OHIO VALLEY ELECTRIC CORPORATION

Requirements for Connection of Generation Facilities

to the OVEC Transmission System

2001

Revised: June 2009

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1. INTRODUCTION

This document outlines the minimum requirements for all generation facilities connecting to the OVEC Transmission System, or to transmission owned by others connected to and operated within the OVEC Balancing Area. This document is used in developing Interconnection and Operation Agreements (IA). The processes and procedures for generation facility interconnection requests are available from OVEC and follow the procedures described in OVEC's Open Access Transmission Tariff (OATT).

1.1. Background

In the present electric utility environment characterized by deregulation, open access to the transmission network, wholesale and retail competition, etc., there is wide recognition that electric system reliability, safety and quality of service are to be maintained. Maintaining reliability, safety and quality of service in this changing environment creates additional challenges in the planning and operation of electric systems.

As a result of this new environment, there are an increasing number of requests to connect to and use the OVEC Transmission System. Each request is studied to identify the facility impacts and necessary system improvements on the OVEC Transmission System necessitated by the new generation facility addition. These studies ensure that comparable treatment is given to all users, and that reliability, safety, and quality of service are maintained.

1.2. Scope

This document informs entities seeking facility connections to the OVEC Transmission System of the transmission connection requirements. The requirements are applicable to all facilities connecting to the OVEC Transmission System. The scope of this document satisfies the NERC Planning Standards by identifying requirements for connections to the bulk transmission system at voltages generally 100 kV and above. The scope of these documents is limited to the technical requirements for connected facility design and operation. **Generation Facility Owners** interested in the terms of transmission service should refer to the OVEC Open Access Transmission Tariff.

1.3. Objectives

OVEC, in its role as a transmission provider, has prepared this document based on the following objectives:

a) Provide information to entities requesting generation facility interconnection with the OVEC Transmission System. This document describes technical requirements to maintain system reliability, personnel and equipment safety, and

quality of service as new generating facilities are added to the transmission network and existing generating facilities are modified.

b) Satisfy compliance with NERC Standards pertaining to documentation of facility connection requirements by those entities responsible for system reliability.

c) Facilitate uniform and compatible equipment specification, design, engineering, and installation practices to promote safety and uniformity of service.

2. PROCEDURES FOR COORDINATED JOINT STUDIES

Procedures for coordinated joint studies of new facilities and their impacts on the interconnected transmission system shall include:

2.1. Coordination with Affected Systems

OVEC will coordinate the conduct of any studies required to determine the impact of the Interconnection Request on Affected Systems with Affected System Operators and, if possible, include those results (if available) in its applicable Interconnection Study. OVEC will offer to include such Affected System Operators in all meetings held with Interconnection Customer. Interconnection Customer will cooperate with OVEC in all matters related to the conduct of studies and the determination of modifications to Affected Systems. A Transmission Provider which may be an Affected System shall cooperate with OVEC in all matters related to the conduct of studies and the determination of modifications to Affected Systems.

2.2. System Impact and Facilities Studies

The process and procedures for requesting a "Notification of Intent to Install and Operate Generation Interconnected with the OVEC Transmission System", System Impact Study or a Facilities Study and the time-line for these studies are available from OVEC.

The results of these studies will be shared with adjacent entities including Control Areas and Regional Transmission Organization. AEP will provide base case study data to these organizations in order to allow them to conduct studies to determine if the contemplated facilities have an adverse impact on neighboring system. If these studies indicated a problem, OVEC shall notify the requesting entity and provide contact information to enable the parties to come to a resolution.

2.3. Additional Analyses

As may be required by FERC Form 715 or by the amended OVEC OATT Filing, other analyses may be required as part of system impact studies depending on the nature of the proposed generating facility and its location within the transmission network. Power quality analyses are undertaken for all generation facilities that could potentially cause harmonic current or voltage, voltage flicker, and/or

telephone interference. Criteria for harmonic interference, voltage flicker, and telephone interference are included in Appendices B and C.

OVEC must be notified of new facilities, upgrades, or additions such as an increase in load or additional generating capacity to existing facilities connected to the transmission system within the OVEC Control Area. System impact studies will be conducted to determine the need for any upgrades of transmission equipment or transmission reinforcements to the OVEC Transmission System to accommodate the changes in the connected facility.

3. PROCEDURES FOR NOTIFICATION OF NEW OR MODIFIED FACILITIES

OVEC will maintain on its OASIS a list of all Interconnection Requests. The list will identify, for each Interconnection Request: (i) the maximum summer and winter megawatt electrical output; (ii) the location by county and state; (iii) the station or transmission line or lines where the interconnection will be made; (iv) the projected In-Service Date; (v) the status of the Interconnection Request, including Queue Position; (vi) the type of Interconnection Service being requested; and (vii) the availability of any studies related to the Interconnection Request; (viii) the date of the Interconnection Request; (ix) the type of Generating Facility to be constructed (combined cycle, base load or combustion turbine and fuel type); and (x) for Interconnection Requests that have not resulted in a completed interconnection, an explanation as to why it was not completed. The list will not disclose the identity of Interconnection Customer until Interconnection Customer executes an Interconnection Agreement (IA) or requests that OVEC file an unexecuted IA with FERC. Before holding a Scoping Meeting with its Affiliate, OVEC shall post on OASIS an advance notice of its intent to do so. OVEC shall post to its OASIS site any deviations from the study timelines set forth herein. Interconnection Study reports and Optional Interconnection Study reports shall be posted to OVEC's OASIS site subsequent to the meeting between Interconnection Customer and OVEC to discuss the applicable study results. OVEC shall also post any known deviations in the Facility's In-Service Date.

