DATE:	June 14, 2017
TO:	Jason Pause, Electric Distribution Systems, Office of Electric, Gas & Water Department of Public Service 3 Empire State Plaza, Albany, NY 12223
FROM:	Joint Utilities of New York – Interconnection Technical Working Group
RE:	05/10/17 ITWG Meeting Follow-Ups – JU Response to draft EPRI Report Questions

Pursuant to your request, below is the response from the Joint Utilities of New York ("JU") regarding the follow-up items on EPRI's recommendations in the draft report "Harmonizing Distributed Generation Interconnection Practices in NY State: Technical Review Processes" from the May 10th ITWG meeting. The response reflects the position of all of the utilities identified on this letterhead, although it does not necessarily apply to network systems.

Summary

Building off discussions at the May 10th ITWG meeting, the JU support maintaining the supplemental screens as an optional procedure, as well as recasting the supplemental screens to assume an engineer's review[1]. More specifically, in regards to proposed Screen F and existing Screen H, to accurately determine if the change in voltage is of concern, an engineer would be required to manually complete a load flow analysis using power systems analysis software. While EPRI's proposed screen considers a number of elements of importance in the circuit model (i.e. average resistance, conductor type, circuit length, etc.), a load flow analysis would still be required to determine the voltage at the Point of Common Coupling[2] (PCC) under existing and proposed circuit conditions. Considering both proposed Screen F and existing Screen H are designed to address the change in voltage after the solar photovoltaic (PV) interconnection, the JU conclude that a load flow analysis manually completed by an engineer would be required for the expected change in voltage to be both accurate and of value. The details of the review process as they pertain to each screen are further elaborated on in the response below.

When completing any analysis described in this document, all installed and preceding distributed generation (DG) applications in the queue must be assumed to be operating at their full nameplate capacity.

Voltage Analysis

The IEEE 519-1992 Std. defines flicker as the following, "This phenomenon is a result of applying a load on the converter[3], releasing it, then reapplying it sometime later, etc." In the case of solar PV, voltage flicker is often defined as a series of voltage fluctuations across a set time interval as a result of changing load or source currents through the system impedance. The impact and solution to correcting voltage flicker will depend on the percent change and frequency of the voltage dips. Those impacts can be classified under three categories:

1. <u>Irritation on Humans</u>: As defined by the standard: If [voltage flicker] is carried out at a frequency to which the human eye is susceptible, and if the resulting system voltage drop is great enough, a modulation of the light level of incandescent or fluorescent lamps will be detected. This is the effect that gives the phenomenon its name, and one that may be a matter of concern[4].

2. <u>Voltage Variation to Equipment</u>: Depending on the percent change and frequency of voltage fluctuations, voltage regulating equipment like Load Tap Changers (LTCs) or regulators may operate more frequently and therefore reduce the life of the LTC or regulator. Excessive tap movement due to time delays between measurement of line voltage and the command to adjust taps can also temporarily cause high or low voltage issues which may damage equipment.

---

[1] May 10th ITWG meeting notes, DPS Staff 2017

[2] The PCC is used as opposed to the Point of Interconnection (POI), as the POI may be located on the customer's premise, making it infeasible to automate because this information is not available in utility load flow databases.

[3] "Converter: A device that changes electrical energy from one form to another. A semiconductor converter is a converter that uses semiconductors as the active elements in the conversion process." – IEEE 519-1992 Std.

[4] IEEE Std. 519-1992 Pg. 81

3. Voltage Rise: The utility is required to maintain the voltage within the ANSI C84.1 limits at the service point or PCC. Depending on the voltage at the PCC under normal conditions, voltage flicker may cause the local voltage to exceed the limits defined in the ANSI standard[5].

Screen F

Is there a need for a "Simplified Voltage Rise at the PCC" screen or test in the preliminary review? If yes, propose a screen and explain in detail. If no, still provide explanation.

No, as this will not be an automated screen. If an application passes all prior automated preliminary screens, a manually conducted "Simplified Voltage Rise at the PCC" test will be completed by an engineer to determine if supplemental review or a CESIR is required. This builds off the consensus reached at the May 10th ITWG meeting that the majority of the screening process is expected to become automated, with manually completed portions requiring an engineer's review.

