



Southern Company Power Quality Policy

November 11, 2015



Alabama Power
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Scope

This document provides the policy pertaining to power quality issues affecting the Electric Supply System (ESS). The term ESS, when used in this document, pertains to either the Southern Company Transmission System (SCTS) or its interconnected distribution system. The policy contained in this document is intended to ensure that the integrity and power quality of the ESS are maintained.

The Owners of the ESS are: Alabama Power Company, Georgia Power Company, Gulf Power Company, and Mississippi Power Company. The Owners of the ESS are collectively referred to as “Owners” or individually referred to as “Owner.” This document shall not be construed to waive, modify or alter the contract for electric service between any Owner and any User connected to the ESS. Where a conflict exists between this document and the contract for electric service, the contract for electric service will govern.

This Policy supersedes the Southern Company Harmonics Policy (10-22-1999), the Southern Company Voltage Flicker Policy (8-23-2001), and the Southern Company Transmission Business Unit Power Quality Guidelines (6-29-2004).

Purpose

This document sets forth Southern Company’s policy with respect to the issues of Harmonics, Voltage Flicker, and Voltage Imbalance (“Policy”). It is the goal of Southern Company and its subsidiaries to provide a supply voltage to all Users that is within the limits referenced in this document. This Policy provides performance criteria to which all Users’ facilities must adhere, as well as procedures on how to monitor and verify performance.

Definitions

For the purpose of this Policy, the following definitions and abbreviations apply:

Disturbing Load:

Any load capable of producing Harmonics, Flicker or other voltage disturbance that could have an adverse effect on the ESS.

Electric Supply System (ESS):

All lines, switchgear, and transformers of the Southern Company Transmission system and distribution systems.

Flicker:

A change in electric light source intensity due to fluctuations of the input voltage. For purposes of this document, the definition of Flicker, lamp Flicker, and voltage Flicker shall be considered equivalent.

Flicker Emission Limit:

The 99th percentile P_{st} and P_{lt} Flicker quantity values that a User shall not exceed based on a one (1) week measurement period or of sufficient duration to characterize the Disturbing Load as determined by the Owner of the ESS at the PCC or equivalent.

Fundamental Frequency:

The fundamental frequency is sixty (60) cycles per second (Hz).

Harmonic Burst:

Any burst of total or individual harmonic current distortion that exceeds the steady state harmonic limits of this Policy for time periods less than 30 minutes and greater than 1 second.

Harmonic Distortion:

The deviation of the AC voltage and/or current from the fundamental frequency sinusoidal waveform(s).

Harmonics and Individual Harmonics:

A sinusoidal component of a periodic wave or quantity having a frequency that is an integer multiple of the fundamental frequency.

Individual Harmonic Distortion (IHD):

The individual harmonic component expressed as a percentage of the fundamental frequency component.

Interharmonics:

A sinusoidal component of a periodic wave or quantity having a frequency that is a non-integer multiple of the fundamental frequency.

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Line Voltage Notch:

The sub-cycle dip in the System voltage due to the high rates of change in User load current caused by the momentary short circuit of the AC lines during a commutation interval of a converter.

Maximum Voltage Deviation ($\Delta V/V$):

The maximum Voltage Fluctuation allowed on the System, at the PCC, as a result of a User's individual and combined Disturbing Load(s).

Normal System Configuration:

Conditions under which the System is configured and operated the majority of the time.

Owner:

The operating company (Alabama Power Company, Georgia Power Company, Gulf Power Company, or Mississippi Power Company) of Southern Company that owns the ESS from which the User is served.

Point of Common Coupling (PCC):

The electrical point on the Owner's System closest to the User under consideration from which another User is or could be connected. It is the location where adherence with this document is determined. The Owner will define this point for a User. The delineation of facility ownership does not necessarily define the PCC.

P_{st} :

The short-term evaluation of Flicker severity is given by P_{st} and is based on a ten (10)-minute time interval.

P_{lt} :

The long-term evaluation of Flicker severity is given by P_{lt} ; a calculation based upon twelve (12) consecutive P_{st} values.

$$P_{lt} = \sqrt[3]{\frac{\sum_{i=1}^{12} P_{st_i}^3}{12}}$$

Rated Generator Current:

Current supplied by the generator at rated voltage and rated volt-amperes (VA).