4. VOLTAGE LEVEL AND MW AND MVAR CAPACITY AT POINT OF INTERCONNECTION

Generation facility connections to the OVEC transmission system are reviewed on a case-by-case basis. This review includes but is not limited to the size (MVA/MW & MVAR, type, location, impact of, and facilities required to integrate the proposed generation facility with the OVEC Transmission System. Since OVEC has only a 345kV transmission system, all interconnections will be at that voltage.

5. BREAKER DUTY AND SURGE PROTECTION

All **Generation Facility Owners** shall provide a three-phase circuit interrupting device with appropriate surge protection and relaying systems (as stated in Section 6.0) to isolate the generation facilities from the OVEC Transmission System for all faults, loss of interconnection

with the OVEC Transmission System, or abnormal operating conditions regardless of whether or not the **Owner's** generation facility is in operation. This device shall be capable of interrupting the maximum available fault current at that location. The three-phase device shall interrupt all three phases simultaneously. The tripping control of the circuit-interrupting device shall be powered independently of the OVEC AC source in order to permit operation upon loss of the OVEC Transmission System connection. The specific reclosing times for the **Generation Facility Owner's** circuit interrupting device will be provided by OVEC. It is the **Generation Facility Owner's** responsibility to design and maintain their interrupting device(s) to properly isolate the generation facility upon loss of the OVEC connection until the appropriate OVEC facilities are returned to service.

6. SYSTEM PROTECTION AND COORDINATION

The **Generation Facility Owner** is responsible for providing adequate protection of OVEC facilities for conditions arising from the operation of the generation facility under all OVEC transmission system operating conditions. The **Owner** is also responsible for providing adequate protection of their own facilities under any OVEC transmission system operating condition whether or not their generation facility is in operation. Conditions may include but are not limited to:

1. single phasing of supply,
2. transmission system faults,
3. equipment failures,
4. abnormal voltage or frequency,
5. lightning and switching surges,
6. excessive harmonic voltages,
7. excessive negative sequence voltages,
8. separation from the OVEC Transmission System,
9. synchronizing generators,
10. resynchronizing the **Owner's** generation after electric restoration of the interconnection with the OVEC Transmission System.

The following utility-grade relays shall be provided by the **Generation Facility Owner** for protection of the OVEC Transmission System. All relays specified for the protection of the OVEC Transmission System, including time delay and auxiliary relays, shall be approved by OVEC. Relay operation for any of the listed functions shall initiate immediate separation of the **Generation Facility Owner's** generation facility from the OVEC Transmission System.

Relay	**Function**
Frequency	To detect underfrequency and overfrequency operation
Undervoltage	To detect undervoltage operation
Overvoltage	To detect overvoltage operation
Ground Detector	To detect a circuit ground on the OVEC Transmission System (applicable to three-phase circuits only)
Directional Overcurrent	To detect the directional flow of current in excess of a desired limit
Transfer Trip Receiver	To provide tripping logic to the generation facility for isolation of the generation facility upon opening of the OVEC supply circuits
Directional Power*	To detect, under all system conditions, a loss of OVEC primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation facility

**Additional relays may be required to provide adequate protection for the OVEC Transmission System.*

The purpose of these relays is to detect the **Generation Facility Owner's** energization of an OVEC circuit that has been disconnected from the OVEC Transmission System, to detect the generation facility operating at an abnormal voltage or frequency, or to detect a fault or abnormal condition on the OVEC Transmission System for which the **Generation Facility Owner** shall separate their generation.

Output contacts of these relays shall directly energize the trip coil(s) of the generator breaker or an intermediate auxiliary tripping relay, which directly energizes the breaker trip coil(s). The relaying system shall have a source of power independent from the ac system or immune to ac system loss or disturbances (e.g., dc battery and charger) to assure proper operation of the protection scheme. Loss of this source shall cause removal of the generation facility from the OVEC Transmission System. The protective relays required by OVEC and any auxiliary tripping relay associated with those relays shall be utility-grade devices.

