VERSION HISTORY

Current Version	Approval Date	Effective Date	Author	Changes
5	12/28/18	12/31/18	Ostrander	Annual Update: Reviewed and revised to include changes to FAC-001-3. Added language for R3.3.
4	12/29/15	12/31/15	Fields	Annual update; Reviewed and revised to include language addressing changes in FAC-001-2
3	12/31/14	12/31/14	Taft	Updated to Standard Hoosier format and modified document
2	05/31/14	05/31/14	Taft	Modifications to clarify requirements and to align with NERC Standards wording
1	02/01/09	02/01/09	Hill	Initial Release
0	01/09/02	02/01/02	Hill	Original legacy procedure

Requirement	Line Number
FAC-001-3 R1.1	30-31, 409-416
FAC-001-3 R1.2	27-29
FAC-001-3 R1.3	27-29
FAC-001-3 R3.1	63-98
FAC-001-3 R3.2	103-113
FAC-001-3 R3.3	115-122

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1.0 PURPOSE

- Documents facility interconnection requirements for transmission Facilities and end user Facilities 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 system to achieve necessary system performance throughout the planning horizon.
- Verifies compliance with industry standards.

2.0 APPLICABILITY

This document includes voltage levels 69 kV and above. Interconnections at voltage levels considered to be part of 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 R3.1

When an interconnection request is submitted, and the applicable facility data and monetary deposits are routed to the appropriate recipients, Hoosier Energy in conjunction with MISO (when applicable) 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 This series of studies will continue as long as the request is active and will be terminated if the request is withdrawn.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 transmission or modifying existing interconnections to Hoosier Energy's BES Transmission System are set forth by MISO at the following site:

https://www.misoenergy.org/planning/LTTSR/

5.0 PROCEDURES FOR NOTIFYING THOSE RESPONSIBLE FOR THE RELIABILITY OF AFFECTED SYSTEM(S) OF NEW OR MATERIALLY MODIFIED EXISTING INTERCONNECTIONS FAC-001-3 R3.2

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 OR MATERIALLY MODIFIED TRANSMISSION FACILITIES ARE WITHIN A BALANCING AUTHORITY AREA'S METERED BOUNDARIES FAC-001-3 R3.3

As part of specifying metering equipment, settings, and requirements, Hoosier Energy shall determine that any new or materially modified transmission Facilities resulting from any Transmission connection to Hoosier Energy's transmission 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 of the modification may include but not be limited to:

- Addition of generator, line or transmission termination to the Facility
- Addition of circuit breakers or switching devices that change the topology.
- Change of impedance (may require coordination under PRC-001)

What may not be considered a material modification:

- 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 provided no change in BES topology, switching devices that can change the topology, or substantial change in connected load take place.

8.0 SYSTEM IMPACT STUDY

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, voltage profiles and schedules, generation capacity (MW) provided a point of connection; 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 transmission connections. 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.

8.1 POWER FLOW ANALYSES

Power flow analyses (steady-state and transient) are conducted to examine the impact of the proposed facility on transmission lines and transformers, and voltage profiles. These analyses may typically determine the maximum load demand in the case of End-User facilities or through flow in the case of a Transmission Interconnection 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. These analyses are primarily concerned with **Transmission Interconnection** facilities. Increased fault duties may require upgrading existing circuit breakers and other facilities.

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

8.3 ADDITIONAL ANALYSES

Other analyses may be required as part of system impact studies based on power flow analysis and depending on the nature of the proposed connected facility and its location within the transmission network:

- Power quality analyses are undertaken for all **End-User** load that could potentially cause harmonic current or voltage, voltage flicker, and/or telephone interference.

- The possibility of adverse subsynchronous torsional interaction is investigated wherever the end-user's equipment such as arc-furnaces and/or cycloconverters is to be located in close electrical proximity to existing generation.

Criteria for harmonic interference, voltage flicker, and telephone interference are included in the document appendices. As for adverse torsional interaction, the criteria are wholly dependent on the specifics of any nearby generation.

The scope of all the above system impact studies will be determined by Hoosier Energy based on the type, location, and power level of the proposed facility. Normally, MISO will perform the system impact studies. The cost of these studies will be chargeable to the **Transmission Interconnection** or **End-User** in accordance with the applicable tariff. A report documenting the assumptions, results, and conclusions of the system impact studies is made available to the **Transmission Interconnectio**n or **End-User**.

Hoosier Energy and MISO must be notified of new facilities, upgrades, or additions such as an increase in load or generating capability of 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 Energy system to accommodate the changes in the connected facility.

8.4 DETAILED PLAN OF SERVICE

A detailed plan of service will be developed by Hoosier Energy to provide for 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 plans of service, but other possibilities exist depending on the particular situation. The physical layout of equipment and right-of-way needs are determined in the plan of service as well. Typically, more than one alternative is considered in developing a plan of service 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 plan of service to accommodate a multi-step increase in load for the connected facility.

8.5 RESPONSIBILITIES

Transmission Interconnection and/or **End-Users** are generally responsible for the costs associated with connecting to the Hoosier Energy Transmission System in accordance with the applicable tariff. The information contained herein is subject to change and may be revised at any time.

9.0 TAP CONNECTION DEFINITION AND REQUIREMENTS

Any connection to the Hoosier Energy transmission system that results in only the **End-User** load to pass through the connecting facilities under any condition is considered a tap connection.

Figure 1 in Attachment A illustrates typical End-User Interconnection configurations and some of the basic connection requirements. As indicated, line switches are typically the minimum requirements at the tap location point. The in-line air break switches allow for sectionalizing the line without supply interruption to the **End-User** and the tap line air break switch can disconnect the **End-User** without outaging the supply line. Motor operated mechanisms (with or without supervisory control) may be required on mainline air break switches to minimize the time required for restoration following a failure on the Hoosier Energy/**End-User** supply line. Hoosier Energy reserves the right to require the above listed equipment in the interconnection configuration. Hoosier Energy also reserves the right to require additional protection devices and configurations depending on the location and situation.

Figure 2 in Attachment A represents a Transmission Interconnection configuration for the Hoosier Energy transmission system and some of the basic connection requirements. Both a ring bus and a breaker-and-a-half scheme are acceptable. Hoosier Energy reserves the right to require the above listed equipment in the interconnection configuration. All connections above 230 kV regardless of End-User or Transmission Interconnection will be required to be treated as a Transmission Interconnection.