Rated Load Current (I_L):

The maximum demand steady-state load current (fundamental frequency component) at the PCC as determined under normal load operating conditions.

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Resonance:

A condition where the inductance and capacitance of the System results in either a high impedance (parallel resonance) or a low impedance (series resonance) to the flow of current. Resonance conditions can result in excessive voltage distortion and/or an increase in current flow at a particular frequency.

Root Mean Square (rms):

The Root Mean Square value of a sinusoidal voltage or current waveform is the square root of the mean value of the square of the voltage or current waveform during a complete cycle.

Short Circuit Current (I_{sc}):

The Short Circuit Current available at a given System location. For this document, the Short Circuit Current will be the maximum three phase short circuit available at the PCC under normal System operating conditions and/or under contingency conditions as determined by the Owner.

Steady State Load Current:

The average of the maximum *rms* current, including Harmonics, over the demand intervals that represent the User's load profile the majority of the time, as determined by the Owner.

Steady State Voltage (V):

The one (1)-minute average value of the *rms* voltage that is normally within the nominal voltage ranges as specified by American National Standards Institute, ANSI C84.1-2011[1].

Study:

Evaluation by Owner of power quality impact in a proposed new User facility, in a proposed modification to existing User facility equipment or operations, or in operation of an existing User facility. The evaluation will model planned User operations, or will analyze existing User operational data, and their effect on the System in terms of power quality.

System:

The electrical facilities and associated equipment of the generation, transmission, and distribution systems of the ESS.

System Contingency:

A condition in which the System is operated in a non-typical configuration for a period of time due to reasons such as normal maintenance, storm restorations, equipment failure, etc.

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Total Demand Distortion (TDD):

The total harmonic current distortion (the square root of the sum of the squares), expressed as a percentage of the maximum demand steady-state load current, i_L .

$$TDD = \frac{\sqrt{\sum_{i=2}^N i_i^2}}{i_L}$$

where N is the highest order harmonic that is considered in the calculation.

Total Harmonic Distortion (THD):

The voltage Total Harmonic Distortion as defined by

$$THD = \frac{\sqrt{\sum_{i=2}^N v_i^2}}{v_1}$$

where N is the highest order harmonic that is considered in the calculation.

User:

Any customer, distributor, wholesaler, retailer, generator (small or large), broker, etc. (not including the Owners) who receives power through or injects power into the ESS.

Voltage Flicker:

See Flicker.

Voltage Fluctuation:

An *rms* voltage variation, that may or may not be strictly periodic.

Voltage Imbalance:

The ratio of the negative sequence voltage to the positive sequence voltage, usually expressed as a percentage.

$$\text{Voltage Imbalance} = 100\% \frac{V_{neg}}{V_{pos}}$$

Also, this term can be defined as the maximum deviation from the average phase Steady State Voltage (line-to-line) expressed as a percentage of average phase Steady State Voltage

$$\text{Voltage Imbalance} = 100\% \frac{\text{maximum deviation from average}}{\text{average voltage}}$$

$$\text{Average Voltage} = \frac{V_{ab} + V_{bc} + V_{ca}}{3}$$

I. Harmonics

Introduction

Many electrical devices can generate harmonic currents, and consequently, affect the voltage of the ESS. These Harmonics should be managed and mitigated because of the potential they have to cause problems such as telecommunication interference, increased thermal heating in transformers and rotating machinery, mis-operation of protective relays and User equipment, and resonant overvoltages.

General

Control of Harmonics is the joint responsibility of the User and the Owner as per IEEE 519 - 2014[3]. In order to properly manage ESS Harmonics, the User must communicate to the Owner any change, addition, and/or expansion proposed, or made to an existing User's facility.

Voltage distortion is generally caused by harmonic current flowing through the System impedance. This Policy places responsibility for the limits of Total Harmonic Distortion and voltage Individual Harmonic Distortion levels upon both the Owner and the User. This Policy places responsibility for the limits of Total Demand Distortion and current Individual Harmonic Distortion upon the User. It is the responsibility of the User to ensure the User's facility operates in adherence with this Policy.

