VERSION HISTORY

Version	Approval Date	Effective Date	Owner	Change
5	12/28/18	12/31/18	Ostrander	Annual review. Added language to address changes to FAC-001-3 requirements.
4	12/28/15	12/31/15	Fields	Annual Review; Revised to include language addressing changes in FAC-001-2
3	1/2/15	1/2/15	Taft	Changed formatting and updated HE connection requirements
2	5/31/14	5/31/14	Taft	Modifications to clarify requirements and to align with NERC standards wording
1	2/01/09	2/01/09	Hill	Initial Release
0	2/01/02	2/01/02	Magyar	Original legacy procedure

Requirement	Line Number
FAC-001-3 R1.1	31-32
FAC-001-3 R4.1	60-100
FAC-001-3 R4.2	102-112
FAC-001-3 R4.3	115-124

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1.0 PURPOSE

- Documents facility interconnection requirements for generation owners that may interconnect to Hoosier Energy's transmission system and control area.
- Updates facility interconnection requirements for generation owners that are already interconnected to Hoosier Energy's transmission system.
- Ensures safe interconnections to the Hoosier Energy system to achieve necessary system performance throughout the planning horizon.
- Verifies compliance with industry standards.

2.0 APPLICABILITY

This document applies to voltage levels of 69kV and above. Interconnections to the Bulk Electric System (BES; typically voltages greater than 100kV) are coordinated through the Midcontinent ISO (MISO) and must adhere to North American Electric Reliability Corporation (NERC) reliability standards.

3.0 HOOSIER CONTACT

Generations facilities applying to interconnect with Hoosier should contact the following.

William C. Ware
Manager, Power Delivery Engineering
Office: 812-876-0366

4.0 PROCEDURES FOR COORDINATED STUDIES OF NEW OR MATERIALLY MODIFIED EXISTING INTERCONNECTIONS AND THEIR IMPACTS ON AFFECTED SYSTEM(S) FAC-001-3 R4.1

When an interconnection request is submitted, and the applicable facility data and monetary deposits are routed to the appropriate recipients, MISO in conjunction with Hoosier Energy will carry out a series of system studies. This series of studies will continue as long as the request is active, and will be terminated if the request is withdrawn. This series of studies consists of the following:

- Feasibility Study
  This is a high level evaluation of the proposed interconnection to identify potential problems that may be unacceptable to the stakeholders involved.
- System Impact Study
  This study is more detailed and is conducted to assess the effects the proposed connection has on transmission system adequacy and reliability. Transmission facility loadings, voltage profiles, power quality impacts, short circuit duties, and transient phenomena are examined over a range of expected system conditions. If the results of this study are acceptable to all stakeholders, a Facility Study will be performed.
- Facility Study
  This study will review and potentially repeat the System Impact Study and develop the physical connection between the transmission system and a proposed connected facility. The electrical configuration of the connection equipment including transformers, circuit breakers, other station equipment, and required transmission line sections are determined. The physical layout of equipment and right-of-way needs are also determined. Multiple alternatives may be considered when developing facility requirements. Cost estimates of required system upgrades for each alternative are included.

The specific steps and requirements of the process for interconnecting new generating capacity or modifying existing interconnections to Hoosier Energy's BES Transmission System are set forth in detail in MISO's Business Practices Manual (BPM) – Generator Interconnection.

A customer request for interconnection to MISO begins the MISO Pre-Queue and Application Review process. The specific requirements of the interconnection request are available on the MISO website Generator Interconnection page at:

https://www.misoenergy.org/planning/generator-interconnection/

5.0 PROCEDURES FOR NOTIFYING THOSE RESPONSIBLE FOR THE RELIABILITY OF AFFECTED SYSTEM(S) OF NEW INTERCONNECTIONS FAC-001-3 R4.2

Hoosier Energy will follow the MISO Planning Coordinator procedures and the MTEP processes and upon notification of a facility connection request Hoosier Energy will notify the MISO Transmission Planning Coordinator and any potentially impacted neighboring entity of the facilities connection request. As facilities connection studies progress and additional information comes available, Hoosier will share that additional or updated information from the study result process with the neighboring reliability entities impacted by the requested facilities connection.

6.0 PROCEDURES FOR CONFIRMING WITH THOSE RESPONSIBLE FOR THE RELIABILITY OF AFFECTED SYSTEM(S) OF NEW INTERCONNECTIONS OR MATERIALLY MODIFIED GENERATION FACILITIES ARE WITHIN A BALANCING AUTHORITY AREA'S METERED BOUNDARIES FAC-001-3 R4.3

As part of specifying metering equipment, settings, and requirements, Hoosier Energy shall determine that any new or materially modified generation facilities resulting from any connection to Hoosier Energy's system are within the appropriate Balancing Authority Area's metered boundaries.

7.0 DEFINITION OF MATERIALLY MODIFIED

FAC-001 requires Transmission Operators to have procedures for the coordination and notification of those having responsibility for reliability when existing facilities are materially modified. What constitutes a "material modification" to a Facility will vary from entity to entity. The entity should use sound engineering judgment to make the determination of who and when studies should be coordinated and communicated. Some items that may constitute a material modification of a generation facility include, but are not limited to the following:

- Addition of generator, line or transmission termination to the Facility
- Addition of circuit breakers or switching devices that change the topology.
- Increases in Generation Output Capability of the facilities from internal upgrades, efficiency improvements or other modifications.
- Change of impedance (may be required coordination under PRC-001)
- Addition to Generator Owner facilities to accommodate another end user or generation/transmission connections.

Items not considered a material modification may include, but are not limited to the following:

- Change in rating of element that constitute the Facility (May require coordination under FAC-008 and FAC-014)
- Change in relay settings (may require coordination under PRC-001)
- Replacement or addition of distribution transformer that provides no change in BES topology OR switching devices that can change the topology.

8.0 SYSTEM IMPACT STUDY REQUIREMENTS

All requesters of generation connection service must petition MISO for approval of the connection. MISO will then perform any system impact studies needed for the interconnections at the requester's cost. All generation connections above 100kV and selected interconnections (at MISO discretion) at 69kV will be evaluated by MISO. See MISO Procedures for details.

In order to assess the impact of a proposed facility connection on system reliability, system impact studies need to be conducted. These system impact studies, as a minimum, examine the transmission line and transformer loading; generation capacity (MW) provided a point of connection; voltage profiles and schedules; minimum reactive (MVAR) requirements; and power quality impacts of the proposed facility for a range of expected seasonal loading and power transfer conditions. The effect of the proposed facility on short circuit duties is examined for all proposed generation facilities and transmission connections. Stability performance is also assessed for all proposed generation facilities. A multi-step approach to the proposed facility may be considered where the impact of each step is assessed separately. Alternative plans of service may be considered.

System Impact Studies may include some or all of the following analyses:

8.1 POWER FLOW ANALYSES

Power flow analyses are conducted to examine the impact of the proposed facility on nearby transmission line and transformer loading, and nearby voltage profiles. These analyses may typically determine the maximum generation that can be accommodated with minimal or no upgrades to the transmission system. Contingencies consisting of single or multiple outages of lines and/or transformers are considered in these analyses. Where the analyses indicate that transmission upgrades are necessary, alternative reinforcement plans may be devised and evaluated for their capability to accommodate the proposed facility. These analyses may also indicate a need to perform dynamic studies.

8.2 SHORT CIRCUIT ANALYSES

Short circuit analyses are conducted to examine the impact of the proposed facility on equipment duties. Increased fault duties may require upgrading existing circuit breakers and other equipment.

8.3 TRANSIENT STABILITY STUDIES

The ability of a proposed generation facility to remain in synchronism with the transmission network during disturbances, including faults, is investigated here. As with load flow analyses, transient stability studies determine how much generation can be accommodated at a given location. Typically, disturbances corresponding to the contingencies examined in the load flow analyses are simulated. Other aspects of system dynamic performance affected by the proposed generation facility may be assessed. Any required remedial measures, transmission facility upgrades and/or additional design requirements for the proposed generation facility are identified.

The criteria Hoosier uses to determine what constitutes acceptable performance in the above system impact studies is readily available from Hoosier's FERC Form 715 filing.

8.4 ADDITIONAL ANALYSES

Other analyses may be required as part of system impact studies depending on the nature of the proposed connected facility and its location within the transmission network. Power quality analyses are undertaken for all generation 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 the document appendices.

The scope of all the above system impact studies is determined by MISO based on the type, location, and power level of the proposed facility. Normally, MISO will perform the system impact studies at the expense of the **Owner**.[1] A report documenting the assumptions, results, and conclusions of the system impact studies is made available to the **Generation Facility Owner**.

