GVEA Interconnect Specifications

A Technical Guide for Operating, Metering, Monitoring, and Protective Relaying of Non-Utility Power Producers and Co-Generators

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Table of Contents

1.0 INTRODUCTION

1.1. General Information

1.1.1. These guidelines serve to provide the minimum acceptable requirements for safe and effective operation of Customer-owned generation interconnected with the Golden Valley Electric Association (GVEA) power system. Customer and GVEA personnel will be guided by this document when planning for the installation of Customer-owned generation. It is emphasized that these requirements are general and may not cover all details in specific cases.

1.1.2. These guidelines apply to applicants/Customers regardless if they self generate, generate for sale back to GVEA, or whether they buy and sell concurrently.

1.1.3. The potential Customer should discuss all project plans with GVEA before purchasing or installing equipment.

1.2. Definitions – Hierarchal Order

1.2.1. “GVEA” will be used in this guideline to refer to Golden Valley Electric Association, Inc.

1.2.2. “NUPP” (Non-Utility Power Producer) will refer to any electrical generation not owned by GVEA.

1.2.3. “COG” will refer to Co-generation and is defined as the production of two useful forms of energy such as high-temperature heat and electricity from the same process facility not owned by GVEA.

1.2.4. “Customer” will refer to either a NUPP or COG facility.

1.2.5. “Members” will be used in this guideline to refer to power consuming Co-operative members who are connected to GVEA and do not have the capability to produce power.

1.2.6. “Interconnection” will mean the point of electrical connection between the Customers facility and the GVEA power system.

1.2.7. “Separate Operation” will be used in this guideline to refer to the operation of a Customers facility that is capable of generation which does not have the capability of transferring electrical energy to GVEA.

1.2.8. “Momentary Paralleling” will be used in this guideline to refer to a Customer who will only operate in parallel with GVEA for durations of 100 milliseconds or less.

1.2.9. “Parallel Operation” will be used in this guideline to refer to a Customers facility that is interconnected with GVEA while operating electrically connected to the GVEA power system. Electrical power may flow either into or out of this Interconnection.

1.2.10. “Open Transition” will be used in this guideline to refer to break-before-make type transfer switches or the transfer of power to a load from different sources without the ability to momentarily or permanently electrically connect the different sources.

1.2.11. “Closed Transition” will be used in this guideline to refer to make-before-break “momentary” type transfer switches with a maximum of 100 milliseconds parallel time. Any parallel time greater than 100 milliseconds will not be considered momentary or Closed Transition.

1.2.12. “Islanding” or “Islanded” refers to the situation where a portion of GVEA’s load becomes isolated from GVEA sources but remains electrically connected to the Customers generation source.

1.2.13. “Back Feed” will be used in this guideline to refer to the transfer of electric power from an emergency stored energy source to any portion of the normal power system.

1.2.14. “Short Circuit Ratio” = (Short Circuit kVA of GVEA + Short Circuit kVA of the Customer) / (Short Circuit kVA of the Customer). When computing the Short Circuit Ratio the first cycle current magnitude shall be used at the point of study. Short Circuit Ratio is sometimes referred to as system stiffness, stiffness ratio, or short circuit current ratio.

1.2.15. “Reclosing” refers to the operation of a device that has the functionality to sense and interrupt over-currents by de-energizing the circuit and to then automatically re-energize the circuit.

1.2.16. “Distributed Resource” refers to electrical power generation fed to the electric utility grid through a distribution circuit not a transmission circuit.

1.2.17. “Grid Interactive” will be used in this guideline to refer to an electric power production device, intended to be interconnected as a

distributed resource, which meets IEEE 1547-2003 and UL 1741 requirements and incorporates all GVEA minimum protective requirement for a given interconnection type.

1.2.18. "CT" is the acronym for Current Transformer

1.2.19. "PT" is the acronym for Potential Transformer

1.2.20. "SCADA" is the acronym for Supervisory Control And Data Acquisition

1.3. Policy Pertaining to Co-generation and Non-Utility Power Production (COG/NUPP)

1.3.1. It is the policy of GVEA to permit any Customer to operate their generating equipment in parallel with GVEA's electric system provided this can be done without adverse effects to the general public, or to GVEA's Members, Customers, equipment, personnel, or system operations. Customer's generation interconnected to GVEA's power system shall be through a transformer.

1.3.2. Protective devices (including relays, circuit breakers, and the like), as specified by GVEA must be installed at any location where a Customer desires to operate generation in parallel with the GVEA power system. The purpose of these devices is to promptly disconnect the Customer's generating equipment from the GVEA system whenever faults or abnormal operation occur which could affect the interconnected system. Other site specific modifications to the electrical system configuration or protective relays shall be required as necessary to safely accommodate parallel operation.

1.3.3. Power electronic equipment such as DC to AC inverters shall meet the most recent IEEE and UL applicable standards as outlined in subsequent sections. Such equipment employing internally protective electronic methods will be subject to GVEA review for acceptance. Any recommendations from GVEA for specific protective settings will be made prior to energizing the Customer's equipment.

1.3.4. Customer facilities with the ability to export greater than 2 MW of electrical power into the GVEA power system shall be required to connect to the GVEA power system at the transmission level. The Customer shall bear any and all costs associated with equipment upgrades required to accommodate Customer Interconnections.

1.3.4.1. Differing transmission system conditions due to location, physical parameters, or any number of factors dictate that Customer applications will be evaluated on a case by case basis to determine the specific Customer Interconnect requirements at the transmission level.

1.3.4.2. A Customer with an Interconnection of 2 MW or greater shall contribute its pro rata share of GVEA's operating reserve capacity as per Section 4, “Spinning Reserve and Load Shedding”.

1.3.5. With the advent of Distributed Resources becoming more popular and the differing conditions of distribution feeders, each Customer application will be evaluated on a case by case basis to determine the specific Customer Interconnect requirements. Differing distribution system conditions may dictate that generation may not be connected to a distribution feeder in a given location.

1.3.6. GVEA does not assume any responsibility for protection of the Customer’s generator(s) or any other portion of the Customer’s electrical equipment. The Customer is fully responsible for protecting their equipment in such a manner that faults or other disturbances on the interconnected system do not cause damage to the Customer’s equipment.

1.4. Generation Sources

1.4.1. The Customer may elect to use any of a variety of energy sources including hydro, solar, wind, conventional fossil fuels, or other types of energy sources. The end conversion for connection to GVEA’s system must be 60 Hz alternating current at a voltage compatible with GVEA’s system at the interconnecting point. Customer generation sources shall be operated so that variations from the acceptable voltage levels and other service impairing disturbances do not occur. This includes: compliance with the harmonic limits stated in IEEE Standards as specified throughout Section 3 of this specification for current and voltage distortion; and any other disturbance from the Customer’s facility which could impair service to GVEA Customers or Members.

1.4.2. Protective devices must provide protection to GVEA's system and to its Customers or Members from a Customers facility experiencing disturbances that produce abnormal voltage and frequencies.

1.4.3. Customers are required to generate their own reactive power requirements to assure generation at a machine specified power factor and to enhance the Customers generator stability. Reactive power requirements for an induction machine shall be reviewed on a case by case basis.

1.4.4. The Customer may elect to run generation in parallel with GVEA or as a separate system with either the capability of momentary parallel or nonparallel load transfer between the two independent systems. The requirements for these three methods of operation are outlined in the following sections.

1.5. Separate Systems

1.5.1. For a Customer's facility operating in a Separate Operation mode to be practical, the Customer may want to maintain the capability of transferring load between the two systems with such transfer being accomplished in an Open Transition mode. This can be accomplished by either an electrically or mechanically interlocked switching arrangement which precludes operation of both switches in the closed position simultaneously.

1.5.2. If the Customer has a separate system, the Customer shall permit GVEA to verify by any reasonable method that the transfer scheme meets the nonparallel requirements. This verification shall be accomplished but is not limited to review of drawings and equipment specifications and by field inspection of the transfer scheme. GVEA is not responsible for approving the Customer's generation equipment system design or operation, not withstanding the fact that GVEA may from time to time comment thereon.

1.5.3. Most Uninterruptible Power Supply (UPS) systems do not specifically meet the Separate Operation criteria. However, if they are not capable of Back Feed they shall be classified as a Separate Operation system. If they can Back Feed, they must meet the requirements of either Momentary Paralleling or Parallel Operation.

1.6. Momentary Paralleling

1.6.1. Momentary Paralleling shall require the use of a Closed Transition (Make-Before-Break) integrated Automatic Transfer Switch with synchronizing capabilities. Other protective equipment as specified in Section 1.6.2 shall be required. The Automatic Transfer Switch shall be incapable of paralleling the Customer with GVEA's system longer than 100 milliseconds and shall be tested, verified, and documented by the Customer for proper operation at least every 2 years. GVEA may require being present during this testing.

1.6.2. Other protective equipment needed for Momentary Paralleling shall include equipment capable of sensing a failed Closed Transition transfer switch operation and tripping the inter-tie breaker. If the Closed Transition transfer switch operation fails (paralleling time greater than 100 milliseconds) then the equipment must open the inter-tie breaker.

1.6.3. Momentary Paralleling shall be limited to 500 kVA to reduce possible voltage flicker for other Members receiving their power from the same distribution feeder as the Customer. Momentary Paralleling of greater than 500 kVA may be permitted following a system study to determine if such an installation will cause adverse effects to other Members or Customers. The cost of the system study shall be borne by the Customer.

1.7. Parallel Operation

1.7.1. A transfer of power between the two systems is a direct and often desired result of parallel operation. A consequence of such parallel operation is that parallel generation becomes an electrically connected part of the GVEA power system which must be considered in the electrical protection of GVEA facilities. GVEA's ability to provide safety to GVEA personnel who may need to perform work on a power line is lost when a Customer facility is operating in an Islanded mode. The ability to maintain electrical power within specifications to Customers or Members is also lost during an Islanded operating condition. For these reasons protection from Islanding shall be incorporated into each Customer's facility connected in parallel to GVEA.

1.7.2. Protection system design incorporated into Customer facilities shall be performed by a power system engineer qualified to perform such

work and who is licensed as a professional engineer in the state of Alaska. The protection system design shall be reviewed by GVEA. Prior to energizing a Customer facility any changes to the protection system design requested by GVEA will be made by the Customer. Smaller inverter type equipment meeting the most recent UL and IEEE standards for interconnecting to utility power systems may have integral protection equipment built into one complete package. All adjustable or factory set protection parameters incorporated into Grid Interactive equipment shall be reviewed by GVEA. Prior to energizing Customer's inverter type generation facilities, all settable protection parameters recommended by GVEA will be made to the Customers equipment by the Customer and confirmed by GVEA and a Customer representative during a facility inspection.

1.7.3. The general and specific requirements for parallel generation installations of various sizes are discussed in the following sections.

2.0 GENERAL REQUIREMENTS

2.1. Design Requirements

2.1.1. When applying protective devices for the protection of GVEA's system, the Customer shall submit a single-line drawing of this equipment to GVEA for approval of the protective functions. Any changes required by GVEA shall be made prior to final acceptance and GVEA shall be provided with dated copies of the final drawings. GVEA will approve only those portions of drawings which apply to protection of the GVEA system. GVEA may comment on other areas which appear to be incorrect or deficient, but will not assume responsibility for the correctness of protection pertaining to the Customer's system.

2.1.2. A manual disconnecting device which can be opened and locked open for line clearances shall be provided. The form of this device will vary with the service voltage and capacity. This device shall permit GVEA to disconnect the Customer's generation from the GVEA system for safety purposes during system maintenance. This device must provide a "visible open" for GVEA personnel.

2.1.3. The protective methods and devices referred to in these guidelines (including but not limited to relays and circuit breakers) which aid in the protection of GVEA's system, metering equipment, Customer equipment and synchronizing equipment must be installed as required by GVEA and/or the protection system engineer. The protective devices may differ with the size and characteristics of the installation. See Section 3 for specific requirements.

2.1.4. Instrument Transformer Specifications:

2.1.4.1. GVEA requires that PTs used for either revenue metering or protective relaying meet an ANSI accuracy rating of 0.3% at IEEE C57.13-1993 standard burden designations. GVEA requires a minimum IEEE PT burden designation rating of "Y". See Section 7.2, Standard Burdens, in IEEE C57.13-1993.

2.1.4.2. GVEA requires that CTs used solely for revenue metering meet an ANSI accuracy rating of 0.3% at a burden of 0.5 Ohms at 100% rated current.

2.1.4.3. GVEA requires that CTs used for protective relaying meet ANSI Standard C57.13 minimum CT accuracy of C200. However higher CT accuracy may be required due to system conditions.

2.1.4.4. One set of PTs may be used for both relaying and metering provided that the total burden placed on the PT's does not exceed the PT's specified limit.

2.1.5. Customer Interconnections with GVEA shall be accomplished through the use of a "dedicated transformer" which serves no other Customers or Members. Small Interconnections may be exempt from this requirement. Each Interconnection Type as described in Section 3 has different transformer connection requirements.

2.1.6. The Customer's installation must meet all applicable national, state and local construction and safety codes in addition to all applicable UL, ANSI and IEEE Standards and Guidelines.

