INTERCONNECTION STANDARDS
FOR GENERATING FACILITES (GF) CONNECTED TO
THE KAYSVILLE DISTRIBUTION SYSTEM

October 2018
Updated Standards

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1.0 Scope and General Requirements

1.1 Scope and Intent

The requirements contained in this document apply to all generation sources connected to the Kaysville Utility Services distribution system 100KW and below at any one location. Any and all connections to the Kaysville Power Services distribution system and any aspect of such connection are subject to the Kaysville Power Services review and such connections shall not be permitted unless approved by the Kaysville Power Services. The operation and design of any GF must meet all of the requirements contained in this document, any written agreement between the Kaysville Power Services and the Operator, as well as any applicable requirements contained in the Kaysville Utilities Electric Service Rules and Regulations.

Any location where the aggregate total generation exceeds 100KW may require additional study by the Kaysville Power Services. This study will consider the specific feeder where the GF is proposed to be connected. If the addition of any GF causes the total amount of generation by all sources on that feeder to exceed 20% of the minimum load on that feeder, additional study by the Kaysville Power Services is required and the requirements produced as a result of that study may exceed those in this document. If the GF source to be added is highly variable such as wind or solar, and the total amount of wind or solar generation by all sources on that feeder exceeds 13.3% of the feeder capacity, or if the total of all the wind or solar generation on any substation exceeds 13.3% of the substation transformer size, additional study by the Kaysville Power Services is required and the requirements produced as a result of that study may exceed those in this document.

Protection and safety devices are intended to provide protection for the Kaysville Power Services distribution system, the Kaysville Power Services utility workers, the Kaysville Power Service customers and the general public. Protective devices installed on the GF are designed to ensure that the fault current supplied by the GF will be interrupted in the event a fault occurs on the Kaysville Power Services distribution system. When a fault occurs, the GF must be designed to automatically disconnect from the Kaysville Power Services distribution system until the distribution system is restored to normal operation.

Any source not explicitly described in this document will require special study before it is allowed to interconnect to the Kaysville Power Services.

1.2 System Phase and Voltage

The GF may interconnect to the system at any service voltage available at the site. Additional voltages may be arranged with the Kaysville Power Services on a case-by-case basis with the understanding that the GF will cover all cost associated with the Additional voltages, subject to the Kaysville Power Services approval.

1.3 System Reclosing

Automatic reclosing is utilized on the Kaysville Power Services distribution systems to clear temporary faults; however, the GF must be designed to ensure that the GF will disconnect from the distribution system in the event an automatic reclose occurs. The GF will not be allowed to interfere with automatic reclosing; however, industry standards require that a GF must automatically disconnect from an islanded system within two seconds.

1.4 Islanding

Islanding occurs when a GF becomes separated from the main generation source on a distribution system, but continues to independently serve a portion of the distribution system. GF's shall be equipped with protective devices and controls designed to prevent the generator from being connected to a de-energized distribution system. Islanding is not permitted on the Kaysville Power Services distribution system.

1.5 Synchronizing

Synchronization of the GF with the Kaysville Power Services system must be done automatically. All GF's must use protective devices that prevent electrically closing a GF that is out of synchronization with the distribution system. The Kaysville Power Services will under no circumstances be responsible or liable for any damage done due to an out of synchronization closure of a GF onto the system. Additionally, the Operator is responsible and liable for any damage done to the Kaysville Power Services system by any type of improper closing onto the system.

1.6 Improper Operation of the GF

Operation and design of the GF must meet all the requirements contained in this document as well as any applicable requirements contained in the Kaysville Municipal Code and the Kaysville Utilities Electric Service Rules and Regulations and any written agreement between the Kaysville Power Services and the Operator. Also, no GF operation will at any time be allowed to adversely impact the operation of the Kaysville Power Services system in any way. The GF must not produce adverse amounts of unbalanced currents or voltages; produce high or low voltages, or unacceptable frequencies; it must not inject DC or harmonics into the system beyond what is allowed by this document; or cause excessive operations of system voltage regulating devices such as load tap changers and voltage regulators. The GF must not adversely affect system grounding or ground fault protection.

The Kaysville Power Services will not normally interfere with the operation of any GF. However, when requested by the Kaysville Power Services by telephone, in person, or in writing, the Operator must immediately stop operation and not resume operation until cleared by the Kaysville Power Services to do so. If the Operator begins to operate the GF out of the ranges or conditions listed herein, the Operator must agree to cease operation until such a time as the GF Operator can demonstrate to the Kaysville Power Services that it has remedied the problem and can once again operate the GF in compliance with these requirements.

If usage of the GF causes unusual fluctuations or disturbances on, or interference with the Kaysville Power Services' system or other Kaysville Power Services customers, the Kaysville Power Services shall have the right to require the GF to install suitable apparatus to reasonably correct or limit such fluctuation, disturbance or interference at no expense to the Kaysville Power Services or other customers.