Hoosier and MISO must be notified of new facilities, upgrades, or additions such as an increase in load or added generating units to existing facilities connected to the transmission system within the Hoosier Energy Control Area. System impact studies are to be conducted to determine the need for any upgrades of transmission equipment or transmission reinforcements to the Hoosier system to accommodate the changes in the connected facility.

[1] Herein after the Owner refers to the Generation Facility Owner or third party acting on behalf of the Generation Facility Owner.

8.5 FACILITY CONNECTION STUDY

A facility connection study is performed to evaluate and determine the physical connection between the transmission system and a proposed connected facility. The electrical configuration of the connection equipment including transformers, switchgear and other station equipment, and required transmission line sections are determined. Attachment A illustrates some of the more typical configurations for facility connections, but other possibilities exist depending on the particular situation. The physical layout of equipment and right-of-way needs are determined in the facility connection study as well. Typically, more than one alternative is considered in developing a facility connection depending upon the accessibility of the local area transmission facilities and the needs of the proposed connected facility. A multi-step approach may be considered in the facility connection study to accommodate a multistep increase in generation for the connected facility. Normally, the expense of developing a facility connection is the responsibility of the **Generation Facility Owner**.

8.6 RESPONSIBILITIES

All Owners may be responsible for the costs associated with connecting to the Hoosier Energy Transmission System. This will include both the costs of the Owner's facilities and all costs of modifications and/or additions to Hoosier transmission facilities required to integrate the generation facilities. Hoosier will also require reimbursement for evaluation of requests for service, for performing necessary System Impact Studies, and for required regulatory filings. These direct costs may also be increased to cover any increase in taxes in those jurisdictions where applicable. The information contained herein is subject to change and may be revised at any time.

9.0 TYPES OF CONNECTED CIRCUIT CONFIGURATIONS REQUIREMENTS

The typical arrangement for generation connected to a transmission line is shown in Attachment A, and the typical arrangement for generation connected to a breakered bus is shown in Attachment B. These figures illustrate some acceptable configurations for connection of generation to the Hoosier Transmission System.

This document is not intended to cover the connection of generation to distribution systems. For requirements applicable to distribution connected generation, the **Generation Facility Owner** should also contact local Hoosier member cooperatives.

10.0 DESIGN REQUIREMENTS FOR CONNECTION

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

local codes. The minimum Hoosier Transmission System connection requirements for generation are as follows.

10.1 GENERATOR FREQUENCY

The Owner's generating facility will provide a balanced, symmetrical, three phase interchange of electrical power with the Hoosier Transmission System at a nominal frequency of 60 Hz.

10.2 SYSTEM PROTECTION

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

- single phasing of supply
- transmission system faults
- equipment failures
- abnormal voltage or frequency
- lightning and switching surges
- excessive harmonic voltages
- excessive negative sequence voltages
- separation from supply
- synchronizing generation
- resynchronizing the **Owner's** generation after electric restoration of the supply

More complete relaying system requirements are identified in Section 12.

10.3 INTERRUPTING DEVICE

All **Generation Facility Owners** shall provide a three-phase circuit interrupting device with appropriate relaying systems (as stated in Section 12) to isolate the generation facilities from the Hoosier supply for all faults, loss of Hoosier supply, or abnormal operating conditions regardless of whether or not the **Owner's** generator is in operation.

This device shall be capable of interrupting the maximum available fault current at that location. Fault current is subject to change and may increase in the future, therefore **Generation Facility Owner** should make necessary provisions at their expense. The three-phase device shall interrupt all three phases simultaneously. The tripping control of the circuit interrupting device shall be powered independently of the utility ac source in order to permit operation upon loss of the Hoosier transmission system connection.

The specific reclosing times for the **Generation Facility Owner's** circuit interrupting device will be provided by Hoosier. It is the **Generation Facility Owner's** responsibility to design and maintain their interrupting device(s) to properly isolate generation upon loss of the Hoosier connection until the appropriate Hoosier facilities are returned to service.

10.4 SYSTEM GROUNDING AND SAFETY

The grounding of the **Generation Facility Owner**'s system and any associated safety devices at the transmission voltage level will be considered on a case-by-case basis.

10.5 VOICE COMMUNICATION CIRCUIT

The **Generation Facility Owner** may be required to establish a dedicated voice communication circuit to the Hoosier System Control Center to permit coordination of the synchronization and operation of the generation.

10.6 DISCONNECTING DEVICES

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 be accessible at all times. The disconnecting device shall be mechanically lockable in the open position with a Hoosier padlock in order to provide for a visible electric isolation of the **Owner's** facility and shall be identified with a Hoosier designated equipment number.

10.7 DISTURBANCE MONITORING

The **Generation Facility Owner**'s system must have disturbance monitoring equipment for interconnections to certain buses in Hoosier Energy's BES system as defined in PRC-002. Hoosier will evaluate the interconnection and determine the need for monitoring equipment.

10.8 TRANSIENT STABILITY PERFORMANCE

Transient stability performance of the generator is the responsibility of the **Generation Facility Owner**. Transient stability performance should be in accordance with Hoosier Transient Stability Criteria. Hoosier may, at its discretion, elect to perform the necessary studies to evaluate transient stability performance. The cost of these studies will be borne by the **Generation Facility Owner** as part of the System Impact Study.

10.9 EXCITATION CONTROL

In addition to the normal excitation system and automatic voltage regulation equipment, the following controls are also required for each synchronous generator.

10.9.1 REACTIVE COMPENSATION

A circuit should be provided in the automatic voltage regulator (AVR) to permit the control of voltage beyond the generator terminals. This is known as reactive line drop compensation. The point of control is to be adjustable over a range covering 0 to 15% reactance (on the generator base) beyond the generator terminals. Hoosier's general practice is to regulate voltage at 6% back from the station bus (toward the generator).

10.9.2 OVERCURRENT LIMITER

The excitation system is to be provided with a current limiting device which will supersede or act in conjunction with the AVR to automatically reduce excitation so that generator field current is maintained at the allowable limit in the event of sustained under-voltages on the transmission system. This device must not prevent the exciter from going to and remaining at the positive ceiling for 0.1 seconds following the inception of a fault on the power system.

10.9.3 UNDEREXCITATION LIMITER

A limiter to prevent instability resulting from generator underexcitation is required.

10.9.4 POWER SYSTEM STABILIZER

Hoosier studies may identify the need for the use of power system stabilizers, depending on the plant size, excitation system type and settings, facility location, area transmission system configuration and other factors. This will be determined on a case-by-case basis.

10.10 SPEED GOVERNING

All synchronous generators shall be equipped with speed governing capability. This governing capability shall be unhindered in its operation consistent with overall economic operation of the generation facility.

10.11 DYNAMIC PERFORMANCE DATA

Dynamic performance data shall be made available to Hoosier as part of the facility specifications and plans for evaluation by Hoosier. This data is required to evaluate the system dynamic performance of the generation facility which includes but is not limited to transient stability. See Attachment C.

10.12 AUTOMATIC GENERATION CONTROL (AGC)

Depending upon various control area factors applicable to tie line and frequency regulation, provision for dispatch control of the generation facility by Hoosier System Control Center AGC system may be required. This will be considered on a case by case

basis and any provision for control by AGC should be included in a Connection Agreement between the **Generation Facility Owner** and Hoosier.

10.13 BLACK START CAPABILITY

Depending upon the geographic location and other considerations applicable to system restoration in the event of a blackout, the provision of black start capability may be required or desirable. A black start capable generation facility is one that can be started without the aid of off-site power supplied by the transmission system. The Connection Agreement is to address this matter. Responsibilities of the Generation Facility Owner will be addressed in the Connection Agreement.

10.14 SUB-SYNCHRONOUS TORSIONAL INTERACTIONS OR RESONANCES

Depending upon the specific location of the generation facility in the transmission network, close electrical proximity to series compensated transmission lines or FACTS devices may result in undesirable or damaging sub-synchronous currents. Also, the provision of high speed reclosing following transmission line faults may result in excessive torsional duties. The **Generation Facility Owner** must provide Hoosier with indemnity from damaging torsional oscillations resulting from all Hoosier transmission system operations, and insure the turbine-generator is not excited into resonance by normal system operations. The Connection Agreement shall address these matters.

10.15 UNBALANCED ELECTRIC CONDITIONS

10.15.1 VOLTAGE BALANCE

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.”

