Interconnection Standards for Qualified Facilities

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 BACKGROUND

Colorado Springs Utilities provides electricity to Colorado Springs, Manitou Springs, Chipita Park, Green Mountain Falls, portions of Security, and several unincorporated areas of El Paso and Teller counties. The U.S. Air Force Academy, Fort Carson, and NORAD also purchase electric power from Colorado Springs Utilities. Colorado Springs Utilities is dedicated to providing safe, economical, and reliable electric power to its customers.

Colorado Springs Utilities is committed to uphold and encourage various Federal and State regulations governing the electric utility industry. Colorado Springs Utilities adopted the Open Access Transmission Tariff (OATT) to comply with the Federal Energy Regulatory Commission's (FERC) interstate open access transmission regulations. The OATT applies to any electric utility, Federal power-marketing agency, or any person generating electric energy for sale or resale.

This document is hereby adopted to regulate customers that elect to operate a qualifying photovoltaic, wind, fuel cell, or fossil fuel generator within Colorado Springs Utilities' service area. These Standards apply to qualifying facilities operating under Colorado Springs Utilities' tariffs that are not subject to FERC's interstate open access transmission regulations.

1.2 PURPOSE

These Standards state the minimum requirements for safe and effective operation of independently owned generators, a co-generator, small power producer, non-utility generator (NUG), and customer-owned generators (hereinafter individually and collectively referred to as "Owner"), operating within Colorado Springs Utilities' electric distribution system.

Because the Owner is responsible for the overall safe and effective operation of its generating facility, the Owner is responsible for designing its own protection scheme. It is recommended the Owner consult an expert in the field of electric distribution system protection.

Owner and Colorado Springs Utilities' personnel may be guided by this document when planning installations of independently-owned generation. It is emphasized that these requirements are general and may not cover all details in specific cases. The Owner should discuss project plans with Colorado Springs Utilities before purchasing or installing equipment.

1.3 POLICY ON INDEPENDENT GENERATION

It is Colorado Springs Utilities' policy to permit any Owner to operate generating equipment in parallel with Colorado Springs Utilities' electric distribution system whenever this can be accomplished without adverse effects on the general public or to Colorado Springs Utilities' equipment or personnel. Certain protective devices (relays, circuit breakers, etc.), specified by Colorado Springs Utilities must be installed at any location where an Owner desires to operate generation in parallel with Colorado Springs Utilities' electric distribution system. The purpose of these devices is to promptly disconnect the Owner's generating equipment from Colorado Springs Utilities' electric distribution system whenever faults or abnormal operating conditions occur. Other modifications to the electrical system configuration or protective relays may be required in order to accommodate parallel operation. All costs of interconnection and of metering shall be borne by and paid by the Owner.

Colorado Springs Utilities reserves the right to deny any application for interconnection that would require modifications to Colorado Springs Utilities' existing infrastructure. Additionally, any application that does not meet these requirements shall be denied. If the interconnection cannot be installed and operated to ensure the safety of Colorado Springs Utilities' employees and the general public, then the interconnection shall be denied.

Owner shall submit in a timely manner, sufficient design and specifications information relating to the facilities to be installed by the Owner and Colorado Springs Utilities shall be entitled to review and approve or accept said facilities prior to installation and energization. Owner agrees to incorporate any reasonable design changes requested by Colorado Springs Utilities prior to, during, or after installation of Owner's portion of interconnection facilities. Colorado Springs Utilities' approval or acceptance of any design and specification information related to the facilities to be installed by Owner shall not be construed as an endorsement of such engineering plans, specifications, or other information.

If the interconnection with the Owner's facilities should cause unusual fluctuations or disturbance on, or inductive interference with Colorado Springs Utilities' electric distribution system or customers, then Colorado Springs Utilities shall have the right to require Owner to install suitable equipment to correct or limit such fluctuation, disturbance or interference at no expense to Colorado Springs Utilities or its customers.

A pre-interconnection study shall be conducted by Colorado Springs Utilities of any proposed interconnection of 10kW or greater capacity with the utility system. Pre-interconnection studies may include, but are not limited to:

a) Feasibility Study - A preliminary evaluation of the feasibility of the proposed interconnection to determine the system voltage and interconnection requirements (capacity) at the proposed site of the distributed generation (DG). The Feasibility Study will consist of a power flow and short circuit analysis.

b) System Impact Study - An engineering analysis that models the Springs Utilities system with the proposed DG in place to determine whether the system will support the DG unit without compromising the reliability and integrity of the system. The analysis includes a review of the DG contribution to power flow, and the effects on the utility system voltage.

c) Facilities Study - Specifies and estimates the cost of the equipment, engineering, procurement and construction work needed to implement the conclusions of the System Impact Study to physically and electrically connect the proposed DG. The Facilities Study shall also identify the electrical switching configuration of the connection equipment, including, without limitation: transformer, switchgear, meters, and other equipment

The maintenance and operation of the downtown secondary network is covered by unique work practices. Therefore, no parallel operation generation will be allowed to be connected to the downtown secondary network.

2.0 PURCHASE RATES

Standard rates of purchase for energy and capacity from qualified facilities have been developed by Colorado Springs Utilities' Financial Planning and Pricing Department and were approved by the Utilities Board. Additional information can be obtained by contacting Colorado Springs Utilities at (719) 448-4800.

3.0 GENERATION SOURCES

The Owner may elect to use any of the available technologies including solar, wind, hydro etc., in addition to conventional fossil fuel type generation. The end conversion for connection to Colorado Springs Utilities' electric distribution system must be into 60Hz sinusoidal alternating current at a standard voltage and phase rotation connected to all phases present at the site.

The Owner may elect to operate the generator in parallel with Colorado Springs Utilities or as a separate system with the capability of non-parallel load transfer between the two independent systems. Each mode of operation requires a different and specific contract. In addition, each mode of operation requires a different and specific means of control. The technical requirements for these two methods of operation are outlined below.

4.0 SEPARATE AND PARALLEL SYSTEMS

4.1 SEPARATE SYSTEMS

A separate system is defined as one in which there is no possibility of connecting the Owner's generating equipment in parallel with Colorado Springs Utilities' electric distribution system.

A separate system can operate by implementing either an electrically or mechanically interlocked switching arrangement, which prevents the two electric power sources (Colorado Springs Utilities' and Owner's) from serving a customer's load simultaneously.

If the Owner has a separate system, Colorado Springs Utilities will require verification that the switching arrangement meets the non-parallel operation requirements. This will be accomplished by approval of drawings by Colorado Springs Utilities in writing and by field inspection of the switching arrangement. Colorado Springs Utilities will not be responsible for approving the Owner's generating equipment and assumes no responsibility for its design, operation, or effects on Owner's loads (see Liability Section 13). For further information on Automatic Throw Over (ATO)requirements, please contact the Colorado Springs Utilities' Enhanced Power Engineering section.

4.2 PARALLEL OPERATION

A parallel system is defined as one in which the Owner's generation system can be connected to the Colorado Springs Utilities' electric distribution system. A transfer of energy between the two systems is direct and continuous, which is often the desired result.

Colorado Springs Utilities' lines are subject to a variety of natural and man-made hazards. The electrical problems, which can result from these hazards, are principally short circuits and open conductors. These fault conditions require that the equipment involved be de-energized as soon as possible because of the hazards they pose to the public and to the operation of Colorado Springs Utilities' electric distribution system. A parallel generator must have adequate protective devices installed to sense trouble on Colorado Springs Utilities' electric distribution system and promptly disconnect. In addition, a parallel generator shall be able to be isolated from Colorado Springs Utilities' electric distribution system for generator troubleshooting and repair.