Considerable effort should be spent, and a Study conducted, if appropriate, in the planning and design phase of User and Owner facilities to limit the level of voltage and current harmonics. In any event, unique problems can arise after the User facility is in operation. To this end, the Owner may periodically verify ongoing adherence through the use of field measurements taken at the Point of Common Coupling or other suitable location as specified by the Owner.

Measurement

Unless specified otherwise by the Owner, measurements to evaluate adherence with this Policy will be taken at the PCC. If measurements cannot be made at the PCC they may be taken at the closest practical location. Voltage and current harmonic levels at the PCC can be calculated from these measurements.

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For purposes of assessing harmonic levels as provided in this Policy, instruments should comply with IEC 61000-4-7[4] and IEC 61000-4-30[5]. Circumstances may require alternate metering and analytical methods to properly capture the impact of some non-linear loads. A brief summary of some of the relevant portions of those IEC specifications include:

- The measurement window width should be 12 cycles (200 milliseconds).
- Very short time harmonics equate to 3 second intervals based upon an rms aggregate of 15 consecutive 12 cycle windows.
- Short time harmonics equate to 10 minute intervals based upon an rms aggregate of 200 consecutive very short time values.
- Daily 99th percentile values should be statistically obtained for very short time (3 sec) harmonics.
- Weekly 95th percentile values should be statistically obtained for short time (10 minute) harmonics.
- Weekly 99th percentile values should be statistically obtained for short time (10 minute) harmonics.

Recommended Harmonic Current Limits

The recommended harmonic limits are included in the following tables:

TABLE I-1: Current Distortion Limits for Systems Rated 120 V –69 kV

I_{sc} / I_L	Individual Harmonic Order (Odd Harmonics)					TDD
	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	
< 20*	4.0	2.0	1.5	0.6	0.3	5.0
20 – 50	7.0	3.5	2.5	1.0	0.5	8.0
50 – 100	10.0	4.5	4.0	1.5	0.7	12.0
100 – 1000	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

- Limits are a percent of Rated Load Current/ Rated Generator Current
- Individual even harmonics are limited to 25% of the odd harmonic limits above.
- Current distortions that result in a dc offset are not allowed.
- * All power generation equipment is limited to the lowest I_{sc}/I_L ratio for current distortion regardless of actual I_{sc} / I_L

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TABLE I-2: Current Distortion Limits for Systems Rated 69.001 kV –161 kV

I_{sc} / I_L	Individual Harmonic Order (Odd Harmonics)					TDD
	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	
< 20*	2.00	1.00	0.75	0.30	0.15	2.50
20 – 50	3.50	1.75	1.25	0.50	0.25	4.00
50 – 100	5.00	2.25	2.00	0.75	0.35	6.00
100 – 1000	6.00	2.75	2.50	1.00	0.50	7.50
> 1000	7.50	3.50	3.00	1.25	0.70	10.00

- Limits are a percent of Rated Load Current/ Rated Generator Current
- Individual even harmonics are limited to 25% of the odd harmonic limits above.
- Current distortions that result in a dc offset are not allowed.
- * All power generation equipment is limited to the lowest I_{sc}/I_L ratio for current distortion regardless of actual I_{sc} / I_L

TABLE I-3: Current Distortion Limits for Systems Rated Greater than 161 kV

I_{sc} / I_L	Individual Harmonic Order (Odd Harmonics)					TDD
	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	
$\leq 25^*$	1.0	0.5	0.38	0.15	0.1	1.5
$25 < 50$	2.00	1.00	0.75	0.30	0.15	2.5
≥ 50	3.00	1.50	1.15	0.45	0.22	3.75

- Limits are a percent of Rated Load Current/ Rated Generator Current
- Individual even harmonics are limited to 25% of the odd harmonic limits above.
- Current distortions that result in a dc offset are not allowed.
- * All power generation equipment is limited to the lowest I_{sc}/I_L ratio for current distortion regardless of actual I_{sc} / I_L

Tables I-1, I-2, I-3 are applicable to six-pulse rectifiers and general distortion situations. When phase shift transformers or converters with pulse numbers (q) higher than six are used, the limits for the characteristic harmonic orders are increased by a factor equal to $\sqrt{\frac{q}{6}}$. In order for the limits to be increased by the factor, a significant portion of the facility load would need to be comprised of the higher pulse order equipment. The Owner reserves the right to make that determination.