10.15.2 CURRENT BALANCE

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.

Situations where high unbalance in voltage and/or current originate from the transmission system are to be addressed in the Connection Agreement.

10.16 HARMONICS AND FLICKER

The **Generation Facility Owner** shall take responsibility for limiting harmonic voltage and current distortion and/or voltage flicker[2] 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 Hoosier harmonics and flicker criteria are given in Attachment D. Hoosier 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 Attachment D, Exhibit 1). Depending upon the nature of the generation and its location, Hoosier 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.

Situations where high harmonic voltages and/or currents originate from the transmission system are to be addressed in the Connection Agreement.

11.0 REQUIREMENTS FOR OPERATION

The **Generation Facility Owner** is responsible for operating their generation with full regard for the safe practices of, and with full cooperation under the supervision of, the Hoosier System Control. A Generation Facility Owner's generation shall not supply power into the Hoosier transmission system unless a specific written agreement has been made to supply power to the Hoosier transmission system.

Under no circumstances shall a **Generation Facility Owner** energize Hoosier transmission facilities which have been de-energized. Circuits which are electrically disconnected from the Hoosier transmission system and are energized by a **Generation Facility Owner** constitute a potential safety hazard for both Hoosier transmission personnel and the general public. Also, the energizing of such circuits at abnormal voltage or frequency could cause damage to electrical equipment of both the Hoosier transmission system and the generation.
Hoosier reserves the right to disconnect service to any generator facility if, for any reason, Hoosier deems the continuation of the generator is, or may be, a detriment to the operation of the Hoosier Transmission System.

The minimum requirements for operation of generation on the Hoosier Transmission System are contained herein.

[2] Flicker is an objectionable, low frequency, voltage fluctuation which can be observed through changes in intensity or color of illumination.

11.1 SYNCHRONIZATION

The **Generation Facility Owner** shall assume all responsibility for properly synchronizing their generation for operation with the Hoosier Transmission System. Upon loss of the Hoosier supply, the **Generation Facility Owner** shall immediately and positively cause the generation to be separated from the Hoosier system. Synchronizing of generation to the Hoosier Transmission System may be, at Hoosier's discretion, performed under the direction of the Hoosier System Control Center.

11.2 VOLTAGE SCHEDULE/POWER FACTOR

Specification of the generator voltage schedule will be determined under the direction of the Hoosier System Control Center. See also NERC Standard VAR-002, B.R2 for details. A steady-state deviation from this schedule between +0.5% to –0.5% of the nominal voltage will be permissible. Nominal Hoosier system voltages are 345, 161, 138, and 69 kV.

In certain unusual situations where a voltage schedule is inappropriate, Hoosier, initially and in the future, may substitute adherence to a specified voltage schedule with a specified power factor. A steady state deviation from this power factor within +2% to –2% will be permissible.

11.3 VOLTAGE RANGE

The generation facility must be capable of continuous non-interrupted operation within a steady-state voltage range during system normal and single facility outage conditions. This range is from 95% to 105% of the nominal transmission voltage. Hoosier system nominal voltages are as indicated in Section 11.2 above. During emergency and/or transient system conditions, as voltage may temporarily be outside the 90% to 110% range, all reasonable measures should be taken to avoid tripping of the generation facility due to high or low voltage.

11.4 FREQUENCY RANGE

The generation facility must be capable of continuous, non-interrupted operation in the frequency range of 59.5 to 60.5 Hz. Time-limited, non-interrupted operation is also expected outside this frequency range in accordance with the generator manufacturer's recommendation or the figure contained in Attachment E.

11.5 NET DEMONSTRATED REAL AND REACTIVE CAPABILITIES

The Net Demonstrated real and reactive capability in accordance with MOD-025 must be provided to Hoosier annually. Hoosier reserves the right to witness these tests. In addition, individual generators in the generation facility must make available the full

steady-state over- and under-excited reactive capability given by the manufacturer's generator capability curve at any MW dispatch level. Tests which demonstrate this capability must be conducted and documented not more than at five year intervals in accordance with MOD-025. Such documentation shall be provided to Hoosier. Hoosier reserves the right to witness these tests.

11.6 OTHER APPLICABLE OPERATING REQUIREMENTS

In order to assure the continued reliability of the Hoosier Transmission System, the **Generation Facility Owner** may be requested to adhere to other operating requirements and/or encouraged to adopt common operating practices. These include the coordination of maintenance scheduling, performance not to exceed a specified forced outage rate, operations procedures during system emergencies, participation in control area operating reserves, provisions for backup fuel supply or storage, and provisions for emergency availability identified by the North American Electric Reliability Council.[3] Hoosier, as the Transmission Provider, may require the Generation Facility Owner to provide Interconnected Operation Services defined by NERC standards. Such requirements shall be addressed in the Connection Agreement with the **Generation Facility Owner**.

Conformance with applicable requirements in MOD-025, VAR-002, and PRC-002 is required. All data reportable to NERC and/or RFC shall also be made available to Hoosier.

11.7 MAKE-BEFORE-BREAK TRANSFER

Make-before-break transfer is only permitted between two live sources which are in, or close to, synchronism. A transfer switch designed for automatic make-before break transition shall be equipped with logic to prevent a transfer if the specifications for either the **Generation Facility Owner** or the Hoosier transmission system source fall outside of the synchronizing requirements recommended by the generator equipment manufacturer. Switch transfers made when the synchronizing requirements cannot be met shall be of the break-before-make type of transfer. The time that the **Generation Facility Owner's** generation is permitted to operate in parallel with the Hoosier Transmission System during a make-before-break transfer shall be no greater than 100 milliseconds (6 cycles).

11.8 OPERATING RESTRICTIONS

Situations necessitating generation curtailments or forced outages as the result of unavailability of transmission facilities owned and/or operated by Hoosier are to be addressed in a Connection Agreement with the **Generation Facility Owner**.

[3] North American Electric Reliability Council, "Reliability Considerations for Integrating Non-Utility Generating Facilities with the Bulk Electric Systems," January 1992.

12.0 PROTECTIVE RELAYING REQUIREMENTS

Generation Facility Owner relay requirements are summarized in Section 12.1. Specific requirements are noted below.

12.1 PARALLEL GENERATION FACILITY

The following utility-grade relays shall be provided by the Generation Facility Owner for protection of the Hoosier system. Use of the transfer trip receiver is conditional as set forth in Section 12.2, Hoosier Facilities. All relays specified for the protection of the Hoosier system, including time delay and auxiliary relays, shall be approved by Hoosier. Relay operation for any of the listed functions shall initiate immediate separation of the **Generation Facility Owner**'s generation from the Hoosier System.

Relay	**Function**
Frequency	To detect underfrequency and overfrequency operation
Overvoltage	To detect overvoltage operation
Undervoltage	To detect undervoltage operation
Ground Detector	To detect a circuit ground on the Hoosier 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 for isolation of the generation upon opening of the Hoosier supply circuits
Directional Power*	To detect, under all system conditions, a loss of Hoosier primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

* *If an agreement exists to supply power to the Hoosier system, additional relays may be required to provide adequate protection for the Hoosier system.*

The purpose of these relays is to detect the **Generator Owner's** energization of an Hoosier circuit that has been disconnected from the Hoosier system, to detect the generation operating at an abnormal voltage or frequency, or to detect a fault or abnormal condition on the Hoosier 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 ensure proper operation of the protection scheme. Loss of this source shall cause removal of the generation from the Hoosier system. The protective relays required by Hoosier and any auxiliary tripping relay associated with those relays shall be utility-grade devices.

Utility grade relays are defined as follows:

- Meet ANSI/IEEE Standard C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus"
- Have relay test facilities to allow testing without unwiring or disassembling the relay
- Have appropriate test plugs/switches for testing the operation of the relay
- Have targets to indicate relay operation

Hoosier will specify settings for the generation's Hoosier-required relays to assure coordination between the generation protective equipment and the Hoosier system relays. It is the **Generation Facility Owner**'s responsibility to determine that their internal protective equipment coordinates with the required Hoosier protective equipment and is adequate to meet all applicable standards to which the generation is subject. Other pilot protection schemes may be required depending on topology and system configuration. Hoosier 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 Hoosier's ability to serve other customers.

12.2 HOOSIER FACILITIES

If at any time it is determined that the use of the above relay systems cannot provide adequate protection to the Hoosier system, the **Generation Facility Owner** shall additionally furnish and install at their expense, upon the request of Hoosier, a transfer trip receiver(s) at his facility to receive tripping signals originating from a Hoosier location(s). This additional protection would also necessitate, at the **Generation Facility Owner's** expense, the purchase and installation of transfer trip equipment at the Hoosier location(s) and a communication channel between the Hoosier location(s) and the generation facility.