Parallel generation can also cause another condition known as "accidental isolation" or "islanding" in which a portion of Colorado Springs Utilities' load becomes isolated from Colorado Springs Utilities' source, but is still connected to the Owner's generator(s). In this condition, the isolated system may continue to operate independently of Colorado Springs Utilities, but with abnormal voltage and/or frequency. Accidental isolation or islanding is avoided by having the correct protective relaying. Therefore, Owner shall install appropriate protective relaying equipment to prevent accidental isolation or islanding. (See Sections 7 & 8)

The protective devices and other equipment required by Colorado Springs Utilities in these standards are intended to disconnect the parallel generator during abnormal operating conditions. These requirements are simple for a small installation, but become elaborate based on the size and complexity of the generation equipment.

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

5.0 ELECTRIC DISTRIBUTION SYSTEM INFORMATION

5.1 VOLTAGE

Colorado Springs Utilities' most common primary distribution voltages are 12.47kV and 34.5kV. The 34.5kV voltage distribution system is being utilized as a sub transmission system and its use as distribution voltage is restricted. The 12.47kV system is "effectively grounded" and is used for four-wire distribution (phase to neutral connected loads). Transmission voltages are 115kV and 230kV. Contact Colorado Springs Utilities' Enhanced Power Engineering section for information on the specific circuit available to serve the Owner's facility.

5.2 CIRCUIT RESTORATION

Because most short circuits on overhead lines are of temporary nature, it is Colorado Springs Utilities' practice to reclose one time. The breakers are set to reclose within 5 seconds on 12.47kV circuits and within 15 seconds on 34.5kV circuits, after they have tripped to clear a fault. Transmission lines are reclosed once only when the faults are cleared by protective relays; the reclosing time on transmission lines is around 35 cycles. The protective relays specified by Colorado Springs Utilities for parallel generator installations are intended to disconnect the generation from faulty or isolated lines before reclosing occurs.

5.3 EFFECTIVE GROUNDING

Effective grounding limits the voltage rise (typically to about 130%) on unfaulted phases during single-line-to-ground fault conditions. Colorado Springs Utilities maintains effective grounding on its electric distribution system and requires that all facilities connected to its system maintain an effectively grounded system. To achieve effective grounding, the Owner's system equivalent (Thevenin equivalent impedance) must meet the following criteria (Reference IEEE Standard 142 "IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems"):

a) The positive sequence reactance is greater than the zero sequence resistance ($X_1 > R_0$)

b) The zero sequence reactance is less than or equal to three times the positive sequence reactance ($X_0 \leq 3X_1$)

The facility Owner shall submit fault current studies to Colorado Springs Utilities' Enhanced Power Engineering section.

When calculating faults and effective grounding using positive, negative and zero sequence networks, the networks should include the following impedances: the step-up transformer, generator sub transient reactance, neutral grounding on the step-up transformer and/or generator, cable runs greater than 50 feet in length, and any grounding transformer.

There are many different system configurations that will meet the effective grounding requirements. Listed below are some standards and restrictions:

a) A grounded wye-grounded wye step-up transformer is acceptable only for facilities less than 1MW. When this transformer arrangement is used, the generator must have an appropriately sized grounding bank or its neutral must be adequately grounded to meet Colorado Springs Utilities' requirement for effective grounding.

b) A step-up transformer with a delta winding on Colorado Springs Utilities' distribution side may be used for facilities over 1MW. When this step-up configuration is used, a grounding transformer must be installed on the distribution feeder side. The grounding bank's impedance must be selected so that it meets the Colorado Springs Utilities' effective grounding requirements above, and must be rated to withstand the system current (see 5.3d below) and/or voltage imbalance.

c) Generators that produce power at line voltage (i.e., a step-up transformer is not needed) either must be adequately grounded or have a grounding transformer to meet Colorado Springs Utilities' effective grounding requirements.

d) Voltage imbalance on Colorado Springs Utilities' distribution may result in substantial current flowing into Owner's generator(s) or grounding equipment. Colorado Springs Utilities allows an imbalance of no more than 1% phase to phase and 3% phase to ground for voltage and 100 Amps neutral current, at 12.47kV. The Owner's equipment must be able to withstand allowable imbalances and be able to operate during an imbalance condition. Source impedance data for a given location should be obtained from the Colorado Springs Utilities' Enhanced Power Engineering section before the Owner purchases grounding equipment so that the equipment purchased will be appropriately rated (both for steady state and short time) for the given location.

e) Generators that are solidly grounded can be a harmonics source or sink and should be avoided. A grounding transformer is recommended if the generator cannot tolerate severe phase current imbalance.

f) The generator reactance used in calculating the ratio X_0/X_1 shall be the sub transient direct axis reactance (X_d").

6.0 SYSTEM INTEGRITY

6.1 GENERAL

The interconnection of the Owner's generating equipment with Colorado Springs Utilities' system shall not cause any reduction in the quality of service being provided to Colorado Springs Utilities' customers. No abnormal voltages, frequencies, or interruptions will be permitted. If high or low voltage complaints or transient voltage complaints result from operation of the Owner's generation, such generating equipment shall be disconnected until the problem is resolved at the Owner's expense.

6.1.1 DOWNTOWN NETWORK

The downtown network is a unique element of the Colorado Springs Utilities' distribution system and as such, the maintenance and operation is covered by unique work practices. Due to this, no parallel operation generation will be allowed to be placed on the downtown network.

6.2 HARMONICS

The Total Harmonic Distortion (THD) from the facility will be measured at the facility's metering point. Harmonics on the power system from any source must be kept to a minimum. Under no circumstances will the harmonic current and voltage be greater than the values listed in tables from IEEE Standard 519, "*IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.*", as amended from time to time.

In addition, any interference with Colorado Springs Utilities' customers' communications caused by harmonics generated by Owner's equipment in excess of federal, state, and local codes will be resolved at Owner's expense.

6.3 VOLTAGE

Operation of Owner's generators shall not adversely affect the voltage stability of Colorado Springs Utilities' system. Operating requirements will be determined via pre-interconnection studies. Sufficient generator reactive power capability shall be provided to withstand normal voltage changes in Colorado Springs Utilities' system. The generator voltage-VAr schedule, voltage regulator, and transformer ratings (including taps if applicable) will be jointly determined by Colorado Springs Utilities and the Owner to ensure proper coordination of voltages and regulator action.

The magnitude and frequency of voltage flicker (i.e., sudden momentary voltage change) caused by the Owner's generator(s) shall not exceed the values provided in IEEE Standard 141, "*IEEE Recommended Practices for Electric Power Distribution for Industrial Plants.*", as amended from time to time.

Voltage flicker will normally be measured at the interface between the Owner's system and Colorado Springs Utilities' system. However, at Colorado Springs Utilities' discretion, if voltage flicker problems are found, the measurements may be taken at the nearest possible Colorado Springs Utilities' customer.

The voltage flicker charts do not address duration of voltage sag. For the purposes of these Standards, a sag of any duration shall be considered as a single occurrence. However, this may be excessively restrictive when a voltage drop exceeds the chart requirements but is extremely short in duration (e.g., on the order of a few cycles), such as might be caused by magnetizing inrush of a transformer, a speed matched induction generator, or a faulted condition. Such a voltage drop may be acceptable after consultation with Colorado Springs Utilities' Enhanced Power Engineering section, but the Owner is responsible for any associated problems caused in the equipment of other Colorado Springs Utilities' customers. It is suggested that the Owner review IEEE standard 446, *IEEE Recommended Practice For Emergency And Standby Power Systems For Industrial And Commercial Applications*, Section 3.11 or consult Enhanced Power Engineering for a typical computer's sensitivity to very short voltage disturbances.

6.4 SECURITY

Infrastructure security of Distribution System equipment and operations and control hardware and software is essential to ensure day-to-day Distribution System reliability and operational security. Colorado Springs Utilities complies with all National America Electric Reliability Corporations (NERC) standards and programs. One such vulnerability called Aurora, focuses on electric power generators. NERC addresses Aurora vulnerabilities to circuit breaker control systems that might allow unauthorized persons to gain physical or cyber access to electric system facilities.

