing-FERC-Order-901-Directives.aspx>
* Development and Filing of Reliability Standards to Address Disturbance Monitoring Data Sharing, Performance Requirements, and Post-Event Performance Validation for Registered IBR (proposed completion: November 4, 2024)
* Development and Filing of Reliability Standards to Address Data Sharing and Model Validation for all IBR (proposed completion: November 4, 2025)
* Development and Filing of Reliability Standards to Address Planning and Operational Studies Requirements for all IBR (proposed completion: November 4, 2026)

A timeline of project development

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* 11 high priority projects after reprioritization
* Anticipated SARs to address FERC Order 901
  + Working with appropriate subcommittees
* 2024 Board adoption dates
  + Feb 2024 – Cold Weather
  + May 2024 – Internal Network, Security Monitoring and Virtualization
  + Oct 2024 – IBR performance and disturbance monitoring
  + Dec 2024 – Extreme Weather and any remaining high priority projects
* The way NERC process works
  + Standard Drafting Team has to put a standard language together and come to agreement
  + Balloting body, all registered entities get to vote and approve it
  + Then it goes to NERC Board for approval and then to FERC
* On slide 5 there are ongoing NERC standard drafting projects listed that are relevant to FERC Order 901 and have priority for this year. Highlighted in red are the projects relevant for this group.
* PRC-024 (generator ride-through), PRC-002 (data sharing), 2023-03 Performance of IBRs
* 13 medium and low priority projects
* Will not post for formal comment/ballot in first half of 2024
  + Only informal postings to solicit feedback
  + Allow industry to focus on postings for high priority projects
* Projects to be reevaluated following conclusion of high priority projects
* Anticipated 2025 Board adoption dates and beyond
* On slide 7 there are ongoing NERC standard drafting projects listed that are relevant to FERC Order 901 and have medium to low priority. Highlighted in red are the projects relevant for this group.
* 2022-04 EMT Modeling in NERC MODs, 2020-06 Verification of Model and Data for Generators, 2023-01 EOP-004 (IBR Event Reporting).
* This standards will need to be written by industry, NERC staff doesn’t write standards so please participate.
* David adds that there are a lot more ongoing standards projects at NERC than just those listed here on the slides. But these are high priority standards that need to be done sooner than others. Other ongoing projects may be delayed as a result.
* Julia seconds Mark and David inviting folks to get involved and participate in SDT meetings at least as observers. Anyone can join as an observer and provide input to the language drafting. With the timeline being so short, there’ll be urgency for the standard development may be rushed – so even more urgency to participate.
* Mark adds that TRE will be working with NERC on IBR strategy and what ERCOT IBRWG is doing will be used as a pilot and TRE will be regularly getting together with NERC disseminating IBRWG’s efforts to the rest of the industry.
* Julia one other thing to think about is that other areas (e.g. MISO, SPP, NYISO etc) including ERCOT started on the path of IEEE2800 adoption so there is a need to make sure that the new standards or updated standards that come out of NERC do not conflicting with these adoption efforts and do not create confusion.

**NERC Standards Update – New Standing Item**

Open discussion

* Julia: with these changes rapidly happening to a number of NERC standards, it would be good to have a standing item on the agenda in this group and provide regular update on what is happening at relevant SDTs, so that the stakeholders can follow the progression of standards.
* Some comments in the chat that this approach is helpful.
* Julia called for meeting participants to put in the chat their name if they are participating on any of the relevant SDTs.
  + Marie Washer - Observer for NERC PRC-028
  + Shawn Wang - SDT PRC-029 ride through standard
  + Patrick is on 2023-02 Analysis and Mitigation of BES Inverter-Based Resource Performance Issues and 2023-01 EOP-004 IBR Event Reporting

**ENSTO-E and AEMO Grid Forming Requirements Update**

Presented by Julia Matevosyan (ESIG)