1.7 System Capacity Limitation

The equipment installed by the Kaysville Power Services to distribute power is limited in size and is normally sized for safe and efficient delivery of power. Adding generation to this system, especially generation supplied by renewable sources which normally have low capacity factors, may quickly overload the existing equipment. Care must be taken when adding generation to avoid damaging the Kaysville Power Services equipment. Also, when system penetration levels of distributed generation becomes large enough, accidental islanding of sections of the system becomes possible, and additional protective devices or systems, such as transfer trip equipment, may be needed for safe operation of the Kaysville Power Services system. Whenever one or more of the following limitations are exceeded, the

Kaysville Power Services may need to conduct an additional study and the Kaysville Power Services may require additional equipment. Additional study is required if:

a) The rated aggregate generation kVA on any distribution transformer after the addition of the new GF equals or exceeds 30% of the rating of the transformer;
b) The rated aggregate generation kVA on any protective device or feeder from the point of interconnection to the substation transformer exceeds 13.3% of the rating that protective device or feeder;
c) The rated aggregate generation kVA on any feeder or portion of a feeder equals or exceeds 20% of the existing annual minimum load on that feeder or feeder section;

1.8 Submittal Requirement

The Operator shall submit in a timely manner, sufficient design and specification information relating to the facilities to be installed by the Operator. The Kaysville Power Services shall be entitled to review and approve or disapprove these facilities prior to their installation and energization. The Operator agrees to incorporate any reasonable design changes requested by the Kaysville Power Services prior to, during, or after installation of the GF's facilities. The Kaysville Power Services' approval or acceptance of any design and specification information related to the GF to be installed shall not be construed as an endorsement of such engineering plans, specifications, or other information.

The following drawings and other documents must be submitted to the Kaysville Power Services for approval before any construction is begun:

a) Single-line diagram of the facility showing the sizes of all equipment and the system protection planned;
b) Cut sheets on all equipment planned including inverters, generators, fuses, circuit breakers, switches, etc.
c) Capability curves on all synchronous and doubly fed induction generators.
d) Short circuit calculations.
e) Or any other documentation that is required by Kaysville City's building department.

2.0 Standards and Definitions

2.1 Standards

In all cases the current edition of the following standards should be referred to in design of the GF"s, choice of equipment, and interconnection design.

a) ANSI C84.1 American National Standard for Electric Power Systems and Equipment- Voltage ratings (60 Hertz)
b) IEEE Std. 18 IEEE Standard for Shunt Capacitors
c) IEEE Std. 32 IEEE Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
d) IEEE Std. 141: IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
e) IEEE Std. 142: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
f) IEEE Std. 242: IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

g) IEEE Std. 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
h) IEEE Std. 665: IEEE Standard for Generation Station Grounding
i) IEEE Std. 1015: IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
j) IEEE Std. 1036: IEEE Standard for Application of Shunt Power Capacitors
k) IEEE 1547 IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
l) IEEE 1547.1 IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
m) IEEE 1547.2 IEEE Application Guide for IEEE Std. 1547, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
n) IEEE Std. C2: National Electrical Safety Code
o) IEEE Std. C37.06: IEEE Standard for AC High-Voltage Circuit Breakers rated on a Symmetrical Current Basis-Preferred Ratings and Required Capabilities.
p) IEEE C37.012: IEEE Application Guide for Capacitor Current Switching for AC High Voltage Circuit Breakers
q) IEEE C37.66: IEEE Standard Requirements for Capacitor Switches for AC Systems (1kV thru 38kV).
r) IEEE C37.90 IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
s) IEEE C37.90.1 IEEE Standard for Surge Withstand capability (SWC) Tests for Relay and Relay Systems Associated with Electric Power Apparatus.
t) IEEE C37.90.2 IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
u) IEEE C37.90.3 IEEE Standard Electrostatic Discharge Tests for Protective Relays
v) IEEE C37.95 IEEE Guide for Protective Relaying of Utility-Consumer Interconnections
w) IEEE Std. C37.102 IEEE Guide for AC Generator Protection
x) IEEE Std. C62.41: IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
y) NERC PRC-024-1: Generator Frequency and Voltage Protective Relays
z) NFPA 70: National Electrical Code
aa) NESC: National Electrical Safety Code
bb) UL 1741: Inverters , Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources

2.2 Definitions

The following definitions will be used throughout this document.