Although Colorado Springs Utilities has taken steps with both protective relaying and substation security to mitigate the possibility of this type of attack, it is strongly recommended that the generator Owner protects its own electrical equipment that could be damaged by Aurora attack attempts to intentionally open a breaker and close it out of synchronism.

7.0 GENERAL DESIGN REQUIREMENTS

7.1 CODES & STANDARDS

The Owner's installations shall meet all applicable national, state, and local construction and safety codes, including IEEE 1547, "*IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems*.", as amended from time to time.

7.2 PROTECTIVE DEVICES

Protective devices (relays, circuit breakers etc.) for the protection of Colorado Springs Utilities' system, metering equipment, and synchronizing equipment must be installed as required by Colorado Springs Utilities. The required protective devices differ with the size of the installation. (See Section 8)

A manual disconnecting device, capable of interrupting the rated generator and/or load current, accessible to Colorado Springs Utilities' personnel and which can be locked open for line clearances, must be provided. The form of this device will vary with the service voltage and capacity.

7.3 EFFECTIVE GROUNDING

Facilities must maintain effective grounding (See Section 5.3)

7.4 GENERATOR REACTIVE CAPABILITY

The voltage at the Owner's generator terminal may be controlled by changing the VAr output of the unit but there are certain physical limitations as to how much reactive power can be supplied or absorbed by the generating unit. These reactive limits are based on the Generator Capability Curves supplied by the manufacturer. The Owner is required to provide a copy of these Generator Capability Curves to Colorado Springs Utilities' Enhanced Power Engineering section for each of the generators at the Owner's facility as soon as the information is available. These curves along with other related electrical impedance, etc. data on the generator and step up transformers must be supplied prior to the final on-line testing, including VAr capability testing required, before a facility can be commissioned.

Either stator or rotor winding heating limits the allowable reactive power. The generator reactive capability is greatly affected by cooling, as shown by the generator thermal curves for different hydrogen pressures.

The portion of the capability curve above horizontal (MW) line represents MVArs that can be supplied to Colorado Springs Utilities' system. Generator operation in this region is referred to as "lagging" or "overexcited." The portion of the curve below the horizontal (MW) line represents the MVArs that can be absorbed from Colorado Springs Utilities' system and is referred to as "leading" or "under-excited" operation.

It is normally preferred that Colorado Springs Utilities does not supply VArs to an Owner's generator(s). However, there may be instances when Colorado Springs Utilities' system conditions may necessitate that Owner's generator(s) may be required to absorb VArs. Colorado Springs Utilities' the System Operator will decide generator-operating point within its capability curve based on system conditions and inform the Owner.

7.5 DESIGN SPECIFICATIONS

The Owner is required to submit detailed design specifications and engineering information as required (usually 150 days minimum prior to interconnection). The design specifications must include the following:

a) The service voltage and the location of the point of interconnection.

b) An electrical one-line diagram of the Owner's system, beginning at the point of interconnection and the including AC and DC schematics.

c) A detailed description of how and where the Owner's load will be connected and disconnected.

d) The capacity and ownership of all equipment and circuits.

> d.1) For Community Solar Gardens, the Owner of the Community Solar Garden is the entity or organization that contracts to sell the output from the Community Solar Garden, not the "subscriber" who owns a subscription.

e) Capacity, available fault current, protective device clearing time Time-Current Characteristic Curves (TCCs), $X_1 + X_0$ values from Section 5.3 and interrupting ratings for equipment and safety devices, including detailed information of all protective relaying with settings.

f) A detailed description of any special control equipment required.

g) Sufficient information to establish all necessary rights-of-way and easements to install, operate, replace, and maintain Colorado Springs Utilities' facilities on Owner's property.

h) A description of intended operating modes, such that Colorado Springs Utilities can review the design and either accept or outline specific additional functions, which must be provided along with supportive data within a reasonable period of time. A rejected plan must be modified by the Owner and re-submitted to Colorado Springs Utilities' Enhanced Power Engineering section for review.

7.6 INDUCTION GENERATORS

For installations with a total generating capacity of 5kW or less, Colorado Springs Utilities will supply VAr requirements from general system sources without a specific charge to the Owner. Installations over 5kW will require capacitors to be installed to maintain a power factor of at least 0.9. Such capacitors will be supplied and installed at the expense of the Owner.

Reactive power supply for large induction generators must be studied on an individual basis It is particularly important to contact Colorado Springs Utilities to determine if an induction machine can be connected to an existing distribution line.

7.7 INVERTER SYSTEMS

Inverters, converters, and charge controllers shall meet standard; UL 1741, *"Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources."*, as amended from time to time.

Reactive power supply requirements for inverter systems can be similar to those of induction generators and the general guidelines in Section 7.4 apply. Inverters will be required to maintain a power factor of at least 0.99.

THD from the facility will be measured at the facility's metering point. See Section 6.2 for THD values. If an Owner is found to be interfering with other Colorado Springs Utilities' customers or public communications, the Owner will be required to install filtering or other corrective measures to bring the harmonic output of its inverter to the values specified in Tables I and II of IEEE Standard 519.

7.8 PHOTOVOLTAIC SYSTEMS

All photovoltaic systems interconnected to Colorado Springs Utilities' electric distribution system shall pass inspection by the Pikes Peak Regional Building Department prior to being interconnected. These systems must also meet the requirements set forth in this document before being energized on the Colorado Springs Utilities' electric distribution system. A typical roof-top photovoltaic system installation can be found in Drawing 21a of the Colorado Springs Utilities' *Electric Line Extension and Service Standards*. A typical large-scale three-phase photovoltaic array system installation can be found in Drawing 21b of the *Electric Line Extension and Service Standards*.

The modules for these systems must be included on California Energy Commission's (CEC) List of Eligible Photovoltaic Modules. The inverters for these systems shall be UL 1741 listed and be on the CEC List of Eligible Inverters. Both CEC lists can be found at www.gosolarcalifornia.org.

7.8.1 SYSTEMS LESS THAN 10kW INVERTER CAPACITY

Systems with less than 10kW of inverter capacity shall be installed in such a way as to not create an imbalance on the service transformer.

Procedures for requesting interconnection to the Colorado Springs Utilities electric distribution system can be found at www.csu.org.

7.8.2 SYSTEMS WITH 10kW OR GREATER INVERTER CAPACITY

Systems with 10kW or greater of inverter capacity shall be installed in such a way as to not create an imbalance on the service transformer.

These systems will be reviewed on a case-by-case basis. Contact Colorado Springs Utilities' Enhanced Power Engineering section to begin the process, unless facility is a Community Solar Garden then contact project manager.

8.0 SPECIFIC PROTECTIVE RELAYING REQUIREMENTS

8.1 PROTECTION CLASSES

Colorado Springs Utilities has established seven different classes of protective relaying for independently owned parallel generation. These classes are:

a) 0 - 9.9kW

b) 10 - 99kW

c) 100 - 999kW

d) 1 - 9.9MW

e) 10MW and above

f) Hot Transfer Standby Generation

g) Demand Reduction Generation

Where multiple generators are connected to Colorado Springs Utilities' system through a single service point, the class will be determined by the sum of the generator ratings. The classes are based on the generator or inverter nameplate ratings.

It should be understood that these classes have been established for convenience and are based on distribution circuits with normal load density. The final decision as to requirements for each installation will be made depending on Owner's load/generation magnitude, the magnitude of other loads connected to the circuit/system, available short circuit contribution, source substation size, line conductor size, etc.

The relays indicated in Figures 14.1-14.4 are starting point standards for the protection of Colorado Springs Utilities' system and the Owner's generators. In each application, protective relaying will be reviewed and approved by Colorado Springs Utilities' Enhanced Power Engineering as described in the following sections.