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TABLE I-4: Harmonic Voltage Distortion Limits

Bus Voltage at PCC	Individual Harmonic Voltage Distortion (%)	Total Voltage Distortion THD (%)
≤ 1 kV	5.0	8.0
1.001 kV through 69 kV	3.0	5.0
69.001 kV through 161kV	1.5	2.5
161.001 kV and above	1.0	1.5
<ul style="list-style-type: none"> • Limits are a percent of nominal fundamental frequency voltage line-to-neutral at the PCC. • High voltage systems (greater than 161kV) can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a User. 		

TABLE I-5: Distribution System Line Voltage Notch Limits

	Special Applications	General System	Dedicated System
Notch Depth	10%	20%	50%
THD (Voltage)	3%	5%	10%
Notch Area (A_N)‡	16,400	22,800	36,500

NOTE -- The value of A_N for other than 480 V System should be multiplied by $V / 480$

*Special applications include hospitals and airports.

†A dedicated System is exclusively dedicated to the converter load.

‡In volt-microseconds at rated voltage and current.

Recommended Interharmonic Limits

Interharmonic current components whose frequencies are not integer multiples of 60 Hz shall be limited so as to not produce undesirable effects on the System and connected equipment. Limiting values and appropriate statistical indices will be developed on a case-by-case basis by the Owner considering the specifics of the System.

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Application of Harmonic Limits

The following stipulations apply regarding proper application of Tables I-1, I-2, and I-3:

- Daily 99th percentile very short time (3 sec) harmonic currents should be less than 2.0 times the values given in the tables.
- Weekly 99th percentile short time (10 min) harmonic currents should be less than 1.5 times the values given in the tables.
- Weekly 95th percentile short time (10 min) harmonic currents should be less than the values given in the tables.
- All values should be in percent of annual maximum demand current IL.
- The values refer to harmonic currents whose frequencies are integer multiples of 60 Hz.
- Interharmonic current components whose frequencies are not integer multiples of 60 Hz shall be limited so as to not produce undesirable effects on the power system and connected equipment. Limiting values and appropriate statistical indices will be developed on a case-by-case basis by the Owner considering the specifics of the supply system.

The following stipulations apply regarding Table I-4:

- Daily 99th percentile very short time (3 sec) harmonic values should be less than 1.5 times the values given in the table.
- Weekly 95th percentile short time (10 min) harmonic values should be less than the values given in the table.
- All values should be in percent of line-to-neutral 60 Hz voltage as measured at the PCC.
- The values refer to harmonic voltages whose frequencies are integer multiples of 60 Hz. Interharmonic voltage components whose frequencies are not integer multiples of 60 Hz shall be limited so as to not produce undesirable effects on the power system and connected equipment. Limiting values and appropriate statistical indices will be developed on a case-by-case basis by the Owner considering the specifics of the System.

Special requirements may be necessary between the User and the Owner to address abnormal configurations that may be possible due to either ESS contingency situations or unusual circumstances regarding the operation of a User's equipment.

Resonance

When shunt capacitors are used, resonant conditions can occur that may result in high levels of harmonic voltage and current distortion. This is primarily a concern only when the resonant condition is accompanied by a harmonic current of the same frequency. In some cases resonance can cause a PCC to no longer adhere to this Policy. This problem can manifest itself as a violation of either the current limits or voltage limits. Resonance conditions will need to be evaluated on a case-by-case basis by the Owner considering the specifics of the System.

II. Voltage Flicker

Introduction

It is the goal of the Southern Company to provide to all Users a power supply System that meets or exceeds electric utility standards. This Policy is based on IEEE Standard 1453-2015[2] .

General

This Policy establishes limits on the amount of Flicker that any one User can cause on the ESS. Sources of Flicker include:

- Motor operations (starting, jogging, extreme load variations)
- Shunt Capacitor or Harmonic Filter switching
- Processes involving an electrical arc
- Welding operations
- Others

The severity of Flicker caused by these sources can be evaluated in terms of limits identified as P_{st} , P_{lt} , and Maximum Voltage Deviation ($\Delta V/V$). In most cases, the System can supply a large number of Users without having adverse effects; however, in some situations special provisions may be necessary between a User and the Owner.