2.2. General Operating Requirements

2.2.1. Any Parallel Operation, regardless of time duration, or any Momentary Paralleling of the Customer's generating equipment with the GVEA system shall not under any circumstance be permitted to cause any reduction in the quality of service being provided to other GVEA Customers or Members. No abnormal voltages, harmonic distortions, frequency deviations, or interruptions shall be permitted. If credible high or low voltage complaints or flicker complaints result from operation of the Customer's generation, such generating equipment shall be immediately isolated from GVEA's system or disconnected until the problem is resolved.

2.2.2. The Customer may not commence parallel operation of generator(s) until final written approval has been given by GVEA. At any reasonable time, GVEA reserves the right to inspect the Customer's facility and test or witness testing of any equipment or devices associated with the Interconnection.

2.2.3. Once a GVEA distribution circuit is de-energized for any reason, the Customer shall disconnect from the GVEA system and will not be permitted to reconnect to GVEA's system until GVEA has first energized its system.

2.2.4. Reclosing of a GVEA distribution feeder will not be adversely effected by the Customer. The Customer shall coordinate with the GVEA reclosing strategies. GVEA will review all anti-islanding functions of the Customers equipment prior to acceptance.

2.2.5. Transmission circuit Interconnections will be reviewed on a case by case basis to determine post disturbance reconnection strategies.

2.2.6. Operation of the Customer's generator shall not adversely affect the voltage regulation of GVEA's system to which it is connected. Adequate voltage control shall be provided by the Customer to minimize voltage fluctuation on GVEA's system caused by changing generator loading conditions.

2.2.6.1. For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on GVEA's system. The generator reactive power requirements, voltage regulation, and transformer ratio settings will be jointly determined by GVEA and the Customer to ensure inter-system coordination and operating capability. Customers are required to generate their own reactive power requirements to assure generation at the specified power factor and to enhance generator stability.

2.2.6.2. In cases where starting or load changing on induction generators will have an adverse impact on GVEA's system voltage, step-switched capacitors or other techniques may be required to bring the voltage changes to acceptable levels. All equipment costs associated with such reactive power production shall be borne by the Customer.

2.2.7. The Customer shall maintain his equipment in good order. GVEA reserves the right to inspect the Customer's facilities whenever it appears that the Customer is operating in a manner hazardous to GVEA's system integrity.

2.2.8. The Customer shall discontinue parallel operation when requested by GVEA:

2.2.8.1. To facilitate maintenance, test or repair of GVEA or other Customer facilities.

2.2.8.2. During system emergencies.

2.2.8.3. When the Customer's generating equipment is interfering with other Customers or Members on GVEA's system.

2.2.8.4. When an inspection of the Customer's generating equipment reveals a condition hazardous to GVEA's system or a lack of adequate maintenance of equipment necessary to protect GVEA's system.

2.2.9. GVEA may require the Customer to notify GVEA, in writing, of the monthly kWh production of each generator on the first regular working day of the following month. Larger power producers shall be required to report energy and peak demand information through a remote telecommunication medium.

2.2.10. For facilities of 225 kVA and larger the Customer shall maintain an operating log at each generating facility indicating changes in operating status (available or unavailable), maintenance outages, trip indications, or other unusual conditions found upon inspection. For generators which are "block-loaded" to a specific kW level, changes in load settings shall also be logged. Logs may be electronic.

2.3. Design Information – GVEA System

2.3.1. GVEA's primary distribution voltages are 7.2/12.47, 14.4/24.9, and 19.9/34.5 kV. Transmission voltages are 69 and 138 kV. GVEA's distribution circuits are effectively grounded with a substantial number of grounding points on each four-wire distribution circuit. Specific requirements for Customer's generation on these circuits are described in Section 3 of this specification. Contact GVEA for information on the specific circuit which shall serve a Customer's facility.

2.3.2. Because most short circuits on overhead lines are temporary in nature, it is GVEA's practice to automatically reclose on such lines one or more times within a few cycles delay after they have automatically tripped. This practice improves continuity of service to all GVEA Customers and Members. The protective relays specified by GVEA or IEEE articles for parallel generation interfaces are intended to disconnect the generation from faulted or isolated lines before reclosing occurs. Should the Customer desire additional protection against the possibility that reclosing might occur with a generator still connected to the line (a potentially damaging occurrence for synchronous generators), GVEA will consider revising

radial line protection schemes on distribution feeders. GVEA's preference is to avoid such measures due to the possibility of adverse effects on service continuity and the problems of moving or rearranging the equipment to accommodate system changes. Costs for installing, maintaining, and/or rearranging such equipment (if permitted) will be borne by the Customer(s) requesting the equipment.

2.3.3. System reconfiguration costs needed to accommodate Customer's connecting generation at either the transmission or distribution level (if permitted) will be borne by the Customer(s) requesting the equipment.

2.3.4. Customers with three-phase generators should be aware that certain conditions in the utility system may cause negative sequence currents to flow in the generator. It is the sole responsibility of the Customer to protect his equipment for excessive negative sequence currents.

2.3.5. The effect that a Customer will have upon a distribution circuit will depend on the total distributed generation on that circuit prior to the Customer's connection. The greater the available short-circuit MVA, the stiffer the circuit. The addition of a Customer on a distribution feeder will have less impact to a stiff system.

2.3.5.1. A Short Circuit Ratio or stiffness of 50 or less at the interconnection shall be used as a determining factor for any additional protection equipment needed above that outlined in the Interconnection Type specifications in Section 3.

2.3.5.2. If physical GVEA power system components differ from the standard norm at a point where a Customer wishes to connect or a Customer wishes to construct a facility with non-standard operating equipment a protection study shall be performed accounting for non-standard variations. The protection system design shall be performed by a power system engineer qualified to perform such work. The protection system design shall be reviewed by GVEA. All protection system design costs will be borne by the Customer.

2.4. Induction Generators

2.4.1. Reactive power supply for induction generators may pose difficult design problems depending upon the generator size. Specific installations may require the installation of capacitors limiting the adverse effects of reactive power flow on GVEA's system for proper voltage regulation. Such capacitor installations will be at the expense of the Customer.

2.4.2. The installation of capacitors for reactive power supply at, or near, an induction generator greatly increases the risk that the induction machine may become self-excited if accidentally isolated from the GVEA system. A self-excited induction generator can produce abnormally high voltages which can cause damage to the equipment of other GVEA Customers or Members. Over-voltage relays can limit the duration of such over-voltages but cannot control their magnitude because of the rapid voltage rise which occurs with self-excitation. Because of these problems, reactive power supply for large induction generators must be studied on an individual basis.

2.4.3. In order to reduce the possibility of self-excited operation, reactive power requirements for induction generators shall be supplied by GVEA except in unusual situations such as those stated in Section 2.4.2. Reactive power supply will be from general utility sources and specific charges may be made to the Customer for the reactive power.

2.4.4. Self-excitation problems are more likely in rural areas where the system capacity and load density are low. Since these areas are more likely to be chosen for certain forms of small power production such as wind and hydro, it is particularly important to contact GVEA when considering connecting induction machines to existing distribution lines. Where self-excitation problems appear likely, special service arrangements will be required in order to avoid the induction generator from becoming isolated with small amounts of load. For example, a two-line loop service back to the existing transmission system or a transmission level service. In many cases, the additional expense for such special service methods may outweigh the cost savings associated with induction generators.

2.5. Inverter Systems

2.5.1. Reactive power supply requirements for inverter systems are similar to those for induction generators and the general guidelines discussed in Section 2.4 shall apply. Likewise, inverter systems are also capable of Islanded operation. Self-commutated inverters have this capability by design. Line commutated inverters could operate Islanded if connected to rotating machines which provide the necessary commutation. Because of the possibilities of self-excited operation, inverter systems are treated as induction machines in these guidelines.

2.5.1.1. Grid Interactive inverters meeting UL 1741 may incorporate all needed protective requirements, and reactive power issues may be incorporated into their design. GVEA will review the Customers inverter specifications for reactive power needs and compliance.

2.5.2. Total harmonic current output of power inverters shall not be greater than 5% total harmonic distortion. Higher order even and odd harmonic currents shall be limited to the most restrictive of that specified in IEEE std. 1547-2003 Table 3 or as specified in IEEE 519 Section 10.2.

2.5.3. Harmonic voltage distortion shall not be greater than 5% total harmonic distortion. Higher order harmonic voltages shall be limited to the most restrictive of that specified in UL 1741 Section 45.4, IEEE 1547-2003 Table 6, or IEEE 519 Table 11-1.

2.5.4. If a Customer’s parallel generation is found to be interfering with other Customers or Members, or exceeds UL or IEEE recommended specifications, the Customer may be required to install filtering to bring the harmonic output of the inverter to a level which will eliminate such interference and comply with UL and IEEE specifications.

3.0 SPECIFIC REQUIREMENTS

3.1. Interconnection Types Described

3.1.1. Customer-owned parallel generation facilities are classified by generation size, ratings, voltage, and current. See Tables 3.1 and 3.2.

3.1.2. A calculated Short Circuit Ratio of 50 or less at the Interconnection will require a system protection study to determine any additional protection equipment needed above that outlined for each of the standard Interconnection types. Such protection may include but is not limited to loss of excitation, loss of synchronism, or over excitation protection. Any cost associated with the study and/or additional equipment due to a Short Circuit Ratio of 50 or less will be borne by the Customer

3.1.3. Each facility shall have distinctive protection, metering, and operating requirements.

3.1.4. Where multiple generators are connected to GVEA's system through a single service point, the Interconnection Type will be determined by the sum of the ratings of the generators. The final decision as to the requirements for each installation will depend on the Customers load magnitude, the magnitude of other loads connected to that circuit/system, ampacity of serving circuit, maximum power to be delivered to GVEA's system, available short circuit contribution, short circuit current ratio, etc.

3.1.5. Interconnection Type definitions, Tables, and notes:

3.1.5.1. The following Tables identify the type of Customer generation and minimum requirements that must be met to Interconnect with GVEA's system.

3.1.5.2. Tables:

Table 3.1 – Amps at Rated kVA and Voltage Classifications

	Transmission		Distribution / Primary				Secondary		
Volts	138,000	69,000	34,500	24,900	13,800	12,470	480	208	240/120
kVA									
5									21
10									42
15							18	42	63
25							30	69	104
30							36	83	125
37.5							45	104	156
50							60	139	208
75							90	208	313
100							120	278	417
112.5							135	312	496
150							180	416	625
167							201	464	696
225							271	625	
300	1	3	5	7	13	14	361	833	
500	2	4	8	12	21	23	601	1388	
750	3	6	13	17	31	35			
1000	4	8	17	23	42	46			
1500	6	13	25	35	63	69			
2000	8	17	33	46	84	93			
3000	13	25							
4000	17	33							
5000	21	42							
10000	42	84							
20000	84	167							
40000	167	335							
60000	251	502							

	Type 1	200 Amps or less @ Secondary Voltages
	Type 2	Greater than 200 Amps and less than or equal to 500 kVA @ Secondary Voltages
	Type 3	Less than or equal to 2000 kVA @ Distribution / Primary Voltages
	Type 4	† Transmission level Interconnections, See Section 1.3.4

NOTES:
Total generation of 10 kW or less may meet reduced requirements
Single-phase pad mount transformer limit of 167 kVA,
Physical distribution feeder conditions may limit Types 1, 2, or 3 interconnect sizes
† See GVEA for Interconnections greater than 60 MVA. Interconnection sizes that are lower than those shown for this Type are allowed but may be impractical.

Table 3.2 - Minimum requirements for Interconnection Types

	Type 1††	Type 2††	Type 3	Type 4
Single Phase Connection (Limited kVA, See Notes)	Y	Y	N	N
Lockable Disconnect with Visible Open	Y	Y	Y	Y
Interconnect Breaker (B) or Fuse (F)	B or F	B or F	B	B
In/Out Metering	Y	Y	Y	Y
Energy Recorder	N	N	N	Y
Dedicated Transformer	N	N	Y	Y
Transformer - Customer Pays / Utility Owns	Y	Y	N	N
Transformer - Customer Pays / Customer Owns	N	N	Y	Y
Under-Voltage (27) †	Y	Y	Y	Y
Over-Voltage (59) †	Y	Y	Y	Y
Under-Frequency (81U) †	Y	Y	Y	Y
Over-Frequency (81O) †	Y	Y	Y	Y
Phase Over-Current (50/51)*, †	Y	Y	Y	Y
Neutral Over-Current (51N) †	N	N	Y	Y
Transfer Trip	N	N	TBD	TBD
Close Permissive Required	N	N	Y	Y
Automatic Synchronizer (synchronous machine) 25†, 25a†	Y	Y	Y	Y
Automatic Synchronizer (induction machine) 25†, 25a†	N	N	N	N
Automatic Synchronizer (UL 1741 inverter) 25†, 25a†	N	N	N	TBD
Isolation Detection / Anti-Islanding†	Y	Y	Y	Y
Comm – Voice	Y	Y	Y	Y
Telemetry	Y**	Y**	Y	Y***
Power Quality Monitoring	N	N	Y	Y
Export Power Control Equipment	N	N	Y	Y
Operational Data Logging	N	N	Y	Y
Sequence of Event Reporting	N	N	Y	Y
Fault Recording	N	N	Y	Y
PSS/E Modeling	N	N	N	Y
Machine Testing	N	N	N	Y
Metering CTs Supplied By GVEA (Customer Installs)	N/A	Y	Y	N
Metering CTs Supplied By Customer (Customer Installs)	N/A	N	N	Y
Momentary Paralleling	Y	Y	N	N

Notes:
TBD means To Be Determined during design phase
* Three Phase Only, may not be required for inverters or induction machines
** Minimal Telemetry may be required
*** Dedicated Telemetry
† These requirements are met if Grid Interactive equipment is used.
†† Physical distribution feeder conditions may limit interconnect size
Short Circuit Current Ratio of 50 or less will require a protection study to determine any additional needed protection
225 kVA Maximum Three-Phase Pole Mount Transformer Limit
75 kVA Maximum Single-Phase Pole Mount Transformer Limit
167 kVA Maximum Single-Phase Pad Mount Transformer Limit
2000 kVA and Greater Special Requirements Apply Regardless of Interconnection Type:
Dedicated Telemetry***
Arrange for Spinning Reserve, See Section 1.3.4.2

3.2. Total generation of 500 kVA or less at secondary voltages

3.2.1. Type 1 and Type 2 Interconnections are described in this section as outlined in Section 3.1. See Figures 6.1 through 6.5 for example one-line diagrams.