Utility grade relays are defined as follows:

1. Meet ANSI/IEEE Standard C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus."

2. Have relay test facilities to allow testing without unwiring or disassembling the relay.

3. Have appropriate test plugs/switches for testing the operation of the relay.

4. Have targets to indicate relay operation.

OVEC will specify settings for the OVEC-required relays at the generation facility to assure coordination between the generation facility protective equipment and the OVEC Transmission System relays. It is the **Generation Facility Owner's** responsibility to determine that their internal protective equipment coordinates with the required OVEC protective equipment and is adequate to meet all applicable standards to which the generation is subject. OVEC further reserves the right to modify relay settings when deemed necessary to avoid safety hazards to utility personnel or the public and to prevent any disturbance, impairment, or interference with OVEC's ability to serve other customers.

7. METERING AND TELECOMMUNICATIONS

The **Generation Facility Owner** shall be responsible for the installation and operating costs of the metering equipment at the delivery point. The metering equipment will include potential and current transformers, meters and test switches. The accuracy of the instrument transformers and meters will be 0.3 percent or better. The secondary wiring and burdens of the instrument transformers will be configured so that they do not degrade the accuracy of the metering equipment to less than 0.3 percent. The metering equipment will be tested periodically as defined in the Interconnection and Operation Agreement and the test results will be available to all involved parties. The meters, test switches and wiring termination equipment will be sealed and the seal may be broken only when the meters are to be tested, adjusted or repaired. Proper authorities in both parties will be notified when seals are broken.

At least (N-1) metering elements will be used to measure all real and reactive power crossing the metering point, where N is the number of wires in service including the ground wire. Bi-directional energy flows including watt-hour and var-hour will be separately measured on an hourly basis. Depending on the tariffs to be applied, appropriate demand quantities will be metered in terms of kilowatts, kilovars or kilovolt-amperes. The meters will have a separate register for loss compensation. If required, voltage measurements will be provided.

If, at the discretion of OVEC, the generation facility necessitates real-time telemetry to the OVEC System Operations Center, the **Generation Facility Owner** shall install and operate at their expense the communication channel, the OVEC approved telemetry equipment and associated devices.

At the discretion of OVEC, generation control facilities and supervisory control and data acquisition of specific electrical devices from the OVEC System Operations Center may be necessary to integrate the generation facility into OVEC's Balancing Area. Such additional facilities, including required communication channels with appropriate isolation and protection, shall, if required, be furnished and installed at the **Generation Facility Owner's** expense. The requirement for data acquisition and control will depend on the generation facility capacity, system location and voltage, and the net generation output to OVEC Transmission System.

Suitable telemetry equipment will be installed at the metering point to provide real-time telemetry data to OVEC and to all other participating parties. Telemetry equipment will include transducers, remote terminal units, modems, telecommunication lines, and any other equipment of the same or better function. The remote terminal unit, or equivalent device, must have multiple communication ports to allow simultaneous communications with all participating parties. That device will accommodate data communication requirements specified by each participating parties' control center, including communication protocol, rate and mode (either synchronous or asynchronous). All metered values provided to the telemetry equipment will originate from common metering equipment. All transducers used for telemetry will have at least 0.2 percent accuracy. As part of real-time data to be provided, OVEC has the right to require the status and remote control of switching devices at the Receipt and/or Delivery Points.

A continuous, accumulating record of megawatt-hours and megavar-hours will be provided by means of the registers on the meter. Freezing accumulation data for transmission will be taken every clock hour. The freezing signals synchronized to within 2 seconds of Universal Coordinated Time must be provided by only one of the agreed-upon participating parties. If the freeze signal is not received within a predefined time window, the remote terminal unit, or equivalent device, will be capable of freezing data with its own internal clock.

The metering, if external power supply is required, and telemetry equipment will be powered from a reliable power source, such as a station control battery, in order to allow the equipment to be continuously operational under any power outage situations. Proper surge protection and isolation will be provided for each communication link to protect communication hardware from ground-potential-rise due to any fault conditions. A separate communication media shall be provided to allow OVEC to remotely retrieve billing quantities from the meters. When real-time telemetry is required, a back-up data link must be provided in case of the outage of the primary telemetry line. The back-up link can be a data communication link between involved control centers; the party requesting service is responsible for furnishing the back-up link.

Data acquisition and control information will typically include, but not be limited to:

1. desired generation MW set point,
2. automatic generation control status (on, off),
3. generator availability,
4. individual generator MW, MVA output,
5. generator minimum and base MW capability,
6. generator MW AGC high limit and low limit,
7. connection facilities' breaker status/control/alarms,
8. connection facilities' MW and MVAr line values and bus voltage, and
9. generator and substation metering (MWh) data.

8. GROUNDING AND SAFETY

The grounding of the **Generation Facility Owner's** system at the transmission voltage level will be considered on a case-by-case basis. For safety the **Generation Facility Owner** may be required to establish a dedicated voice communication circuit to the OVEC System Operations Center to permit coordination of the synchronization and operation of the generation facility. A three phase air break switch or a three-pole single-throw disconnect switch shall be installed on each transmission line supply entrance to the **Owner's** facility and must be accessible by OVEC personnel at all times. The disconnecting device shall be mechanically lockable in the open position with an OVEC padlock in order to provide for a visible electric isolation of the **Owner's** facility and shall be identified with an OVEC designated equipment number.

