conEdison

CONSOLIDATED EDISON CO. OF NEW YORK, INC.
4 IRVING PLACE
NEW YORK, NY 10003

DISTRIBUTION ENGINEERING DEPARTMENT
SYSTEM DESIGN SECTION

SPECIFICATION EO-2115
REVISION 11

Handbook of General Requirements For Electrical Service To Distributed Energy Resource (DER) Customers

PREPARED BY	CONSTANTINE SPANOS, Ph.D, PRAGATI GOPAL, ANDY WOO
TARGET AUDIENCE	DISTRIBUTION ENGINEERING ELECTRIC CONSTRUCTION REGIONAL ENGINEERING
NESC REFERENCE:	SECTION 123, 124, 41, 42, 44, 92, 93 32
REVIEWED BY:	DE SYSTEM DESIGN
FILING:	FILE: APPLICATION AND DESIGN MANUAL No. 4 FIELD MANUALS No. 16, Section 4
APPROVER:	JASVINDER BLAH APPROVAL ON FILE/ 12/01/2022
EFFECTIVE DATE:	December 01, 2022

TABLE OF CONTENTS

VIII – UTILITY REFERENCE DRAWINGS

I - GENERAL

1.0 PURPOSE

This handbook has been compiled by the Consolidated Edison Company of New York, Inc. (Con Edison) to serve as a guideline for Distributed Energy Resource (DER) Customers, interconnecting at two distinct class sizes of < 5 MW or > 5 MW of aggregate generation at a single location. The handbook contains information concerning the interconnection and operating process from the planning stages through the generation system's operating life. It includes the Company's general requirements for interconnection design, installation, testing and operation. The information found herein is intended for both new installations of generating equipment and for cases where existing systems are being upgraded or modified. While this Handbook presents general interconnection requirements, it is important to note that individual projects can have specific requirements not identified herein, Con Edison will supplement, on an individual basis, the requirements of this handbook to address any site-specific issues.

Throughout this handbook the Consolidated Edison Company will be referred to as the Company and the owner or operator of Distributed Energy Resource or the small independent power producer will be referred to as the Customer.

Any information contained in this handbook is subject to change without notice, and Customers shall verify current applicability of information through written inquiry to the Company.

2.0 APPLICATION

This document applies to Customer locations interconnecting Distributed Energy Resources (DER) to High Tension service in all Regions.

Requirements for Distributed Energy Resource installations connected to the Company transmission system or existing low-tension service are covered elsewhere.

This specification may not address completely interconnections made to the system for generation that intends to make wholesale sales. Additional details regarding projects interconnecting to the New York State Transmission System and the New York Independent System Operator (NYISO) Process are outlined on the utility's Transmission Developer's Welcome Kit.

This document does not cover emergency generation equipment that is not at any time operated in parallel with the Company power system.

The Company reserves the right to exclude a power producing facility from connection to the Company's secondary network systems when the Company deems it necessary to protect its system, facilities, and/or other Customers. DER interconnected to operate in parallel with the distribution system must comply with the requirements set forth in this handbook.

The provisions of this handbook are applicable to the following categories of generation:

2.1 DER <5 MW ("5 MW & Under Class") Customers with private generation facilities with a total nameplate rating of 5 MW or less and connected in parallel with the distribution system must comply with the New York State Standard Interconnection Requirements (SIR) found on the Department of Public Service Distributed Generation site in effect at the time of the application. The SIR includes information about the interconnection process (i.e., applying for service) and about design, interconnection, installation, testing and operating requirements.

The SIR also applies to any modification to existing generating facilities connected in parallel with the distribution system with a total nameplate of 5 MW or less.

Customers are recommended to review the requirements of the SIR. The Company will follow the process and application for such projects.

2.2 DER >5 MW

Distributed Energy Resource (DER) penetration for interconnection in distribution system is depending on but not limited to:

a) DER DG type, configuration, application, capacity.

b) Con Edison Distribution System intended point(s) of interconnection (POI) - service characteristics at the POI(s), the Con Edison existing or customer proposed distribution system interconnection configuration at the POI(s) (e.g., multibank block house 460 Volt bus, radial service, secondary network grid service, high tension station, etc.), Contingency and the feeders that supply the intended POI.

c) Interconnected (operating) and queued generation capacity aggregated to the intended feeders from high tension service and/or multibank busses.

d) Interconnected (operating) and queued generation capacity aggregated to the secondary network related grid when applicable.

e) Interconnected (operating) and queued generation capacity aggregated to the area distribution substation) Con Edison's distribution system related protection scheme and devices.

f) The results Con Edison's Distribution Engineering Department's distributed energy resource system impact studies and analysis performed under Con Edison's Interconnection Approval Process.

3.0 POLICY ON DISTRIBUTED ENERGY RESOURCE (DER) INTERCONNECTION

It is the policy of the Company to permit operation of distributed generating equipment in parallel with the Company's electric system if the protection requirements are satisfied and the appropriate approvals are obtained. This can be done whenever there is no adverse effect on the Company's other Customers, equipment, or personnel, while maintaining the quality of service. The Customer will need to sign a binding standard interconnection agreement, amended as necessary to allow interconnection, prior to energization.