At most installations, Utility Grade Relays are required. The following specifies what a Utility Grade Relay should include:

a) Meets or exceeds IEEE standards for protective relays:
    1. C37.90 *IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus*

    2. C37.90.1 *IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus*

    3. C37.2 *IEEE Standard Electrical Power System Device Function Numbers and Contact Designations*

b) Extensive documentation covering application, testing, maintenance, and service.

c) Positive indication of what caused a trip (Targets).

8.2 INSTALLATIONS UP TO 9.9kW

All installations in this class will require a site review. Most installations in this class feature a standard protective package offered by a manufacturer. Each package will be reviewed. As long as no changes are made in configuration or equipment, no further review of that package will be required for additional installations. All installations that are not a standard package must be reviewed individually.

The protective relaying and other details are shown in Figure 14.1. The installation must be permanently wired into a suitable load center and a lockable disconnect switch must be provided that is readily accessible to Colorado Springs Utilities' personnel. This switch is to be at the meter unless an alternate location is readily accessible and easily identifiable. The alternate location must be approved by Colorado Springs Utilities.

8.3 INSTALLATIONS FROM 10kW to 99kW

All installations in this class will require a site review. Those installations, which are a standard package, will be reviewed once. No further package review will be required for additional installations, provided no changes in configuration or equipment are made to the package. All installations that are not a standard package must be reviewed individually.

The protective relaying and other details are shown in Figure 14.2. Installations in this class must use Industrial Grade Relays or Utility Grade Relays. For an explanation of what a Utility Grade Relays is, see Section 8.1. These installations may vary somewhat from the layout shown in Figure 14.2. Some variations in the specifics, but not of the intent of the requirements, will be allowed. All variations must be approved by Colorado Springs Utilities.

8.4 INSTALLATIONS FROM 100kW to 999kW

All installations in this class require a full protective relaying and site review. The intent of the protective requirements is given in Figure 14.3. With some of the larger installations, the Owner, instead of Colorado Springs Utilities, may own

the transformer and associated equipment. Utility Grade Relays such as those normally found in utility switchgear and utility grade equipment are required. For an explanation of Utility Grade Relays, see Section 8.1.

8.5 INSTALLATIONS FROM 1MW to 9.9MW

All installations in this class require a full protective relaying and site review. The intent of the protection requirements is given in Figure 14.4. With some larger installations, the Owner, instead of Colorado Springs Utilities, owns the transformer and associated equipment. Utility Grade Relays such as those normally found in utility switchgear and utility grade equipment are required. For an explanation of Utility Grade Relays, see Section 8.1.

8.6 INSTALLATIONS 10MW AND ABOVE

In general, the Colorado Springs Utilities' distribution system is designed to handle loads and generation up to 10MW. Installations above 10MW are normally served by sub-transmission and transmission systems. Each installation at this level must be discussed and reviewed on a case-by-case basis. Colorado Springs Utilities must be contacted to determine the feasibility of any proposal due to the restrictive nature and the costs associated with such interconnections.

8.7 HOT TRANSFER STAND BY GENERATION REQUIREMENTS

A Hot Transfer Stand by Generator system is defined as one in which the Owner's generation can be connected to Colorado Springs Utilities' system on a short-term basis. The usual purpose of this system is to transfer loads from Owner's generator(s) to Colorado Springs Utilities' system and back again later without an interruption. The duration of the interconnection is not to exceed one minute. This type of interconnection is often referred to as a closed transition. The closed transition is used exclusively to prevent interruption to Owner's critical loads. Owner shall prevent a transfer of power from the Owner's generator(s) to Colorado Springs Utilities by a sensitive directional power relay.

8.9 DC FUSING

Adequate protection for the clearing of a DC fuse must be provided. Figure 14.5 shows an example of a DC fuse scheme utilizing a loss of potential relay to trip the breaker. A loss of potential scheme will be required when no relay redundancy exists. The DC fusing design must prevent common mode failure of the sensing, tripping and interruption equipment. The entire tripping scheme should not become disabled by a single DC fuse operation. Relay redundancy can be achieved through a combination of and/or segregation of many relays and functions and/or an exact duplication of relays.

8.10 SYCHRONIZING RELAYING

Relay settings are chosen to prevent excessive voltage and current surges at the interface with the Colorado Springs Utilities' system. Colorado Springs Utilities cannot take responsibility for the appropriateness of the settings for the Owner's equipment. It is highly recommended that the Owner consult with appropriate equipment manufacturers to determine if tighter settings are advisable.

8.10.1 SYCHRONOUS GENERATORS

Sync-check relays will be required and settings will be reviewed and approved the Colorado Springs Utilities Enhanced Power Engineering section.

9.0 METERING REQUIREMENTS

9.1 GENERAL

In general, metering installation requirements for the different categories of Owner's parallel generators are the same as outlined in the Colorado Springs Utilities' *Electric Line Extension and Service Standards*. The metering voltage will be the same voltage as at the point of delivery. Typically, high side metering will be used when the Owner owns the facility transformer and low side metering will be used when Colorado Springs Utilities owns the facility transformer. In some cases, Colorado Springs Utilities may own the facility transformer that was purchased by the Owner. In these cases there is a "loss adjustment" through the transformer when metering on the low side or high side metering may be used. Typically, the metering will be located on Colorado Springs Utilities' side of ownership of the electric facilities.

For an Owner who has contracted to sell power to Colorado Springs Utilities, two metering schemes are available for facilities greater than 10kW:

a) Metering Scheme Option “A” will be used when the Owner’s load requirements are served directly by the Owner’s generator. Two metering points will be utilized for this option. The generator meter will measure the power leaving the facility when the generation exceeds load. The load meter will measure power entering the facility when load exceeds generation.

b) Metering Scheme Option “B” will be used when Colorado Springs Utilities, or another utility, serves Owner’s load requirements. Three meters will be utilized for this option (see Figure 14.2 or 14.3). The generation meter will measure the net output of the generator, which is the gross output of the generator minus the metered power consumed by the power production process (station service). The load meter will measure all other loads not associated with the power production process.

Regardless of the size of the facility or options used, all metering installations must be reviewed by Colorado Springs Utilities’ Enhanced Power Engineering and approved by Electric Construction Quality Control sections.

9.2 METERING FOR INSTALLATIONS UP TO 9.9kW

Two meters will be installed on these systems. A revenue meter that will be used for billing and a second meter to account for the energy generated. It will be electrically located as shown in the one-line diagram shown in Figure 14.1 Installation requirements as outlined in the *Electric Line Extension and Service Standards* for “self contained metering” are applicable.

9.3 METERING FOR INSTALLATIONS 10kW TO 99.9kW

Metering options for this category will be utilized per the one-line diagram shown in Figure 14.2. Installation requirements for these meters will again conform to the *Electric Line Extension and Service Standards*. Self-contained watt-hour meters equipped with an indicating demand feature will be used for ampacity requirements up to 200 Amperes and where the nominal voltage does not exceed 480 Volts.

Where the ampacity exceeds 200 Amperes and the nominal voltage is < 480 volts, transformer rated watt-hour meters equipped with indicating demand feature will be used, and installation requirements outlined in the current version of the *Electric Line Extension and Service Standards*.

9.4 METERING FOR INSTALLATIONS 100kW to 999kW

Metering options for this category will be utilized per the one-line diagram shown in Figure 14.3. In general, all of these metering points will require dedicated instrument transformers, and conform to the Standards for “Instrument Transformer Type Metering-Secondary 480 Volts or under.”

If the nominal voltage of the circuit to be metered exceeds 480 Volts, a transformer type primary meter installation using both current and voltage transformers is required, regardless of the load current. This is referred to as primary meter and may be installed either in Owner-owned switchgear (indoor or outdoor) or on Colorado Springs Utilities-owned facilities. Such installations require coordination between the Owner and Colorado Springs Utilities regarding accuracy class, technical details, and locations.