9. INUSLATION AND INSULATION COORDINATION

Equipment installed by the **Generation Facility Owner** shall be of the appropriated insulation level consistent with interconnection at the 345kV level at which the OVEC Transmission System is operated.

10. VOLTAGE, REACTIVE POWER, AND POWER FACTOR CONTROL

Specification of the generator voltage schedule will be determined by OVEC. The **Generation Facility Owner** will install, operate, and maintain an automatic voltage regulator to the extent possible to maintain the assigned voltage schedule. A steady-state deviation from this schedule between +0.5% to –0.5% of the nominal voltage will be permissible. Nominal OVEC Transmission System voltage is 345 kV.

In certain unusual situations where a voltage schedule is inappropriate, OVEC may substitute adherence to a specified voltage schedule with a specified power factor or reactive output schedule. A steady state deviation from this power factor or reactive output schedule of +2% to –2% will be permissible.

The generation facility must be capable of continuous non-interrupted operation during normal system conditions at the scheduled voltage. The generation facility should also be capable of continuous non-interrupted operation during abnormal conditions when steady state voltages could range between 95% to 105% of nominal. OVEC Transmission System nominal voltages are as indicated in Section 4.2 above. During emergency and/or transient system conditions, as voltage may temporarily be outside this range, all reasonable measures should be taken to avoid tripping of the generation facility due to high or low voltage.

The generation facility must be capable of continuous, non-interrupted operation in the frequency range of 59.5 to 60.5 Hz. Limited time, non-interrupted operation is also expected outside this frequency range in accordance with the generator manufacturer's recommendation.

The net demonstrated real and reactive capability shall be periodically demonstrated in accordance Regional and NERC Planning Standards. In addition, individual generators in the generating facility must be capable of providing the steady-state over- and under-excited reactive capability given by the manufacturer's generator capability curve at any MW dispatch level. Documentation of the results of these tests shall be provided to OVEC. OVEC reserves the right to witness these tests.

11. POWER QUALITY IMPACTS

All three-phase generation shall produce balanced 60 Hz voltages. Voltage unbalance attributable to the **Generation Facility Owner** combined generation and load shall not exceed 1.0% measured at the point-of-service. Voltage unbalance is defined as the maximum phase deviation from average as specified in ANSI C84.1, "American National Standard for Electric Power Systems and Equipment – Voltage Ratings, 60 Hertz."

Phase current unbalance attributable to the **Generation Facility Owner** combined generation and load shall not exceed that which would exist with balanced equipment in service, measured at the point-of-common coupling.

The **Generation Facility Owner** shall take responsibility for limiting harmonic voltage and current distortion and/or voltage flicker[4] caused by their generation equipment. Limits for harmonic distortion (including inductive telephone influence factors) are consistent with those published in the latest issues of ANSI/IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems." Specific AEP harmonics and flicker criteria, as adopted by OVEC, are given in Appendix B. This criteria requires that flicker occurring at the point of compliance shall remain below the Border Line of Visibility curve on the IEEE/GE curve for fluctuations less than 1 per second or greater than 10 per second. However, in the range of 1 to 10 fluctuations per second, voltage flicker shall remain below 0.4% (see Appendix B, Exhibit 1). Depending upon the nature of the generation facility and its location, OVEC may require the installation of a monitoring system to permit ongoing assessment of compliance with these criteria. The monitoring system, if required, will be installed at the **Generation Facility Owner's** expense.

12. EQUIPMENT RATINGS

The **Generation Facility Owner** is responsible for installing appropriate equipment and facilities so that the generation facility is compatible with the OVEC Transmission System. The **Owner** is also responsible for meeting any applicable federal, state, and local codes.

13. SYNCHRONIZING OF FACILITIES

The **Generation Facility Owner** shall assume all responsibility for properly synchronizing their generation facility for parallel operation with the OVEC Transmission System. Upon loss of the interconnection to the OVEC Transmission System, the **Generation Facility Owner** shall immediately and positively cause the generation facility to remain separated from

the OVEC Transmission System until such time the OVEC System Operations Center authorizes the restoration of the interconnection. Synchronizing of generation facility to the OVEC Transmission System may be, at OVEC's discretion, performed under the direction of the OVEC System Operations Center.

14. MAINTENANCE COORDINATION

The **Generation Facility Owner** shall permit testing and maintenance of devices and control schemes provided by the **Generation Facility Owner** for the protection of the OVEC Transmission System by an OVEC approved organization. Included in the testing and maintenance will be any initial set up, calibration, and check out of the required protective devices, periodic routine testing and maintenance, and any testing and maintenance required as the result of changes to protective devices by the **Generation Facility Owner** or OVEC.

All testing and maintenance performed by the OVEC approved organization shall be under the general surveillance of OVEC. This may include circuit breakers, circuit switchers, power fuses, instrument transformers, switches, surge arresters, bushings, relays, and associated equipment (including battery and battery charger). Maintenance procedures are detailed in the AEP "Guidelines for Transmission and Distribution Maintenance and Frequencies", as adopted by OVEC. Also, a copy of all test and maintenance reports shall be forwarded to OVEC.