- ANSI-American National Standards Institute
- the Kaysville Power Services-Kaysville Utility Services
- GF-Generating Facility
- IEEE-Institute of Electrical and Electronic Engineers
- KVA-Kilovolt-amps
- KW-Kilowatt
- MW-Megawatt
- NEC-National Electrical Code
- NEMA-National Electric Manufactures Association
- NEMA-National Electrical Manufacturers Association
- NESC-National Electrical Safety Code

- Operator-Generating facility owner and operator, successors, heirs, agents, employees, and assigns
- PCC-Point of common coupling
- UL-Underwriters Laboratories
- VAR-Volt-Amps reactive (reactive power)

3.0 GF Equipment and Installation Requirements

3.1 General Requirements

The installation of any GF shall meet the relevant requirements of the National Electrical Code (NEC) and the National Electrical Safety Code (NESC). Where required by the municipality, the Operator cleared to move forward with the installation must obtain all necessary building permits, pass all applicable building department inspections, and meet other applicable requirements including but not limited to municipal code and Kaysville Electric Service Rules and Regulations.

Unless otherwise modified in this document, the interconnection must meet the requirements of IEEE Std. 1547. Where the requirements of this document vary from the requirements of IEEE Std. 1547, this document governs.

The Operator shall be solely responsible for protecting the GF and all associated equipment from abnormal distribution system conditions such as outages, short circuits, voltage or frequency variations, or other disturbances. The Kaysville Power Services will not install equipment for the protection of the GF generator or other equipment. The GF equipment must be designed and operated so that it is capable of properly synchronizing the generator to the system, maintaining safe operation of the generation equipment, detecting any unusual operating condition, and disconnecting the generator from the system anytime damage to the generator or other equipment may occur. The equipment protection provided by the Operator will prevent the GF from adversely affecting the distribution system's capability of providing reliable service to other Kaysville Power Services customers. The GF must automatically disconnect itself from the system anytime system conditions are outside the ranges described in this document and is not permitted to reconnect to the system until system conditions return to normal and are maintained within the normal range for a minimum of five (5) minutes.

3.2 Interconnection Disconnect Switch

Each GF installation must include a manually operated, lockable, disconnect switch with a visual break. The disconnect switch must be visible and accessible at all times by the Kaysville Power Services personnel to allow the GF to be disconnected safely during maintenance or outage conditions. In the case of a PV system this disconnect switch must be located next to the Kaysville Power Services electric meter. In all cases the disconnect switch must be rated to interrupt the maximum output of the generator and must be rated for the voltage and fault current requirements of the GF and must meet all applicable NEMA, UL, ANSI, IEEE, and NEC standards as well as local and state electrical codes. The disconnect switch shall be permanently labeled with text indicating that the switch is for the GF. The labeling shall also clearly indicate the open and closed position of the switch. The disconnect switch must be located on the output or load side of the GF such that the entire GF can be isolated from the Kaysville Power Services distribution system. If the site contains several generators, a single disconnect switch may be used providing its rating is sufficient for all generators and opening it produces a visible open point between all generators and the Kaysville Power Services system.

All lock-out and tag-out capabilities must also be available for the devices used and must be assessable to the Kaysville Power Services personnel.

3.3 Dedicated Transformer and Additional Primary Protection

If the GF rating requires a dedicated transformer the Operator will be required to cover all cost. The transformer must meet the Kaysville Power Services standards and design criteria. The transformer must be labeled according to the Kaysville Power Services practices.

3.4 Interrupting Devices Required

Circuit breakers or other interrupting devices located at the Point of Common Coupling (PCC) must be certified or "Listed" (as defined in Article 100, the Definitions Section of the National Electrical Code) as suitable for their intended application. This includes being capable of interrupting the maximum available fault current expected at their location. The Operator's GF Facility and associated interconnection equipment must be designed so that the failure of any single device will not potentially compromise the safety and reliability of the Kaysville Power Services' distribution system.

3.5 System Protective Functions

The protective functions and requirements contained in this document are designed to protect the Kaysville Power Services' distribution system and not specifically the Operator's GF. The Operator is solely responsible for providing adequate protection for the GF and all associated equipment. The Operator's protective devices must not impact the operation of other protective devices utilized on the Kaysville Power Services distribution system in a manner that would affect the Kaysville Power Services' ability to provide reliable service to its customers.

The GF's protective functions must sense abnormal conditions and disconnect the GF from the Kaysville Power Services distribution system during abnormal conditions. All GFs must be capable of sensing line-line-line, line-line, and line-ground faults on the distribution feeder supplying the GF and must disconnect from the line to protect both the line from further damage and the generator from damage due to excessive currents or unusual voltages.

For induction machines speed matching must be done automatically and shall match speed to less than 5% before closing the associated breaker.
The minimum protective functions needed for various types of generators, and other requirements for system protection are shown below. Any machine that is not included in one of the following categories must be individually considered by the Kaysville Power Services.