In general, connecting to an Hoosier Energy substation bus would use transformer switching arrangements similar to that required for tapped line supply configurations. The substation bus connections will be reviewed on a case-by-case basis. In all cases connections to an Hoosier Energy substation bus will require review and additional expense for the End-User or Transmission Interconnection requestor. For connections that are up to 230 kV, the requester should be prepared to include:

- Motor operated full-load break switches required on the main line.
- Manually operated air break switch required on the tap line, unless the tap line is longer than 1 span. A line longer than 1 span may require a motor operated tap line switch.
- Substation high-side disconnect switch and protective device.
- For loads that do not exceed 10 MVA, fused protection is the typical requirement.
- For loads that are in excess of 10 MVA, or any voltage above 100 kV, a circuit breaker or circuit switcher is the typical requirement.
- An inline metering station with circuit breaker may be required at the option of Hoosier Energy at the tap point of the Hoosier Energy main line.

For **End-User** tap supply configurations, either a delta or ungrounded-wye high side transformer winding configuration is preferred. The installation of a grounded-wye high side transformer could require additional protection facilities and costs to be borne by the **End-User**. Transmission interconnections shall interface the Hoosier Energy system with a grounded-wye winding configuration.

10.0 LOOPED CONNECTION DEFINITION AND REQUIREMENTS

Any connection to the Hoosier Energy Transmission System that provides two line extensions to supply the **End-User** is considered a looped connection. In general, the two line extensions are installed to facilitate **End-Users** obtaining looped service, not to enable Hoosier Energy to provide adequate electrical service to any location other than the **End-User**.

Since some looped connections have the potential to significantly affect the reliability and loadability of the Hoosier Energy Transmission System, specific design and operational requirements are imposed which may not be required for a tapped connection. In addition to the requirements outlined in Section 20.0, the following conditions apply:

- For voltages greater than 100 kV, but less than 230 kV, the preferred connection is through a ring-bus and optionally a breaker-and-a-half scheme. Other configurations may be allowed at the discretion of Hoosier Energy.

11.0 NETWORK CONNECTION DEFINITION AND REQUIREMENTS

Any connection to the Hoosier Energy Transmission System that allows bi-directional energy and/or fault current flow between otherwise independent transmission systems is considered a network connection. This is considered a special circumstance, which requires a detailed system impact study to determine the acceptability of the proposed transmission interconnection and the specific interconnection requirements. Transmission interconnection requests on the Hoosier Energy Transmission System will be considered on a case- by-case basis. The **Transmission Interconnection Requester**[1] will be responsible for reimbursement of the cost for these studies (generally done by MISO). In addition, the cost of facilities to establish and reliably integrate the new network connection will be at the expense of the **Transmission Interconnection Requester** to the extent allowed by the appropriate MISO Tariff documents.

[1] **Transmission Interconnection Requester** -refers to the entity requesting a network transmission interconnection to the Hoosier Energy transmission system.

12.0 VOLTAGE LEVELS

The **Transmission Requester's**[2] facility will be supplied from Hoosier Energy's Transmission System, which generally under system normal conditions and single transmission element outage conditions can range between 90% and 105% of nominal. If the **Requester's** supply voltage requirements are more restrictive than the 92% to 105% range, Hoosier Energy recommends that the **Requester** consider the addition of voltage regulation equipment in their facility. Nominal transmission system voltages presently on the Hoosier Energy system are: 345 kV, 161 kV, 138 kV and 69 kV.

Under certain emergency conditions, the Hoosier Energy Transmission System may operate for a period of time outside of the 90% to 105% range. The **Requester** is responsible for providing any voltage sensing equipment required to protect their equipment during abnormal voltage operation.

13.0 POWER FACTOR REQUIREMENTS

The NERC Planning Standards state that distribution entities and customers connected directly to the transmission systems should plan and design their systems to operate at close to unity power factor to minimize the reactive power burden on the transmission systems. The Hoosier Energy interpretation of “close to unity power factor” is that the power factor of the connected load should be within the range of approximately 0.98 lagging to 0.98 leading.

Unless otherwise restricted by Retail Tariffs, the maximum hourly reactive power (kVAR) demand, both leading and lagging, will be identified each month at the delivery point(s). An **End-User** will incur no charges for power factor if the maximum leading and lagging kVAR demands do not exceed 20% of the real power (kW) demand in the same hour(s). If the maximum hourly leading and/or lagging kVAR demands exceed 20% of the corresponding kW demand, charges will be assessed. The charge will be one rate per kVAR for all leading and/or lagging kVAR demand in excess of 20% of the corresponding kW demand. When the leading and/or lagging kVAR demand exceeds 50% of the corresponding kW demand, the charge will be a higher rate per kVAR, for all kVAR in excess of 20% of the kW demand. The cost of reactive demands for Hoosier Energy full requirements customers will be based on the applicable state or FERC filed tariff.

Capacitors generally provide an effective means of controlling the power factor of a **Requester's** facility. However, there are several factors that should be addressed in

[2] **Transmission Requester** - can refer to either a **Transmission Interconnection Requester** or a **Transmission End-User Requester** and hereinafter is referred to as a **Requester**.

applying capacitors. These factors can include, but are not limited to, transient voltages due to capacitor switching and voltage amplification due to resonance conditions. The services of a Hoosier Energy approved consultant should be obtained to review the specific application and provide recommendations in regard to control of these phenomena.

14.0 FREQUENCY RANGE

The Hoosier Energy transmission system typically operates at a nominal 60 Hz with a variation of +0.05 Hz to -0.05 Hz. Under certain emergency conditions, the transmission system may operate for a period of time outside of this range. The **Requester** is responsible for providing any frequency sensing equipment required to protect their facility during abnormal frequency operation.

15.0 POWER QUALITY

15.1 HARMONICS AND FLICKER

Certain electrical equipment located at the **End-User's** facility (arc furnaces, cycloconverters, etc.) will generate voltage flicker[3] and harmonic distortion which can negatively impact other **End-Users**. Should this be the case, the **End User** shall take responsibility, initially or in the future, for limiting interfering levels of harmonic voltage and current distortion and/or voltage flicker. Limits for harmonic distortion (including inductive telephone influence factors) are as published in the latest issues of ANSI/IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

Specific Hoosier Energy harmonics and flicker criteria are given in Attachment C. Hoosier Energy 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 C, Exhibit 1). Hoosier Energy may, initially or in the future, 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 **End-User's** expense.