If the **Generation Facility Owner's** testing and maintenance program is not performed to the satisfaction of OVEC or at the required maintenance interval, OVEC reserves the right to inspect, test, or maintain the protective devices required for the protection of the OVEC Transmission System. If the **Generation Facility Owner's** protective relaying is determined to be unsatisfactory, OVEC reserves the authority to disconnect the generation facility from the OVEC Transmission System.

All costs associated with the testing and maintenance of devices provided by the **Generation Facility Owner** for the protection of the OVEC Transmission System, including costs incurred by OVEC in performing any necessary tests or inspections, shall be the responsibility of the **Generation Facility Owner**.

15. OPERATIONAL ISSUES (Abnormal Frequency and Voltages)

The generation facility must be capable of continuous, non-interrupted operation in the frequency range of 59.5 to 60.5. Limited time, non-interrupted operation is also expected outside this frequency range in accordance with the generator manufacturer's recommendation.

16. INSPECTION REQUIREMENTS

Before a generation facility can be energized, it must pass a final inspection by OVEC personnel. OVEC will inspect all substation equipment from the point of interconnection to

the first protective fault interrupting device. This may include circuit breakers, circuit switchers, power fuses, instrument transformers, switches, surge arresters, bushings, and relays and associated equipment (including battery and battery chargers). The inspection will consist of a visual inspection of all major equipment as well as review of required test results.

17. COMMUNICATIONS AND PROCEDURES DURING NORMAL AND EMERGENCY OPERATING CONDITIONS

17.1. Normal

At OVEC's request, the **Generation Facility Owner** shall provide an appropriately protected and isolated dedicated voice communication circuit to the OVEC System Operations Center. Such a dedicated voice communication circuit would originate from the **Owner's** office staffed 24 hours a day and would be typically required for generation facility synchronization and operation within OVEC's Control Area.

All other normal voice communication concerning facility operations shall be conducted through the public telephone network to the OVEC System Operations Center phone number(s) issued by OVEC.

17.2. Emergency

Voice communications in the event of a transmission system or capacity emergency shall use the appropriately protected and isolated dedicated voice circuits, or public telephone network and phone number(s) designated for emergency use.

In the event of a transmission system or capacity emergency, the **Generation Facility Owner** may be notified by the OVEC System Operations Center. Specific instructions may also be given regarding the operation of the **Owner's** unit(s) depending on the nature of the emergency. These instructions may consist of voltage schedule changes, real and/or reactive dispatch changes, or instructions to shut down or start-up the **Owner's** unit(s). It is the **Owner's** responsibility to ensure that the unit operators follow all instructions given by the OVEC System Operations Center during system emergencies.

Version History

REVISION	DATE	REVISED/REVIEWED BY	PURPOSE
	1/31/2001	**RJM**	**Initial Document**
	10/22/2004	**RJM**	**Incorporate FERC Pro Forma**
	10/27/2008	**RJM**	**Include NERC Compliance Items**
	6/23/2009	**RJM**	**Clarify NERC Compliance Items**
	12/31/09	**RJM**	**Updated title page**

APPENDIX A

Generation Dynamic Performance Data

Customer Name _____ Date ___/___/___ Page 1/2

MW CAPABILITY AND PLANT CONFIGURATION

Winter and summer gross and net MW capability per generator and total plant.
Plant one-line diagram showing generators, generator step-up transformers, circuit breakers, main auxiliary transformers, and connection to transmission system.

GENERATOR DATA

UNIT RATINGS

kVA	_____	_____ °F	Voltage		_____
Power Factor		_____	H_2 psig		_____
Speed (RPM)		_____	Connection (e.g. Wye)		_____
Short Circuit Ratio		_____	Frequency, Hertz		_____
Stator Amperes at Rated kVA		_____	Field Volts		_____
Max Turbine MW	_____	_____ °F			

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H	=	_____	kW sec/kVA
Moment-of-Inertia, WR^2	=	_____	lb. $ft.^2$

REACTANCE DATA (PER UNIT-RATED KVA)	**DIRECT AXIS**		**QUADRATURE AXIS**	
Synchronous – saturated	Xdv	_____	Xqv	_____
Synchronous – unsaturated	Xdi	_____	Xqi	
Transient – saturated	X'dv	_____	X'qv	_____
Transient – unsaturated	X'di	_____	X'qi	_____
Subtransient – saturated	X"dv	_____	X"qv	_____
Subtransient – unsaturated	X"di	_____	X"qi	
Negative Sequence – saturated	X2v	_____		
Negative Sequence – unsaturated	X2i	_____		
Zero Sequence – saturated	X0v	_____		
Zero Sequence – unsaturated	X0i	_____		
Leakage Reactance	Xlm	_____		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'do	_____	T'qo	_____
Three-Phase Short Circuit Transient	T'd3	_____	T'q	_____
Line to Line Short Circuit Transient	T'd2	_____		
Line to Neutral Short Circuit Transient	T'd1	_____		
Short Circuit Subtransient	T"d	_____	T"q	_____
Open Circuit Subtransient	T"do	_____	T"qo	_____