Two watt-hour meters from a common set of instrument transformers will be utilized for the generation installation. The meters will be installed with a detented and connected so that energy from the generator is measured by one meter and the other will measure energy to the Owner’s facility from Colorado Springs Utilities’ system. For generators up to 500kW, the meters will be equipped with pulse initiators, which initiate pulses at a rate proportional to the energy flow being measured. These pulses will be recorded on separate channels of a demand recorder, providing the basis for monthly interval demand information.

In Metering Scheme Option “B” a third watt-hour meter will be utilized for the load installation on its own separate set of instrument transformers. Again, for loads up to 500kW, the meter will be equipped with indicating demand feature. For loads larger than 500kW, a pulse initiator and demand recorder will be used to provide monthly interval demand information.

9.5 METERING FOR INSTALLATIONS 1MW AND ABOVE

Metering options for this category will be utilized per the one-line diagram shown in Figure 14.4. In general, all of these metering points will require dedicated instrument transformers and conform to the Standards for “Instrument Transformer Type Metering-Secondary 480 Volts or Under”.

If the nominal voltage of the circuit to be measured exceeds 480 Volts, a transformer type primary meter installation using both current and voltage transformers is required regardless of the load current. This is referred to as primary meter and may be installed either in Owner-owned switchgear (indoor or outdoor) or in Colorado Springs Utilities' facilities. Such installations require coordination between the Owner and Colorado Springs Utilities regarding accuracy class, technical details, and locations.

Two watt-hour meters from a common set of instrument transformers will be utilized for the generation installation. The meters will be detented and connected so that energy from the generator is measured by one meter and the other will measure energy to the generator from the utility system. The meters will be equipped with pulse initiators, which initiate pulses at a rate proportional to the energy flow being measured. These pulses will be recorded on separate channels of a demand recorder, providing the basis for monthly interval demand information.

In Metering Scheme Option "B," a third watt-hour meter will be utilized for the load installation on its own separate set of instrument transformers. A pulse initiator and demand recorder will be used to provide monthly interval demand information.

Please contact Colorado Springs Utilities' Enhanced Power Engineering section if you need a copy of metering standards referenced in this section.

10.0 DEMONSTRATION OF PROTECTIVE DEVICES

10.1 GENERAL

Calibration, Trip Checks, and Functional Operation Testing shall be submitted to Colorado Springs Utilities' Enhanced Power Engineering section for review and comment. Colorado Springs Utilities' representatives may elect to be present during testing demonstration.

11.0 GENERAL OPERATING REQUIREMENTS

11.1 DE-ENERGIZED CIRCUITS

The Owner will not be permitted to energize a de-energized Colorado Springs Utilities' circuit under any circumstances without prior authorization from Colorado Springs Utilities. Failure to observe this requirement will be cause for immediate and permanent disconnection of the generating facility. In addition, Owner will be held responsible for all damages and injuries resulting from such actions.

11.2 OPERATIONAL LOG

Colorado Springs may request operating logs at each generating facility 100kW and over indicating changes in operating status (available and unavailable), maintenance outages, trip indications or other unusual conditions found upon inspection.

11.3 DISCONTINUATION OF OPERATION

The Owner shall discontinue parallel operation when requested by Colorado Springs Utilities:

a) To facilitate maintenance, test, or repair of utility facilities. Colorado Springs Utilities will coordinate this with the Owner

b) During system emergencies

c) When, in Colorado Springs Utilities' sole discretion, the Owner's generating equipment is interfering with other customers on the system

d) When an inspection of the Owner's generating equipment reveals, in Colorado Springs Utilities' sole discretion, a condition hazardous to Colorado Springs Utilities' system or lack of scheduled maintenance or maintenance records for equipment necessary to protect Colorado Springs Utilities' system

11.4 OPERATING AGREEMENT

An operating agreement between the facility Owner and Colorado Springs Utilities will be executed prior to commissioning and interconnection to Colorado Spring Utilities' System.

11.5 TELEMETRY MONITORING PROVISIONS

Distributed Generating (DG) facilities above 250kW nameplate rating will require telemetry monitoring equipment provisions. The design, purchase, installation, testing, maintenance, and replacement of the telemetry equipment and circuits from the Owner's facility to Colorado Springs Utilities' Control Center will be the responsibility of Colorado Springs Utilities or its designated representative. The direct costs will be charged to the Owner.

The Owner must provide a suitable enclosure with a convenience outlet to house the telemetry equipment. Reasonable access must be provided by the Owner to Colorado Springs Utilities or its designated representative for installation, testing, and repair of the telemetry.

12.0 ANNUAL TESTING STANDARDS

12.1 MAINTENANCE

The Owner shall maintain its equipment in good order. Colorado Springs Utilities reserves the right to inspect the Owner's facilities whenever it appears that the Owner is operating in a manner hazardous to Colorado Springs Utilities' system integrity and/or customer/Colorado Springs Utilities' personnel safety. Functional testing of all breakers, relays and transformers must be performed yearly. Installations must have full relay calibration checks performed every three years or less by qualified personnel and certified test reports are to be sent to Colorado Springs Utilities' Enhanced Power Engineering section.

13.0 LIABILITY

This section outlines the responsibilities and liabilities between Colorado Springs Utilities and the Owner. The responsibilities and liabilities detailed in an actual contract between Colorado Springs Utilities and Owner takes precedence over this section.

Acceptance means "approve," "approved," and "approval" as used through out this document. Acceptance by Colorado Springs Utilities does not mean that Colorado Springs Utilities endorses or is held responsible for the safety or reliability of an Owner's design and facility.

Unless agreed to otherwise in a written contract, whenever any liabilities are incurred by either or both of the parties for damages caused by injuries to either party (or their employees or agents) of the property of either party, or caused by injuries to other persons on the two parties' property arising out of the subject matter of the interconnection agreement, then the liabilities for such damages between the parties will be as follows:

a. Each party will be liable for all damages because of injuries to persons or property caused solely by its negligence or solely by its failure to comply with the interconnection agreement;
b. Each party will be liable for all damages to its own property that are caused by the concurrent negligence of both parties, or that are due to causes that cannot be traced to the sole negligence of the other party, to the extent of its negligence therefore;
c. Each party will be liable for all damages because of injuries to itself or its own employees or agents that are caused by the concurrent negligence of both parties, or that are due to causes that cannot be traced to the sole negligence of either party; provided that in no event will a party be liable for damages because of injuries to itself or its own employees and agents in any amount in excess of applicable Workmen's Compensation insurance; and provided further that the interconnection agreement will in no way impair the right of the injured party or its employee or agent to the extent that third party negligence proximately caused injuries or damages to party of its employee or agent.
d. In the event of claims brought to recover damages because of injuries to persons not employees or agents of either party and because of injuries to property not belonging to either party that are alleged to be caused by the concurrent negligence of both parties or are alleged to be due to causes that cannot be traced to the sole negligence of either party, the parties agree to apportion said liabilities according to the principles of the Colorado Uniform Contribution Among Joint Tortifeasors Act, Colo. Rev. Stat. § 13-50.5-101, *et seq.*, and further agree that in the event of such concurrent or joint negligence that no right of indemnification will exist, so that in all such claims, the issues of liabilities will be determined as a matter of contribution and not as a matter of indemnity.

e. No provision of the interconnection agreement shall be deemed or construed to be a relinquishment or waiver of any kind of the applicable limitations of liability provided Colorado Springs Utilities, the City of Colorado Springs, its officers, Utilities Board, directors, employees, agents, and representatives by the Colorado Governmental Immunity Act, Colo. Rev. Stat. § 24-10-101, *et seq.*
f. Neither party will have any liability whatsoever for any special, indirect, consequential, or punitive damages.