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

15.2 SENSITIVE ELECTRICAL EQUIPMENT

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

Certain electrical equipment in the **Requester's** facility may be sensitive to normally occurring electric interference from nearby connected loads in the **Requester's** facility, from other **End-Users** connected to the power system, from natural causes, and system switching, etc. If sensitive electrical equipment is to be supplied directly from the electric power system, it is recommended that the equipment grounding requirements and power supply requirements be examined by the **Requester** or the **Requester's** consultant prior to installation. Attention should be given to equipment tolerance to various forms of electric interference, including voltage sags and surges, momentary outages, transients, current and voltage harmonic distortion, or other electrical and electromechanical noise. When electrical disturbances to sensitive electrical equipment such as computers, electronics, controls, and communication equipment cannot be tolerated, the **End-User** shall install additional equipment as may be necessary to prevent equipment malfunctions and protect against equipment failure. The **End-User** should consult the supplier of such sensitive electrical equipment regarding the power supply requirements or the remedial measures to be taken to alleviate potential mis-operation or failure of the equipment. The **End-User** may need to hire a power quality consultant to also perform a site survey of the electric power supply environment and furnish recommendations to provide the acceptable levels of reliability and quality of service.

15.3 TRANSFORMER PROTECTIVE DEVICES

Hoosier Energy requires **End-Users** to install circuit switchers and/or circuit breaker. Hoosier Energy will allow fuses as an exception for voltages <69kV and <10 MVA.

15.4 UNBALANCED ELECTRIC CONDITIONS

15.4.1 VOLTAGE BALANCE

Voltage unbalance attributable to the **End-User** facilities 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 C84.1-2011, “American National Standard for Electric Power Systems and Equipment Voltage Ratings, 60 Hertz.”

15.4.2 CURRENT BALANCE

Phase current unbalance attributable to the **End-User** facility 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.

15.5 SUBSYNCHRONOUS TORSIONAL INTERACTION

Certain **End-User** equipment, in particular electric arc furnaces and cycloconverters, may cause adverse interactions and possible damage to existing turbine-generators located in close electrical proximity. These situations will be analyzed by Hoosier Energy, or Hoosier Energy's consultant, and appropriate corrective or preventive measures identified. Corrective and preventive measures may consist of torsional current monitoring, special protective relaying on the turbine-generator shaft(s), or constrained operation of the **End-User** equipment under certain system configurations. Costs of studies and the design and installation of protective and/or monitoring equipment shall be the responsibility of the **Requester**.

16.0 SYNCHRONIZATION

The **Transmission Facility Owner** and End User shall assume all responsibility for properly synchronizing their transmission for operation with the Hoosier Energy Transmission System, and for remaining synchronized with Hoosier Energy in accordance with industry accepted practice.

17.0 GENERATION

Generation connected to and operated in synchronism with the Hoosier Energy transmission system in conjunction with **End-User** load is subject to additional requirements beyond those specified in this document. Information concerning these requirements is contained in “Requirements for Connection of Generation to the Hoosier Energy Transmission System.” The **Generation Facility Owner** should contact the local Hoosier Energy Industrial/Commercial Service Representative for this document.

18.0 INFORMATION REQUIRED

As soon as available, the **Requester** shall provide two copies of the following information for review and comment by both the Technical Assets and the Design Services groups at Hoosier Energy, as well as to MISO.

a. **Requester's** Information

- company name
- mailing address
- contact representative
- phone number

b. Project Design/Engineering Information

- company name
- mailing address
- contact representative
- phone number

c. Requested in-service date for the transmission connection, and for temporary service to test facilities prior to formal in-service.

d. Plot plan or description showing exact location and orientation of Requester's proposed facilities and point of electric service delivery.

e. One-line, schematic diagrams, plan and elevation drawings of the proposed facilities showing dimensions, clearances and grounding layout.

f. Information on characteristics of load, including initial load build-up, 5 and 10 year load projections, and power factor of such loads.

g. Information concerning the **Requester's** power factor correction equipment. This should include size and amount of fixed or switched capacitors, or other power factor correction equipment and methods used for operation.

At least three months before starting electrical construction of the **Requester's** facility, the following additional information must be sent to Hoosier Energy's Manager of Power Delivery Engineering or their designee(s). Failure to provide this information in a timely manner may delay the facility in-service date.

h. Data on equipment to be installed.

i. High side interrupting and sectionalizing devices –
- Manufacturer
- Type
- Voltage rating
- Current ratings.

ii. High side relaying equipment with complete manufacturer's data.

iii. Power transformers -Complete nameplate and test report data, including manufacturer, serial number, high and low side voltage taps, kVA ratings, high and low side connections, low side grounding (if used), load loss watts and positive and zero-sequence impedances between the high-low, high-tertiary, and low-tertiary transformer windings (as applicable) at each tap.

iv. Data on **Requester's** low voltage protection equipment, including fuses, breakers, relays, and relay settings.

The information in subsections h and i is required to perform coordination selectivity studies in a timely manner. Any disagreement in this regard must be resolved prior to energization.

Depending upon the nature of the **End-User** equipment to be installed, the following data may be required to complete the portion of the system impact studies addressing power quality and/or subsynchronous torsional interactions.

j. Data on the harmonic and sub-harmonic current/voltage spectra of the end-user equipment to be installed under three phase balanced and unbalanced conditions.

k. Maximum magnitudes (MW and MVAR) of sudden load swings at the point of connection and the number of such fluctuations per second, minute or hour.

l. Data on SVC equipment and harmonic filters if applicable.

m. Maximum expected MW and MVAR demand at the point of connection.

19.0 REQUESTER'S FACILITY EQUIPMENT

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

The **Requester's** structure shall be designed for on a case-by-case basis 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.

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**.

If the incoming high voltage lines will cross road ways or railroad tracks, such as a siding or main line, to reach the **Requester's** facility, it may be necessary to increase the above tensions or provide additional height on the structure to meet appropriate crossing requirements.

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.

19.2 SHORT CIRCUIT DATA & INTERRUPTING DEVICE RATINGS

The following estimated short circuit levels will be provided by Hoosier Energy 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

*Note: Phase-to-ground fault values are calculated assuming the **Requester's** transformers have either a wye-ungrounded or delta connected high side. For wye-grounded transformers, the transformer contribution to the total fault current will have to be taken into account and the fault values recalculated.