3.1 Protection Responsibility

The Company is not responsible for protection of the Customer's generator(s), or of any other portion of the Customer's electrical equipment. The Customer is solely responsible for protecting his equipment in such a manner that faults or other disturbances on the Company's electrical power system do not cause damage to the Customer's equipment. The Company does not warrant the adequacy, safety or other characteristics of any structures, equipment, wires, pipes, appliances or devices owned, installed or maintained by others.

All interconnection equipment including any protection equipment required to protect and coordinate with the Company's distribution system will be specified by the Customer submitted for Company review.

3.2 Limitation of Liability

In no event shall The Company or its subcontractors, or consultants be liable for indirect, special, incidental, punitive, or consequential damages of any kind including loss of profits, arising under or in connection with this specification even if one or more of the Parties or its subcontractor consultants have been advised of the possibility of such damages. Nor shall The Company or its subcontractor, or consultants be liable for any delay in delivery or for the non-performance or delay in performance of its obligations under this Agreement.

3.3 No Implied Waivers

The failure to insist upon or enforce strict performance of any of the provisions of this Agreement shall not be construed as a waiver or relinquishment to any extent of such party's right to insist or rely on any such provision, rights and remedies in that or any other instances; rather, the same shall be and remain in full force and effect.

4.0 GENERAL

4.1 Tariff Provisions

Customers with onsite generation are subject to different rates for power and energy. The rates and terms of service under which the Company provides electric are set forth in schedules referred to as the 'Tariff.' The Tariff is regulated and approved by the New York State Public Service Commission. The Tariff can be found on the Company website (http://www.coned.com/rates/), click on "Electric Rates and Tariffs" at the bottom of the page. Other Company commodity rates may also be found on this website.

4.2 Customer Interconnection Costs

Customers with generation facilities shall be subject to charges for interconnection costs incurred by the Company and directly related to the installation of the facility deemed necessary by the Company to permit interconnected operations with a Customer, as provided in the Tariff and the SIR. These costs may include the reasonable costs of connection, engineering evaluations and acceptance, switching, metering, transmission, distribution, safety provisions, engineering and administrative costs.

4.3 Penalty for Interconnecting without Company Authorization

A Customer who interconnects a DER unit without the Company's authorization will be: (1) liable and responsible for all damages (including any and all third party damages) and expenses (including all legal fees) that result; (2) responsible for all of the Company's incurred expenses to ensure the safety and reliability of the electric system caused by the unauthorized interconnection of the Customer's DER unit; and (3) subject to a contract demand surcharge equal to twice the amount of the charge for Contract Demand that would otherwise be applicable under standby service rates in the Tariff.

4.4 Standards and Code Requirements

The Customer's generation and associated interconnection equipment must be designed, installed, interconnected, tested, and operated in accordance with the requirements of the latest, and most stringent, government, and industry standards not limited to the IEEE (ANSI), NEMA, National Electric Code (NEC), National Electric Safety Code (NESC), City Administrative Code, DEP, EPA, OSHA and all applicable local codes and authorities having jurisdiction. Company requirements are in addition to and will not waive any of applicable standards and/or codes. Where a difference between codes and Company requirements exists, the most stringent requirement shall apply.

4.5 Company Specifications and Requirements

The interconnection of the Customer's facilities with the Company's electric distribution system shall also comply with the Company's applicable criteria, guides and procedures for such interconnections.

4.5.1 Generating facilities that are large enough to fall under the New York Independent System Operator (NYISO) and the Northeast Power Coordinating Council's (NPCC) Operating and Planning Guidelines, must be in compliance with those requirements.

4.5.2 All Customers planning to connect generation to the system must comply with IEEE 1547 – Standard for Interconnecting Distributed Resources with Electric Power Systems. The DER Customer shall utilize the following protection settings adapted from the standard for abnormal voltage or frequency conditions:

Table 1—Interconnection system response to abnormal voltages

Voltage range (% of base voltage[a])	**Clearing time(s)**
V≤ 50	1.1
50 < V ≤ 80	3
110 ≤ V < 120	2
V ≥ 120	0.16

[a]Base voltages are the nominal system voltages stated in ANSI C84.1-1995, Table1.

Table 2—Interconnection system response to abnormal frequencies

Frequency range (Hz)	**Clearing time(s)**
F ≤ 56.5	0.16
56.5 < F ≤ 58.5	300.0
61.2 ≤ F < 62.0	300.0
F ≥ 62.0	0.16

4.5.3 All Customers planning to connect generation to the system must apply for interconnection. It is advised that the Customer visit the Company's DER website (www.coned.com/dg) and familiarize themselves with the appropriate application documentation and process.

4.5.4 The design of the Customer-owned generation and associated interconnection to the distribution system and any studies associated with the interconnection shall be submitted to the Company for review.

4.5.5 All Customers interconnecting with the distribution system at primary voltage must also comply with the General Specification for High Tension Service (EO-2022).

.