A P_{st95} value of 1.0 is defined as the Compatibility Level at which objectionable light Flicker can occur in a low voltage (LV) System. The Flicker Planning Levels described in Table II-1 establish System design levels of allowable Voltage Flicker created by the combination of all fluctuating loads that will still ensure compatibility with LV Systems. The Flicker Planning Levels of Table II-1 represent the cumulative effect of all Users served by the ESS, and are not to be interpreted as Flicker Emission Limits for any individual User.

Considerable effort should be spent, and a Study conducted, if appropriate, in the planning and design phase of User and Owner facilities, and during the equipment installation phase, to reduce overall impact to the System. In any event, many unique problems can arise after the facility and equipment are in operation. Therefore, the Owner may periodically verify ongoing adherence through the use of field measurements taken at the Point of Common Coupling or other suitable location as specified by the Owner. Customer installations must satisfy the Flicker emission limits agreed to by the Owner and the User.

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Table II-1: System Design Flicker Planning Level

Flicker Quantity	Flicker Planning Level (P_{st99})	
	≤ 35 kV	> 35 kV
Pst	0.9	0.8
Plt	0.7	0.6

When Flicker is created by a rapid change in voltage (e.g. single motor starting or capacitor switching), it is more appropriate to use Maximum Voltage Deviation as opposed to P_{st} to determine Flicker severity. The System Design Flicker Planning Level for loads that create rapid voltage changes are provided in Table II-2.

Table II-2: System Design Flicker Planning Level for Rapid Voltage Changes

Number of Changes N	$\Delta V/V$ %	
	≤ 35 kV	> 35 kV
$n \leq 4$ per day	5-6	3-5
$n \leq 2$ per hour and > 4 per day	4	3
$2 < n \leq 10$ per hour	3	2.5

When the number of voltage changes falls outside the ranges specified in Table II-2 (e.g. more than 10 motors starting within an hour), it is more appropriate to use P_{st} to determine Flicker severity.

The amount of Flicker emitted by an individual User must be limited so that the combined Flicker emission of all Users does not exceed the Flicker planning level. The Flicker emission limits provided in Table II-3 apply to all Users unless specified otherwise in writing by the Owner. The Owner will determine whether these limits may be exceeded under special circumstances, so long as no other User is adversely impacted. IEEE Std. 1453-2015[2] will be used to establish individual Flicker emission limits.

Table II-3: Voltage Flicker Emission Limit

Flicker Quantity	Operational Flicker Limit (Based on 99th percentile)		
	$V \leq 1$ kV	1 kV $< V \leq 35$ kV	$V > 35$ kV
Pst	0.6	0.4	0.35
Plt	0.5	0.3	0.25

The Flicker planning levels provided in Table II-2 can be used as Flicker emission limits for processes that create rapid changes in the supply voltage.

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Measurement

Unless specified otherwise by the Owner, measurements to evaluate adherence with this Policy will be performed at the PCC using an IEEE Std. 1453 compliant flickermeter. If it is not practical to obtain measurements at the PCC, they may be taken at the closest available location. The corresponding Flicker emission at the PCC will then be calculated from those measurements. The monitoring period will be of sufficient duration to characterize the variable nature of the User's load profile. For Flicker evaluations this will generally be a period of at least one week.

III. Voltage Imbalance

Introduction

Voltage imbalance can cause excessive stator currents in polyphase induction machines. These excessive currents can potentially cause motor performance degradation and permanent damage. This Policy references ANSI C84.1-2011[1] and ANSI/NEMA MG 1 - 2011[6]

General

The limit described in this Policy establishes a System limit for Voltage Imbalance before it is of sufficient level to cause problems with polyphase induction machines. Considerable effort should be spent, and a Study conducted, if appropriate, in the planning and design phase of service to an individual User with imbalanced loads to reduce the amount of phase Voltage Imbalance.

The design and operation of the ESS are such that the maximum Voltage Imbalance is 3%, as recommended by ANSI C84.1 [1]. The imbalanced loads of any single User should not cause the phase voltages to differ by more than 1%. The Owner may verify adherence through the use of field measurements taken at the PCC or equivalent location as determined by the Owner.