3.2.1.1. The difference between a Type 1 and Type 2 Interconnection is the ampacity. Interconnections of 200 Amps and less (Type 1) do not require a current transformer meter installation.

3.2.1.2. Type 1 and Type 2 Interconnection requirements are based on an assumed low density of parallel generation Customers on the serving circuit. Other conditions may be imposed should the density exceed a tolerable limit.

3.2.1.3. Type 1 and Type 2 Interconnections with a GVEA distribution level circuit may be done on a single-phase or three-phase basis.

3.2.1.4. Where GVEA has only single-phase distribution lines:

3.2.1.4.1. The Customer shall fund a single-phase to three-phase line conversion, if required for a three-phase generator installation.

3.2.1.4.2. If the Customer is a Qualifying Facility (QF) as defined by the Alaska Administrative Code, 3 AAC 52.500 (23), and the Customer has three-phase generation, the Customer shall either fund a single-phase to three-phase line conversion prior to interconnection with GVEA or arraigned for long-term financing for the single-phase to three-phase line conversion prior to interconnection with GVEA. The terms and conditions of any long-term financing shall be at GVEA's sole discretion.

3.2.2. A manual disconnecting device with provisions for locking in the open position shall be required at or near the point of Type 1 and Type 2 Interconnections as per Section 2.1.2 of this specification.

3.2.3. The Customer’s Interconnection shall be equipped with fuses or a breaker rated for the installation ampacity and must have an interrupt rating adequate for the available fault current at the Interconnection.

3.2.4. Metering of Type 1 and Type 2 Interconnections

3.2.4.1. Type 1 and Type 2 Interconnections shall be equipped with metering equipment capable of recording the kWh (in) and kWh (out) separately. Additional metering for kW and kVARH will be

determined by the requirements of the individual installations. See Section 5 for more detailed metering information.

3.2.4.2. Current Transformers (CTs) for revenue metering shall be provided by GVEA and installed by the Customer at locations shown in Figures 6.4 and 6.5.

3.2.5. Customer Interconnections of Type 1 and Type 2 shall be served from a GVEA four-wire multi-grounded neutral distribution circuit to provide adequate grounding. This is necessary to avoid dangerous over-voltages to other customers served from phase-to-neutral connected distribution transformers. A three-phase Interconnection transformer shall have a grounded-wye, grounded-wye winding configuration connection to GVEA's system.

3.2.5.1. Type 1 and Type 2 Interconnection transformers shall be supplied, installed, and maintained by GVEA.

3.2.5.2. Single-phase pad mounted transformer Interconnections are limited to a maximum of 167 kVA. Single-phase pole mounted transformer Interconnections are limited to a maximum of 75 kVA.

3.2.5.3. Pad mount transformers shall be installed by GVEA on a Customers constructed pad mount transformer base as detailed in GVEA's Commercial and Multi-Residential Services Requirements Booklet. Single-phase limitations may apply depending on the electrical Interconnection location, total generation size, and total Member load on a distribution feeder. Each Interconnection shall be reviewed on a case-by-case basis.

3.2.5.4. Pole mounted transformers shall be installed by GVEA. If the Customer's facility is to be Interconnected via an underground feeder the Customer shall be responsible for all costs and materials required as outlined in GVEA's Commercial and Multi-Residential Services Requirements Booklet.

3.2.6. Customer protection systems and Compliance with IEEE 1547-2003 and UL 1741 shall be as follows:

3.2.6.1. Generation equipment used for Type 1 and Type 2 Interconnections shall meet the requirements of IEEE 1547-2003 and UL 1741 along with any supporting documents created for testing, clarification, or information follow up of each article.

3.2.6.2. Customer Interconnections using generation equipment such as standalone synchronous or induction machines that do not comply with IEEE 1547-2003 or UL 1741 must be equipped with protective devices that will make the Interconnection installation meet the requirements of these articles. A line voltage relay and a shunt trip breaker which will prevent the generator from being connected to a de-energized or single-phased (if normally three-phase) source may be required. This relay is to disconnect the generator from a de-energized utility line and prevent its reconnection (islanding) until the line is re-energized by GVEA. Re-energizing times and feeder reclosing will be coordinated with GVEA. A Customer's facility shall not adversely affect GVEA feeder reclosing.

3.2.6.3. Depending upon specific system conditions or the type of Customer generation other protective devices above those outlined throughout Section 3.2 may be required.

3.2.6.4. Instrument transformer accuracy for protective relaying shall meet the accuracy requirements of Section 2.1.4 of this specification. Circuit design and specified equipment shall be reviewed by GVEA prior to installation. System design costs shall be borne by the Customer.

3.2.6.5. Phase fault relay protection shall be required for three-phase installations. Inverter and Induction machine installations may not require phase fault relay protection. A fuse or main breaker may suffice for over-current protection of single-phase installation and inverter or induction machines.

3.2.6.6. The Customer shall provide information on the type of anti-islanding protection used and coordinate those protection schemes such that any GVEA circuit reclosing will not be adversely affected.

3.2.7. The Customer shall provide and maintain an on-site, 24 hr. "Voice Quality" communication method. This may be a phone to a manned control room at the Customers facility or a message phone where emergency information can be left for the Customer to contact GVEA control center.

3.2.8. Remote Control, Telemetry, and SCADA.

3.2.8.1. Remote control of Customer equipment or devices by GVEA system operators will not be required for Type 1 and Type 2 Interconnections.

3.2.8.2. GVEA may require telemetry capability to allow GVEA to "dial-up" the installation and verify at a minimum, on-line/off-line (tie point breaker) status and measure amps, watts, vars and voltage output. The Customer will be required to install the necessary transducers, provide space for a telephone line interface, provide telephone isolation equipment, and arrange for the telephone line. All costs related to operational telemetry as required for GVEA to accommodate Customer's generation shall be borne by the Customer as part of the interconnect costs.

3.2.9. Harmonic output of power inverters will comply with IEEE 1547, IEEE 519, and/or UL 1741. If a Customer is found to be interfering with other Customers or Members, or exceeds IEEE recommended specifications, the Customer may be required to install filtering to bring the harmonic output of their inverter(s) to an acceptable level.

3.3. Total generation less than or equal to 2000 kVA

3.3.1. Type 3 Interconnections are described in this section as outlined in Section 3.1. See Figures 6.6 through 6.8 for example one-line diagrams.

3.3.1.1. A Type 3 employs a point of service at the primary or distribution circuit voltage.

3.3.1.2. All Type 3 Interconnections require a GVEA review of the Customers protective functions.

3.3.1.3. All Type 3 Interconnections with a GVEA distribution level circuit shall be done on a three-phase, four wire basis only.

3.3.1.4. Where GVEA has only single-phase distribution the Customer shall NOT be allowed to connect a Type 3 Interconnection. GVEA may upgrade the distribution feeder to accommodate the Customers generation needs at the Customers expense.

3.3.2. A manual disconnecting device with provisions for locking in the open position shall be required at or near the point of Type 3 Interconnections as per Section 2.1.2 of this specification.

3.3.3. The Customers Interconnection shall be equipped with breakers, reclosers, or switch gear rated for the installation ampacity and have an interrupt rating adequate for the available fault current at the Interconnection.

3.3.4. Metering of Type 3 Interconnections.

3.3.4.1. Type 3 Interconnections shall be equipped with metering equipment capable of recording the kWh (in) and kWh (out) separately. Additional metering for kW and kVARH will be determined by the requirements of the individual installations. Required metering points are shown in Figures 6.6 through 6.8.

3.3.4.2. Current Transformers (CTs) and Potential Transformers (PTs), for Type 3 Interconnections shall be provided by GVEA and installed by the Customer. Type 3 Interconnections are primary metered. See Figures 6.6 and 6.8.

3.3.4.3. Instrument transformer accuracy shall be as specified in Section 2.1.4.

3.3.4.4. In installations where surplus power sales are anticipated, and for all simultaneous buy and sell arrangements, GVEA will install metering and be given access as required. This metering will be located at the GVEA interconnection facility or at the Customer's switchgear, as appropriate.

3.3.4.5. The Customer shall provide adequate space in the generator switchgear for GVEA to install, at its option, metering and/or telemetering of the generator output.

3.3.4.6. See Section 5 for more detailed metering information.

3.3.5. Customer Interconnections of Type 3 shall be served from a GVEA four-wire multi-grounded neutral distribution circuit to provide adequate grounding. This is necessary to avoid dangerous over-voltages to other customers served from phase-to-neutral connected distribution transformers.

3.3.5.1. Type 3 Interconnection dedicated transformers shall be purchased, owned, installed, and maintained by the Customer.

3.3.5.2. Type 3 Interconnection Pad mount transformers shall be installed by GVEA on a Customers constructed pad mount transformer base as detailed in GVEA's Commercial and Multi-Residential Services Requirements Booklet.

3.3.5.3. Pole mounted transformers shall be installed by GVEA. If the Customer's facility is to be Interconnected via an underground feeder the Customer shall be responsible for all cost and materials required as outlined in GVEA's Commercial and Multi-Residential Services Requirements Booklet.

3.3.5.4. The Customer's main power transformer shall have a grounded-wye, grounded-wye winding configuration connection to GVEA's system if the Interconnection is to supply any Customer load.

3.3.5.5. If the Customer's machine configuration is a delta connection and the Customer plans to supply load, the Interconnection transformer will be grounded-wye, grounded-wye and it will be the Customer's responsibility to supply the appropriate equipment to connect a delta machine configuration.

3.3.5.6. If the Customer Interconnection is solely used for generation, a grounded-wye (high side), delta (low side) connection may be used depending upon the Customer's machine configuration.

3.3.6. Customer protection systems and Compliance with IEEE 1547-2003 and UL 1741.

3.3.6.1. Customer generation equipment used for Type 3 Interconnections shall meet the requirements of IEEE 1547-2003 and UL 1741 along with any supporting documents created for testing, clarification, or information follow up of each article.

3.3.6.2. Customer Interconnections using generation equipment such as standalone synchronous or induction machines that do not comply with IEEE 1547-2003 or UL 1741 must be equipped with protective devices that will make the Interconnection installation meet the requirements of these articles. A line voltage relay or contactor which will prevent the generator from being connected to a de-energized or single-phased (if normally three-phase)

source may be required. This relay is to disconnect the generator from a de-energized utility line and prevent its reconnection (islanding) until the line is re-energized by GVEA. Re-energizing times and feeder reclosing will be coordinated with GVEA. A Customer's facility shall not adversely affect GVEA feeder reclosing.

3.3.6.3. Customer provided protection and typical protection devices which may be required to satisfy Type 3 Interconnection requirements:

3.3.6.3.1. The Customer shall provide adequate protective devices to detect and clear the generator(s) from short circuits or grounds on the GVEA facilities serving the Customer.

3.3.6.3.2. The Customer shall provide adequate protective devices to detect the voltage and frequency changes which can occur if the GVEA facilities serving the Customer are disconnected from the main system; and if abnormal voltages or frequencies exist, these relays would then clear the Customer generation from the isolated system. Isolation from the GVEA system should be such that it will not affect the GVEA reclosing cycle normally employed on the serving facilities.

3.3.6.3.3. Phase over-current trip devices (Device 51). In most cases these will be voltage-restrained or voltage-controlled over-current relays in order to provide coordination with GVEA relays.

3.3.6.3.4. Residual over-voltage relay to trip for ground faults on the GVEA system (Device 59N).

3.3.6.3.5. Phase under/over-voltage relays (Device 27/59). Under-voltage Relays should be adjustable from 75-90% of nominal voltage and have time delay to prevent unnecessary tripping of external faults. The time delay should coordinate with the utility reclosing cycle. Over-voltage relays should be adjustable from 110-120% of nominal voltage and should be instantaneous. Setting change with temperature variation should not exceed $\pm$ 2 volts over the expected temperature range.