Transmission Interconnection and **End-Users** equipment should have adequate interrupting and momentary ratings for the future short circuit conditions listed above.

While Hoosier Energy 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. **Transmission Interconnection** and **End-Users** 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 **Transmission Interconnection** or **End-Users'** facilities will be at the **Transmission Interconnection** or **End-Users'** expense.

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

19.3 OTHER DESIGN CRITERIA

19.3.1 EQUIPMENT BASIC INSULATION LEVELS

The minimum required Basic Insulation Levels (BIL) for stations are listed in Attachment D. Facilities in areas with significant airborne pollution may require a higher insulation level. The Requester will coordinate insulation levels to meet Hoosier Energy requirements in Attachment D.

19.3.2 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.

19.3.3 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 Energy transmission system network capability and (2) have adequate capability for the initial and future system conditions identified by Hoosier Energy.

19.3.4 ELECTRICAL CLEARANCES (OUTDOOR)

Electrical facility design clearances are listed in the table in Attachment D. These design clearances should be used for electrical facilities up to and including any interrupting device connected directly to an Hoosier Energy transmission line and for all facilities that are part of the Hoosier Energy transmission system.

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.

19.3.5 INSULATORS FOR STATION

The required station post insulator types are listed in the table in Attachment D. 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 values.

19.3.6 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 Energy personnel at all times. The switch shall be mechanically lockable in the open position with an Hoosier Energy padlock in order to provide for a visible electric isolation of the **Requester's** facility and shall be identified with an Hoosier Energy designated equipment number.

All air break switches shall be three phase, single throw, group operated. Disconnect switches shall be three pole, single throw devices. 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 D. 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.

As a minimum, a protective grounding loop shall be provided around all group operated switches as illustrated in Attachment E. 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 Energy.

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

19.3.7 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.”

19.3.8 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.
Ground fault levels from Hoosier Energy sources are listed in Section 11.2, Short Circuit Data & Interrupting Device Ratings. **Requester** equipment ground sources can contribute significant fault current independent of the ground fault values in Section 11.2. 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.

20.0 SYSTEM PROTECTION

20.1 TRANSMISSION PROTECTION

The **Requester** is responsible for functional specifications and relay settings for all protective relays at the **Requester's** facility that have a potential impact on the reliability of the Hoosier Energy transmission system. Hoosier Energy reserves the right to specify the type and manufacturer for these protective relays to ensure compatibility with existing relays. The specific recommendations and requirements for protection will be made by Hoosier Energy based on the individual substation location, voltage, configuration, utility grade relays, including fault recording, redundant protection, battery requirements, relay failure alarming, etc.

20.2 REQUESTER PROTECTION

It is the **Requester's** responsibility to assure protection, coordination and equipment adequacy within their facility for conditions including but not limited to:

1. single phasing of supply,
2. system faults,
3. equipment failures,
4. deviations from nominal voltage or frequency,
5. lightning and switching surges,
6. harmonic voltages,
7. negative sequence voltages,
8. separation from Hoosier Energy supply,
9. synchronizing generation.

20.3 AUTOMATIC UNDER-FREQUENCY LOAD SHEDDING

Hoosier Energy may require automatic under-frequency load shedding relaying on connected loads to comply with NERC EOP-003 “Load Shedding Plans” and PRC-006 or other system stability considerations.

20.4 TAP CONNECTED FACILITIES

Remote relay access is not normally required at tap connected facilities.

20.5 LOOP OR NETWORK CONNECTED FACILITIES

All digital relays which have the capability of recording system disturbance information and are used for protection of Hoosier Energy transmission facilities shall be provided with the equipment necessary to allow Hoosier Energy to remotely retrieve this data via **Requester** supplied access.

21.0 REVENUE METERING AND TELEMETRY REQUIREMENTS

21.1 REVENUE METERING

Hoosier Energy approved revenue class metering equipment shall be installed at the delivery point to meter the aggregated load of the connected facility consisting of instantaneous bi-directional real and reactive power and integrated hourly real and reactive energy metering.

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 total accuracy by more than 0.3%. The metering equipment will be tested periodically as defined in the service 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. Representatives from 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. If required, voltage measurements will be provided.

The instrument transformers used for revenue metering shall be installed on the high voltage side of the **Requester's** step-down transformer. Under special circumstances and with written approval granted by Hoosier Energy, revenue metering may be performed on the low voltage side of the step-down transformer. Written approval shall only be given if the **Requester** can demonstrate that accurate transformer loss compensation will be programmed into the revenue metering when instrument transformers are installed on the low voltage side of the step-down transformer.

21.2 TELEMETRY

Suitable telemetry equipment will be installed at the metering point to provide real-time telemetry data to Hoosier Energy and to all other participating parties.

Telemetry equipment will include transducers, remote terminal units, modems, telecommunication lines, radio equipment and any other equipment of the same or better function. The remote terminal unit must have multiple communication ports to allow simultaneous communications with all participating parties. The 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 0.3% accuracy. As part of real-time data to be provided, Hoosier Energy 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 in the meter. Freezing accumulation data for transmission will be taken every clock hour. The freezing signals synchronized to within 2 seconds of Eastern Standard Time or time defined by MISO 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, 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 abnormal power supply 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 Energy 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.

22.0 COMMUNICATIONS

22.1 VOICE COMMUNICATIONS

A. Normal - At Hoosier Energy's request, the **Requester** shall provide a dedicated voice communication circuit to the Hoosier Energy System Control Center (SCC). Such a dedicated voice communication circuit would originate from the **Requester's** office staffed 24 hours a day and would be typically required for connected transmission facilities that significantly affect the Hoosier Energy transmission network capacity and operations.

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 Energy.

B. Emergency - Voice communications in the event of a transmission facility emergency shall use the dedicated voice circuits, if available, or public telephone network and phone number(s) designated for emergency use.

It is the **Requester's** responsibility to take prudent steps when an area or system wide capacity emergency is declared. Load reductions shall be implemented by reducing non-essential loads. This type of reduction is usually conveyed through the local media. Interruptible customer load reductions may already be in effect depending on the nature of the emergency. The **End-User's** Hoosier Energy representative is responsible for providing the respective Hoosier Energy Transmission Dispatch Center (TDC) a “customer contact list.” This listing contains the **End-User's** Hoosier Energy representative and backup person as well as their business, home and pager numbers.

These **End-Users** shall be provided an unlisted phone number to be used for emergency or routine operations. Operational emergencies (equipment) warrant a direct call either way. The TDC will advise the Hoosier Energy representative of problems that they should handle directly with the **End-Users**.