3.5.1 Synchronous Machines up to 100kW

a) Over and under voltage functions (27/59)
b) Over current trip functions. (50/51) which may be included in a breaker trip-unit or a fuse.
c) Ground fault protection (50/51G)
d) Over and under frequency functions. (81O/U)
e) Sync Check (25)
f) Phase-sequence or negative sequence voltage (47)
g) A function to prevent the GF from contributing to the formation of an unintended island and to prevent the GF from reconnecting with the distribution system under abnormal conditions is required.

h) Relay settings and test reports will be submitted to the Kaysville Power Services for review. The Kaysville Power Services will determine if an on-site inspection is required.

3.5.2 Induction Machines up to 100kW

a) Over and under voltage functions (27/59)
b) Over current trip functions. (50/51) Which may be included in a breaker trip-unit or a fuse.
c) Ground fault protection (50/51G) which may be included in a breaker trip-unit or a fuse.
d) Phase-sequence or negative sequence voltage (47)
e) Speed matching to within 5% (15)
f) If it is determined that it is possible for the machine to self-excite in this installation the GF must include a function to detect and trip the unit during a self-excited condition. This will prevent system over voltages and also prevent the GF from contributing to the formation of an unintended island. If such evidence does not meet the Kaysville Power Services approval, anti-islanding protection is required.
g) Relay settings and test reports must be submitted to the Kaysville Power Services for approval. The Kaysville Power Services will determine if an on-site inspection is required.

3.5.3 Inverter Connected Systems 100kW and Below

This may include photovoltaic systems (PV), some wind turbines, fuel cells, micro turbines and all other machines that deliver their power to the utility system via an inverter or converter utilizing power electronics.

a) The Inverter must be tested to meet IEEE 1547, and IEEE 1547.1. One way to meet this requirement is to be tested to UL1741.
b) The Kaysville Power Services will require over current trip functions (50/51) which may be included in a breaker trip-unit or a fuse. This device must be separate from the inverter control system and internal disconnect device.
c) The Kaysville Power Services will determine if an on-site inspection is required to observe calibration and testing of the inverter functions.

3.5.4 All Machines above 100kW

Any type of GF of this size must be studied and considered individually by the Kaysville Power Services.

3.6 Momentary Paralleling Generation Facilities

At times an Operator may decide to install a system that may operate parallel to the Kaysville Power Services system only momentarily (normally less than 0.1 seconds). With the Kaysville Power Services' approval, the transfer switch or system used to transfer the Operator's loads from the Kaysville Power Services' distribution system to the Operator's GF may be used in lieu of the protective functions required for parallel operation.

4.0 Facility Grounding

4.1 Facility Grounding

In all cases the GF grounding system must not adversely impact the Kaysville Power Services grounding or ground fault protective relaying. The GF grounding must not cause high voltages to occur under any condition either normally occurring or occurring during a system fault such as allowing high voltages to exist on the un-faulted phases during a single-line-to-ground fault.

4.2 Equipment Bonding Conductor

The Operator must install an equipment-grounding conductor, in addition to the ungrounded conductors and grounded conductor (neutral), between the GF and the distribution system. The grounding conductor must be permanent, electrically continuous, and must be capable of safely carrying the maximum fault current that could be imposed it by the systems to which it is connected. Additionally, the equipment-grounding conductor must be of sufficiently low impedance to facilitate the operation of over current protection devices under fault conditions. All conductors shall comply with the National Electrical Code (NEC). The GF must not be designed or implemented such that the earth becomes the sole fault current path.

4.3 Surge Protection

It is strongly recommended but not required that a surge protective device (SPD) be utilized to protect GF equipment.

4.4 System Grounding

The Kaysville Power Services maintains an effectively grounded distribution system and requires that all GFs be designed to contribute to an effectively grounded system. Effective grounding prevents the occurrence of excessively high voltages during ground faults and protects existing Kaysville Power Services equipment. Effective grounding of the GF may desensitize existing Kaysville Power Services ground fault protection, which could require the Kaysville Power Services ground fault relay settings changes or modifications in the design of the GF. The transformer supplied to interconnect the GF voltage to the Kaysville Power Services system will normally be a grounded-wye to grounded-wye transformer. This connection will not provide a grounding source by itself and will not provide an effectively grounded system from the GF side of the interconnection unless effective grounding of GF is provided. When designing the grounding system for the GF, the designer should consider the condition that will result when a ground fault occurs on the line serving the GF. This ground fault would be cleared on the Kaysville Power Services side of the line by opening a breaker or recloser in the Kaysville Power Services substation. This will result in momentarily islanding the line on the GF until it opens its breaker. Under this condition, where the line is islanded and being supplied by the GF, the system must remain effectively grounded.

Effective grounding shall be defined by IEEE Std.142 which states that to be considered effectively grounded both of the following two conditions must be met:

a) The ratio of zero-sequence reactance to positive-sequence reactance (X_0/X_1) must be positive at three or less.
b) The ratio of zero-sequence resistance to positive-sequence reactance (R_0/X_1) must be positive and less than 1.