3.3.6.3.6. Under/over frequency relays (Device 81). The Under-frequency relay should be adjustable from 55-60 Hz and the over-frequency relay from 61-65 Hz. Setting change with temperature variation over the expected range, or voltage variation over ± 10%, should not exceed ± 0.008 Hz. Time delays should be settable from no intentional delay up to 60 cycles in one cycle increments.

3.3.6.3.7. Phase sequence/under-voltage relay (Device 47/27). To permit paralleling when GVEA voltage and phase sequence are normal.

3.3.6.3.8. A synchronizing check relay shall be required for a synchronous generator (Device 25).

3.3.6.3.9. In specific installations, particularly with large generators (over 1,000 kVA), GVEA may require specific additional protective functions such as loss of excitation, loss of synchronism, and over excitation protection, if these conditions would have an impact on GVEA's system.

3.3.6.3.10. Depending on the size of the generation and the size of the distribution system to which it is connected, GVEA may require the Customer to utilize "utility grade" protective relays. Such relays have more stringent tolerances, are more flexible, and the characteristics are more widely published than "industrial grade" relays. This requirement shall be invoked only if generation is of such size that close coordination with GVEA's relays is required. In general, installations aggregating less than 200 kVA will not be subject to this requirement.

3.3.6.3.11. Where induction generators or static inverters are employed rather than synchronous machines, the phase over-current protective devices required by GVEA may be waived since these sources will not deliver sustained over-currents. The other protective devices would still be required.

3.3.6.3.12. In some cases, protective devices supplied with the Customer's generating equipment will meet some or all of the GVEA protective device requirements. However, the minimum requirement must provide the ability to trip the generator whenever GVEA source is lost. If the Customer

desires to automatically separate from the GVEA source and commence isolated operation upon loss of the GVEA source, additional devices may be necessary to effect the separation.

3.3.6.3.13. All protective devices supplied to satisfy the requirements in 3.3.6.3 shall be equipped with operation indicators (targets) or shall be connected to an annunciator or event recorder so that it will be possible to determine, after the event, which devices caused a particular trip.

3.3.6.3.14. All protective devices supplied to satisfy the requirements in 3.3.6.3 shall be tested, certified and sealed by qualified personnel at intervals recommended by the manufacturer. Special tests may also be required by GVEA to investigate apparent misoperations or to compile a record of performance.

3.3.6.4. Instrument transformer accuracy for protective relaying shall meet the accuracy requirements of Section 2.1.4 of this specification.

3.3.6.5. The Customer shall provide information on the type of anti-islanding protection used and coordinate those protection schemes such that any GVEA circuit reclosing shall not be adversely affected. Additionally system design information showing the method of preventing reparalleling Customer generation shall be provided to GVEA. Reparalleling Customer generation shall not occur after a circuit is disconnected unless the GVEA service voltage is of normal magnitude, normal phase sequence, and approval is received from the GVEA control center.

3.3.7. The Customer shall provide and maintain on-site, 24 hr. “Voice” dedicated telephone, VHF radio, or microwave facilities for communications between the Customers generating facility and GVEA’s control center. The Customer shall provide telephone isolation equipment where necessary to protect the communications circuit and site workers.

3.3.8. Remote Control, Telemetry, and SCADA

3.3.8.1. Remote control of Customer equipment or devices by GVEA system operators shall be required for Type 3 Interconnections.

Remote control may be waived depending upon total generation, physical system parameters, or other governing factors. Types of control by the GVEA control center includes:

3.3.8.1.1. Close Permissive Control

3.3.8.1.2. Transfer Trip Capabilities

3.3.8.1.3. Interconnect breaker tripping

3.3.8.2. GVEA shall require telemetry capability to allow GVEA to "dial-up" the installation and verify at a minimum, on-line/off-line (tie point breaker) status and measure amps, watts, vars and voltage output. The Customer shall be required to install the necessary transducers, provide space for a telephone line interface, provide telephone isolation equipment, and arrange for the telephone line. All costs related to operational telemetry and control as required for GVEA to accommodate Customer's generation shall be borne by the Customer.

3.3.9. Harmonic output of power inverters will comply with IEEE 1547, IEEE 519, and/or UL 1741. If a Customer is found to be interfering with other Customers or Members, or exceeds IEEE recommended specifications, the Customer may be required to install filtering to bring the harmonic output of their inverter(s) to an acceptable level.

3.4. Transmission Level or Direct Substation Interconnections

3.4.1. Type 4 Interconnections are described in this section as outlined in Section 3.1. Total generation greater than 2000 kVA shall be Interconnected at the transmission level. The Customer shall bear the costs of all upgrades to existing infrastructure required to accommodate the Interconnection. Total generation less than 2000 kVA may be Interconnected at transmission voltages or directly to the low voltage distribution substation bus.

3.4.1.1. See Section 1.3.4.2 for required reserve provisions with regard to conditions of the Alaska Intertie Agreement.

3.4.1.2. Type 4 Interconnections will require an independent design review for each Customer facility. Type 4 Interconnections utilize a point of service at the transmission voltage level and will be done on a three-phase, three wire basis only.

3.4.1.3. All Type 4 Interconnections require a GVEA review of protective functions. Design information shall be provided by the Customer. Refer to Figures 6.9 to 6.10 for installation requirements. GVEA shall be contacted during the design process for information and coordination of the Customer's facility and protective requirements.

3.4.2. A manual disconnecting device with provisions for locking in the open position shall be required at or near the point of Type 4 Interconnections as per Section 2.1.2 of this specification.

3.4.3. The Customer's Interconnection shall be equipped with breakers rated for the installation ampacity and have an interrupt rating adequate for the available fault current at the Interconnection.

3.4.4. Metering of Type 4 Interconnections:

3.4.4.1. Type 4 Interconnections shall be equipped with metering equipment capable of recording the kWh (in), kWh (out), kVARh (in), and kVARh (out) separately. Additional demand metering will be determined by the requirements of the individual installations. A backup energy recording device shall be required.

3.4.4.2. Metering for Type 4 Interconnections shall be capable of load profiling.

3.4.4.3. CTs and PTs for Type 4 Interconnections shall be provided and installed by the Customer after approval by GVEA.

3.4.4.4. Instrument transformer accuracy shall be as specified in Section 2.1.4.

3.4.4.5. In installations where surplus power sales are anticipated, and for all simultaneous buy and sell arrangements, GVEA will install metering and be given access as required. This metering will be located at the Interconnection point.

3.4.4.6. The Customer shall provide adequate space in the facility switchgear for GVEA to install, at its option, metering and/or telemetering of the generator output.

3.4.4.7. See Section 5 for more detailed metering information.

3.4.5. The Customer shall bear the costs of all upgrades to existing infrastructure, including design and construction, required to accommodate Type 4 Interconnections. GVEA shall review and comment on the design and shall be an active participant reviewing each design phase submittal from a qualified Engineer performing the design.

3.4.5.1. Type 4 Interconnections at the GVEA transmission level shall be accomplished through the use of a dedicated grounded wye (high side) delta (low side) winding configuration transformer and shall be provided, owned, and maintained by the Customer.

3.4.6. Customer protection systems for Type 4 Interconnections:

3.4.6.1. Customer protection and generation equipment shall comply with the most recent standards and utility practices.

3.4.6.2. Generation equipment used for Type 4 Interconnections shall be reviewed on a case by case basis.

3.4.6.3. Customer provided protection and typical protection devices which may be required to satisfy Type 4 Interconnection requirements.

3.4.6.3.1. The Customer shall provide adequate protective devices to detect and clear the generator(s) from short circuits or grounds on the GVEA facilities serving the Customer.

3.4.6.3.2. The Customer shall provide adequate protective devices to detect the voltage and frequency changes which can occur if the GVEA facilities serving the Customer are disconnected from the main system; and if abnormal voltages or frequencies exist, these relays shall disconnect the Customer generation from the system.

3.4.6.3.3. Phase over-current trip devices (Device 51). In most cases these will be voltage-restrained or voltage-controlled over-current relays in order to provide coordination with GVEA relays.

3.4.6.3.4. Residual over-current relays to trip for ground faults on the GVEA system (Devices 51N).

3.4.6.3.5. Under/over-voltage relays (Device 27/59). Under-voltage relays shall be adjusted to a percentage of nominal voltage as specified by GVEA during design coordination and have sufficient time delay to prevent unnecessary tripping of external faults. Over-voltage relays should be adjustable from 110-120% of nominal voltage and should be instantaneous. Setting change with temperature variation should not exceed $\pm$ 2 volts over the expected temperature range.

3.4.6.3.6. Under/over-frequency relays (Device 81). The under/over-frequency relay shall be set as specified by GVEA during design coordination.

3.4.6.3.7. Phase sequence/under-voltage relay (Device 47/27). To permit paralleling when GVEA voltage and phase sequence are normal.

3.4.6.3.8. A synchronizing check relay and an auto-synchronizing relay shall be required for a synchronous generator (Device 25).

3.4.6.4. Instrument transformer accuracy for protective relaying shall meet the accuracy requirements of Section 2.1.4 of this specification.

3.4.6.5. The Customer shall provide information on the type of anti-islanding protection used and coordinate those protection schemes such that any GVEA circuit reclosing shall not be adversely affected. Additionally system design information showing the method of preventing reparalleling Customer generation shall be provided to GVEA. Reparalleling Customer generation shall not occur after a circuit is disconnected unless the GVEA service voltage is of normal magnitude, normal phase sequence, and approval is received from the GVEA control center.

3.4.6.6. In specific installations, particularly with large generators GVEA may require specific additional protective functions such as loss of excitation, loss of synchronism, and under/over excitation limiting protection, if these conditions would have an impact on the GVEA’s system.

3.4.6.7. All Type 4 Interconnections require the Customer to utilize "utility grade" protective relays. Such relays have more stringent tolerances, are more flexible, and the characteristics are more widely published than "industrial grade" relays.

3.4.6.8. All protective devices supplied to satisfy the requirements in 3.1.1 shall be equipped with operation indicators (targets) or shall be connected to an annunciator or event recorder so that it will be possible to determine, after the fact, which device(s) caused a particular trip.

3.4.6.9. All protective devices supplied to satisfy the requirements in 3.1.1 shall be tested, certified and sealed by a qualified person. Special tests may also be required by GVEA to investigate apparent misoperations or to compile a record of performance.

3.4.6.10. Phase over-current protection shall be required regardless of generation source type.

3.4.7. The Customer shall provide and maintain on-site, 24 hr. "Voice" dedicated telephone, VHF radio, or microwave facilities for communications between the Customer's generating facility and the GVEA control center. The Customer shall provide telephone isolation equipment where necessary to protect the communications circuit and site workers.

3.4.8. Remote Control, Telemetry, and SCADA: All costs related to operational telemetry and control as required for GVEA to accommodate Customer's generation shall be borne by the Customer.

3.4.8.1. Remote control of Customer equipment or devices by the GVEA control center shall be required for Type 4 Interconnections. GVEA shall require dedicated communications for both telemetry and control. Additionally, GVEA may also have other communication or control requirements which will be determined during the project design coordination phase. Types of control by GVEA's control center includes:

3.4.8.1.1. Close Permissive Control

3.4.8.1.2. Transfer Trip Capabilities

3.4.8.1.3. Interconnect breaker tripping

3.4.8.2. GVEA shall require telemetry capability to allow GVEA continuous monitoring of the installation and verify at a minimum, on-line/off-line (tie point breaker) status and measure amps, watts, vars and voltage output.

3.4.8.2.1. The Customer shall provide and install a Remote Terminal Unit (RTU) compatible with GVEA's SCADA system along with any necessary transducers.

3.4.8.2.2. All transducers used for GVEA monitoring shall be utility grade quality and subject to GVEA approval.

3.4.8.2.3. The Customer shall provide a telephone line interface, a four wire data circuit, provide telephone isolation equipment, and arrange for the telephone lines. Fiber optic communication may be substituted for dedicated phone lines if such system infrastructure is feasible.

3.4.8.2.4. The Customer shall provide space for all required communication and control equipment in their facility.

3.4.9. Harmonic output of Customer generation shall comply with IEEE 519. If Grid Interactive power sources are used IEEE 1547 and UL 1741 shall also apply and the most stringent specification shall govern. If a Customer is found to be interfering with other Customers or Members, or exceeds IEEE recommended specifications, the Customer may be required to install filtering to bring the harmonic output of their inverter(s) to an acceptable level.

3.4.10. Adequate facility and equipment grounding meeting NESC, IEEE recommended standards, and current safe utility practices for grounding must be designed and installed by the Customer.

3.4.11. Reactive power requirements: In order to reduce the possibility of self-excited operation, all reactive power requirements for induction generators shall be supplied by GVEA. Except in unusual situations, this reactive power supply shall be from general utility sources and specific charges may be made to the Customer for the reactive power.

3.4.12. Machine testing and Computer Modeling

3.4.12.1. Power flow and transient stability power system modeling shall be provided by the Customer to GVEA for review. Modeling shall be done in the most recent PSS/E software version. GVEA can provide the Customer this service if requested and all costs of the study shall be borne by the Customer. GVEA's system data shall be released to the Customer's engineer for the power flow and stability analysis of this single project. All Customer copies of GVEA's system data shall be destroyed upon completion of the study. Contact GVEA Engineering services for the most recent Alaska Railbelt Power System PSS/E Model or provide the required information for GVEA to complete the study. This requirement may be waived for generation of 2 MW or less.