Measurement

Unless specified otherwise by the Owner, measurements to evaluate adherence with this Policy will be performed at the PCC. If measurements are not practical at the PCC, they may be taken at the closest available location and Voltage Imbalance values at the PCC will be calculated from those measurements. The monitoring period will be of sufficient duration to characterize the variable nature of the User's load profile.

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The preferred measurement method is the ratio of negative sequence voltage to positive sequence voltage. An alternate method that may be used is the maximum deviation from the average phase Steady State Voltage (line-to-line), expressed as a percentage of average phase Steady State Voltage. Circumstances may require alternate metering and analytical methods to properly capture the imbalance.

IV. Adherence and Enforcement

Adherence

The Owner is responsible for evaluating adherence with this Policy as it applies to Users served from its ESS. A User that is not adhering with this Policy will potentially create service issues for the User, other Users, and/or the ESS. These service issues include, but are not limited to: equipment damage, process disruption, communication issues, excessive voltage distortion on the ESS, or service complaints from other Users.

As discussed in the applicable section of this Policy, the evaluation of a User's adherence with this Policy will be performed, as deemed appropriate, by the Owner. For planned facilities, or planned modifications to existing facilities or operations, the Study will model the interaction of the anticipated operations with the System. For existing User facilities and operations, measured data, taken at the User's PCC or other suitable location, will be the basis for determining adherence with the Policy. The data collected will be over time periods deemed necessary to characterize the impact of the load on the ESS.

Probationary Period

If Study results (whether for planned facilities or actual operations) produce inconclusive results regarding the need for mitigation equipment or mitigation measures, the User may be allowed a probationary period at the Owner's sole discretion. The probationary period is not to exceed a period of time as determined by the Owner, during which field measurements can be made to evaluate adherence or during which alternate mitigation methods can be evaluated. If the probationary results show that the User is not adhering to this Policy, the Owner may proceed as provided below in *Enforcement*.

Enforcement

If Study results for planned facilities indicate that the potential User will not be in adherence with this Policy, the User will be required to engineer, design, and install necessary mitigation equipment, at the User's expense, prior to interconnecting to the ESS.

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If Study results, or results of probationary operations, indicate that an existing User is not adhering with this Policy, the Owner will notify the User in writing. The Owner will specify a reasonable date for Policy adherence, which may be based on the severity and impact to other Users and/or the ESS or on availability of necessary mitigation equipment. The Owner may require temporary corrections or mitigation efforts, until permanent corrections can be made to achieve Policy adherence. Temporary mitigation could be a reduction in operating levels, eliminating the operation of certain equipment, or discontinuation of service consistent with policies of the appropriate state or federal regulatory agencies.

If a User does not achieve adherence with a permanent solution within a reasonable period of time as determined by the Owner, the Owner will determine and may implement necessary mitigation corrections including, but not limited to, discontinuation of service consistent with policies of appropriate state or federal regulatory agencies. If the User refuses to make appropriate corrections or mitigation efforts and the Owner must install equipment to mitigate the User's Disturbing Load, the User will be responsible for reimbursing the Owner.

V. References

1. **ANSI C84.1-2011:** *American National Standard for Electric Power Systems and Equipment Voltage Ratings (60Hz)* (Current edition)
2. **IEEE 1453:** *IEEE 1453 (2015) – IEEE Recommended Practice – Adoption of IEC 61000-4-15:2010, Electromagnetic compatibility (EMC) – Testing and measurement techniques – flickermeter – Functional and design specifications*
3. **IEEE 1453.1:** *IEEE 1453.1 (2012) – IEEE Guide – Adoption of IEC/TR 61000-3-7:2008, Electromagnetic compatibility EMC) – Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems***IEEE-519:** *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.* (2014 Edition)
4. **IEC 61000-4-7** - Edition 2.1 2009-10 - Electromagnetic compatibility (EMC) –Part 4-7: Testing and measurement techniques – General guide on Harmonics and Interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
5. **IEC 61000-4-30** – 2008 - Electromagnetic compatibility (EMC) - Part 4-30: Testing and measurement techniques - Power quality measurement methods
6. **ANSI/NEMA MG 1 -2011** American National Standard Motors and Generators