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	Ta3	_____
Line to Line Short Circuit	Ta2	_____

Line to Neutral Short Circuit Ta1 _____

Customer Name _____ Date ___/___/___

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

Positive	R1	_____		
Negative	R2	_____		
Zero	R0	_____		
Rotor Short Time Thermal Capacity $I2^2t$	=	_____		
Field Current at Rated kVA, Armature Voltage and PF	=	_____	amps	
Field Current at Rated kVA and Armature Voltage, 0 PF	=	_____	amps	
Three Phase Armature Winding Capacitance	=	_____	microfarad	
Field Winding Resistance	=	_____	ohms	_____ °C
Armature Winding Resistance (Per Phase)	=	_____	ohms	_____ °C

CURVES

Saturation, Vee, Reactive Capability, Capacity Temperature Correction

GENERATOR STEP-UP TRANSFORMER DATA

RATINGS

Capacity Self-cooled/maximum nameplate _____/_____ kVA

Voltage Ratio Generator side/System side _____/_____ kV

Winding Connections Low V/High V (Delta or Wye) _____/_____

Fixed Taps Available _____

Present Tap Setting _____

IMPEDANCE

Positive Z1 (on self-cooled kVA rating) _____ % _____ X/R

Zero Z0 (on self-cooled kVA rating) _____ % _____ X/R

EXCITATION SYSTEM DATA

Identify appropriate IEEE model block diagram of excitation system and power system stabilizer (PSS) for computer representation in power system stability simulations and the corresponding excitation system and PSS constants for use in the model.

GOVERNOR SYSTEM DATA

Identify appropriate IEEE model block diagram of governor system for computer representation in power system stability simulations and the corresponding governor system constants for use in the model.

APPENDIX B

AEP Voltage Flicker Criteria and Harmonic Distortion Criteria

AEP Voltage Flicker Criteria and Harmonic Distortion Criteria

This document summarizes AEP's policy, as adopted by OVEC, on voltage flicker and harmonic distortion for customers connected to the electrical system via a Company dedicated transformer or a Customer owned transformer. The term Company is defined as Ohio Valley Electric Corporation (OVEC). The term Customer is defined as the party connected to the OVEC Transmission System.

I. POINT OF COMPLIANCE – The point where the Company dedicated transformer or Customer owned transformer connects to the Company system will be the point where compliance with the voltage flicker and harmonic distortion requirements are evaluated.

II. VOLTAGE FLICKER CRITERIA – The Company requires that the voltage flicker occurring at the point of compliance shall remain below the Border Line of Visibility curve on the IEEE/GE curve for fluctuations less than 1 per second or greater than 10 per second (see Exhibit 1). In the range of 1 to 10 fluctuations per second, the voltage flicker shall remain below 0.4%.

The Customer agrees that under no circumstances will it permit the voltage flicker to exceed the Company criteria, whether or not complaints are received or service/operational problems are experienced on the Company subtransmission or transmission system. Should complaints be received by the Company or other operating problems arise, or should the Customer flicker exceed the borderline of visibility curve, the Customer agrees to take immediate action to reduce its flicker to a level at which flicker complaints and service/operational problems are eliminated.

Corrective measures could include, but are not limited to, modifying production methods/ materials or installing, at the Customer's expense, voltage flicker mitigation equipment such as a static var compensator. The Company will work collaboratively with the Customer to assess problems, identify solutions and implement mutually agreed to corrective measures.