3.4.12.2. PSS/E machine Power Flow and Transient Stability model parameters shall be developed. The recommended generator, governor, and automatic voltage regulator (AVR) settings coinciding with these modeled parameters shall be provided by the Customer. PSS/E dynamic simulations shall be performed to ensure that the generator, prime mover, governor, and excitation models have parameters corresponding to as-left equipment settings and represent equipment dynamic performance with sufficient accuracy for power system stability studies. Data for excitation system limits and trips (refer to Table 1 of the Western Systems Coordinating Council letter "Testing of Synchronous Unit Reactive Limits and Dynamic Testing / Model Validation") shall also be submitted, free of charge, to GVEA to retain for use in GVEA's PSS/E system model.

3.4.12.3. Machine testing results shall be provided to GVEA and shall include, but not be limited to, generator, governor and automatic voltage regulator (AVR) parameters. Field testing of all machines shall be provided in accordance with the requirements of the March 21, 1997 letter from Western Systems Coordinating Council entitled "Testing of Synchronous Unit Reactive Limits and Dynamic Testing / Model Validation".

3.4.13. The Customers facilities shall be secure to prevent unauthorized personnel access. GVEA shall review the Customers security plan along with site plan drawings showing proper fencing and other features required to prevent unauthorized personnel from entering the Customers facility.

4.0 SPINNING RESERVE AND LOAD SHEDDING

4.1. Alaska's electrical grid system is different from most other electrical systems in the United States in that it is not interconnected with a much larger system. Alaska is made up of many individual grids, with very few actual interconnections. Although the GVEA system is interconnected with several other Railbelt Electric utilities, it still remains a relatively small interconnected system in terms of "on-line" generation and backup reserves. For this reason, it is essential that any NUPP or COG above 2,000 kW (2 megawatts) be subject to the same rules and guidelines as other electric utilities on the grid. Spinning reserve formulas, rules, and guidelines are subject to change as changes are made to the Alaska Intertie Agreement by the participants of that agreement.

4.2. A NUPP or COG which has the ability to deliver 2,000 kW or more capacity into the GVEA system, and who with the loss of its own generation would place an instantaneous capacity burden on the GVEA system in excess of 2,000 kW shall be required to meet spinning reserve, as calculated by the spinning reserve formula, by either one or any combination of the following:

4.2.1. Arrange with GVEA or another electric utility interconnected with the system to have "on-line" spinning reserves scheduled to cover the load the NUPP or COG could instantaneously place on the GVEA system if they were to experience a loss of generation.

4.2.2. Arrange for an automatic load shedding scheme designed to simultaneously remove all the Customers load, or a block of the Customers load equal to or greater than the amount of generation lost on the NUP or COG system.

4.2.3. Supply its own spinning reserve from a different generator.

4.3. Spinning Reserve Formula:

$$\frac{\text{Largest Customer Unit On-Line} \times \text{Largest GVEA Unit On-line}}{\text{Largest Customer Unit On-Line} + \text{Largest GVEA Unit On-line}}$$

5.0 METERING

5.1. Energy flow to GVEA shall be measured by bi-directional meters or meters equipped with detents so that the record of those flows will not be affected by any flows to the Customer. Flows to Customer shall be metered separately and billed monthly in accordance with the terms of the Purchase Agreement, if any, existing between the parties, and/or otherwise in accordance with tariffs filed and approved by the Regulatory Commission of Alaska.

5.2. At GVEA's option, GVEA shall procure, install, own, inspect, test, and maintain meters to record flows to and from GVEA's system. All such metering equipment shall conform to the requirements specified in the Alaska Intertie Agreements, or its successor(s). Such meters shall be placed at GVEA's designated location(s), shall measure kWh, and shall record and indicate the integrated demand.

5.3. GVEA shall determine the integrated demand for each fifteen (15) minute period for such recordings. GVEA shall also procure, install, own, inspect, test, and maintain meters for measurement of reactive volt-amperes. GVEA may also, in its sole discretion, install additional metering devices at a location agreed upon by both parties within Customer's facility to enable GVEA to telemeter information and data. All costs relating to metering devices and any metering related telemetering equipment installed and required for GVEA to accommodate Customer's generation shall be borne by Customer as part of the interconnection costs.

5.4. Metering error adjustment

5.4.1. Meters shall be replaced and tested at the Customers request or at GVEA discretion.

5.4.2. If the Customer is either producing or consuming power and the meter does not over or under register by more than 2%, a charge as set forth in the applicable schedule of fees will be made to the Customer who requests such a test.

5.4.3. When the Customer is consuming power and the meter in service is tested and found to have over-registered the amount of energy delivered to the Customer by more than 2%, GVEA will recalculate the bills for service from the known date of error and will make a refund if the amount of adjustment exceeds $5. If the beginning date of error is unknown, GVEA will refund or credit the most recent Customer of record for the billed error for the period since the meter

was last tested, not to exceed six months, or the period during which the most recent Customer of record received service through the meter, whichever period is shorter. Adjustments will be made in reference to 100% accuracy of the meter.

5.4.4. When the Customer is consuming power and a meter in service is tested and found to have under-registered the amount of energy delivered to the Customer by more than 2%, GVEA shall for GS2 and wholesale Custormers recalculate the bills for service from the known date. GVEA will not charge the Customer for the underbillings for GS1 Customers unless there is evidence of meter or electric service tampering.

5.4.5. When the Customer is producing power and the meter in service is tested and found to have over-registered the amount of energy received from the Customer by more than 2%, GVEA shall for GS2 and wholesale Custormers recalculate the bill for service from the known date. GVEA will not charge the Customer for the underbillings for GS1 Customers unless there is evidence of meter or electric service tampering.

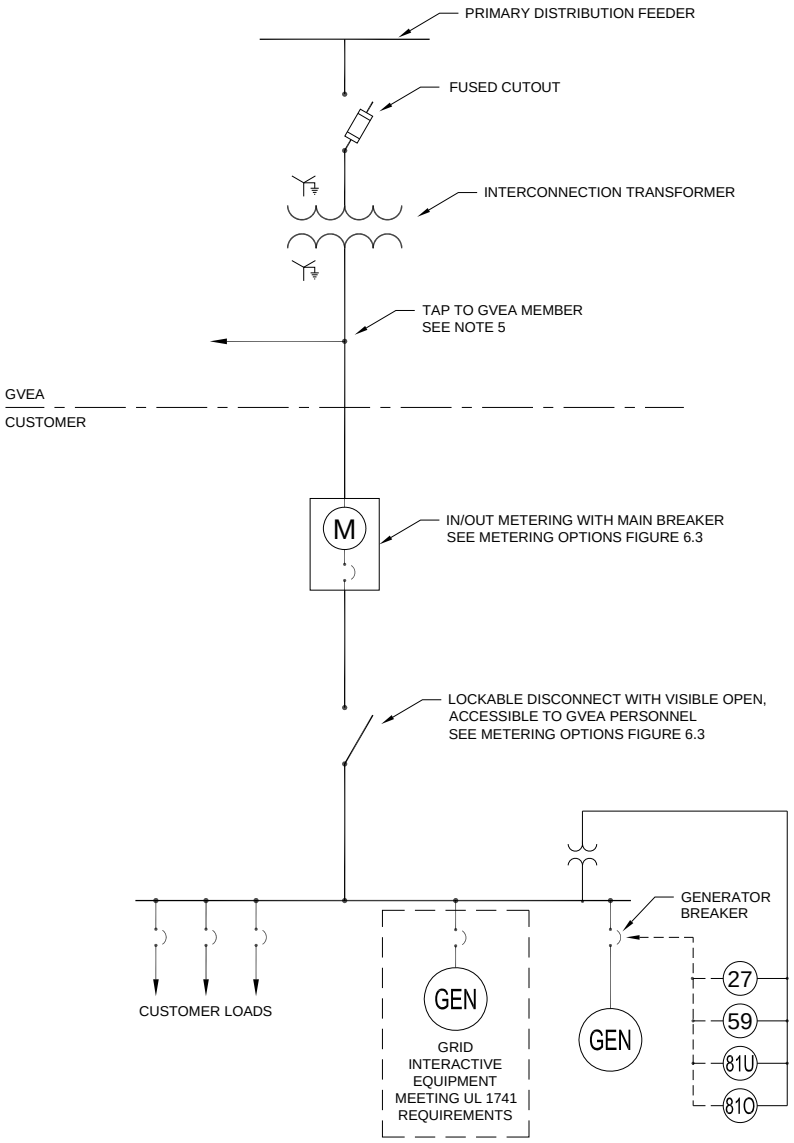
5.4.6. When the Customer is producing power and a meter in service is tested and found to have under-registered the amount of energy delivered to the Customer by more than 2%, GVEA will recalculate the bills for service from the known date of error and will make a refund if the amount of adjustment exceeds $5. If the beginning date of error is unknown, GVEA will refund or credit the most recent Customer of record for the billed error for the period since the meter was last tested, not to exceed six months, or the period during which the most recent Customer of record received service through the meter, whichever period is shorter. Adjustments will be made in reference to 100% accuracy of the meter.

6.0 FIGURES

6.1. Type 1 – Grid Interactive or Induction Machine

200 Amps or Less and 480 Volts or Less

REVISED 1/8/07



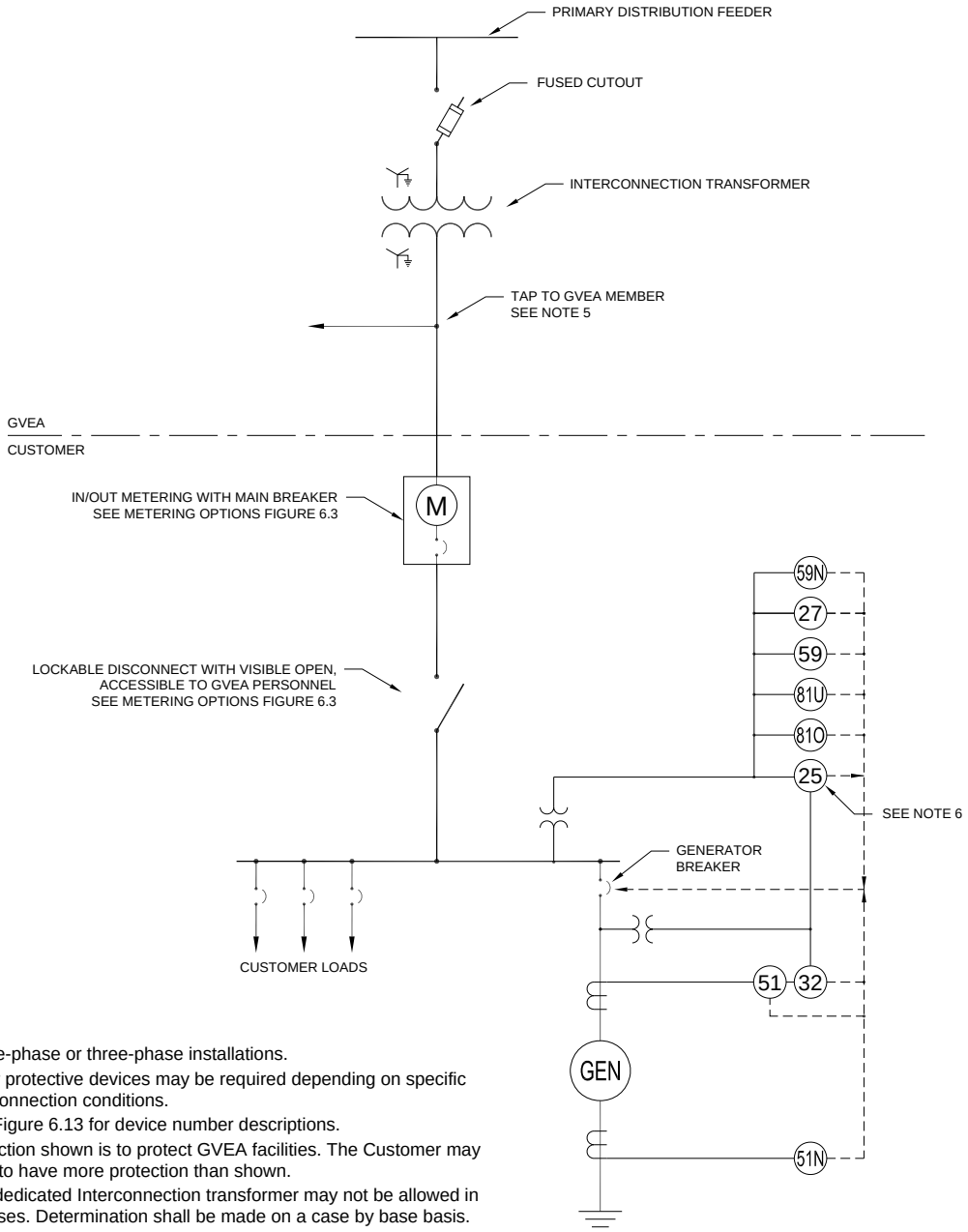
NOTES:

1. Single-phase or three-phase installations.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Non-dedicated Interconnection transformer may not be allowed in all cases. Determination shall be made on a case by base basis.