12.3 OTHER PROTECTION REQUIREMENTS

The following items should be coordinated with each other:

- Volts/Hz and overexcitation protection/limiting
- Loss-of-excitation and underexcitation limiting

13.0 TESTING AND MAINTENANCE OF PROTECTION DEVICE REQUIREMENTS

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 Hoosier Transmission System by and Hoosier 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 Hoosier.

All testing and maintenance performed by the Hoosier approved organization shall be under the general surveillance of Hoosier. This may include circuit breakers, circuit switches, power fuses, instrument transformers, switches, surge arresters, bushings, relays, and associated equipment (including battery and battery charger). Maintenance procedures are detailed in the Hoosier Energy Power Delivery Maintenance Plan. Also, a copy of all test and maintenance reports shall be forwarded to Hoosier.

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

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

14.0 MAINTENANCE AND COORDINATION REQUIREMENTS

All Requester owned equipment up to and including the first protective fault interrupting device is to be maintained to Hoosier standards. 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 Hoosier Energy Power Delivery Maintenance Plan.

The Requester shall have a Hoosier Energy approved organization test and maintain all devices and control schemes provided by the Requester for the protection of the Hoosier system. 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 caused by a Requester or Hoosier change to the protective devices. All testing and maintenance shall be coordinated with Hoosier and as necessary with MISO via the CROW system for coordinating generation outages.

If the Requester's testing and maintenance program is not performed in accordance with Hoosier Energy Power Delivery Maintenance Plan, Hoosier reserves the right to inspect, test, or maintain the protective devices required for the protection of the Hoosier system.

All costs associated with the testing and maintenance of devices provided by the Requester for the protection of the Hoosier system, including costs incurred by Hoosier in performing any necessary tests or inspections, shall be the responsibility of the Requester.

15.0 METERING AND TELEMETRY REQUIREMENTS

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 connection 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 Hoosier, the generation necessitates real-time telemetry to the Hoosier System Control Center, the **Generation Facility Owner** shall install and operate

at their expense the communication channel, the Hoosier approved telemetry equipment and associated devices.

At the discretion of Hoosier, generation control facilities and supervisory control and data acquisition of specific electrical devices from the Hoosier System Control Center may be necessary to integrate the generation into Hoosier's control area. Such additional facilities, including required communication channels, 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 capacity, system location and voltage, and the net generation input into Hoosier System Control.

Suitable telemetry equipment will be installed at the metering point to provide real-time telemetry data to Hoosier 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, Hoosier 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 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 Hoosier 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:

- desired generation MW set point
- automatic generation control status (on, off)
- generator availability
- generation MW, MVAR output
- generator minimum and base MW capability
- generator MW AGC high limit and low limit
- connection facilities' breaker status/control/alarms
- connection facilities' MW and MVAR line values and bus voltage
- generator and substation metering (MWh) data

16.0 COMMUNICATION REQUIREMENTS

16.1 VOICE COMMUNICATIONS

16.1.1 NORMAL

At Hoosier's request, the **Generation Facility Owner** shall provide a dedicated voice communication circuit to the Hoosier System Control Center (SCC). 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 Hoosier's Control Area.

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

16.1.2 EMERGENCY

Voice communications in the event of a transmission system or capacity emergency shall use the 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 Hoosier System Control 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 Hoosier Control Center during system emergencies.

17.0 DESIGN REVIEW REQUIREMENTS

The **Generation Facility Owner** is responsible for submitting all specifications and detailed plans to Hoosier for review and approval prior to receiving permission to connect to the Hoosier transmission system.

17.1 FACILITY DATA

At least three (3) months prior to the in-service date, the following data shall be received by Hoosier. If the data is not available three months prior to the in-service date, the **Generation Facility Owner** shall provide estimates based on their design information. Such data shall be identified as "estimated" and replaced with actual data by the **Generation Facility Owner** as it becomes available prior to installation. The purpose of generation facility data to be provided to Hoosier by the Generation Facility Owner is to ensure proper coordination to protect against equipment or facility damage, to mitigate safety hazards to utility personnel and the public, and to minimize disturbances, impairment, or interference with Hoosier's ability to serve other transmission system users.

17.1.1 DATA ON EQUIPMENT TO BE INSTALLED

Interrupting Devices and Relays	Complete manufacturer's data for interrupting devices and relays or fuses used for the protection of the Hoosier system and the generation.
Power Transformers	Complete nameplate or test sheet data, including manufacturer, serial number, high- and low-side voltage taps, kVA ratings, impedance, load loss and no load loss watts, high- and low side voltage winding connections, low-side voltage winding grounding (if used), and high voltage inrush current.
Power Capacitors	Location, kV and kVAR rating of capacitor banks, number of units, and bank configuration.

17.1.2 DATA ON THE GENERATION PROTECTION EQUIPMENT

Including make-before-break transfer switches, fuses, breakers, relays, relay settings associated with the proposed generation, and detailed schematic diagrams of protective relaying proposed for the Hoosier transmission system.

Complete manufacturer's data and specifications for make-before-break transfer switches, including transfer times and conditions of transfer, testing procedures, equipment schematics, and backup protection.

17.1.3 INFORMATION ON CHARACTERISTICS OF LOAD

Such as initial and near future expected load, power factor of such load, and dynamic (flicker, harmonics, etc.) character of such load.

17.1.4 MINIMUM AND MAXIMUM REQUIRED LOW-SIDE OPERATING VOLTAGES

17.1.5 GENERATOR DATA

- Type (synchronous, induction, dc with solid-state inverter, etc.)
- Nameplate data and ratings, including any rectifying, regulating, or inverting equipment;
- Harmonic content at full rated output
- Detailed Dynamic Performance Data in accordance with Attachment C
- Real and Reactive capabilities at scheduled voltages

17.1.6 ELECTRIC ONE-LINES AND SCHEMATIC DIAGRAMS

Showing the generation, the interconnecting facility with the Hoosier transmission system, and the protective relaying.

18.0 REQUESTER'S FACILITY EQUIPMENT – GROUNDING AND SAFETY REQUIREMENTS

18.1 SIZE AND TAKE-OFF TENSION OF LINE CONDUCTORS AND OVERHEAD GROUND WIRES

The **Requester's** structure shall be designed for (# of) incoming (size and type of) phase conductors and (# of) incoming (size and type of) overhead ground wire(s). The approximate take-off or dead-end tension will be (#) lbs. for each phase conductor and (#) lbs. for each overhead ground wire in accordance with Rule 250 of the National Electric Safety Code (NESC). The exact take-off tensions will be determined after the facility plans are finalized. Additionally, the transmission interconnection design will be subject to Hoosier Energy design criteria.

The line terminal connectors furnished by the **Requester** should be (copper or aluminum) wire-and-pad connector to bolt to and be materially compatible with the air switch terminal pad. The overhead ground wire shall be grounded using aluminum compression wire and a pad type connector furnished by the **Requester**.

The point of attachment of the line entrance conductors shall be of sufficient height to provide the basic vertical clearance requirements for lines crossing over public streets, alleys, or roads in urban or rural districts, as outlined in the NESC.

18.2 SHORT CIRCUIT DATA & INTERRUPTING DEVICE RATINGS

The following estimated short circuit levels will be provided by Hoosier at the point of common coupling.

Estimated Initial Short Circuit Levels (Year)		
3 Phase Fault	MVA	ANSI X/R Ratio
Phase-to-Ground Fault*	MVA	ANSI X/R Ratio
Estimated Future Short Circuit Levels (Year)		
3 Phase Fault	MVA	ANSI X/R Ratio
Phase-to-Ground Fault*	MVA	ANSI X/R Ratio

Generation Interconnection equipment should have adequate interrupting and momentary ratings for the future short circuit conditions listed above.

While Hoosier will endeavor, where possible, to anticipate system changes which may affect these values, it does not assume responsibility or liability with respect to such protective devices, nor guarantee their continuing adequacy against increased interrupting capacity requirements resulting from system changes. **Generation Interconnection** who use this information should periodically review existing and future fault conditions and equipment ratings for adequacy. Any equipment replacements or upgrades to maintain adequacy of the **Generation Interconnection** facilities will be at the **Generation Interconnection** expense.

All gas insulated protective devices within the **Requester's** facility having a direct connection to an Hoosier transmission line shall be equipped with a low gas pressure alarming/tripping/lockout scheme as appropriate for the particular device.