* AEMO Voluntary Specification for Grid-forming Inverters: Core Requirements Test Framework <https://aemo.com.au/-/media/files/initiatives/engineering-framework/2023/grid-forming-inverters-jan-2024.pdf?la=en>
* Slides 3-7, quick recap on the AEMO GFM Specification itself that came out in May 2023 and was presented previously at IBRWG. <https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2023/gfm-voluntary-spec.pdf?la=en&hash=F8D999025BBC565E86F3B0E19E40A08E>
* Stephen asked what’s the lowest SCR that the tests go down to. Julia responded that not in the specifications but in the test framework document the tests are specified at different SCR and down to 1.25 as the lowest. This is traditional SCR metric (not WSCR). [ Julia followed up offline: In existing DMAT test GFL IBR is allowed to trip at SCR = 1 or lower. The SCR ramp down test in GFM testing framework specifies that for GFM, stability of the resource down to the minimum level of 1.25 is required as a “pass” criterion. An SCR of 1.25 was selected as the lower limit as it is below the SCR stability threshold of typical GFL devices but is above power transfer limits. Testing an SCR drop to (or near) 1.0 is possible as an informative test but may require an active power dispatch reduction to respect power transfer limitations. A 6-cycle 2 phase-to-ground fault is applied with a minimum fault depth of 0.5pu just before each SCR transition. The SCR transition occurs at fault clearing time.]
* Currently there is a framework for system strength, the resources are evaluated for their impact on system strength and if they have negative impact resources then need to contract with the TO in the area for system strength service or bring their own system strength support. Currently this framework seems to be incentivizing GFM, where resources owners are bringing their own GFM capability to support system strength.
* Slides 9-11 provide high level description of the framework and slide 11 specifically shows 3 test benches and the notes under the slides have more details.
* Some of the tests are the same as in the NERC GFM BES Specification that was presented at IBRWG in 2023. – Great to see similarities!
* Stephen: do you know why it’s 4 Hz/s not 5 Hz/s as in IEEE2800? Julia: Don’t know actually but 4 Hz/s experienced in South Australia black out led to malfunction of UFLS relays, that could be the reason why operating where RoCoF can be higher than 4 Hz/s is not desirable.
* Stephen adds that it’s good that the voltage angle phase jump is tested for different thresholds to see where it breaks and asks if all of these tests RoCoF, SCR, Voltage Phase Angle tests are with the faults? - Julia promised to follow up.

**Julia followed up:** The fault is only applied in SCR ramp down tests, see an excerpt from the [testing specs](https://aemo.com.au/-/media/files/initiatives/engineering-framework/2023/grid-forming-inverters-jan-2024.pdf?la=en) below. RoCoF and phase jump tests do not include fault in the test sequence and are just steps in frequency or steps in phase angle respectively without fault.

A diagram of electrical wiring

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Excerpt from the [AEMO testing specs](https://aemo.com.au/-/media/files/initiatives/engineering-framework/2023/grid-forming-inverters-jan-2024.pdf?la=en): Test 6 (SCR Step Down with Fault) is very similar to existing tests applied for connection assessment, with a key difference that in the existing DMAT test protocols the test is informational rather than “pass/fail”, and is allowed to trip at SCR = 1 or lower. This this test specifies that for GFM, stability of the resource down to the minimum level of 1.25 is required as a “pass” criterion. (Footnote 19: An SCR of 1.25 was selected as the lower limit as it is below the SCR stability threshold of typical GFL devices but is above power transfer limits. Testing an SCR drop to (or near) 1.0 is possible as an informative test but may require an active power dispatch reduction to respect power transfer limitations.)

Tests sequence:

1. SCR at connection point stepped down repeatedly in this progression: 10, 3, 2, 1.5, 1.25.
2. A 6-cycle 2 phase-to-ground fault is applied with a minimum fault depth of 0.5pu just before each SCR transition. The SCR transition occurs at fault clearing time.

* Models for GFM IBR should be usable and accurate and go through same modeling requirements as other IBRs.
* These additional tests are only to verify grid forming specifications. All interconnection studies will be still conducted as is the case with GFL IBRs.
* Switching gears to ENTSO-E Requirements, it was presented at IBRWG in Jan 2023
* Slide 13-16 provide a recap on the proposed requirements
* The version that was recently approved by the regulator ACER specifies high level GFM requirements, as per initial proposal, but unlike in the initial proposal leaves it up to each system operator to adopt these requirements. This decision was based on industry pushback due to varying IBR penetration levels in various parts of ENTSO-E.
* Some additional updates:
* Relevant ESIG Webinar on how Finish system operator is addressing stability issues in their grid: <https://www.esig.energy/event/webinar-measures-to-address-stability-issues-in-fingrid/> (recording and slides available here)
* Upcoming ESIG Spring Workshop with following sessions relevant to IBRWG:
  + Tutorial: Electromagnetic Transient Analysis Simulation Tools
  + Opening Plenary Session: Grid Forming Technology Applications
  + Session: Grid Forming Technology Developments
  + Session: System Oscillations
* Gautham Ravichandran (Vistra): Is there guidance on the duration of storage that is needed for GFM. Julia: For example, in AEMO testing specs for the core capability it’s the amount of storage is necessary to support your inertia constant, but if you are to provide additional capabilities such as black start capability for example then you need to design storage for that specific application.