22.2 INTERRUPTIBLE CONTRACTS

Owners of transmission facilities that have an Hoosier Energy interruptible contract shall install communication facilities with the Hoosier Energy TDC specified in the contract.

22.3 EMERGENCY OPERATING CONDITIONS

End-User's facilities may be subject to Hoosier Energy 's Emergency Operating Plan (EOP) and other applicable plans which can require interruption of load to deal with generation deficiencies and/or transmission system emergencies.

It is noted that interrupting of load will only be done in extreme conditions that would result in a more serious degradation of system performance than if the load were not shed.

System emergencies are communicated through the local media. Interruptible customers are also notified electronically in the event of an “Emergency Interruption.”

23.0 TURNOVER INSPECTION REQUIREMENTS

Before a **Requester** owned facility can be energized, it must pass a final turnover inspection by Hoosier Energy personnel. Hoosier Energy will inspect all substation equipment from the point of interconnection to the first protective fault interrupting device and the ground system. 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.

The ground system must be checked by using the resistance measurement procedures in accordance with IEEE Standard 81 “Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.”

The inspection will be performed by Hoosier Energy personnel who will document the inspection. An example of the form, showing the types of information required is shown in Attachment F.

23.1 MAINTENANCE REQUIREMENTS

All **Requester** owned equipment up to and including the first protective fault interrupting device is to be maintained to Hoosier Energy standards. This includes 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 “Maintenance Plan”.

The **Requester** shall have an organization approved by Hoosier Energy test and maintain all devices and control schemes provided by the Requester for the protection of the Hoosier Energy 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 Energy change to the protective devices. All testing and maintenance shall be coordinated with Hoosier Energy 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's "Maintenance Plan". Hoosier Energy reserves the right to inspect, test, or maintain the protective devices required for the protection of the Hoosier Energy System.

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

Hoosier Energy reserves the right to approve the testing and maintenance practices of a **Requester** when the **End-User's** system is operated as a network with the Hoosier Energy transmission system.

24.0 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 Energy furnishes electric service. It is the responsibility of the **Transmission Interconnection** or **End-User** to conform to all applicable national, state and local laws, ordinances, rules, regulations, codes, etc.

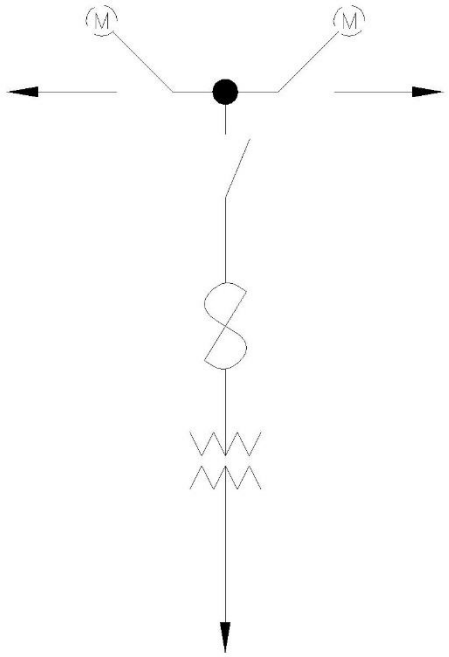
25.0 INDEMNIFICATION

The use and reliance upon the information contained in this document shall in no way relieve the **Transmission Interconnection** or **End-User** from the responsibility to meet NEC, IEEE, and NESC requirements governing their design, construction, operation, and materials.

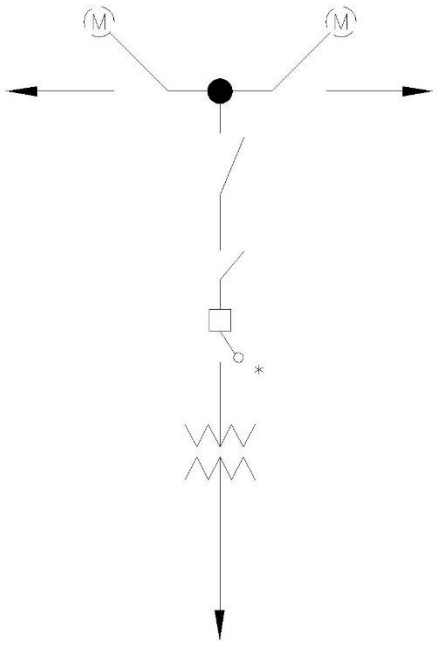
The **Requester**, for itself, its successors, assigns and subcontractors will be required to pay, indemnify and save Hoosier Energy, its successors and assigns, harmless from and against any and all court costs and litigation expenses, including legal fees, incurred

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 Energy. Reliance upon the information in this document shall not relieve the **Transmission Interconnection** or **End-User** from responsibility for the protection and safety of the general public.