The JU expects any screens pertaining to voltage fluctuation to require an engineer's review. Specifically, the JU conclude that a voltage fluctuation screen would only be of value if the change in voltage is compared to the actual voltage at the point of common coupling. The details of the required review process to accurately determine voltage rise or fluctuation is further expounded upon in the later responses.

Existing Screen H (Will the DG cause flicker, harmonics, or other PQ issues?)

Is there a need for a voltage flicker screen in the supplemental review? If yes, propose a screen and explain in detail what standard(s) the screen should comply with (IEEE 1453 or 519). If no, still provide explanation.

Yes, a voltage flicker screen is needed in the supplemental review. However, as screens in the supplemental review are not capable of being automated, this screen will require an engineer's review. The JU support screening for voltage flicker in the supplemental screens for compliance with the commonly referred to "GE Flicker Curve" in the IEEE 519-1992 Standard. While the March 2016 SIR and subsequent versions indicate that the voltage fluctuation/flicker assessment should be assessed based on the IEEE 1453-2015 Standard, the screen provides flexibility in allowing the utility to utilize a similar practice to the IEEE 1453-2015 Standard for voltage fluctuation/flicker assessment. As such, the JU recommend the use of the GE Flicker Curve under IEEE 519-1992 Standard to evaluate voltage fluctuation/flicker.

It is not clear that the IEEE 1453-2015 Standard provides the guidance necessary to analyze projects prior to installation. The JU find that the standard is more focused on defining how to measure and define

[5] Where Conservation Voltage Reduction (CVR) applies to a utility, the voltage limit will differ in a CVR condition, typically having a lower tolerance than the normal limit.

limits for voltage fluctuations as they are occurring (e.g. after the DG is in-service). Applying the IEEE 1453-2015 Standard as designed, after the installation of a DG system, includes utilizing a voltmeter to gather measured data to determine the short term (Pst) and long term (Plt) flicker values. As this level of information is not available during CESIR analysis, assumptions are required to calculate Pst and Plt values. This includes:

- Obtaining available hourly irradiance data for the proposed PV system size – hourly irradiance data can vary greatly depending on the source used as well as assumptions made on the PV system (e.g. tracking vs. fixed)
- Calculating the change in real and reactive output between each time interval – hourly load data may not be available at the feeder head or near the proposed PV site
- Calculating the Thevenin equivalent impedances near the proposed PV site
- Determining a shape factor based upon the approximate type of voltage change and time interval

Resolving flicker issues after a DG system is installed and operating requires extensive time and cost for both the utility and the customer. This includes installing recording devices(s) for monitoring, disconnecting the DG from the grid, analyzing results over a period of time, and then finally determining and implementing acceptable mitigation solutions that the DG customer would be responsible to pay. This can take weeks to months to resolve. Screens must be designed to identify any potential issues prior to commissioning, as it can be difficult and costly to mitigate issues in a timely fashion. However, the JU support a mechanism to address problems discovered during commissioning or after installation and acceptance. The JU recommends that the Interconnection Policy Working Group (IPWG) work through contractual changes necessary for inclusion in the next SIR update to strengthen this mechanism[6].

Given the above considerations, the JU support the continued use of the GE Flicker Curve in the IEEE 519-1992 Standard for the supplemental screening analysis.

CESIR

Propose and explain in detail how voltage flicker should be studied/reviewed as part of the utility CESIR. Again, explain in detail what standard(s) the screen should comply with (IEEE 1453 or 519)

While the March 2016 SIR and subsequent versions indicate that the voltage fluctuation/flicker assessment should be assessed based on the IEEE 1453-2015 Standard, this requirement is specific to Screen H of the Supplemental Screening Analysis only, and not the CESIR. The rationale described in the previous sections regarding the application of the IEEE 519-1992 Standard pertains to the CESIR as well.

While the JU's earlier response provides greater clarity and standardizes the existing supplemental Screen H, the JU expect the review process for evaluating voltage flicker to be closely related between the supplemental screens and the CESIR. Despite that the final result of a screen (testing for compliance with the IEEE 519-1992 Standard for voltage flicker) yields a simple pass/fail, the process to reach that conclusion requires detailed load flow analysis and an engineer's review. For that reason, the review process to evaluate voltage flicker does not significantly differ between the supplemental screens and the CESIR.