18.3 OTHER DESIGN CRITERIA

18.3.1 EQUIPMENT BASIC INSULATION LEVELS

The minimum required Basic Insulation Levels (BIL) for stations are listed in Table 1 of Attachment F. Facilities in areas with significant airborne pollution may require a higher insulation level. The Requester will coordinate insulation levels as needed to meet Hoosier Energy requirements in Table 1 of Attachment F as well as switching surge clearances for EHV.

18.3.2 TRANSFORMER SURGE PROTECTION (LIGHTNING ARRESTERS)

Lightning arresters protecting transformers are generally porcelain design and mounted on the transformer. However, since lightning arresters can adequately protect equipment some distance from the arresters, the overall number of lightning arresters required in each design can be reduced. Lightning arrester allowable separation distance from the equipment being protected is based on Table 4 of IEEE Std. C62.22.

The **Requester** should consult the manufacturer's catalog for details concerning arrester protective characteristics, ratings, and application.

18.3.3 CURRENT CARRYING EQUIPMENT RATINGS

For tap and looped connections, the **Requester's** high voltage bus and associated equipment, such as switches, connectors, and other conductors shall have minimum continuous current and momentary asymmetrical current ratings which: (1) do not limit the Hoosier transmission system network capability and (2) have adequate capability for the initial and future system conditions identified by Hoosier. All **Requester** equipment must meet the requirements of FAC-008. The **Requester** is all required cases must submit Facilities Rating data to Hoosier Energy as part of the Information submittal.

18.3.4 ELECTRICAL CLEARANCES (OUTDOOR)

Electrical facility design clearances are listed in the table in Attachment F. These design clearances should be used for electrical facilities up to and including any interrupting device connected directly to a Hoosier transmission line and for all facilities that are part of the Hoosier transmission system. This includes switching surge for EHV.

The minimum vertical clearance of the conductors above ground and the vertical and horizontal clearance of conductors passing by but not attached to a building or wall shall be in accordance with the NESC or applicable state and local codes.

18.3.5 INSULATORS FOR STATION

The required station post insulator types are listed in the table in Attachment F. Facilities in areas with significant airborne pollution may require a higher insulation level. Higher strength insulators are available and should be used if needed to meet bus momentary short circuit withstand values.

18.3.6 AIR BREAK SWITCH(ES) AND DISCONNECT SWITCH(ES)

A group operated switch shall be installed on each transmission line supply entrance to the **Requester's** facility and accessible to Hoosier personnel at all times. The switch shall be mechanically lockable in the open position with a Hoosier padlock in order to provide for a visible electric isolation of the **Requester's** facility and shall be identified with a Hoosier designated equipment number.

All air break switches shall be three phase, single throw, group operated. Disconnect switches shall be a three pole, single throw device. Characteristics for all air break switches and disconnect switches including voltage and BIL ratings, clearances and pole spacing shall meet the requirements shown in the table in Attachment F. Facilities in areas with significant airborne pollution may require a higher BIL level. There shall be no braids in the current carrying parts of the switch. Group operated switches shall be complete with a horizontal, rotating-type operating handle. A grounding device is to be furnished for the operating shaft and shall consist of a tin coated, flexible copper braid, located as close as possible to the operating handle. The braid shall have a cross-sectional area equivalent to 4/0 copper cable, or greater. The braid shall be secured to the shaft by means of a galvanized steel V-bolt clamp and associated cradle-type galvanized steel hardware. The opposite end of the braid shall have two (2) 9/16 inch holes at 1-3/4 inch spacing. Both ends of the braid shall be stiffened and protected by a ferrule or additional tinning. Switches for voltages above 100 kV will be required to have wormgear and/or motor operators.

As a minimum, a protective grounding loop shall be provided around all group operated switches as illustrated in Attachment G. This table applies to areas where native soil resistivity does not exceed 500 Ohm-meters. When the above condition is exceeded a detailed engineering assessment study must be undertaken by Hoosier.

All workers, who are using the operating handles on air break switches and disconnects on energized lines and equipment shall use protective headgear, insulating gloves and approved protective footwear. Before operating, the switch and ground arrangement shall be visually checked.

All switches are to be manufactured and tested in accordance with the latest revision of ANSI C37.30, ANSI C37.32, and ANSI C37.34.

18.3.7 FACILITY FENCE SAFETY CLEARANCES

The fence safety clearances in the **Requester's** facility shall comply with Section 11 of ANSI C2-2012, “National Electrical Safety Code.”

18.3.8 GROUND SYSTEM RESISTANCE

The grounding system should be designed in accordance with IEEE Standard 80 -latest revision, “IEEE Guide for Safety in AC Substation Grounding.” In evaluating the step and touch potential the target body weight value should be set to 50 kg. If a reasonable grounding design is unobtainable using the 50 kgs, then consider a body weight of 70 kg as the absolute minimum allowable.

Ground fault levels from Hoosier sources are listed in Section 18.2, Short Circuit Data & Interrupting Device Ratings. Requester equipment ground sources can contribute significant fault current independent of the ground fault values in Section 18.2. These Requester ground sources should be considered in the design of the grounding system.

If the facility structure is to be wood-pole type construction, the transmission line overhead ground wire, all switch bases, fuse bases, and other noncurrent-carrying metal parts shall be grounded to the station grid.

19.0 FINAL INSPECTION REQUIREMENTS

Before a generation facility can be energized, it must pass a final inspection by Hoosier personnel. Hoosier 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.

20.0 FINAL DOCUMENTATION

Hoosier shall receive final documentation of the generation facility that replaces the above specifications and data submitted for the design review under Section 17.0 once the facility is ready for operation.

Prior to operation of a generation facility, the **Generation Facility Owner** shall supply to Hoosier three copies of all final electric one-lines, equipment data, and schematic diagrams. Subsequent revisions affecting the generation shall be documented with three copies of the revised electric one-line and schematic diagrams.

21.0 PROTECTION EQUIPMENT APPROVAL

The construction, testing, and maintenance of the protective equipment provided by the **Generation Facility Owner** for protection of the Hoosier transmission system shall be subject to review and approval by Hoosier.

Prior to establishing service for operation, the **Generation Facility Owner** shall obtain approval from Hoosier for the generation, electrical equipment specifications, and operating procedures.

Final approval for operation of a **Generation Facility Owner**'s generation will be issued by Hoosier. A signed contractual document with Hoosier for the generation is required for final approval. Failure to meet any of the requirements stated herein to the satisfaction of Hoosier may result in a refusal to permit operation of the generation.

Review and approval by Hoosier of the proposed generation facility specifications and plans shall not be construed as confirming or endorsing the design or warranting the safety, durability, reliability, adequacy, or otherwise of the generation facility.

Note that the proposing entity must have approval from MISO before receiving any approval from Hoosier.

22.0 SPECIAL PROVISIONS

Special provisions may be made with operators of small power production facilities and other co-generators pursuant to rules of the Federal and/or State agencies of the applicable regulatory jurisdiction.

23.0 COORDINATION WITH OTHER CODES, STANDARDS, AND AGENCIES

The information contained in this document is supplementary to and does not intentionally conflict with or supersede the National Electric Code (NEC) as approved by the American National Standards Institute (ANSI) or such federal, state and municipal laws, ordinances, rules or regulations as may be in force within the cities, towns or communities in which Hoosier furnishes electric service. It is the responsibility of the **Generation Facility Owner** to conform to all applicable national, state and local laws, ordinances, rules, regulations, codes, etc.

24.0 COSTS INCURRED

1. The **Generation Facility Owner** shall reimburse all costs incurred by Hoosier to provide operation of their generation. The costs include but are not limited to:

2. Each review of the engineering and engineering drawings associated with the generation.

3. All metering not covered under the transmission tariff of general applicability.

4. The necessary facility modifications on the Hoosier transmission system to adequately accommodate the operation of the **Generation Facility Owner**'s generation.

5. Hoosier facility replacements, modifications, and/or enhancements due to exceeded ratings directly caused by or which could potentially be caused by the power flow attributed to the generation.

6. All communications circuits required for telemetering, SCADA, protective relaying, and/or voice communications with the generation.

7. All protective devices to be provided by the **Generation Facility Owner** for the protection of the Hoosier transmission system.

8. All protective relaying, including the transfer trip transmitter(s), receiver(s), and associated equipment, not on the **Generation Facility Owner**'s premises required by Hoosier due to the addition of the generation.