The GF system equivalent (Thevenin equivalent) impedance must meet the criteria for effective grounding stated above. The networks used in determining this impedance, and other fault current calculations for the GF, will include the positive, negative, and zero sequence networks of the step- up transformer connected to the Kaysville Power Services system, all other transformers between the generator and the point of common coupling, the generator sub transient , positive, negative and zero sequence values, the neutral grounding device for the generator, the grounding transformer and neutral grounding device (if used) and any significant cable runs. The GF shall maintain an effectively grounded system under normal operating conditions while operating in connection with the Kaysville Power Services lines.

The short circuit contribution ratio (SCCR) of the GF is defined as the ratio of the GF short circuit contribution to the Kaysville Power Services' contribution to a short circuit (IscGF/IscFcu) for either a three-phase or single- line-to ground fault measured at the high voltage side of the transformer stepping up from the generation voltage to the Kaysville Power Services voltage.

The GF must be grounded in such a way that the SCCR for a line-ground fault calculated at the high voltage side of the transformer connecting the GF to the Kaysville Power Services is less than 3% while still achieving effective grounding as defined above. In rare cases connecting a certain GF to a particular feeder may not be practical due to protection issues or special protection techniques may be needed to make the connection safe.

Proper grounding of the GF can be achieved in a number of ways. The Kaysville Power Services may at its discretion accept any of the following methods:

a) Solidly grounding the generator or installing a solidly grounded grounding transformer (zig-zag or grounded wye-delta transformer). While a solidly grounded generator is acceptable to the Kaysville Power Services if all other requirements are met, it must be used with care. ANSI standards generally require that for a synchronous generator the ground fault current must be limited to the three-phase fault current. This usually requires a resistance or reactance be used for grounding the generator neutral. Also, a solidly grounded generator may conduct large amounts of harmonic currents. There may be some unbalanced voltage at the terminals of the generator. This can cause circulating current through the generator if it is solidly grounded which may make de-rating of the generator necessary. If a solidly grounded system is used the designer must consider and plan for all issues that may result.
b) Resistance grounding. A resistance grounded generator or grounding transformer with a resistance placed between neutral and ground may be used if it meets the requirements of effective grounding.
c) Reactance grounding. A reactance grounded generator or grounding transformer with a reactor between the transformer neutral and ground may be used if it meets the requirements of effective grounding.
d) Other methods may be suggested for consideration by the Kaysville Power Services.

5.0 Prevention of Interference and Unacceptable Operating Conditions

The Operator must not operate the GF in any way that causes a system disturbance or that superimposes a voltage or current upon the Kaysville Power Services' distribution system that results in interference with the

Kaysville Power Services operations, service to the Kaysville Power Services' customers, or other Kaysville Power Services equipment and facilities. When the Kaysville Power Services suspects that interference with electric service to other Kaysville Power Services customers is occurring, and such interference exceeds the Kaysville Power Services Standards, the Kaysville Power Services reserves the right at its expense to install special test equipment as may be required to perform a disturbance analysis and monitor the operation of the GF to evaluate the quality of power produced. If the GF is demonstrated to be the source of the interference, and it is demonstrated that the interference produced exceeds the Kaysville Power Services Standards or generally accepted industry standards, the Kaysville Power Services may, without liability, disconnect the GF from the Kaysville Power Services distribution system. It shall be the responsibility of the Operator to eliminate any interference caused by the GF and the Operator must diligently pursue and take corrective action, at the Operator's own expense, to eliminate undesirable interference caused by the GF. The GF will be reconnected to the Kaysville Power Services system only after the Operator demonstrates to the satisfaction of the Kaysville Power Services that the cause of the interference has been remedied.

The Operator's protective devices must prevent the GFs from contributing to an island. If the Kaysville Power Services feeder to which the GF is connected is de-energized for any reason, the GF must sense this and disconnect itself within 2 seconds of the de-energization of the feeder.

5.1 Voltage Regulation

The GF shall not actively regulate the voltage at the point of common coupling (PCC) unless the effects of this are first reviewed and approved by the Kaysville Power Services. If a study has been done by the Kaysville Power Services which determines that it is advantageous for a GF to actively control its voltage, the Kaysville Power Services will inform the Operator and the Operator will be required to control the GF's terminal voltage.

5.2 System Voltage

The voltage operating range limits for GFs shall be used as a protection function that responds to abnormal conditions on the Kaysville Power Services' distribution system. The Kaysville Power Services voltage operating range is normally - 95% to 105% of the nominal voltage at the electrical service point, and 92% to 105% of nominal voltage at the utilization point, as required by ANSI C84.1. All GFs must be capable of operating within the voltage range normally experienced on the Kaysville Power Services' distribution system. Occasional excursions outside this range may occur, and tripping of the GF is not suggested until the voltage range is less than 88% or more than 110% of the nominal voltage. The operating range and GF protection shall be selected in a manner that minimizes nuisance tripping between 88% and 110% of nominal voltage. GFs must not energize or, after a trip, re-energize the Kaysville Power Services' circuits whenever the voltage at the PCC deviates from the allowable voltage operating range allowed by ANSI C84.1 Table 1 voltage range (95-105% of nominal voltage at the service or 92-105% of nominal voltage at the utilization point).

