

NODAK ELECTRIC COOPERATIVE, INC.
Grand Forks, North Dakota

Policy Bulletin No. **414**

**POWER QUALITY CRITERIA FOR LARGE LOADS
(SUCH AS MOTORS)**

This policy is primarily intended to provide guidelines for allowable voltage flicker and voltage sag on the Nodak system during motor starting situations. These guidelines will also be applied to evaluation of voltage disturbances due to other load issues. The customer causing objectionable power quality issues is physically and financially responsible for correcting the problem being created.

Voltage Flicker:

Starting motors under high loads can cause voltage drop, which is often evidenced by flickering lights. Such voltage drop associated with motors is called voltage flicker. This flicker is objectionable only when the magnitude and frequency of occurrence of the voltage drop exceed certain thresholds. If the magnitude of the voltage drop and the frequency of occurrence lie below the threshold of perception, people generally do not notice any flicker.

In view of the adverse effects of high motor starting amperages, common to large motors, all motors that will be started from a single-phase source and are 15 h.p. or larger, and all three-phase motors that will be started from a three-phase source and are 45 hp or larger must follow the guidelines as stated below. In certain cases, special permission may be given by the cooperative permitting a larger motor; however, if the starting characteristics of the motor results in an adverse effect on the distribution system, it will be the member's responsibility to take corrective action.

IEEE Standard 141-1993 Voltage Flicker Curve

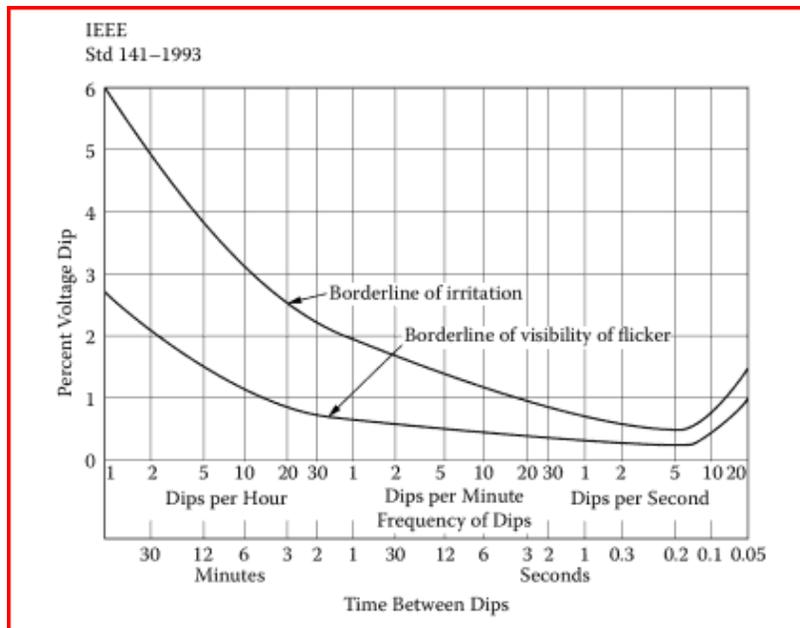


Table 1 below was developed from the IEEE Standard 141-1993. It lists the reasonable levels below which voltage flicker should not be objectionable. Reasonable limits for other starting frequencies can be interpolated from the table or derived from the IEEE Standard 141-1993 flicker curve graph.

Table 1. Voltage Flicker Limits

Motor Starting Frequency	Maximum Voltage Drop Limit on Nodak Distribution System	Maximum Voltage Drop Limit At Member's Connection to Nodak Facilities	Maximum Voltage Drop Limit At Member's Utilization Locations *
1 per Hour or greater	3.0 %	4.0 %	6.0 %
5 per Hour	1.7 %	2.5 %	3.5 %
20 per Hour	1.0 %	1.5 %	2.5 %

* This level is only shown for reference; specific limit is dependent on equipment design.

Voltage Sag:

Voltage sag is a short-term decrease in voltage beyond just a flicker that lasts anywhere from milliseconds up to a few seconds. The most common cause of voltage sags is the starting current drawn when a motor starts. Nodak uses the Information Technology Industry Voltage Tolerance Envelope, known as the ITI CBEMA curve, as a guideline to evaluate effects of voltage sags. In general, the ITI CBEMA curve states that equipment should tolerate voltage sags to 80% of the nominal service voltage for up to ten seconds and to 90% continuously according to the voltage tolerance limits. Most motors should be up to speed within the ten second timeframe. If starting times exceed ten seconds, voltage sags need to be limited to 90% of the nominal service voltage.