9. All protective relaying required to protect the generation from faults and abnormal system operating conditions.

10. All additional regulating and control devices required to meet the conditions set forth in Section 11.0. This would include any equipment necessary for suppression of harmonic current and/or voltages.

11. Hoosier equipment replacements or modifications due to an increase in available short circuit fault current directly caused by the addition of the Generation Facility Owner's equipment.

12. Calibration, testing, and maintenance of relays and protective devices provided by the **Generation Facility Owner** for the protection of the Hoosier transmission system.

13. All telemetering equipment to provide necessary telemetry to the Hoosier System Control Center.

14. Future changes associated with the generation due to changing conditions on the Hoosier system.

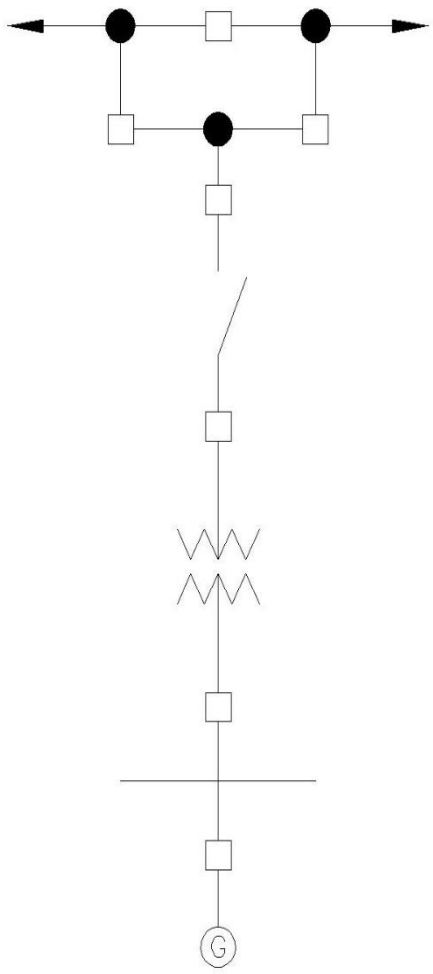
15. All studies performed by Hoosier pertaining to the generation.

25.0 INDEMNIFICATION

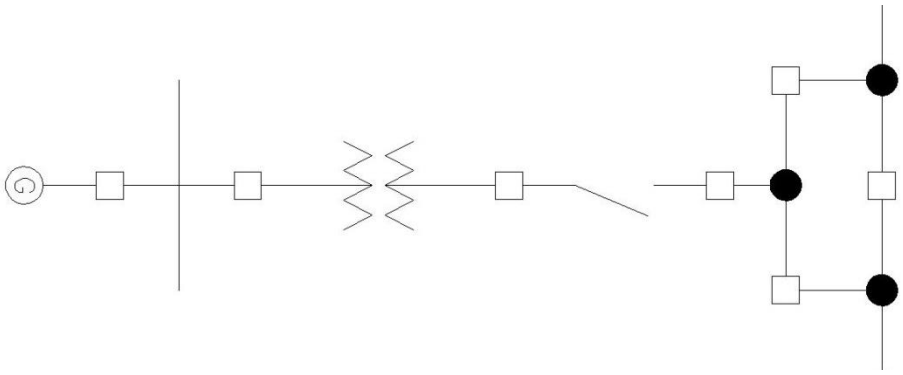
The use and reliance upon the information contained in this document shall in no way relieve the **Generation Facility Owner** from the responsibility to meet NEC and NESC requirements governing their design, construction, operation, and materials.

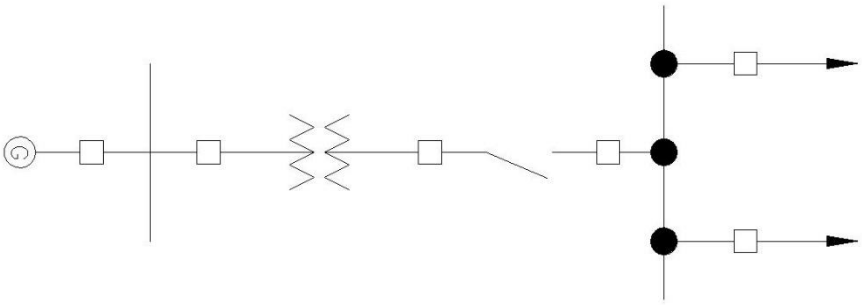
The **Generation Facility Owner**, for itself, its successors, assignees and subcontractors will be required to pay, indemnify and save Hoosier, its successors and assignees, harmless from and against any and all court costs and litigation expenses, including legal fees, incurred or related to the defense of any action asserted by any person or persons for bodily injuries, death or property damage arising or in any manner growing out of the use and reliance upon the information provided by Hoosier. Reliance upon the information in this document shall not relieve the Generator Facility Owner from responsibility for the protection and safety of the general public.

ATTACHMENT A: TYPICAL GENERATION TAP LINE SUPPLY CONFIGURATION



ATTACHMENT B: TYPICAL GENERATION ARRANGEMENTS FOR TRANSMISSION BUS CONNECTION





ATTACHMENT C: GENERATION DYNAMIC PERFORMANCE DATA

Customer Name _____ Date ___/___/___

GENERATOR DATA

UNIT RATINGS

kVA _____	_____ °F	Voltage	_____
Power Factor	_____	H2 psig	_____
Speed (RPM)	_____	Connection (e.g. Wye)	_____
Short Circuit Ratio	_____	Frequency, Hertz	_____
Stator Amperes at Rated kVA	_____	Field Volts	_____

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 _____

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

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA (Provide one)

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

CURVES
Saturation, Vee, Reactive, 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	_____	
Load Tap Changer?	_____ Yes	_____ No
Range (+/-%)	_____	_____

IMPEDANCE

Positive	Z1 (on self-cooled kVA rating)	_____ %
Zero	Z0 (on self-cooled kVA rating)	_____ %

EXCITATION SYSTEM

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. Also, identify the source(s) (e.g., vendor or field tests) of the model and modeling data.

GOVERNOR SYSTEM

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. Also, identify the source(s) (e.g., vendor or field tests) of the model and modeling data

ATTACHMENT D: HOOSIER VOLTAGE FLICKER CRITERIA AND HARMONIC DISTORTION CRITERIA

This document summarizes Hoosier's policy 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 Hoosier Energy REC, Inc. (Hoosier). The term Customer is defined as the party connected to the Hoosier 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 sub transmission 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 measure.