Whenever the Kaysville Power Services distribution system voltage at the PCC varies from normal (nominally 120 volts) by the amounts as set forth in Table 5-1 the GF's protective functions shall disconnect the generator(s) from the Kaysville Power Services distribution system with delay times no longer than those shown.

Table 5-1: Voltage Trip Settings

(Adapted from IEEE 1547-2003 and ANSI C84.1-2006)

Voltage at Point of Common Coupling (% of base Voltage)	Maximum Tripping Time Delay (seconds/cycles)
V-PCC < 50%	0.16 / 10

50% < V-PCC < 88%	2.0 / 120
92% < V-PCC < / 105%	Normal operating range
110% < V-PCC < 120%	1.0 / 60
120% < V-PCC	0.16 / 10

5.3 System Frequency

The GF shall operate in synchronism with the Kaysville Power Services distribution system. Whenever the Kaysville Power Services' distribution system frequency at the PCC varies from normal (nominally 60 Hertz) by the amounts as set forth in Table 5-2 the GF's protective functions shall disconnect the generator(s) from the Kaysville Power Services distribution system with delay times no longer than those shown.

Table 5-2: Frequency Settings
(Adapted from IEEE 1547-2003 and NERC PRC-021-1)

GF Facility Size	Frequency (Hz)	Maximum Tripping Time Delay (sec./cycles)
GF 30kW or Less	GF<59.3	0.16/10
	59.3 :S GF :S 60.5	Continuous Operation
	GF>S0.5	0.16/10
GF > 30kW	GF<57.8	0.16/10
	57.8 :S GF :S 58.0	4/240
	58.0 < GF :S 58.5	40/2,400
	58.5 < GF :S 59.0	200/12,000
	59.0 < GF < 59.5	1,800/108,000
	59.5 :S GF :S 60.5	Continuous Operation
	60.5 < GF :S 61.5	600/36,000
	61.5 < GF	0.16/10

Unless some other anti-islanding scheme is employed, the GF should disconnect due to low frequency resulting from islanding the feeder load on the GF. The frequency settings must be adjusted to insure that, during the lowest loading level on the feeder, the resulting frequency change of the GF when it is islanded with those feeder loads , should cause the under frequency relaying to disconnect the generators within two seconds.

5.4 Synchronization

Synchronous machine automatic synchronizers and sync-check relays must be set as shown in Table 5-3.

Table 5-3: Synchronizer/sync check relay settings.
(Adapted from IEEE 1547-2003)

Rating of GF (kVA)	Maximum Slip Rate (Hz)	Maximum Voltage Difference (%V)	Maximum Phase Angle Difference (deQ) .
0-500	0.3	10	20
500-1500	0.2	5	10

1500 and above	0.1	3	10

5.5 Flicker

Any voltage flicker at the PCC caused by the GF should not exceed the limits defined by the "Maximum Borderline of Irritation Curve" identified in IEEE 519, IEEE 141, and IEE 1453. This limit is shown in Figure 5-1. This requirement is necessary to minimize the adverse voltage effects which may be experienced by other customers on the Kaysville Power Services distribution system due to the operation of the GF. Induction generators may only be connected to the system and brought up to synchronous speed (as an induction motor) if these flicker limits are not exceeded.