6.2. Type 1 – Synchronous Machine

200 Amps or Less and 480 Volts or Less

REVISED 1/8/07



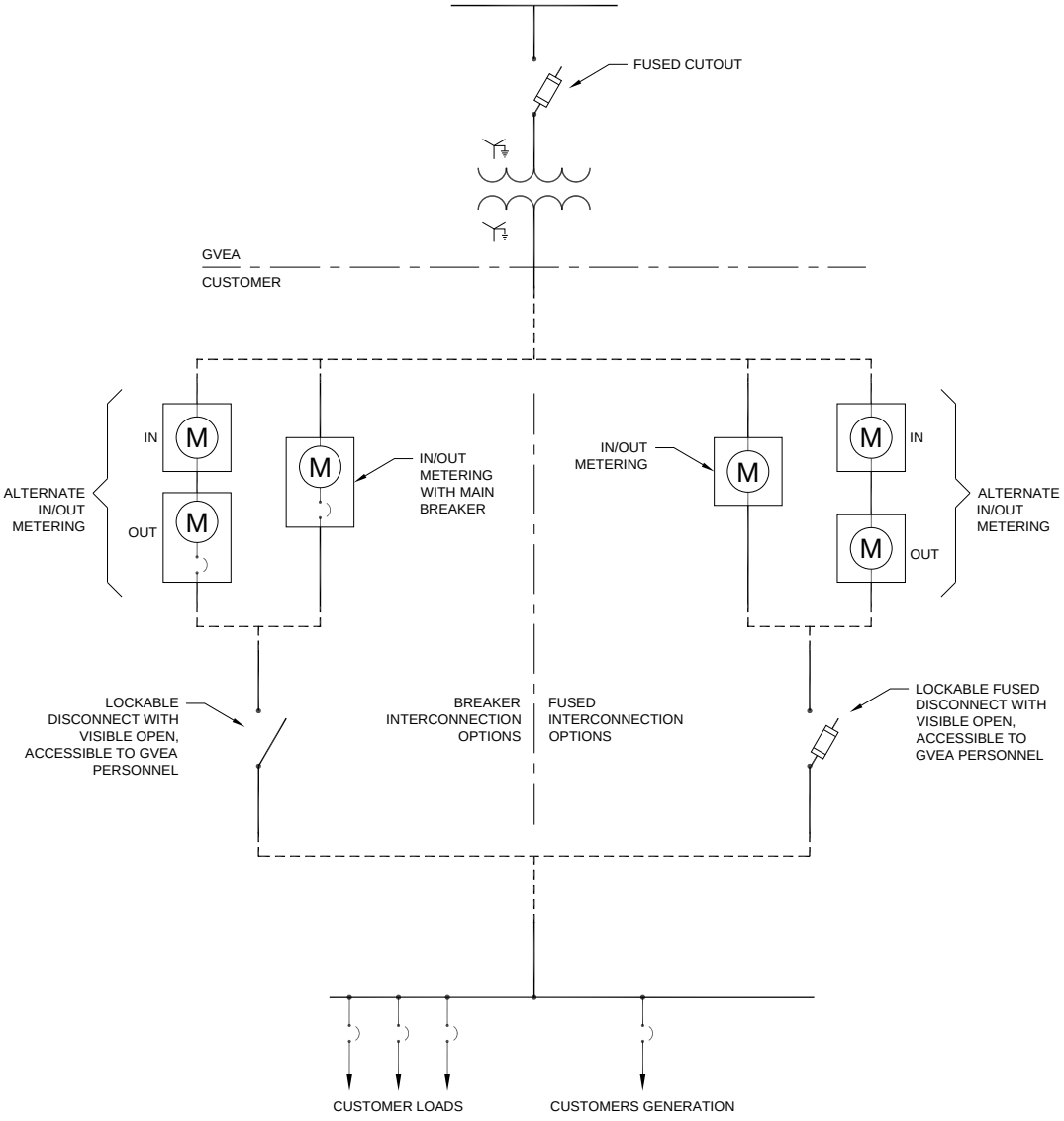
NOTES:

1. Single-phase or three-phase installations.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Non-dedicated Interconnection transformer may not be allowed in all cases. Determination shall be made on a case by base basis.
6. Sync check relay (25) supervises manual synchronized closing.

6.3. Type 1 – Metering, Disconnect & Fusing Options

200 Amps or Less and 480 Volts or Less

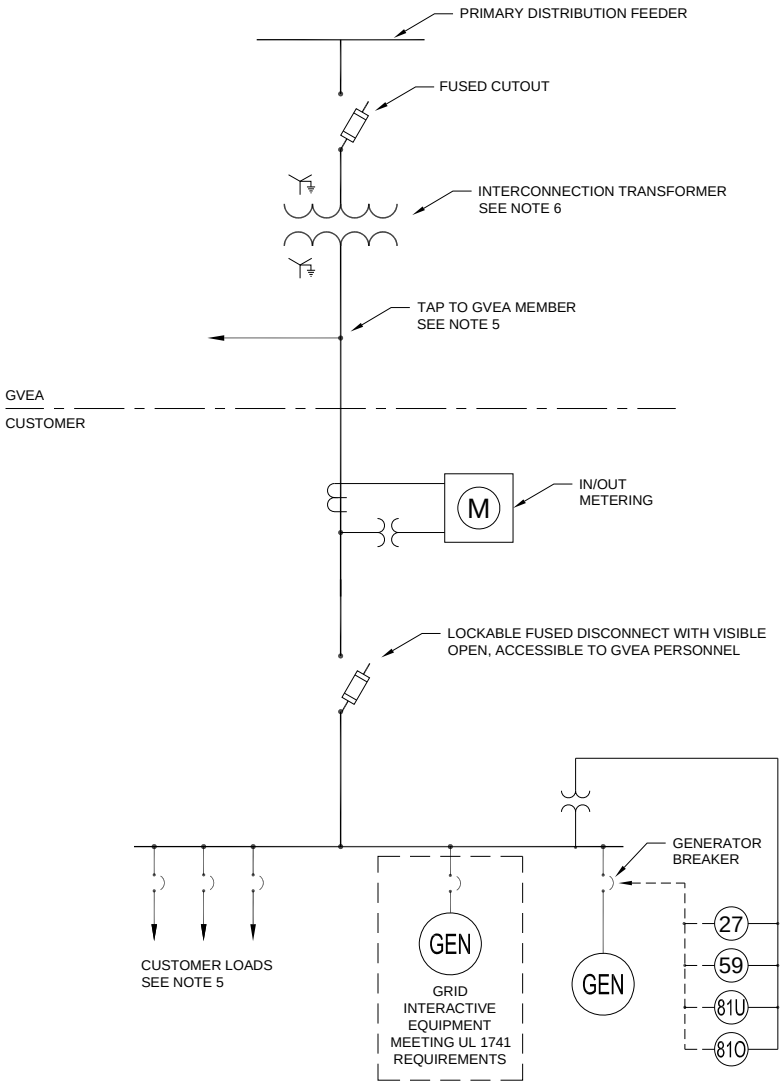
REVISED 1/8/07



6.4. Type 2 – Grid Interactive or Induction Machine

Greater than 200 Amps and 500 kVA or Less at Secondary Voltages

REVISED 1/8/07



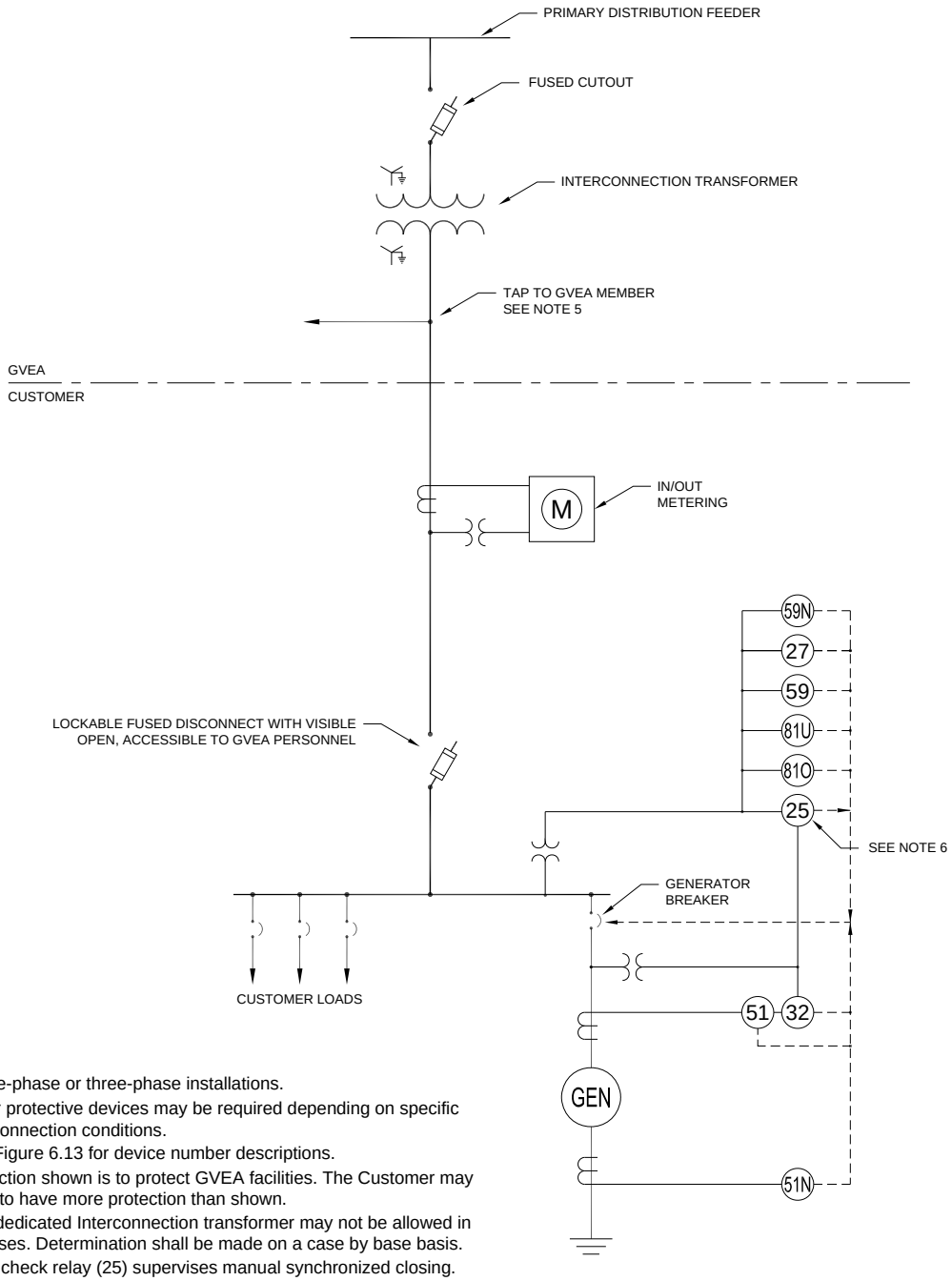
NOTES:

1. Single-phase or three-phase installations.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Non-dedicated Interconnection transformer may not be allowed in all cases. Determination shall be made on a case by base basis.
6. If no GVEA Members or Customer loads are served the transformer may be wye (high side) delta (low side) connected.