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: RELATIONS OF VOLTAGE FLUCTUATIONS TO FREQUENCY OF THEIR OCCURANCE

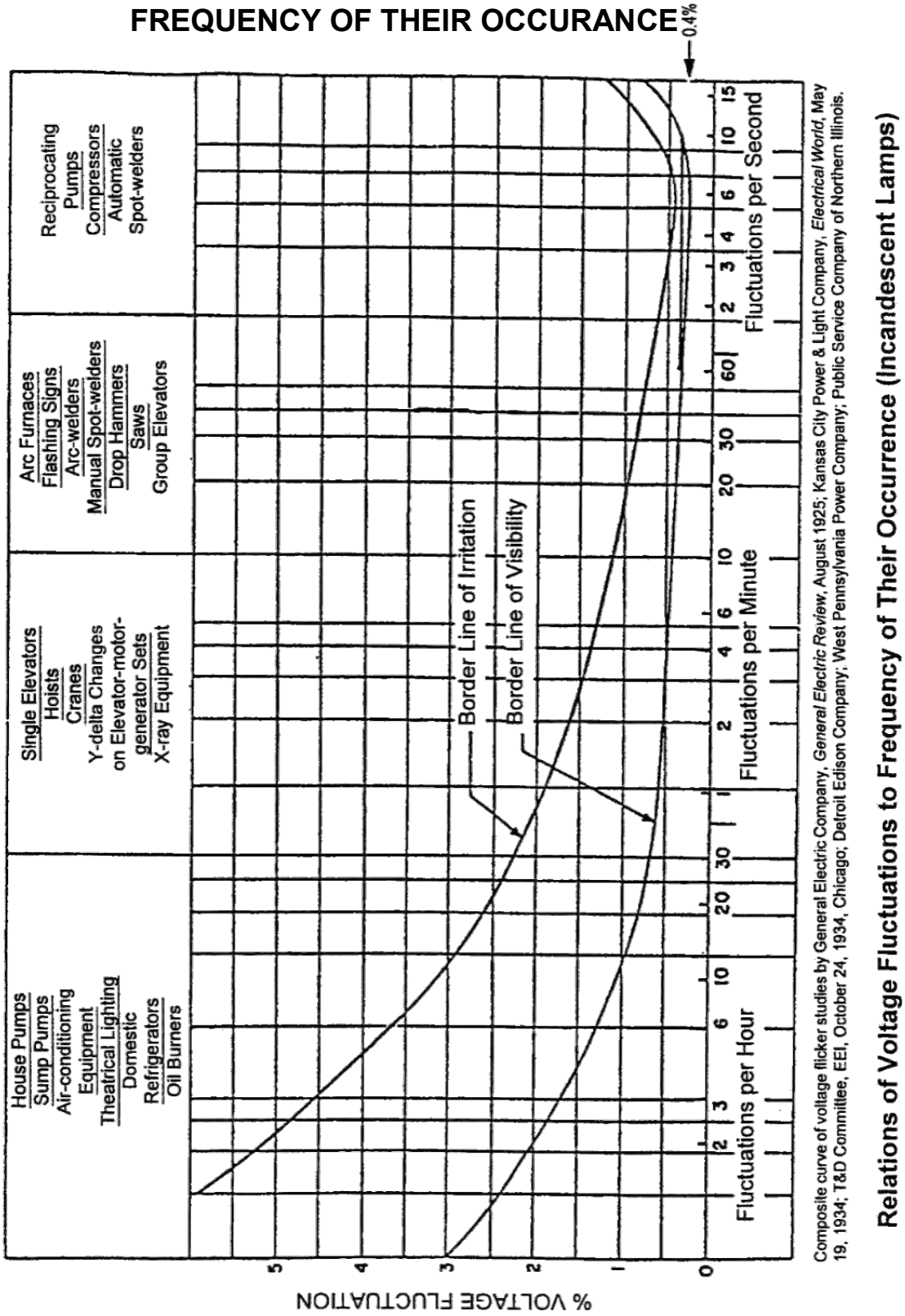


EXHIBIT 2: HARMONIC DISTORTION REQUIREMENTS

The HE Harmonic Distortion Requirements shown below are based on the information I_L 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 (FCC).

HARMONIC VOLTAGE DISTORTION (THD_v) LIMITS

Bus Voltage at PCC	Individual Harmonic Voltage Distortion (%)	Total Voltage Distortion THD_v (%)
≤69kV	3.0	5.0
69kV<v≤161kV	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≤ 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 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.

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 at 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 customers 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 live 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.

EXHIBIT 4: HARMONIC INFLUENCE

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 our (refer 10 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
II	Levels that probably will cause interference	> 50,000

The limit applicable to HE 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.

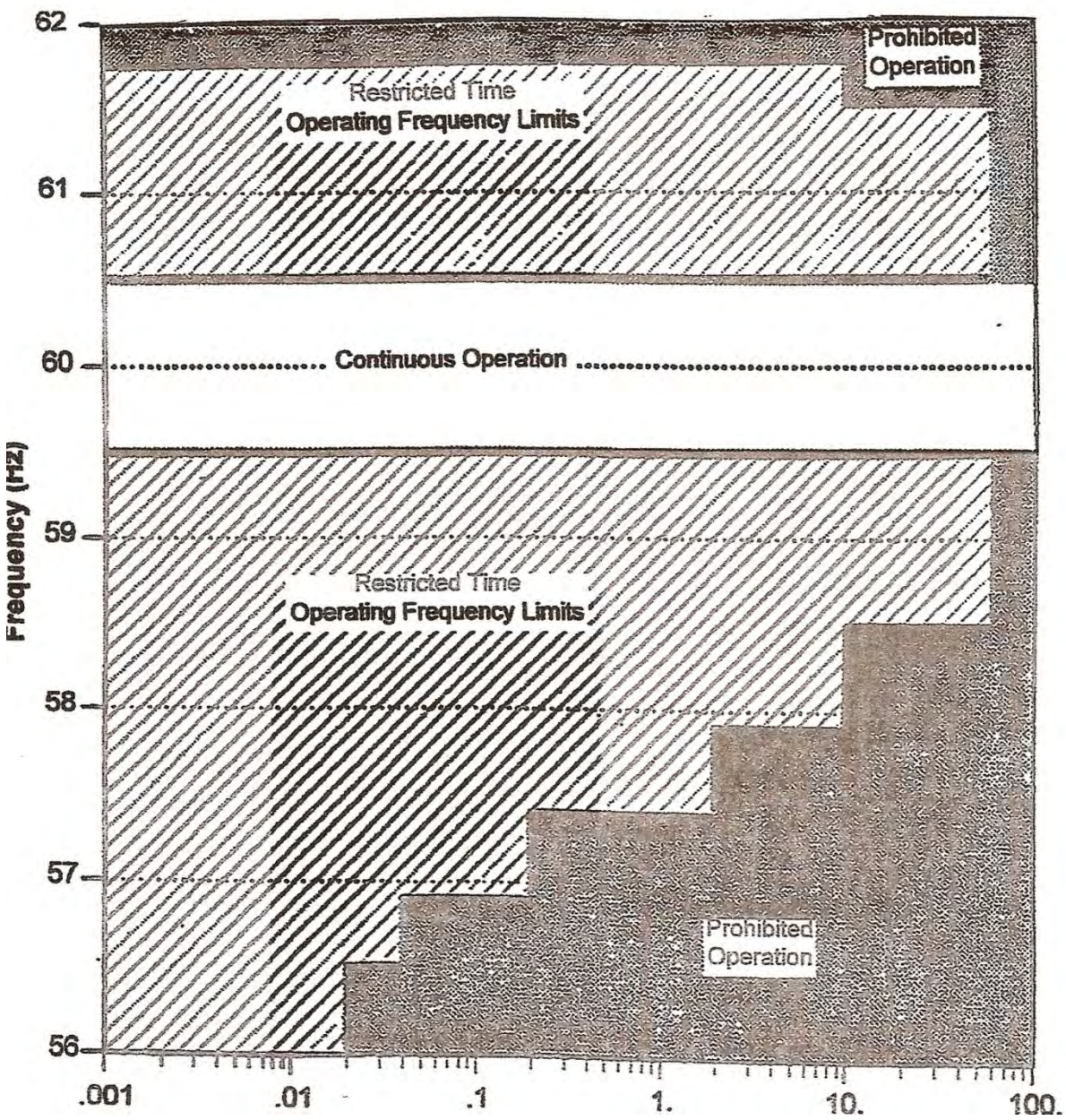
$$I*T = I*TIF = \sqrt{\sum_{n=1}^{K} (I_n * W_n)^2} \quad \textit{weighted amperes (Eq.3)}$$

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	5650	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						

ATTACHMENT E: GENERATION ABNORMAL FREQUENCY OPERATING ALLOWANCE



ATTACHMENT F: ELECTRICAL CLEARANCES AND EQUIPMENT RATINGS

Nominal System Voltage (kV)	Basic Impulse Insulation Level (BIL) (KV crest) (2)		Outdoor Design Clearance (in.)				Air Insulated Switch Design Clearance (in.)		Station Post Insulators Technical Reference Number(1)(2)
							Air Break	Disconnect	
	Bus & Xfmer Winding	Xfmr Bushing	Centerline-Ground		Centerline-Centerline		Phase Spacing	Phase Spacing	
			Rigid Bus	Strain Bus	Rigid Bus	Strain Bus			
765	2050	2050	195	240	390	480	480	390	n/a
500	1550	1550	147	180	270	300	300	270	379
345	1050	1050	99	132	150	180	216	150	316
230	900	900	84	120	124	164	192	124	304,308
161	750	750	63	86	86	116	168	86	291,295
138	550	650	46	60	72	84	144	72	286,287
88	450	550	37	44	54	60	108	54	286,287
69	350	350	29	36	42	48	84	42	216
46	250	250	21	24	36	42	72	36	214
34.5	200	200	16	21	30	36	60	30	210
23	150	200	13	18	24	30	60	30	208

(1) The technical reference numbers shown are a widely used identification series for post type insulators and are the Hoosier standard for the voltage class. Refer to ANSI Standard C29.9-1983, Table 1, for dimensions and characteristics for each insulator. Higher strength insulators with different technical reference numbers are available and should be used if required. The ANSI Technical Reference (T.R.) numbers refer to insulators with specific mechanical ratings. Higher ratings may be required or may be adequate according to the duty of the specific application.

(2) Substations in heavily contaminated areas may require a higher insulation level than indicated.