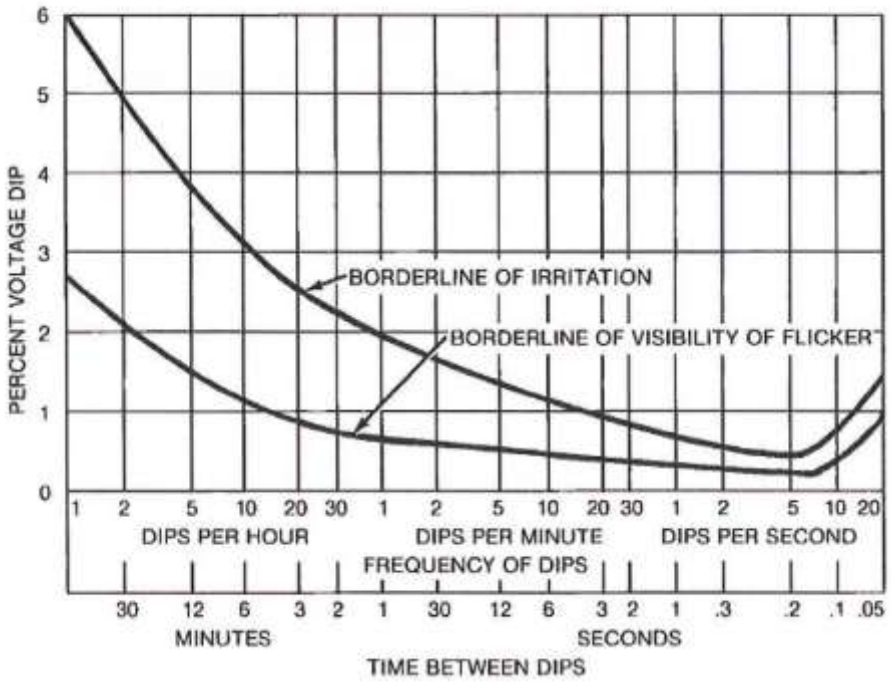

Figure 5-1: Allowable voltage flicker vs. time (reproduced from IEEE Std.141)

5.6 Harmonics

Harmonic distortion measured at the PCC must be in compliance with IEEE 519 and IEEE 1547. Harmonic current injection limits are shown in Table 5-4.

Table 5-4: Maximum harmonic current distortion as a percentage of fundamental frequency at the point of common coupling.
(Adapted from IEEE 1547-2003)

Individual Harmonic Order h (Odd Harmonics Only)										
h<11	I	11:5h<17	I	17:5h<23	I	23:5h<35	I	35:5h	I	TDD
4.0	I	2.0	I	1.5	I	0.6	I	0.3	I	5.0

The even harmonic limits must be 25% of those shown in Table 5-4.

GF's must not inject direct current into the Kaysville Power Services distribution system.

5.7 Power Factor

The power factor at the point of common coupling (PCC) with the Kaysville Power Services (the low voltage terminals of the transformer connecting the GF to the Kaysville Power Services) shall always remain within 0.95 lagging (VARs going into the site) to 0.95 leading (Vars going out of the site). The only exception to this requirement is a GF consisting of an inverter connected generator 1O kW or less. For this exception it is expected that the site power factor will deteriorate anytime the GF is operating, and the Kaysville Power Services will provide the VARs needed at the site. However the site power factor must be maintained such that it would remain within the limits stated above if the GF was not operating and, as a result, the power factor was allowed to revert to the value it had before the GF was added.

a) Each synchronous generator in a GF shall be capable of operating at any point within a power factor range of 0.95 leading (Vars going into the generator) to 0.95 lagging (Vars going out of the generator). Synchronous generators should automatically control power factor and should be set to deliver VARs to the system as needed to keep the power factor at the PCC with the Kaysville Power Services to the range required by this section.

For generators other than synchronous generators, operation outside this power factor range is acceptable provided the cumulative power factor of the customer's entire facility is kept within the range noted. This may be done using capacitor banks, controlling the inverter settings, adding static VAR compensators (SVC) or synchronous condensers, or other means agreeable to both the GF and the Kaysville Power Services. If capacitor banks are used they shall be sized and installed per IEEE Stds. 18, 1036, C37.012, C37.06, C37.66, and 1015. Capacitors may need to be stepped and switched to meet the power factor requirements above. Before the addition of capacitors the GF should completely study the effects of the capacitor additions on the resonance conditions and harmonic values that will result. If the GF's addition of capacitors causes adverse resonance or harmonics effects on the Kaysville Power Services' system, the GF shall be required to pay for any modifications needed to mitigate the problem.

6.0 Testing

6.1 Commissioning Tests

In addition to any commissioning tests required by the owner of the GF or manufacturer of equipment used, the following tests must be performed before operation of the GF. The Operator must notify the Kaysville Power Services two weeks in advance of the time of the testing so that the Kaysville Power Services representative may observe any tests required by the Kaysville Power Services.

a) Visual inspection to ensure proper grounding.

b) Visual inspection shall confirm the presence of the isolation device described in section 3.2 and the device shall be tested for operation.
c) Trip tests must be performed to prove each device which is required to trip any breaker is capable of doing so.
d) Relays or protective functions provided by the generator manufacture must be tested and relay test reports must be made available to the Kaysville Power Services. All of the functions required in Section 3.5 must be tested. Inverter connected devices tested by an independent testing laboratory as required in Section 3.5 are not be required to perform this test.
e) In the case of a synchronous generator the Operator must prove that the generator is connected to the system with the proper phase rotation and that all three phases of generator voltage match those of the system at the same instant in time. This test is commonly known as "phasing out" the generator.
f) In the case of a synchronous generator the Operator must prove that the generator synchronizer and sync check relay is capable of connecting the generator to the system properly and in synchronism. This test must be done before the generator is allowed to actually connect to the system.
g) The ability of the control system to disconnect the generator within two seconds in the event of islanding must be tested.