6.5. Type 2 – Synchronous Machine with Customer Loads

Greater than 200 Amps and 500 kVA or Less at Secondary Voltages

REVISED 1/8/07



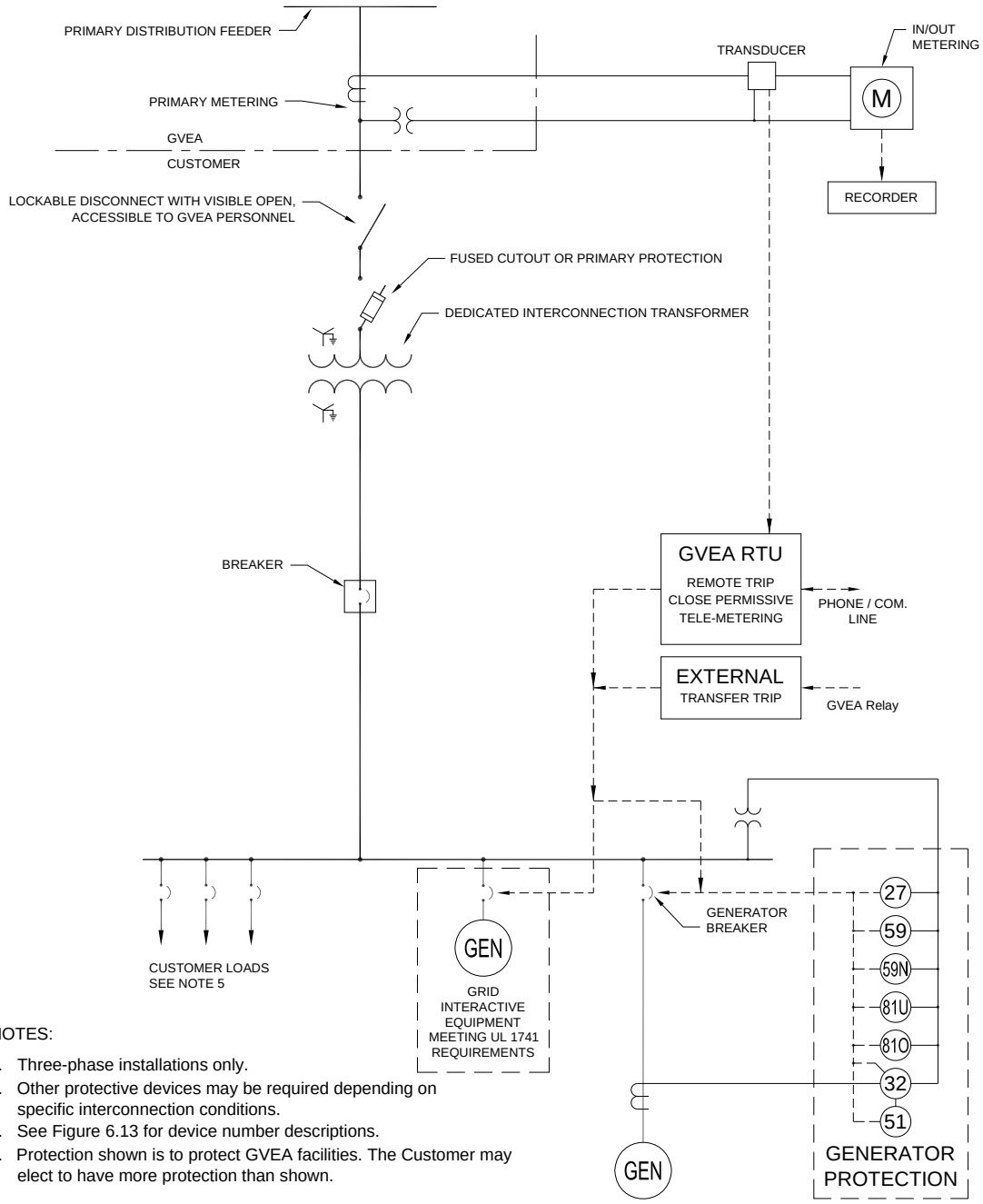
NOTES:

1. Single-phase or three-phase installations.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Non-dedicated Interconnection transformer may not be allowed in all cases. Determination shall be made on a case by base basis.
6. Sync check relay (25) supervises manual synchronized closing.

6.6. Type 3 – Grid Interactive or Induction Machine

Less than or equal to 2 MVA at Primary Voltages

REVISED 1/8/07



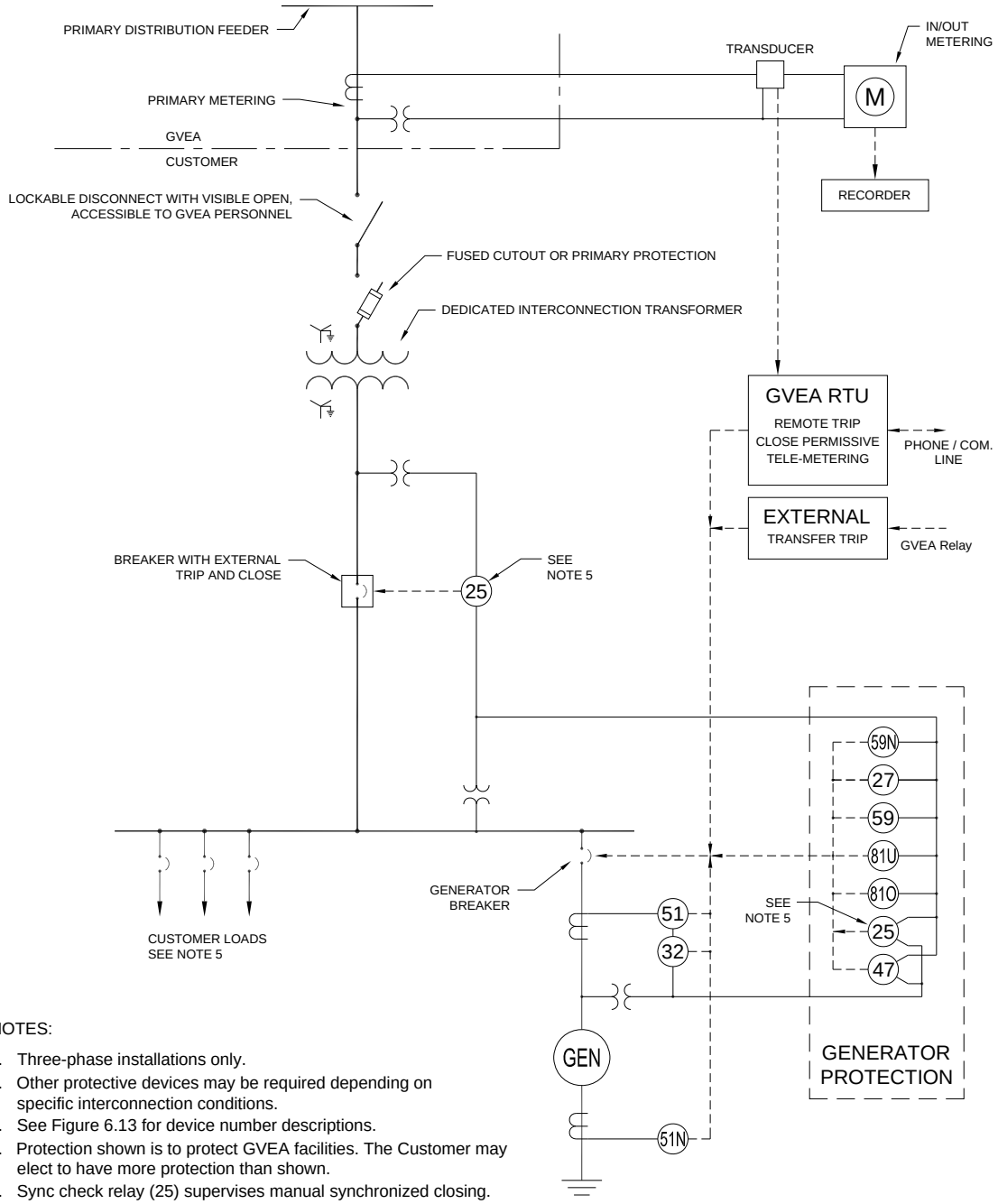
NOTES:

1. Three-phase installations only.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.

6.7. Type 3 – Synchronous Machine with Customer Loads

Less than or equal to 2 MVA at Primary Voltages

REVISED 1/8/07



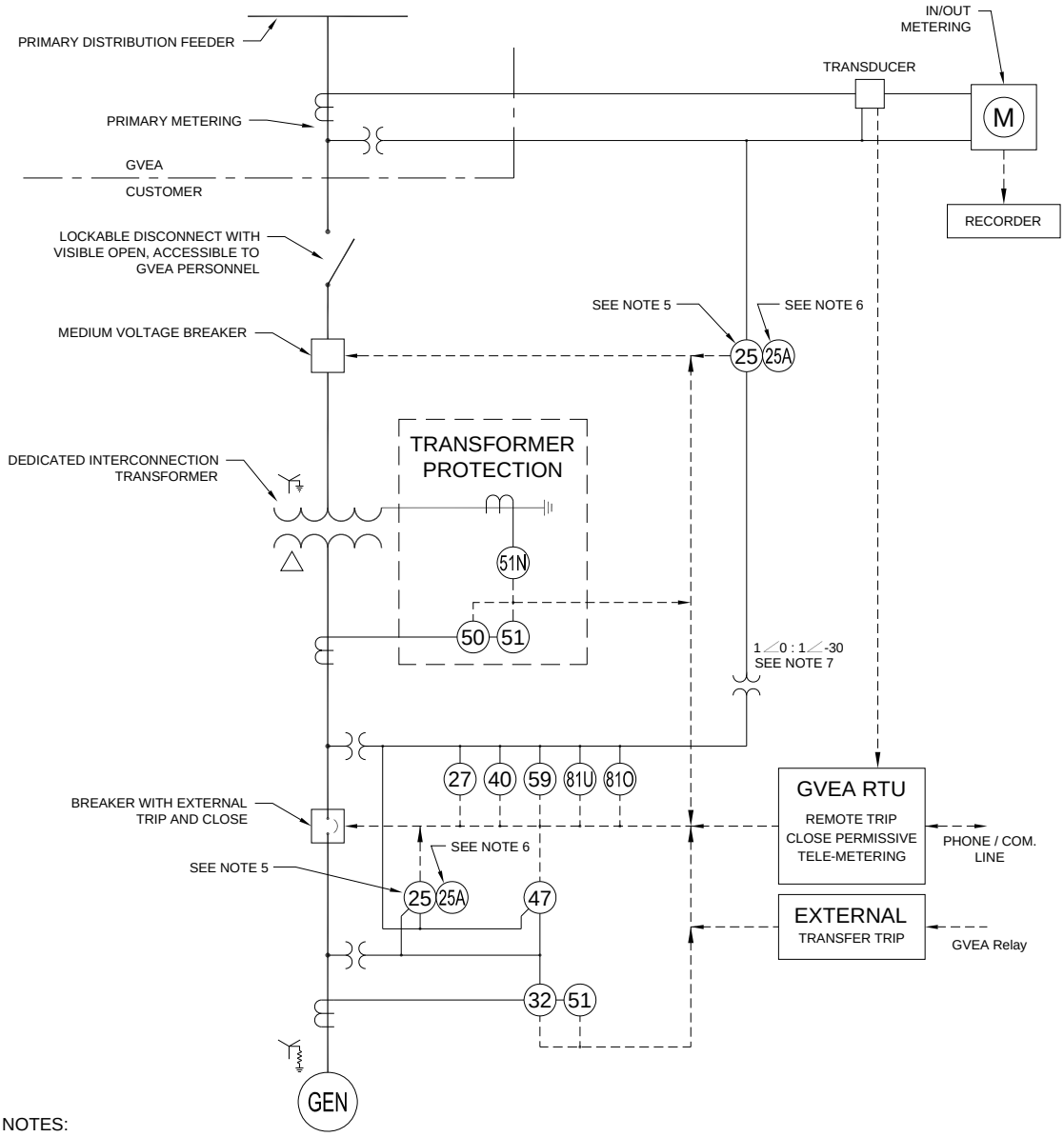
NOTES:

1. Three-phase installations only.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Sync check relay (25) supervises manual synchronized closing.

6.8. Type 3 – Synchronous Machine without Customer Load

Less than or equal to 2 MVA at Primary Voltages
Interconnection with Generation Only

REVISED 1/8/07



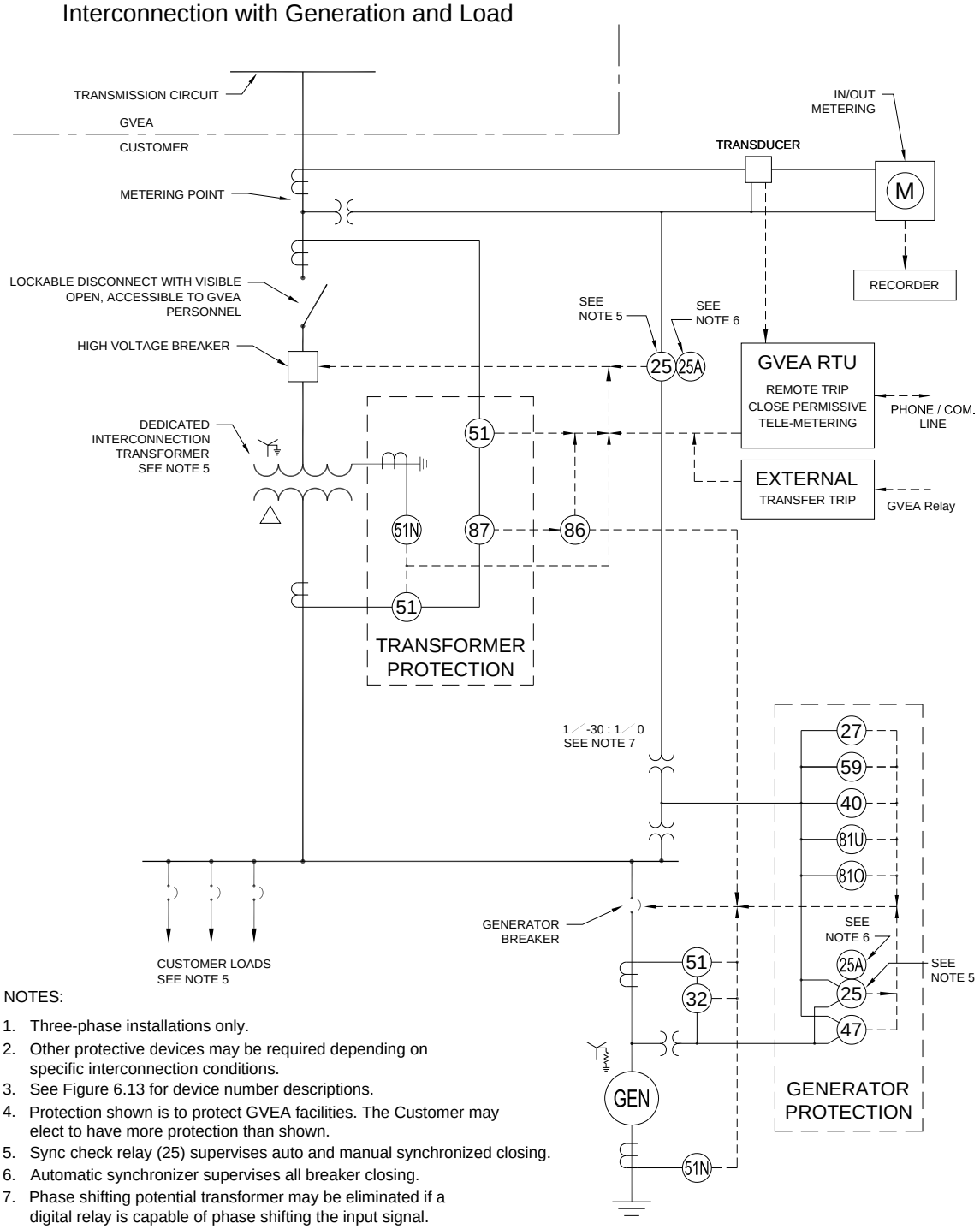
NOTES:

1. Three-phase installations only.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Auto and manual sync closing supervised by 25 sync check.
6. Automatic synchronizer supervises all breaker closing.
7. Phase shifting potential transformer may be eliminated if a digital relay is capable of phase shifting the input signal.