14.0 DRAWINGS

FIGURE 14.1 - UNDER 10kW URBAN CONDITIONS

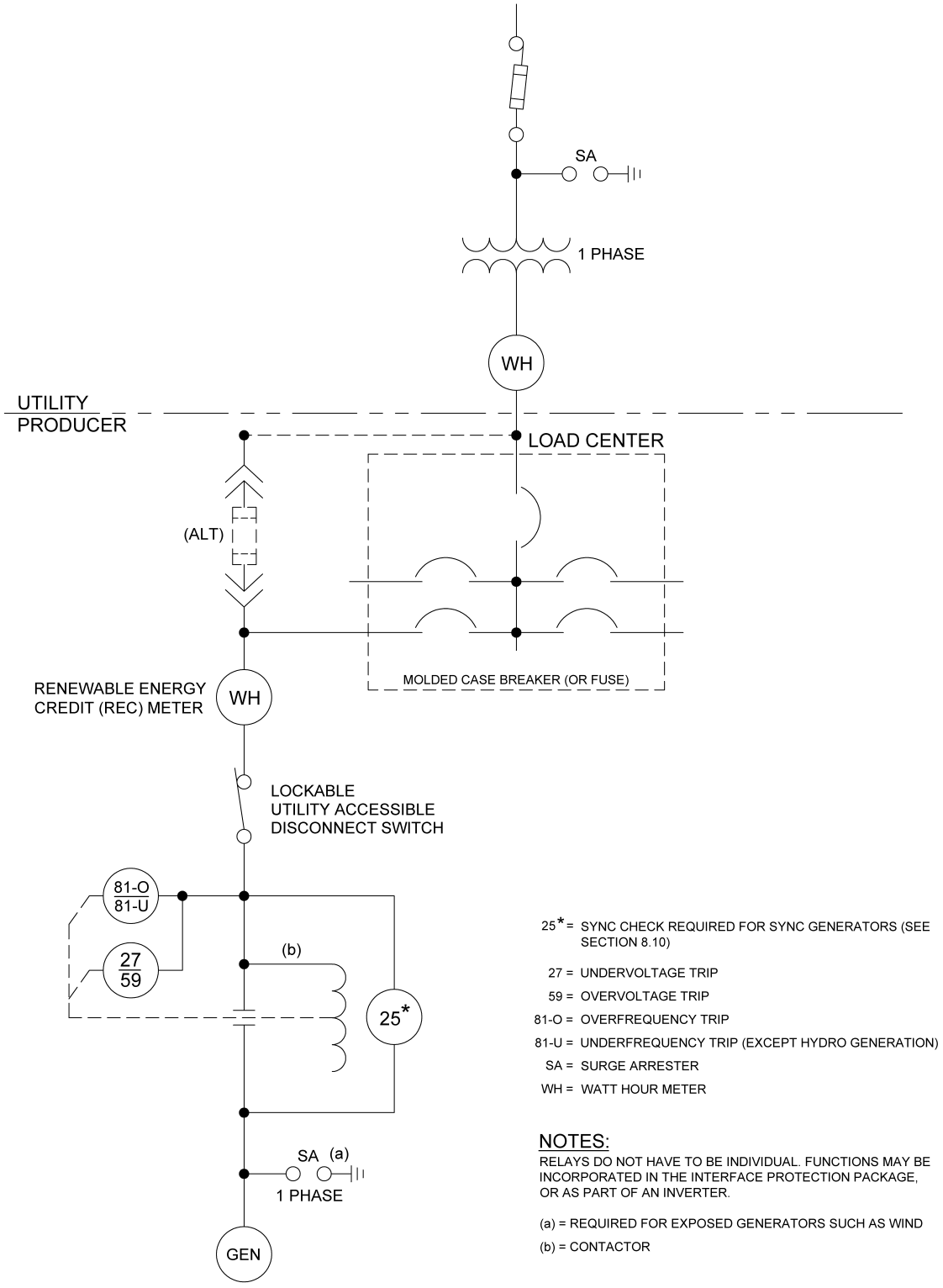
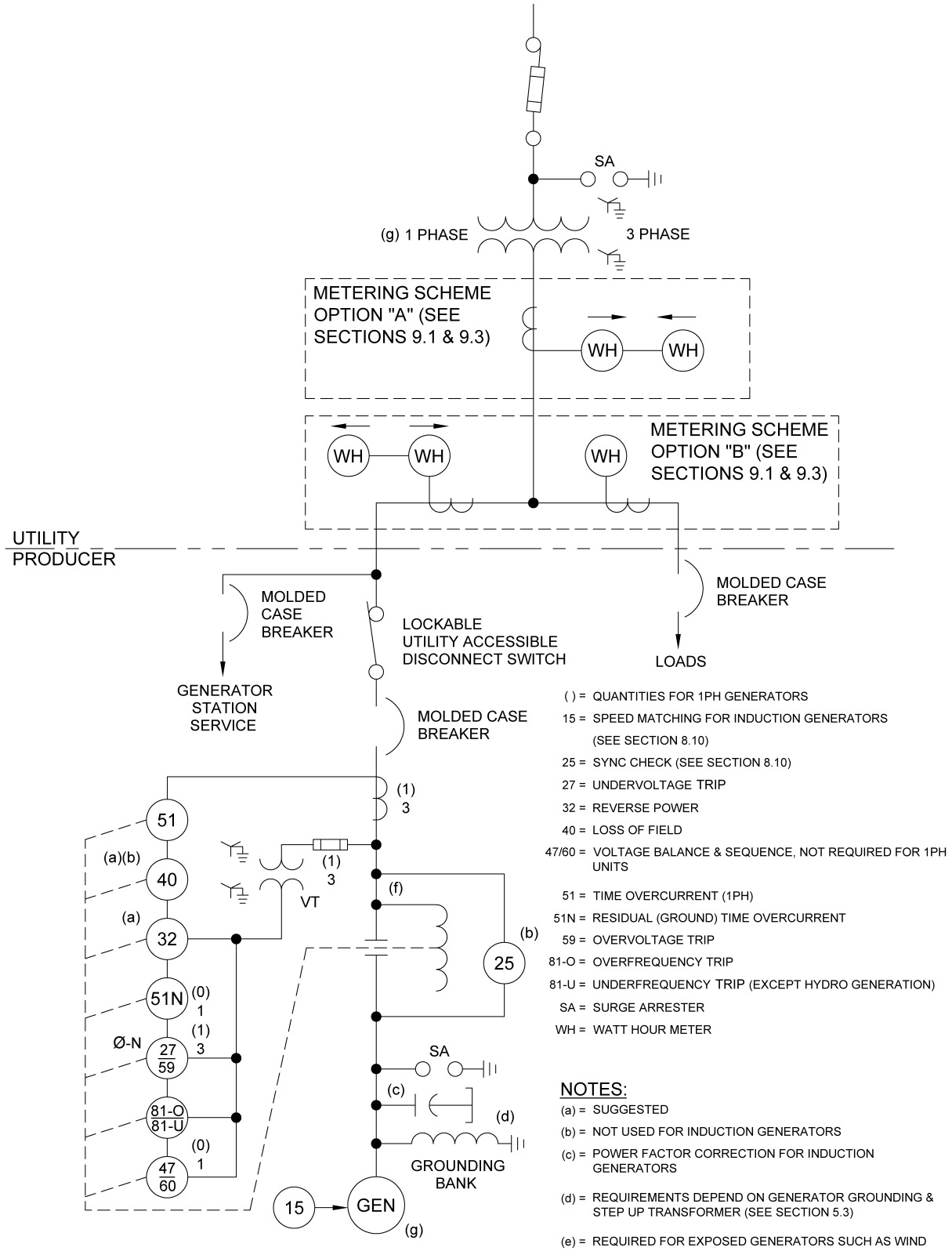