6.2 Periodic Maintenance Test

An Operator must maintain his or her equipment in good order and in compliance with all manufacturers suggested periodic maintenance. If it is discovered that an Operator is not properly maintaining his or her equipment, the Kaysville Power Services may disconnect the GF until such time that the Operator can prove that he or she has provided all required maintenance needed to allow the GF to operate properly and safely.

The Kaysville Power Services reserves the right to inspect the GF equipment whenever it appears the GF is operating in a manner that is hazardous to the Kaysville Power Services system.

Functional testing must be performed every year to prove the proper operation of the isolation device and all breakers and relays. For all GFs consisting of synchronous machines, no less than once every three years all protective functions must be re-tested and calibrated to prove their operation complies with the requirements contained in this document. The Operator must maintain written records of these tests and these records will be made available to the Kaysville Power Services on request.

Battery systems used for generator control or protective relaying must be maintained and periodically tested as suggested by the battery manufacturer.

6.3 Qualified Personnel

All testing and calibration shall be done by qualified personnel.

7.0 Design Changes

After the GF begins operation any design changes, such as the addition of more generation, must be submitted to the Kaysville Power Services for review. Protective devices or any other requirements listed in this document must not be modified or their settings changed without approval of the Kaysville Power Services.

8.0 Liability and Insurance

In no event shall the Kaysville Power Services be held responsible for the safety, reliability, design, or protection of the GF. Compliance with these interconnection standards does not mean the GF is safe to operate and the Operator is solely responsible for making a determination about whether the GF is safe to operate.

Nothing herein shall be construed to create any duty to, any standard of care with reference to, or any liability to any person who is not a party to an arrangement or agreement between the Kaysville Power Services and the Operator pursuant to these requirements. The Kaysville Power Services is not liable for damages caused to the facilities, improvements or equipment of the Operator by reason of the operation, faulty operation or non-operation of the Kaysville Power Services facilities.

To the extent permitted by law, the Operator shall be solely responsible for and shall defend, indemnify and hold the Kaysville Power Services harmless from and against any and all claims or causes of action for personal injury, death, property damage, loss or violation of governmental laws, regulations or orders, which injury, death, damage, loss or violations occurs on or is caused by operation of equipment or facilities on the Operator's side of the point of connection. Notwithstanding the above and to the extent permitted by law, the Operator shall be solely responsible for and shall defend, indemnify and hold harmless the Kaysville Power Services from and against any and all claims or causes of action for personal injury, death, property damage or loss or violation of governmental laws, regulations or orders, wherever occurring , which injury, death, damage, loss or violation is due solely to the acts of omissions of such Operator, including but not limited to the use of defective equipment or faulty installation or maintenance or equipment by such party. However, nothing contained in this section shall be construed as relieving or releasing either party from liability or personal injury, death, property damage or loss, or violation of governmental laws, regulations or orders, wherever occurring, resulting from its own negligence or the negligence of any of its officers, servants, agents or employees. In the event of concurrent negligence, liability shall be apportioned between the parties according to each party's respective fault. Neither the Operator nor the Kaysville Power Services shall be liable to the other or any other third party, in contract or in tort or otherwise, for loss of use of equipment and related expenses, expense involving cost of capital, claims of customers of the Kaysville Power Services or the Operator, as applicable, loss of profits or revenues, cost of purchase or replacement power, or any indirect, incidental or consequential loss or damage whatsoever.

For systems of ten kW or more, the Operator, at its own expense, except when the Operator is a governmental entity that self-insures in accordance with Utah law, shall secure and maintain in effect during connection of its GF to the Kaysville Power Services system, liability insurance with a combined single limit for bodily injury and property damage of not less than $300,000 (Three Hundred Thousand Dollars) each occurrence. Such liability insurance shall not exclude coverage for any incident related to the subject GF or its operation. Except when the Operator is a governmental entity that self-insures in accordance with Utah law. Any insurance policy required herein shall include that written notice be given to the Kaysville Power Services at least 30 days prior to any cancellation or reduction of any coverage. A copy of the liability insurance certificate must be received by the Kaysville Power Services prior to GF operation. Certificates of insurance evidencing the requisite coverage and provision(s) shall be furnished to the Kaysville Power Services prior to date of interconnection of the generation system. The Kaysville Power Services shall be permitted to periodically obtain proof of current insurance coverage from the Operator in order to verify proper liability insurance coverage. The Operator will not be allowed to commence or continue interconnected operations unless evidence is provided that satisfactory insurance coverage is in effect at all times.

This Interconnection Standard shall remain in effect until terminated by either party upon thirty (30) days prior written notice, provided, however that this Interconnection Standard will terminate automatically upon:

a) Any change of ownership of the Facility
b) Any change in ownership of the Facility or the Facility or the premises upon which the Facility

is located, or

c) Any change in the location of the Facility.

The Interconnection Standard may be adjusted or discontinued by the Kaysville City Council for any reason, at any time, without any obligation to existing Participants.