ATTACHMENT G: PROTECTIVE LOOP INSTALLATION

Air Break Switch on a Line	Wood Pole Line Direct Embedded Steel Pole Self Supported Steel Pole
1. With shield wires grounded at every structure and extending for at least ½ mile in both directions from the air break switch location.	Grounding Protection Loop Fig. 1
2. With ungrounded shield wires extending for at least ½ mile in both directions from the air break switch location.	Grounding Protection Loop Fig. 2
3. With air break switch ground bonded to multi-grounded neutral or to nearby station ground grid.	Grounding Protection Loop Fig. 1
4. With no shield wire or shield wire extending less than ½ mile in both directions, with no multi-grounded neutral and with air break switch not bonded to nearby station ground grid.	Grounding Protection Loop Fig. 2

Design Limits:

$I_{\Phi\text{-Gnd}}$ = 8000A Max.

Soil Resistivity = 500 Ω-Meter Max.

(If exceeded further analysis is required)

Spread 3/4 " crushed stone with 10-15% binding material,

4 " deep over entire area extending 1'-0" beyond grounding

NOTES FOR FIGURE 1 & 2

A.) For wood pole structures, a minimum 8 foot length of wood or plastic protective molding should be installed to completely cover the 4/0 AWG copper ground wire.

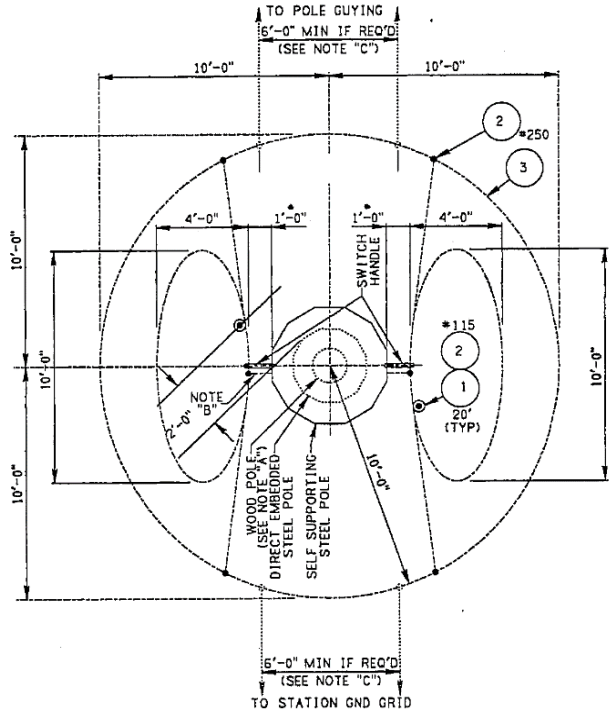
B.) Tie protective grounding loop to 4/0 AWG copper ground wire (Wood Pole) or structure ground pad (Steel Pole). In either case, the switch handle ground must be terminated to this 4/0 AWG copper ground wire.

C.) If switch structure is 100 feet or less from existing station ground grid, guy wire anchor grounding is recommended. Also, connect protective ground loop to existing station ground grid as noted.

FIGURE 1

GROUNDING PROTECTIVE LOOP WITH STATIC WIRE

(MANUAL OPERATION ONLY)



*= MAINTAIN 1'-0" BETWEEN POLE EDGE AND GROUND LOOP REGARDLESS OF POLE TYPE OR DIAMETER

LEGEND
1. ¾" GROUND ROD (LENGTH AS NOTED)
2. EXOTHERMIC CONNECTION (CART SIZE AS NOTED)
3. 4/0 AWG CU-SOLID SOFT DRAWN

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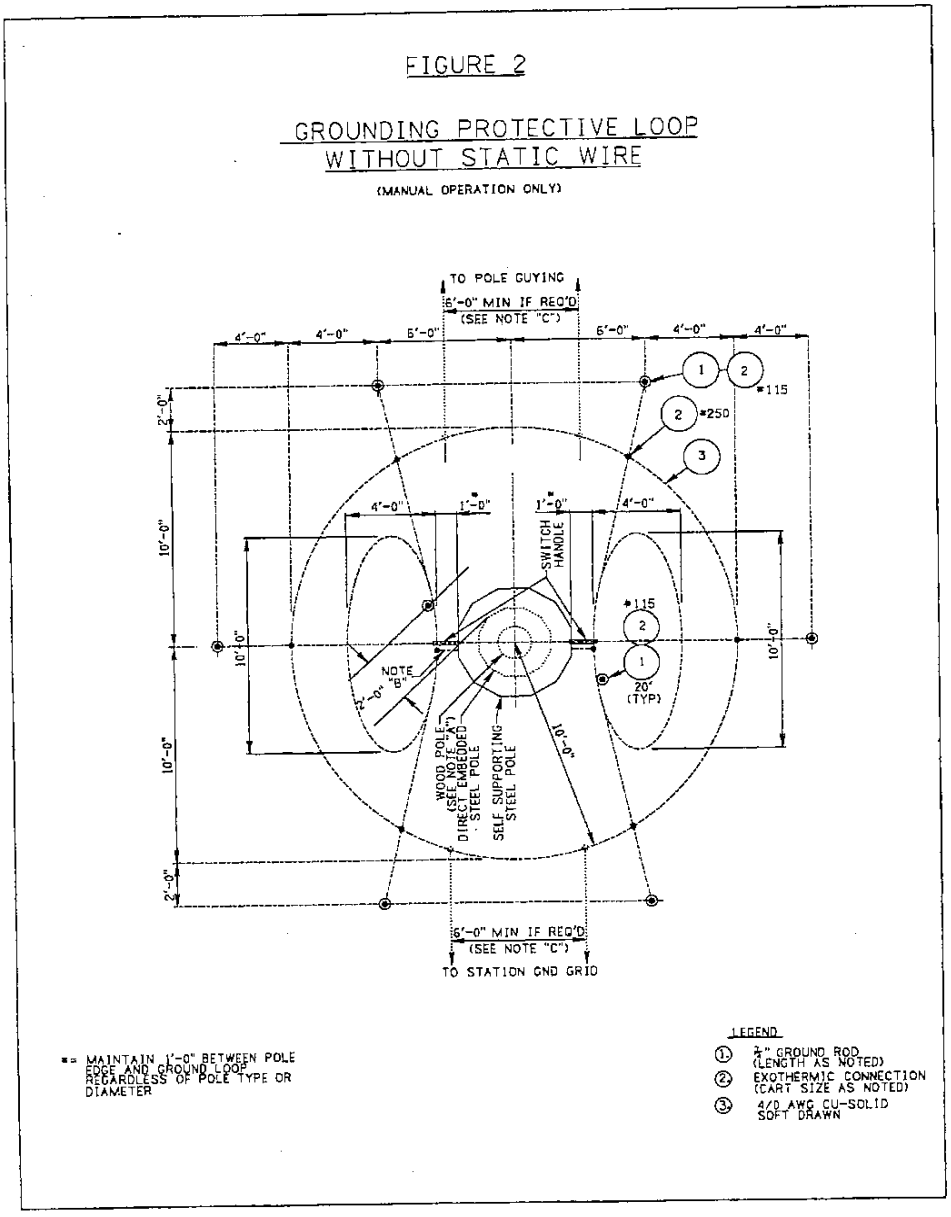
FIGURE 2
GROUNDING PROTECTIVE LOOP
WITHOUT STATIC WIRE
(MANUAL OPERATION ONLY)
TO POLE GUYING
6'-0" MIN IF REQ'D
(SEE NOTE "C")
4'-0"
4'-0"
5'-0"
6'-0"
4'-0"
4'-0"
#115
#250
2'-0"
10'-0"
4'-0"
1'-0"
1'-0"
4'-0"
SWITCH HANDLE
#115
20' (TYP)
NOTE "B"
2'-0"
WOOD POLE (SEE NOTE "A") DIRECT EMBEDDED STEEL POLE
SELF SUPPORTING STEEL POLE
10'-0"
6'-0" MIN IF REQ'D
(SEE NOTE "C")
TO STATION GND GRID
= MAINTAIN 1'-0" BETWEEN POLE EDGE AND GROUND LOOP REGARDLESS OF POLE TYPE OR DIAMETER
LEGEND
① ¾" GROUND ROD (LENGTH AS NOTED)
② EXOTHERMIC CONNECTION (CART SIZE AS NOTED)
③ 4/0 AWG CU-SOLID SOFT DRAWN

26.0 APPROVALS

PREPARED BY	DATE
System Planning Engineer  **Sara Ostrander**	12/25/18

APPROVAL	DATE
Manager, Power Delivery Engineering  **William C. Ware**	12/28/18