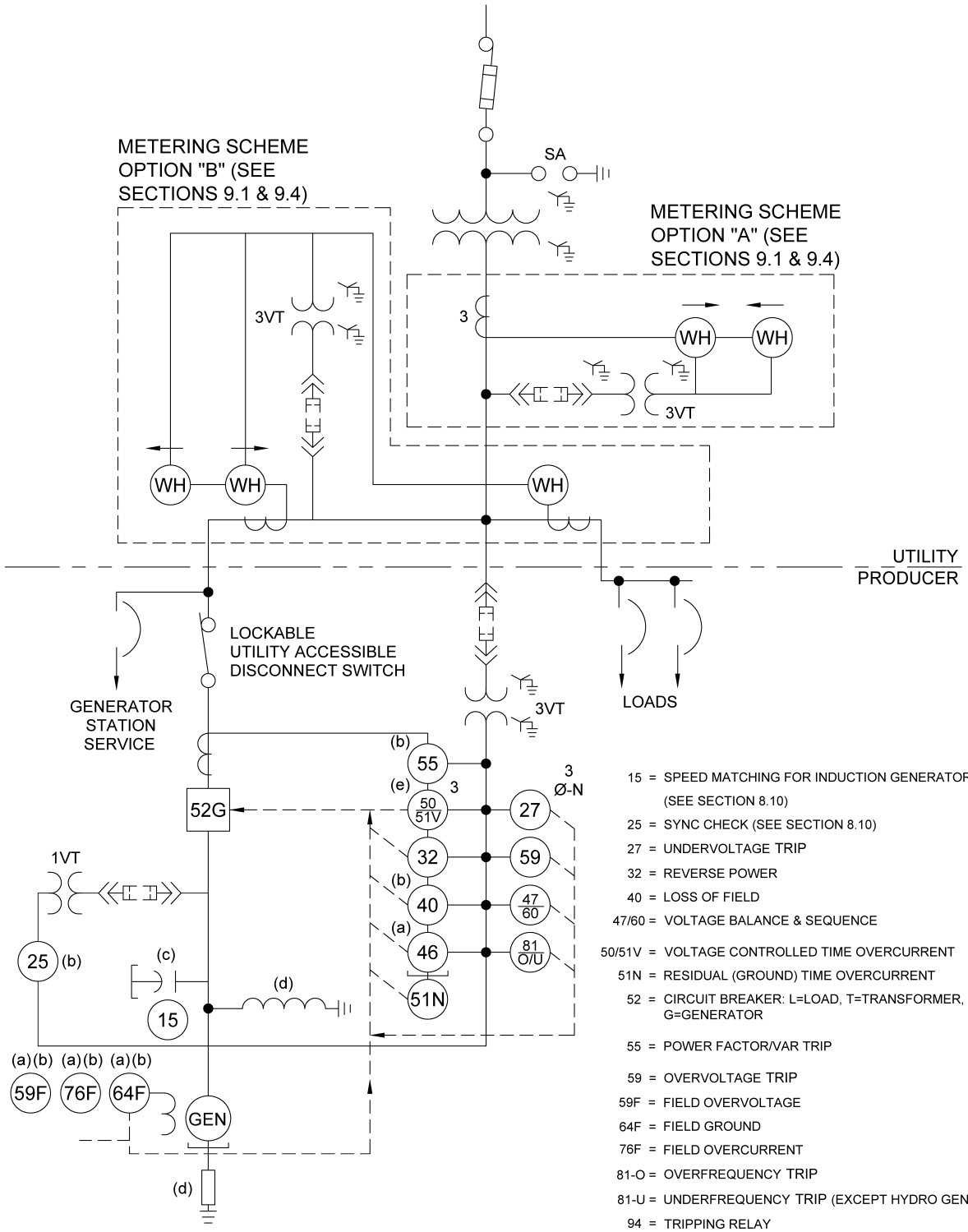
FIGURE 14.2 - 10kW TO 99kW URBAN CONDITIONS



( ) = QUANTITIES FOR 1PH GENERATORS
15 = SPEED MATCHING FOR INDUCTION GENERATORS (SEE SECTION 8.10)
25 = SYNC CHECK (SEE SECTION 8.10)
27 = UNDERVOLTAGE TRIP
32 = REVERSE POWER
40 = LOSS OF FIELD
47/60 = VOLTAGE BALANCE & SEQUENCE, NOT REQUIRED FOR 1PH UNITS
51 = TIME OVERCURRENT (1PH)
51N = RESIDUAL (GROUND) TIME OVERCURRENT
59 = OVERVOLTAGE TRIP
81-O = OVERFREQUENCY TRIP
81-U = UNDERFREQUENCY TRIP (EXCEPT HYDRO GENERATION)
SA = SURGE ARRESTER
WH = WATT HOUR METER

NOTES:
(a) = SUGGESTED
(b) = NOT USED FOR INDUCTION GENERATORS
(c) = POWER FACTOR CORRECTION FOR INDUCTION GENERATORS
(d) = REQUIREMENTS DEPEND ON GENERATOR GROUNDING & STEP UP TRANSFORMER (SEE SECTION 5.3)
(e) = REQUIRED FOR EXPOSED GENERATORS SUCH AS WIND
(f) = CONTACTOR
(g) = 1PH GENERATOR MAXIMUM SIZE 20KW