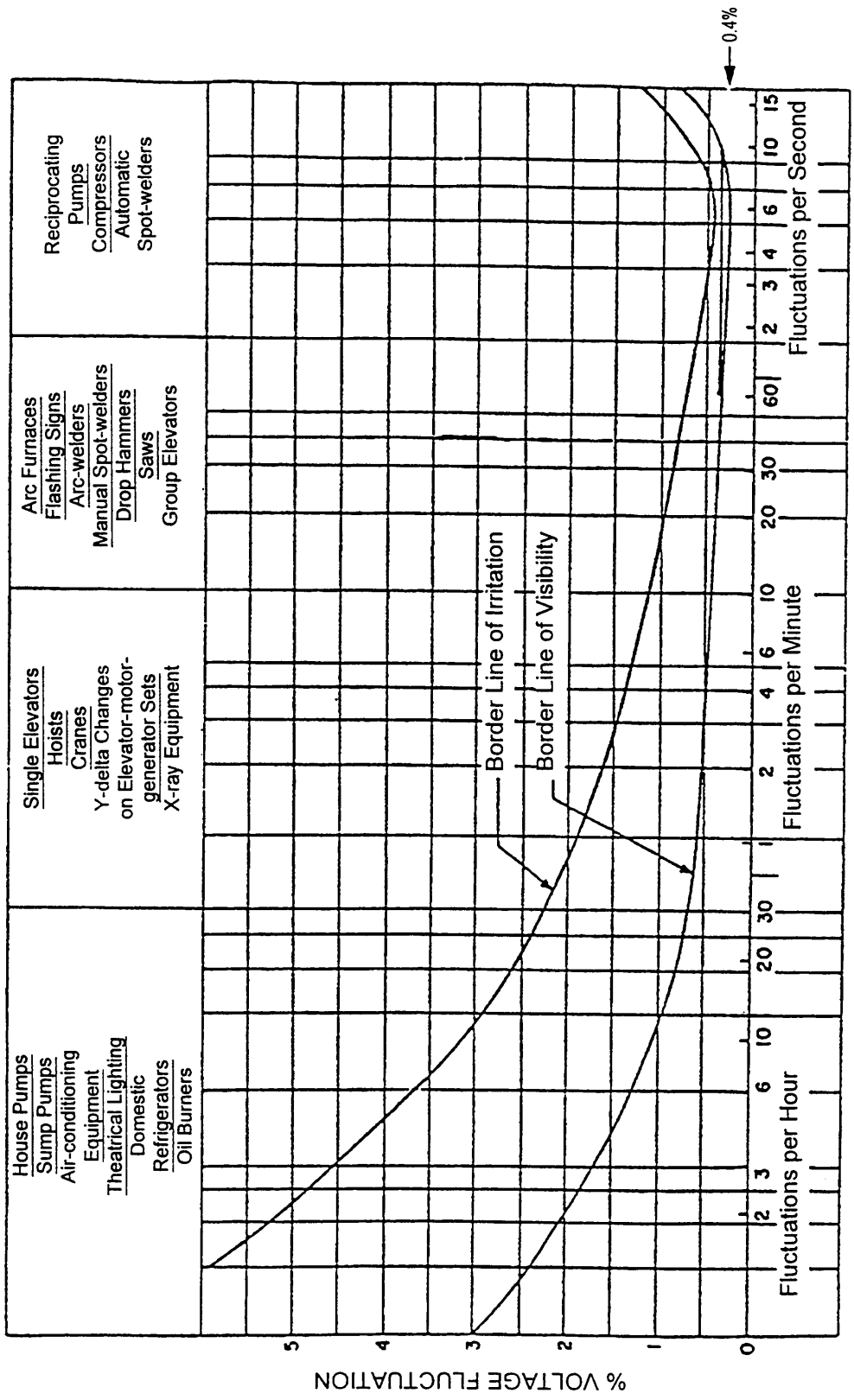
If the Customer fails to take corrective action after notice by the Company, the Company shall have such rights as currently provided for under its tariffs, which may include discontinuing service, until such time as the problem is corrected.

III. HARMONIC DISTORTION CRITERIA - The Company also requires that the Customer's operation be in compliance with the Company's Harmonic Distortion Guidelines (see Exhibit 2). These requirements are based on IEEE Standard 519, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems".

The Customer agrees that the operation of motors, appliances, devices or apparatus served by its system and resulting in harmonic distortions in excess of the Company's Requirements will be the Customer's responsibility to take immediate action, at the Customer's expense, to comply with the Company's Harmonic Distortion Requirements. The Company will work collaboratively with the Customer to assess problems, identify solutions and implement mutually agreed to corrective measures.

If the Customer fails to take corrective action after notice by the Company, the Company shall have such rights as currently provided for under its tariffs, which may include discontinuing service, until such time as the problem is corrected.

Exhibit 1



Composite curve of voltage flicker studies by General Electric Company, *General Electric Review*, August 1925; Kansas City Power & Light Company, *Electrical World*, May 19, 1934; T&D Committee, EEI, October 24, 1934, Chicago; Detroit Edison Company; West Pennsylvania Power Company; Public Service Company of Northern Illinois.

Relations of Voltage Fluctuations to Frequency of Their Occurrence (Incandescent Lamps)

Exhibit 2

AEP HARMONIC DISTORTION REQUIREMENTS

The AEP Harmonic Distortion Requirements shown below are based on the information presented in the IEEE Standard 519, approved in 1992 and titled, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems." The voltage limits are intended to be used to gauge the acceptability of harmonic magnitudes on the transmission systems, while the current limits are applicable to individual customers injecting harmonic currents at the point of common coupling (PCC).

HARMONIC VOLTAGE DISTORTION (THD_V) LIMITS

Bus Voltage at PCC	Individual Harmonic Voltage Distortion (%)	Total Voltage Distortion THD_V (%)
≤ 69 kV	3.0	5.0
69 kV < v ≤ 161 kV	1.5	2.5
Above 161 kV	1.0	1.5

HARMONIC CURRENT DEMAND DISTORTION (TDD) LIMITS

MAXIMUM HARMONIC CURRENT DISTORTION IN % OF BASE QUANTITY Harmonic Order (Odd Harmonics)						
v ≤ 69 kV						
I_{SC}/I_L	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20	4.0	2.0	1.5	0.5	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
69 kV < v ≤ 161 kV						
<20*	2.0	1.0	0.75	0.3	0.15	2.5
20-50	3.5	1.75	1.25	0.5	0.25	4.0
50-100	5.0	2.25	2.0	0.75	0.35	6.0
100-1000	6.0	2.75	2.5	1.0	0.5	7.5
>1000	7.5	3.5	3.0	1.25	0.7	10.0
161 kV < v						
<50	2.0	1.0	0.75	0.3	0.15	2.5
≥50	3.0	1.5	1.15	0.45	0.22	3.75

Where I_{SC} = Maximum short circuit at PCC
I_L = Load current at the time of the maximum metered amount

*All power generation equipment is limited to these values of current distortion, regardless of actual I_{SC}/I_L.