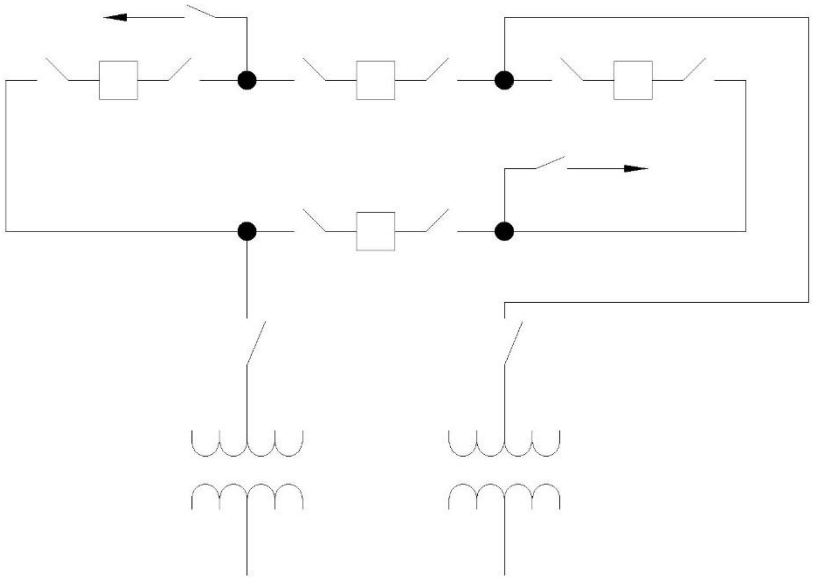
ATTACHMENT A: TYPICAL END-USER INTERCONNECTION



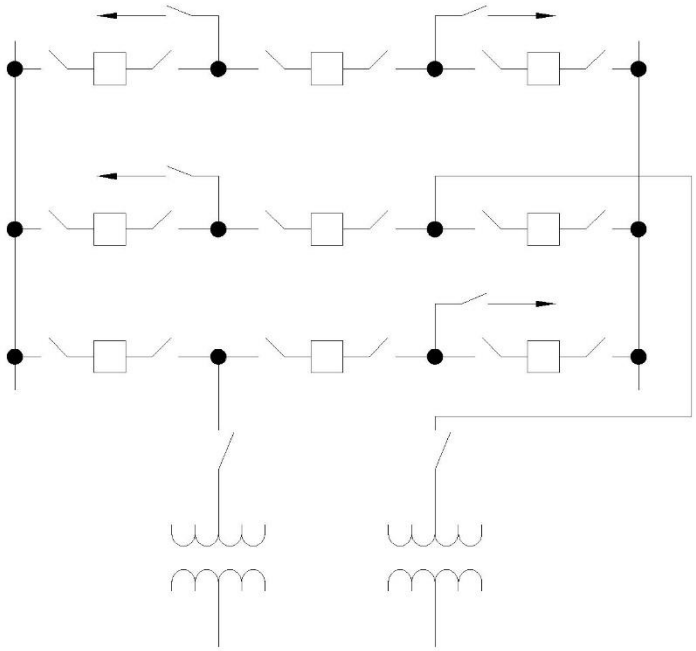
OR



ATTACHMENT B: TYPICAL TRANSMISSION INTERCONNECTION



OR



ATTACHMENT C: VOLTAGE FLICKER CRITERIA AND HARMMONIC DISTORATION CRITERIA SUMMARY

This attachment summarizes Hoosier Energy'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. The term Customer is defined as the party connected to the Hoosier Energy 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 I 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.

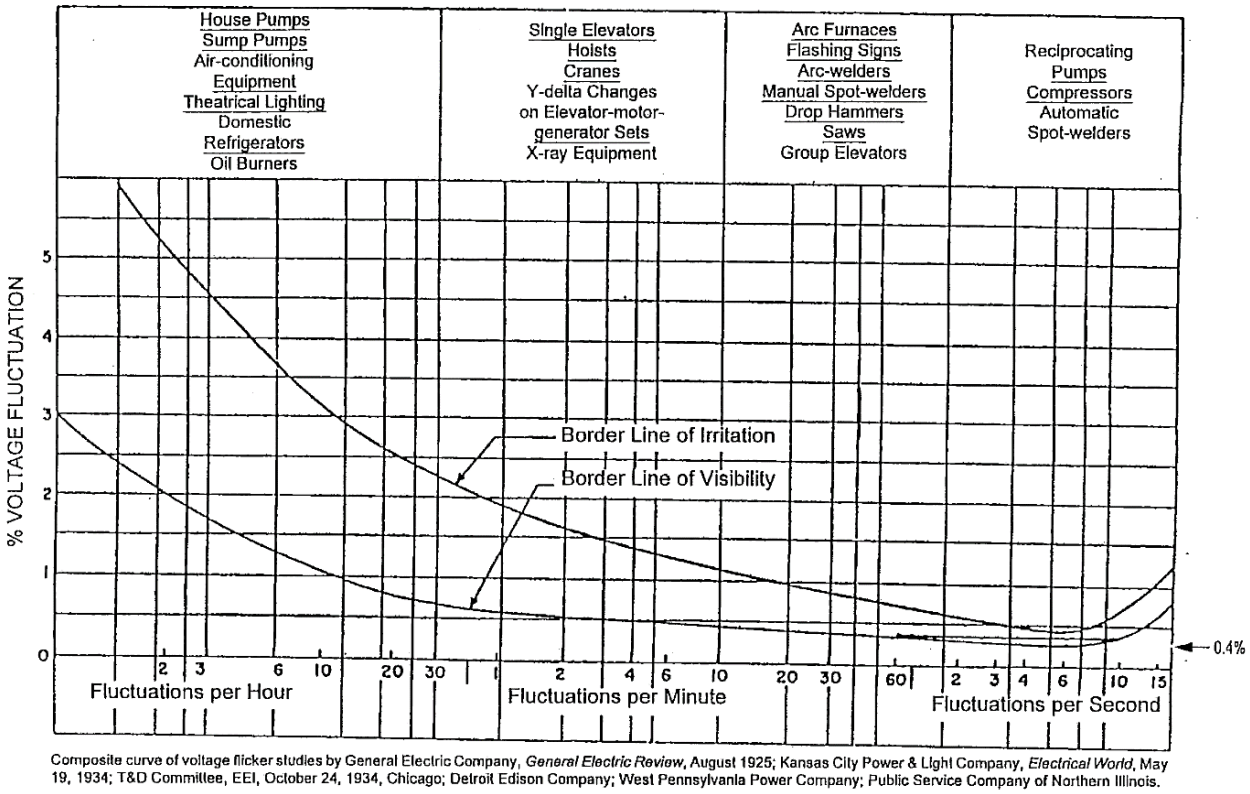
If the Customer fails to take corrective action after notice by the Company, the Company shall have such rights as currently provided for under its tariffs, which may include discontinuing service, until such time as the problem is corrected.

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 RELATIONS OF VOLTAGE FLUCTUATIONS TO FREQUENCY OF THEIR OCCURANCE



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 HARMONIC DISTORTION REQUIREMENTS

The Hoosier Energy 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 HARMONIC DISTORTION CALCULATIONS

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 Hoosier Energy 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

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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						

990

ATTACHMENT D: ELECTRICAL CLEARANCES AND EQUIPMENT RATINGS

ELECTRICAL CLEARANCES

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 & Xfmr 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 Energy standard for the voltage class. Refer to ANSI Standard C29.9-1983(R2012), 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 E PROTECTIVE LOOP INSTALLATION

PROTECTIVE LOOP INSTALLATION for various line conditions

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:

IΦ-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

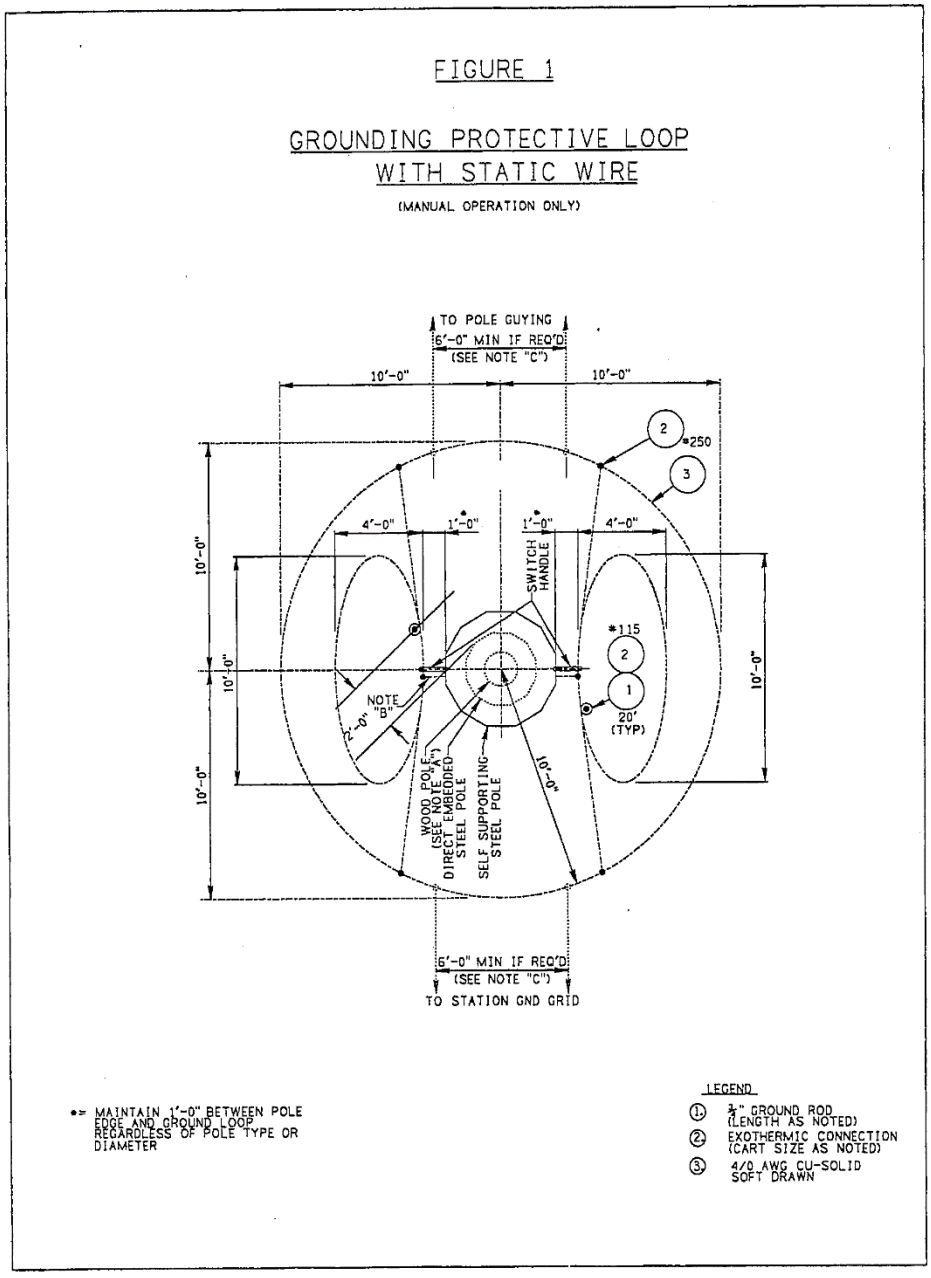
FIGURE 1
GROUNDING PROTECTIVE LOOP
WITH STATIC WIRE
(MANUAL OPERATION ONLY)
TO POLE GUYING
6'-0" MIN IF REQ'D
(SEE NOTE "C")
10'-0"
10'-0"
2
*250
3
4'-0"
1'-0"
1'-0"
4'-0"
SWITCH HANDLE
10'-0"
10'-0"
10'-0"
*115
2
1
20'
(TYP)
NOTE "B"
2'-0"
WOOD POLE (SEE NOTE "A") DIRECT EMBEDDED STEEL POLE
SELF SUPPORTING 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