---

[6] JU Response to EPRI Draft Report, 4/28/2017 Joint Utilities

Application of IEEE 519-1992 Curve

When applying the GE Flicker Curve as described in previous sections, each utility completes a load flow analysis on the proposed interconnection feeder and records the steady-state voltage during both peak and off-peak[7] load conditions at the point of interconnection. After the steady-state voltages have been recorded, the engineer then re-models both on and off-peak scenarios with the proposed DG operating at full nameplate capacity. This methodology provides the maximum possible voltage change by simulating if the DG were to go from operating at full nameplate capacity to zero across an instant in time. After the maximum percent voltage change is known, the utility compares the percent voltage change against the given time interval in the GE Flicker Curve. The aforementioned process is consistent across the JU; however due to inherent differences in utility service territories and planning criteria, the application of the GE Flicker Curve varies slightly between utilities, as shown in Table 1. For example, based on time between dips, and percent voltage dip, the utility could reach a different conclusion if they were to choose to use either the curve for borderline of irritation or borderline of visibility of flicker.

Table 1: Application of the GE Flicker Curve by Utility

	Con Edison[8]	Central Hudson	National Grid	NYSEG / RG&E	Orange and Rockland
Percent Voltage Dip	N/A	2%	2%	1.2%	0.7%
Dips Per Minute	N/A	1	1	10[9]	1
Borderline Curve	N/A	Irritation	Irritation	Visibility	Visibility

[7] Off-peak load is often referred to as a minimum daytime loading in this scenario.
[8] Applies a separate methodology for their secondary networks.
[9] Per hour

GE Flicker Curve

IEEE Std 1453-2015
IEEE Recommended Practice for the Analysis of Fluctuating Installations on Power Systems

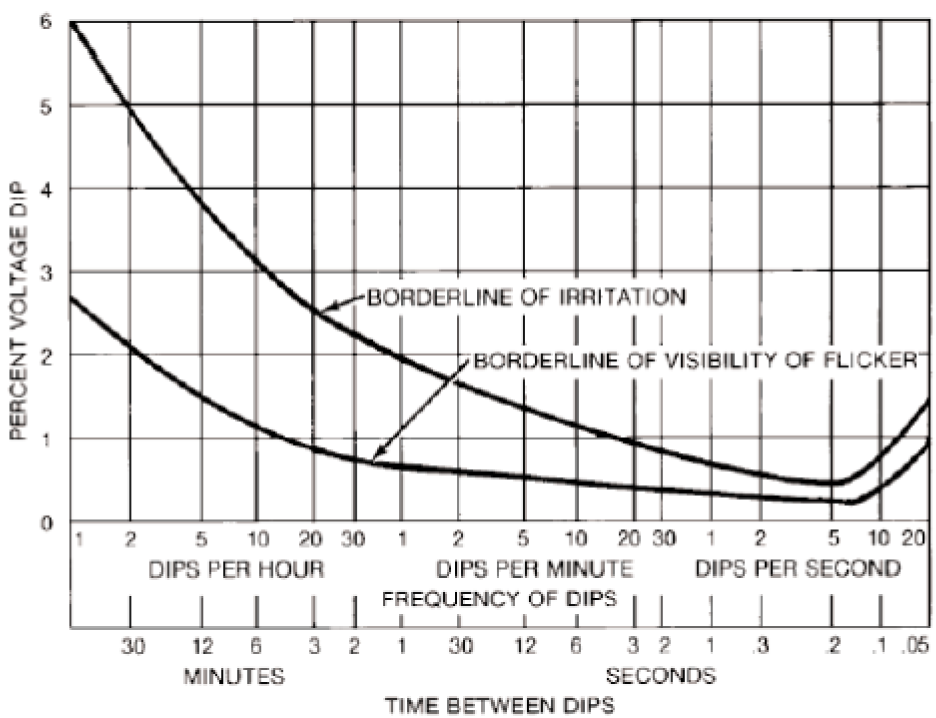

Figure 1—GE flicker curve [B14]

Conclusion

The JU support the need for a simplified voltage test to be manually completed by an engineer and therefore do not recommend the automation of Screen F at this time. This will require changing the current structure of Screen F. While the JU support the automation of Preliminary Screens A – E, the JU recommend the Supplemental Screens remain manual, and also as an optional procedure to be completed at the request of the applicant. Additionally, the voltage flicker analysis detailed in this document shall be required within the CESIR, if an applicant chooses to forego the Supplemental Screens. Finally, the JU reiterate the need for the manual intervention, and for the review to be completed by an engineer, in regards to any voltage analysis.