ITI (CBEMA) Curve
(Revised 2000)

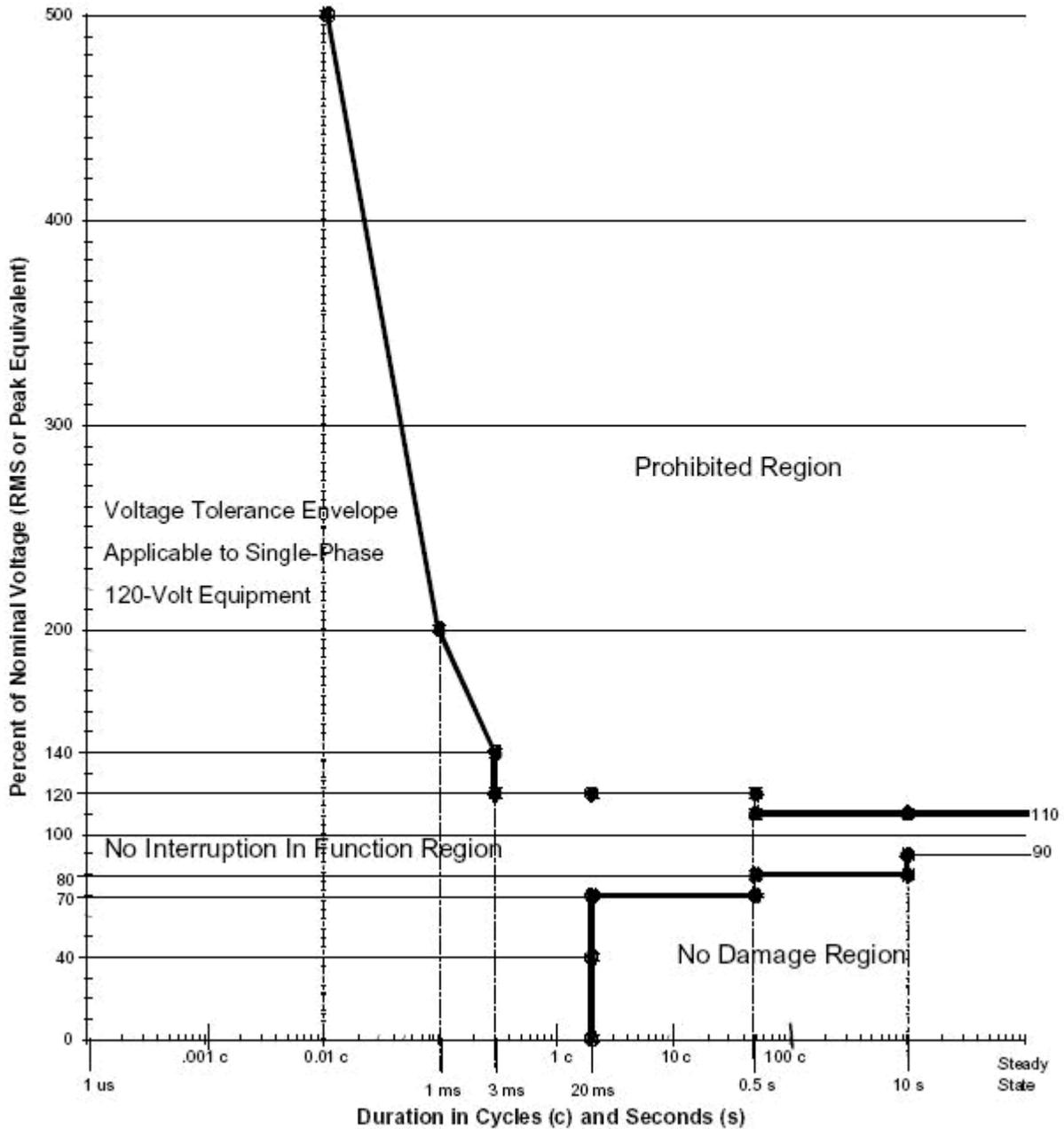


Table 2 below shows the typical maximum starting current limitations and has been developed to provide members with guidance regarding the amount of starting current draw permissible for motors that can be started without exceeding voltage flicker and sag limitations on the Nodak distribution system. Starting currents may need to be further constrained due to effects on the secondary side of the transformer, if there are other members served from the same transformer.

Table 2. Maximum Starting Current Limits

Single-Phase 240 volt:	260 Amps
Three-Phase 208 volt:	500 Amps
Three-Phase 240 volt:	450 Amps
Three-Phase 480 volt:	225 Amps
Notes:	
1. Starting currents may need to be further limited if they cause adverse effects for other members, or if starting frequency exceeds four starts per hour.	
2. The starting current limitations are applied to the sum of motor starting currents if multiple motors are started simultaneously.	

Motor starting current is considered to be the same as the locked-rotor current when started at full voltage. Motors with higher locked-rotor currents than shown may be operated if used in conjunction with a device designed to limit starting currents to the specified values. Such devices include reduced voltage, autotransformer, and wye-delta starters, as well as variable speed frequency drives. In any case, a member causing service interference to others will be responsible for the costs of any corrective actions.

Electrical harmonic disturbances can create a very negative effect on electrical equipment. If discovered to be present, they are generally created from the customer's equipment. Variable frequency drives are known to be a significant potential cause of harmonics. All electrical equipment connected to the Nodak Electric distribution system shall be designed to follow the current IEEE Standard 519 and future revisions to such standards as they relate to harmonic distortion.