FIGURE 2

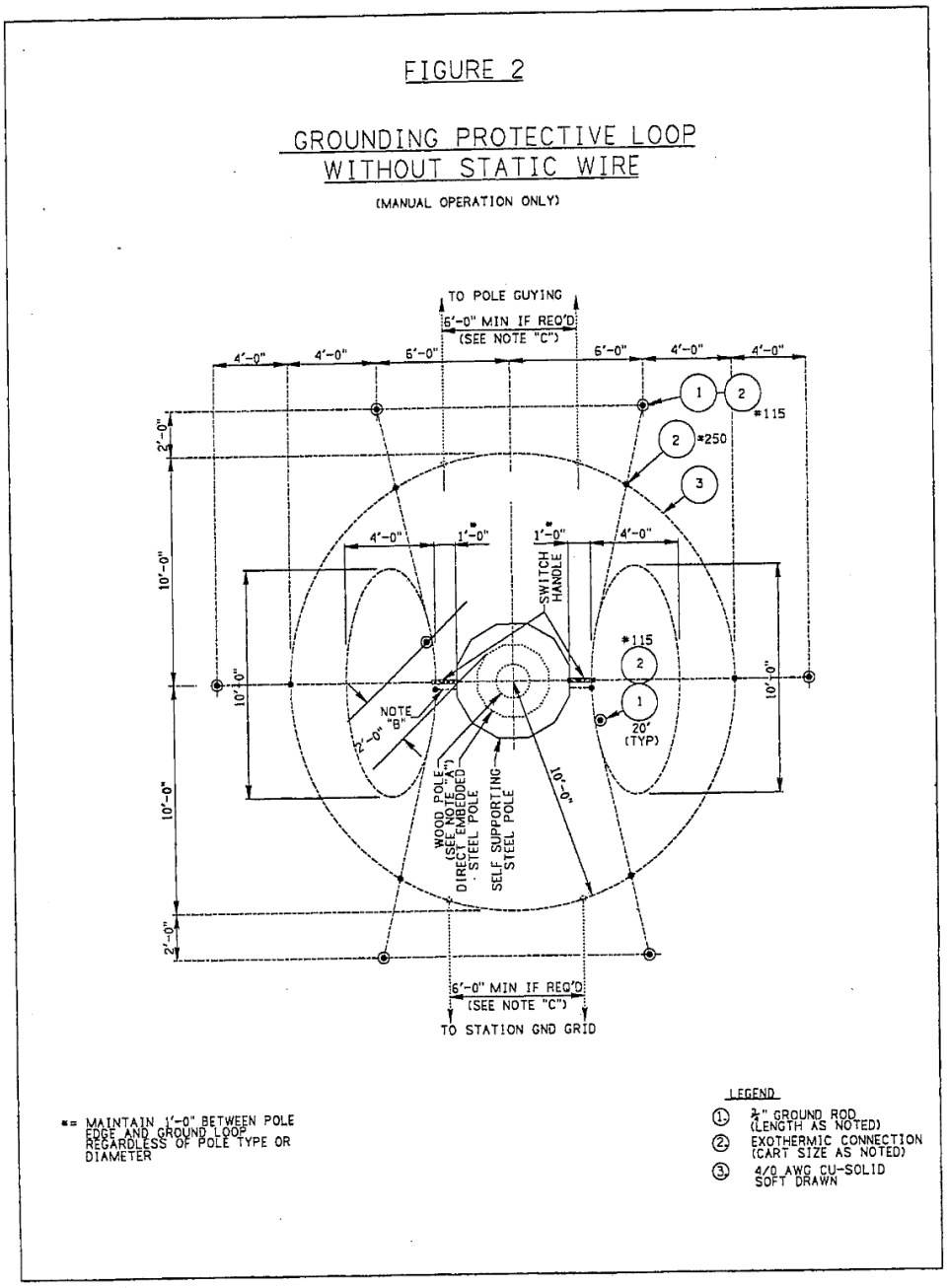
FIGURE 2
GROUNDING PROTECTIVE LOOP
WITHOUT STATIC WIRE
(MANUAL OPERATION ONLY)
TO POLE GUYING
6'-0" MIN IF REQ'D
(SEE NOTE "C")
4'-0"
4'-0"
6'-0"
6'-0"
4'-0"
4'-0"
2'-0"
10'-0"
10'-0"
10'-0"
2'-0"
#115
#250
#115
1'-0"
1'-0"
SWITCH HANDLE
NOTE "B"
22'-0"
20' (TYP)
WOOD POLE (SEE NOTE "A") DIRECT EMBEDDED 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

ATTACHMENT F: TURNOVER INSPECTION REQUIREMENTS FORM

CONNECTING FACILITY

Electrical Facility Checkout Guide (Turnover Inspection)

ITEM	ACTION/INFORMATION BY		DATE
1. Facility Ground Resistance	Review Test Results	_____	_____
2. Air break and Disconnect Switch Alignment			
a. *Switch Device Number* _____	Visual Inspection	_____	_____
b. *Switch Device Number* _____	Visual Inspection	_____	_____
c. *Switch Device Number* _____	Visual Inspection	_____	_____
d. *Switch Device Number* _____	Visual Inspection	_____	_____
e. *Switch Device Number* _____	Visual Inspection	_____	_____
f. *Switch Device Number* _____	Visual Inspection	_____	_____
3. Circuit Breakers			
a. kV Circuit Breaker *Device Number*			
1. Gas Filled	Visual Inspection	_____	_____
2. Timing Tests	Review Test Results	_____	_____
3. Digital Low R Ohmmeter	Review Test Results	_____	_____
4. Doble Test	Review Test Results	_____	_____
5. CT Ratio & Polarity	Review Test Results	_____	_____
6. Breaker Alarms	Detailed Inspection	_____	_____
4. Circuit Switcher			
a. _____kV Circuit Breaker *Device Number*			
1. Hipot Test	Review Test Results	_____	_____
2. Timing Test	Review Test Results	_____	_____
3. Digital Low R Ohmmeter	Review Test Results	_____	_____
5. Fuses			
a. _____kV Fuses *Device Number*			
1. Rating/Type	Visual Inspection	_____	_____
2. Air Flow Test	Review Test Results	_____	_____
6. Power Transformer			
a. _____kV Transformer *Device Number*			
1. CT Ratio & Polarity	Review Test Results	_____	_____

7. CCVT/VT

a. _____kV *Circuit/Line Name* CCVT/VT *Device Number*

1. Doble Test	Review Test Results	_____	_____
2. Potential Polarizing Test	Review Test Results	_____	_____
3. Ratio & Polarity Test	Review Test Results	_____	_____

b. _____kV CCVT/VT *Device Number*

1. Doble Test	Review Test Results	_____	_____
2. Potential Polarizing Test	Review Test Results	_____	_____
3. Ratio & Polarity Test	Review Test Results	_____	_____

8. Phasing

a. _____kV BUS *Number*	Detailed Inspection	_____	_____

9. Batteries and Charger

a. _____V DC Battery and Charger

1. Battery Acceptable	Review Test Results	_____	_____
2. Intercell Resistance Test	Review Test Results	_____	_____
3. Charger Settings	Visual Inspection	_____	_____
4. Ground Detector	Detailed Inspection	_____	_____

10. SCADA

a. Function Test with SCC

1. Control	Detailed Inspection	_____	_____
2. Indication	Detailed Inspection	_____	_____
3. Alarms	Detailed Inspection	_____	_____

b. Metering	Detailed Inspection	_____	_____

11. Relay and Control Schematics

a. _____kV Circuit Breaker *Device Number*

1. Correct Settings Applied	Review Test Results	_____	_____
2. Calibration Test	Review Test Results	_____	_____
3. Trip Test	Detailed Inspection	_____	_____
4. In-Service Load Angles	Detailed Inspection	_____	_____
5. Remote Relay Communication	Detailed Inspection	_____	_____

b. _____Annunicators and Alarms

1. Set Undervoltage & Time Delay Relays	Review Test Results	_____	_____

2. Function Tested	Review Test Results	_____	_____

12. Miscellaneous

a. Arrestors

1. Sized Correctly	Visual Inspection	_____	_____
2. Located Properly	Visual Inspection	_____	_____

b. Clearance

1. Bus to Ground	Visual Inspection	_____	_____
2. Bus to Bus	Visual Inspection	_____	_____
3. Bus to Steel	Visual Inspection	_____	_____

26.0 APPROVALS

WRITTEN BY:	DATE
System Planning Engineer Sara Ostrander	12/28/18

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