Even harmonics are limited to 25% of the odd harmonic limits above.

RDR2-12.LWP

EXHIBIT 3

Definitions

- **Harmonic Voltage Distortion** is to be normalized to the nominal system voltage and calculated using Equation 1.

TOTAL VOLTAGE HARMONIC DISTORTION (THD_V) in percent:

$$THD_V = \frac{\sqrt{\sum_{n=2}^{\infty} V_n^2}}{V_s} \times 100\% \qquad (Eq.1)$$

Where:

V_n = Magnitude of Individual Harmonics (RMS)
V_s = Nominal System Voltage (RMS)
n = Number of Harmonic Order

- **Harmonic Current Distortion** is to be normalized to the customer's load current at the time of the maximum metered demand which occurred over the preceding twelve months for existing customers and the customer's anticipated peak demand for new customers. For existing customers who are increasing their load, the projected demand should be used. The harmonic current demand distortion (TDD) should be calculated using Equation 2.

TOTAL CURRENT DEMAND DISTORTION (TDD) in percent:

$$TDD = \frac{\sqrt{\sum_{n=2}^{\infty} I_n^2}}{I_L} \times 100\% \qquad (Eq.2)$$

Where:

I_n = magnitude of Individual Harmonic (RMS)
I_L = Load Current at the Time of the Maximum Metered Demand
n = Harmonic Order

- **PCC - Point of Common Coupling.** The location where the customer accepts delivery of electrical energy from the utility.

Field Measurements

To gauge the acceptability of field measured harmonic distortion, a statistical evaluation of the data is to be performed. Measurements should be taken at five minute intervals or less over a minimum of 24 hours. For the measured data to be considered acceptable, two criteria must be met: 1) 95% of the measured data must fall below the limits stated; 2) no measured data shall exceed the limits specified by more than 50% of the absolute upper limit value.

Communication Interference Limits (I*T)

EXHIBIT 4

As stated in IEEE Standard 519, it is difficult to place specific limits on the telephone influence which the harmonic components of current and voltage can inflict. Hence, IEEE Standard 519 outlines a range of values where problems could occur (refer to the table below). The actual interference to voice communication systems in proximity to the power system is dependent upon a number of factors not under the control of the utility or customer. These factors will vary from location to location and from time to time as the state-of-the-art of inductive coordination progresses.

IEEE Standard 519 - Balanced I*T Guidelines		
Category	Description	I*T
I	Levels most unlikely to cause interference	<10,000
II	Levels that might cause interference	10,000 to 25,000
III	Levels that probably will cause interference	> 50,000

The limit applicable to AEP is the upper bound limit of the I*T levels that might cause interference on telephone systems. Thus, the customer induced harmonics shall not result in an I*T product to exceed 25,000 weighted amperes per phase, applicable to both the transmission and distribution systems. Residual I*T should also be minimized. Residual I*T is I_G*T, where I_G is the earth return current and is defined as the difference between the phasor sum of phase currents and neutral current. The I*T calculation is to be performed using Equation 3. The weighting of harmonic currents should conform to the 1960 TIF curve shown below.

$$I*T = I*TIF = \sqrt{\sum_{n=1}^{K} (I_n * W_n)^2} \quad weighted\ amperes \qquad (Eq.3)$$

Where:

I = Current of individual harmonics, amperes, RMS
T = Telephone Influence Factor (TIF)
W_n = Single frequency TIF weighting at frequency n (refer to table and chart below)
K ≤ 42, Maximum harmonic order

FREQ	TIF (W)	FREQ	TIF (W)	FREQ	TIF (W)	FREQ	TIF (W)
60	0.5	1020	5100	1860	7820	3000	9670
180	30	1080	5400	1980	8330	3180	8740
300	225	1140	5630	2100	8830	3300	8090
360	400	1260	6050	2160	9080	3540	6730
420	650	1380	6370	2220	9330	3660	6130
540	1320	1440	6650	2340	9840	3900	4400
660	2260	1500	6680	2460	10340	4020	3700
720	2760	1620	6970	2580	10600	4260	2750
780	3360	1740	7320	2820	10210	4380	2190
900	4350	1800	7570	2940	9820	5000	840
1000	5000						

APPENDIX C

Allowable Generation Abnormal Frequency Operation

Generation Abnormal Frequency Operating Allowance