FIGURE 14.3 - 100kW TO 999kW URBAN CONDITIONS

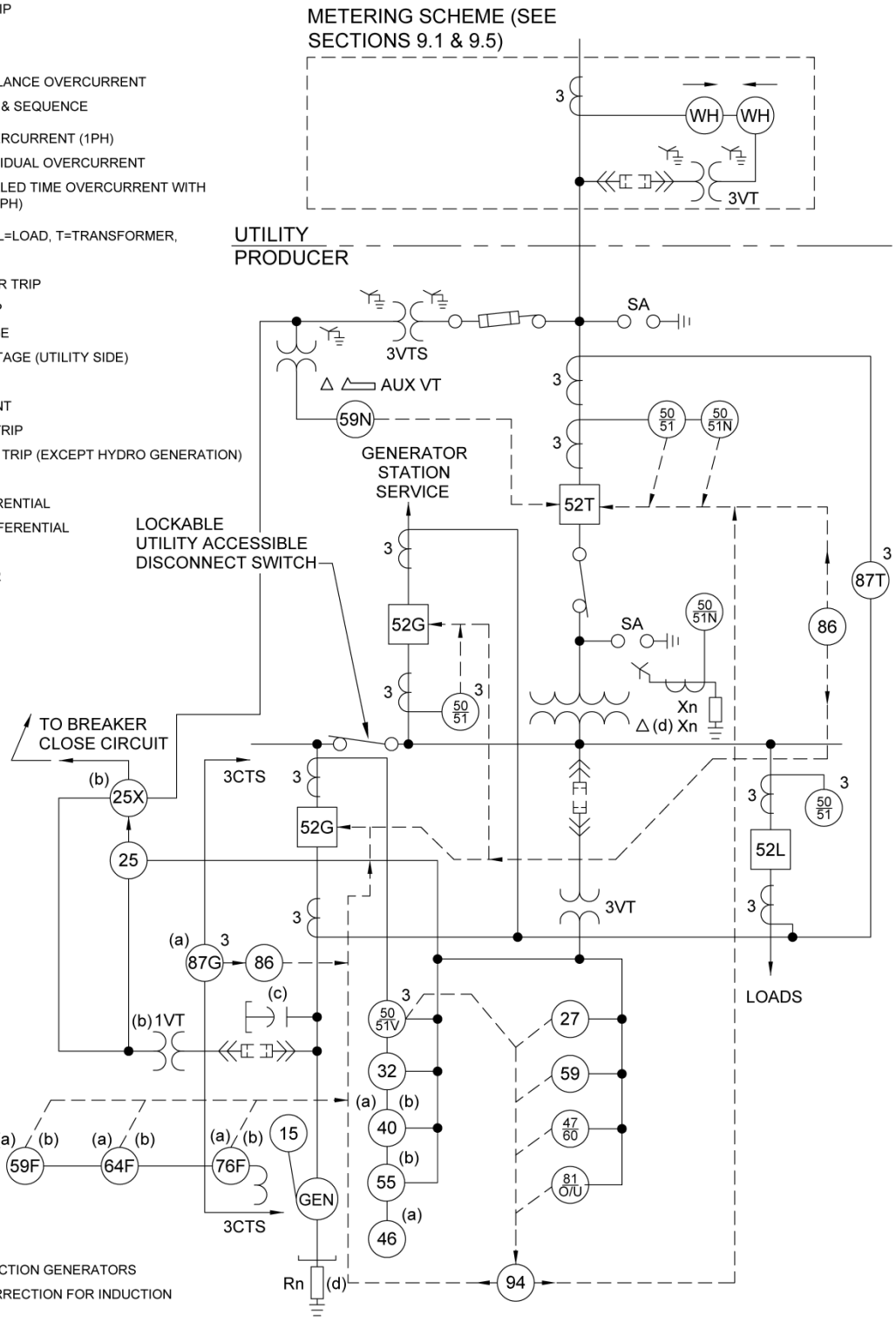


15 = SPEED MATCHING FOR INDUCTION GENERATORS (SEE SECTION 8.10)
25 = SYNC CHECK (SEE SECTION 8.10)
27 = UNDERVOLTAGE TRIP
32 = REVERSE POWER
40 = LOSS OF FIELD
47/60 = VOLTAGE BALANCE & SEQUENCE
50/51V = VOLTAGE CONTROLLED TIME OVERCURRENT
51N = RESIDUAL (GROUND) TIME OVERCURRENT
52 = CIRCUIT BREAKER: L=LOAD, T=TRANSFORMER, G=GENERATOR
55 = POWER FACTOR/VAR TRIP
59 = OVERVOLTAGE TRIP
59F = FIELD OVERVOLTAGE
64F = FIELD GROUND
76F = FIELD OVERCURRENT
81-O = OVERFREQUENCY TRIP
81-U = UNDERFREQUENCY TRIP (EXCEPT HYDRO GENERATION)
94 = TRIPPING RELAY
SA = SURGE ARRESTER
WH = WATT HOUR METER

NOTES:
(a) = SUGGESTED
(b) = NOT USED FOR INDUCTION GENERATORS
(c) = POWER FACTOR CORRECTION FOR INDUCTION GENERATORS
(d) = REQUIREMENTS DEPEND ON GENERATOR GROUNDING & STEP UP TRANSFORMER (SEE SECTION 5.3)
(e) = 50/51 FOR INDUCTION GENERATORS

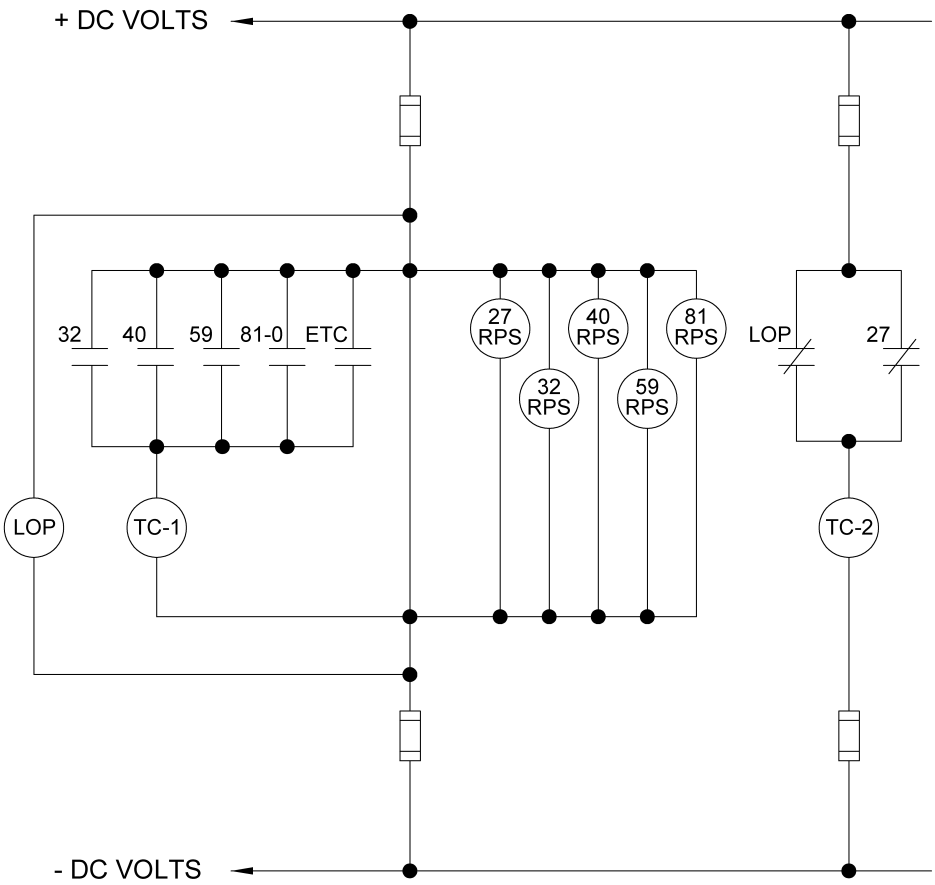
FIGURE 14.4 - 1MW TO 9.9MW URBAN CONDITIONS

15 = SPEED MATCHING FOR INDUCTION GENERATORS (SEE SECTION 8.10)
25 = SYNC CHECK (SEE SECTION 8.10)
27 = UNDERVOLTAGE TRIP
32 = REVERSE POWER
40 = LOSS OF FIELD
46 = NEG SEQ OR PH BALANCE OVERCURRENT
47/60 = VOLTAGE BALANCE & SEQUENCE
50/51 = INST. AND TIME OVERCURRENT (1PH)
50/51N = INST. AND TIME RESIDUAL OVERCURRENT
50/51V = VOLTAGE CONTROLLED TIME OVERCURRENT WITH INSTANTANEOUS (1 PH)
52 = CIRCUIT BREAKER: L=LOAD, T=TRANSFORMER, G=GENERATOR
55 = POWER FACTOR/VAR TRIP
59 = OVERVOLTAGE TRIP
59F = FIELD OVERVOLTAGE
59N = GROUND OVERVOLTAGE (UTILITY SIDE)
64F = FIELD GROUND
76F = FIELD OVERCURRENT
81-O = OVERFREQUENCY TRIP
81-U = UNDERFREQUENCY TRIP (EXCEPT HYDRO GENERATION)
86 = LOCKOUT
87G = GENERATOR DIFFERENTIAL
87T = TRANSFORMER DIFFERENTIAL
94 = TRIPPING RELAY
Rn = NEUTRAL RESISTOR
Xn = NEUTRAL REACTOR
SA = SURGE ARRESTER
WH = WATT HOUR METER



NOTES:
(a) = SUGGESTED
(b) = NOT USED FOR INDUCTION GENERATORS
(c) = POWER FACTOR CORRECTION FOR INDUCTION GENERATORS
(d) = REQUIREMENTS DEPEND ON GENERATOR GROUNDING & STEP UP TRANSFORMER (SEE SECTION 5.3)

FIGURE 14.5 - SEPARATE FUSING REQUIREMENTS FOR RELAY SCHEMES



TC = TRIP COIL
RPS = RELAY POWER SUPPLY
LOP = LOSS OF POTENTIAL RELAY
LOP & 27 CONTACTS OPEN WHEN ENERGIZED