6.9. Type 4 – Synchronous Machine with Customer Load

Greater than 2 MVA at Transmission Voltages
Interconnection with Generation and Load

REVISED 2/2/07



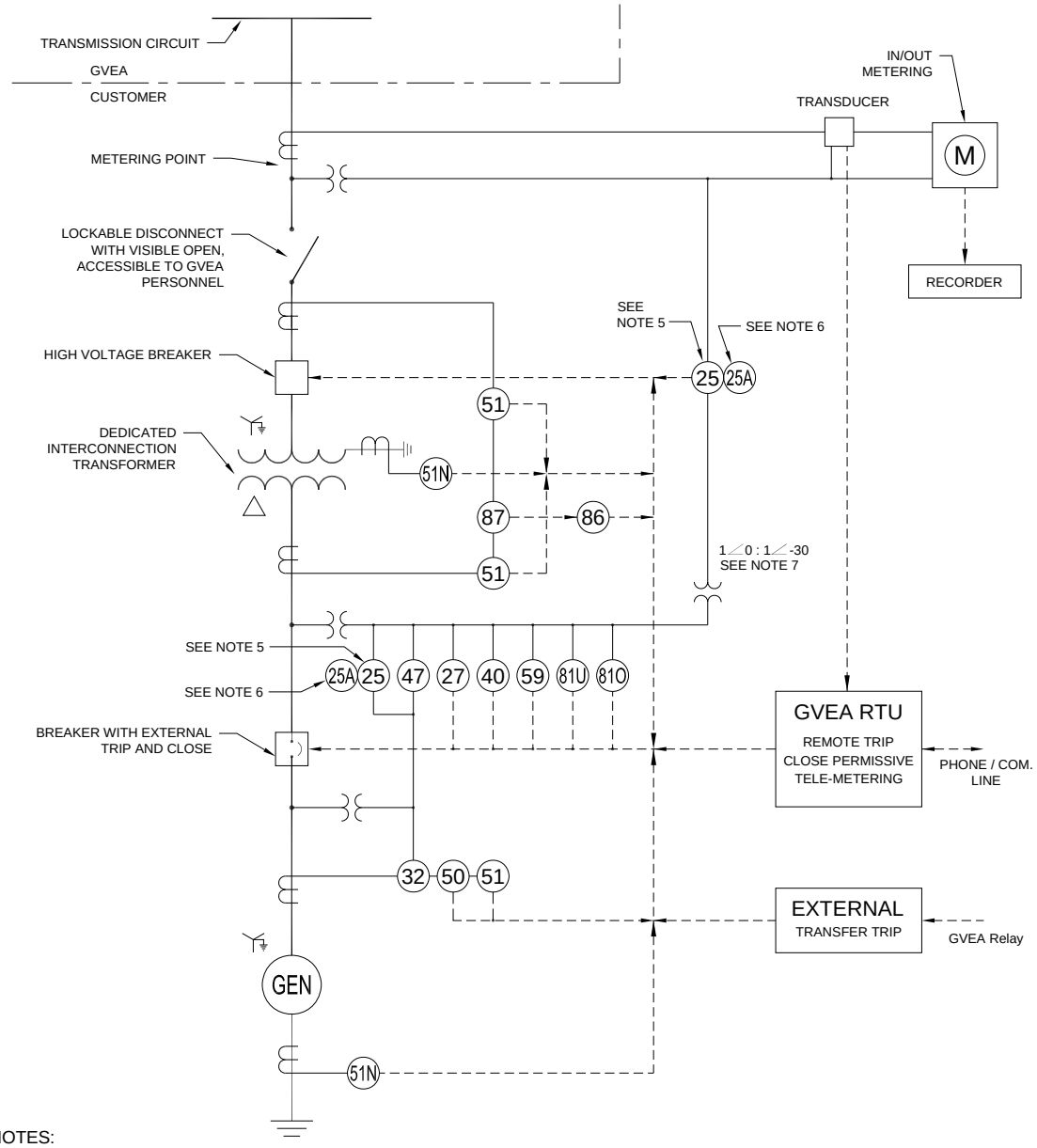
NOTES:

1. Three-phase installations only.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Sync check relay (25) supervises auto and manual synchronized closing.
6. Automatic synchronizer supervises all breaker closing.
7. Phase shifting potential transformer may be eliminated if a digital relay is capable of phase shifting the input signal.

6.10. Type 4 – Synchronous Machine without Customer Load

Greater than 2 MVA at Transmission Voltages
Interconnection with Generation Only

REVISED 2/2/07



NOTES:

1. Three-phase installations only.
2. Other protective devices may be required depending on specific interconnection conditions.
3. See Figure 6.13 for device number descriptions.
4. Protection shown is to protect GVEA facilities. The Customer may elect to have more protection than shown.
5. Auto and manual sync closing supervised by 25 sync check.
6. Automatic synchronizer supervises all breaker closing.
7. Phase shifting potential transformer may be eliminated if a digital relay is capable of phase shifting the input signal.

6.11. IEEE Protective Device Numbers

Typical Protective Device Numbers

4 Master Contactor

25 Synchronizing of Synchronism Check

25A Automatic Synchronizer

27 Under-voltage

32 Directional Power

40 Loss of Field Detection

46 Phase Balance Current

47 Voltage Phase Sequence

51 Phase Over-current

51G Ground Time Over-current

51N Neutral Time Over-current

51V Voltage Restrained/Controlled Time Phase Over-current

52 Circuit Breaker

59 Over-voltage

59N Residual Over-voltage (Ground Fault Detection)

79 Reclosing Relay

81O Over-frequency

81U Under-frequency

87 Current Differential

NOTE: For additional information on device numbers, refer to ANSI C37.2

7.0 APPLICATION FOR PARALLEL OPERATION WITH UTILITY SERVICE

To ensure that GVEA has received adequate information to properly and thoroughly review an application from a Qualifying Facility, GVEA has prepared an application form to facilitate this process. A sample of this form is included in this section.

It is the policy of GVEA to provide a preliminary written response to a Qualifying Facility applicant within 15 working days. The preliminary written response is intended to accomplish the following:

1. Acknowledge receipt of Qualifying Facility's application.

2. Clearly identify any deficiencies in the contents of the application and to state what additional information is required to complete the application, if any.

3. If the application is complete, GVEA will attempt to identify any areas of concern which GVEA feels the application must address.

4. Identify a preliminary time schedule for the initial review process and identify the person or persons within GVEA who will be a point of contact for continued coordination.

5. Advise the applicant if there are costs attributable to the applicant for the initial review process.

6. Establish a date, time, and place to conduct a follow-up coordination meeting to assist the applicant in the on-going process.

It is further the policy of GVEA to thoroughly document the review process as it progresses. As such, it will be necessary at each phase of the review process to reduce to writing, the understandings reached between the applicant and GVEA.

It is the intent of GVEA to assure the applicant at all times that this application is receiving a prompt review.

APPLICATION FOR PARALLEL OPERATION WITH UTILITY SERVICE

Customer's Name: _____

Contact Person: _____

Mailing Address: _____

Zip Code: _____ Telephone: (_____)_____

Proposed Service Point Location (Scott Number):_____

(Name of existing service point or attach map)

_____

The following information shall be furnished upon application by the customer or his representative for consideration in the mutual interest of the customer and the Utility:

Customer shall defend, indemnify and hold GVEA harmless for all damages and injuries to Customer, or others (including damage to the GVEA, Members, or other Customers) arising out of Customer's use, ownership, or operation of Customer's facilities. Customer is solely responsible for providing adequate protection for Customer's facilities operating in parallel with GVEA's system. Customer shall maintain in-force liability insurance in the amount of $_____ to cover all reasonably foreseeable liabilities arising out of its electrical generating system.

GENERATOR: (Complete all applicable items)

Station Name:

_____

Unit Number:

_____

Manufacturer:

_____

Type: _____INDUCTION _____SYNCHRONOUS

GENERATOR (cont.):

Kilowatt Rating: _____

Kilovolt-ampere Rating: _____

Power Factor: _____

Volts: _____

Amperes: _____

Phase and Frequency: _____

R.P.M.: _____

Field Amps: _____

Field Volts: _____

Synchronous Reactance: _____% on _____ base.

Transient Reactance: _____% on _____ base.

Subtransient Reactance: _____% on _____ base.

Negative Sequence Reactance: _____% on _____ base.

Zero Sequence Reactance: _____% on _____ base.

Motoring Power: _____kw _____

Year Manufactured: _____

Serial Number: _____

PRIME MOVER:

Manufacturer: _____

Year Manufactured: _____

Type: _____

Energy Source: Briefly describe the cogeneration, wind, solar, stream, hydro, or other energy source:

_____

_____

_____

_____

INTERFACE CIRCUIT:

Describe the proposed interface circuit to be interposed between the generator and the Utility supply circuit.

Manufacturer:_____

Manufacturer's Reference Number:_____

Serial Number: _____

Describe power conversion (if any) process, i.e. rectifiers, inverters, batteries, etc.

_____

_____

_____

_____

_____

_____

COMBINED CHARACTERISTICS OF GENERATOR AND INTERFACE CIRCUIT

(a) Maximum generated capacity (to be measured at interface output terminals). This is not the generator capacity but the capacity that can be fed into the network when operating at nominal voltage.

_____kW
_____kVA

(b) Output voltage to system:

_____

(c) Unit WR^2 (Lbs-Ft^2):

_____

Items d, e, and f apply to inverter installations only.

(d) Attach to this form an oscillographic print showing the wave shape of current supplied to the network system at the interface output terminals. The wave shape of the utility system voltage should also be shown on the same print. If energy source is wind, state wind velocity at time of the test and output capacity (power supplied to

the system). If actual data is not available, oscillograms from a similar installation will be considered.

(e) Estimated (or measured) percent wave-shape distortion, at interface output terminals, for equipment operating at maximum output. Submit calculations or certified test report.

(f) Estimated (or measured) power factor at interface output terminals for same conditions as above. Submit calculations or certified test report.

PROTECTION EQUIPMENT: Do NOT complete Items a, b, and c below for three-phase generator installations since the Utility will specify protective device model numbers and settings at the interface.

(a) Manufacturer: _____

(b) Manufacturer's Reference Number, Type, or Style:
_____

(c) Submit diagram and describe the operation (including protective device settings) for the tripping of the interface or generator circuit breaker for both:
(1) Utility voltage outage (Loss of supply voltage)
(2) Utility short circuit (Three-phase and single Phase-to-ground)

(d) Name of individual, licensed electrician, or electrical contracting firm responsible for circuit breaker maintenance (if the customer owns the circuit breaker tripped by the interface protective devices).
_____
_____
_____

Upon any changes in Item (d), the customer hereby agrees to provide prompt written notification to the Utility of the name of the individual or firm responsible for the maintenance f the circuit breaker.

(e) Submit maintenance schedule to be followed for the circuit breaker.
(f) A maintenance log sheet shall be kept at the premises and made available for verification by the Utility.

ADDITIONAL REQUIREMENTS:

1. The customer shall submit a detailed, one line, electrical diagram of his generating equipment, protective features, and connection to the Utility's supply line.

2. The customer agrees to allow the Utility to install on his premises any equipment needed to measure loads or any part thereof, to measure the energy produced, to collect and obtain any other data necessary to determine operating characteristics of such installation served under this particular service classification.

Other Information Requested by:

Prepared and submitted for Approval by:

(Name and Address)

_____

_____

_____

_____

Applicant or Legal Representative:

_____

Date: _____

Name and address of applicant and _____
premises to be served:_____

Received by: _____ (For: Name of the Utility)

_____

_____

Date: _____

GOLDEN VALLEY ELECTRIC ASSOCIATION INC