4.6 Specifications Approval

In order to fulfill the detailed interconnection specification requirements, the Customer shall ensure that all information requested by the Company in Form G "ADDENDUM TO APPLICATION FOR SERVICE: APPLICATION FOR NET METERING OR STANDBY SERVICE AND/OR BUY-BACK SERVICE" is completed. This form can be found at http://www.coned.com/dg.

Additional documentation and data shall be made available to the Company such as: three-line electrical diagrams of Customer generating equipment, protective features and method of interconnection to the Company's supply line.

4.6.1 Company - Following preliminary design review of the Customer's proposed interconnection, the Company will provide the Customer with a written assessment of the feasibility of the proposed interconnection and an estimate of the interconnection charges to which the Customer will be subjected. The Company's cost estimate will be made in good faith and, as such, shall be subject to revision when actual costs become known.

The Company will issue a detailed specification for each Customer based upon documents submitted by the Customer and the requirements outlined in this general handbook.

4.6.2 Customer - Additional documentation to be attached shall include a one-line diagram of the Customer's installation including the interconnecting feeder(s). It shall show the existing and proposed classification(s); type and capacities of generation, and protection requirements; and it shall set forth transformer and/or interconnecting cable capacities; fuse or circuit breaker ratings, maximum kW generator output, the Customer's maximum connected load and the estimated maximum kVA and kW demand. This documentation will become the basis for the Company's prepared detailed specification.

The Customer shall sign two copies of the Company's detailed design specification and return them to the Company. The Company's detailed specification shall remain valid for three years. If for a period of three years after the Customer signs the detailed specification, the Customer has not commenced construction of the interconnection, and still wishes to interconnect, the Customer shall resubmit the detailed specification to the Company for revalidation.

Distributed Energy Resource Customers must submit an operating specification (aka Description of Operations) for their facilities, which shall include a description of the plant, it's interconnect and how it will be operated under normal and contingency conditions. The operation part shall include items such as switching, interlocking, grounding, start-up and shutdown of the facility and contingency modes of operation. The Customer shall keep an operating log which will detail all changes of breaker or switch status, including time of operation and relay targets, if any.

4.7 Maintenance Procedures

The Customer is required to perform periodic maintenance tests on protective devices, circuit breakers, transformers, generators, inverters, relays, batteries, and other equipment as recommended by the manufacturer. The maintenance schedule to be followed shall be submitted to the Company prior to energization.

4.8 Metering

The Customer agrees to install equipment required to measure, collect and obtain any data necessary to determine operating characteristics of such installation served under the particular service classification. Please note, the customer will need to arrange separately for any and all other monitoring required for any other program not associated with Con Edison, including but not limited to interconnection metering and SCADA requirements to participate in NYISO programs.

The Company shall:

a) Furnish drawings that show the mounting dimensions and wiring of current and voltage transformers necessary for revenue metering to be installed by the Customer.

b) Furnish and maintain current and voltage transformers necessary for revenue metering.

c) Furnish, install, and maintain all meters necessary for revenue metering, and make the final connections to them.

4.9 Monitoring & Control

The company will require monitoring & control for applications above 5MW. The company will require DNP3 and IEC 61850 compliance. Specific performance requirements will depend on DER characteristics and application. The Requirements will be provided after a feasibility study is completed. These requirements do not cover NYISO or any other external program requirements. The customer is responsible for making appropriate provisions enable participation for non-Con Edison related programs.

4.10 Safety Procedures

In addition to the Occupational Safety and Health Administration (OSHA) requirements, the Customer shall adopt the Company's recommendations and practices governing work performed on electrical equipment. The "General Rules and Regulations" are covered in the Company's Publication 27-13 Safety Services, and "General Instructions Governing Work on System Electrical Equipment."

The Customer shall provide relay protection of the intertie feeders in conjunction with generators and load feeder protection to meet the requirements outlined in the Technical Requirements in this document. The Customer's generation load control shall meet compatibility and safety standards for the proposed interconnection operation with the Company system.

4.11 Company Approval of Customer's Proposals

The Customer shall submit, for Company review, final protection design and detailed specifications and descriptions of all protection devices and accessories the Customer intends to purchase. This submission shall include:

a) For Customers using capacitor banks for power-factor correction, the proposed control circuit design of the capacitor switching to ensure prevention of excessive reactive compensation and/or over voltages.

b) A description of generation load control for compatibility and safety of the proposed interconnecting operation with the Company system.

c) Specifications for circuit breakers and protective devices, relay coordination studies, relay setting specification and relay test procedures.

d) A full set of wiring and schematic diagrams, marked "FINAL" and sealed by a New York State licensed Professional Engineer.

Schematic AC diagrams must be checked by the Customer in order to verify correct connections, and polarity for all power transformers, differential and directional relays. Wiring diagrams shall agree with the schematic diagrams and be verified by the Customer to be correct prior to equipment installation.

In order to avoid purchasing improper equipment, the Customer should obtain Company approval of the above prior to purchasing interconnection equipment.

The Company shall have the option to inspect construction work to ensure the installation will be compatible with the Company's requirements.

Prior to operation, the Customer's installation shall be inspected by the Company to verify compliance with the Company's detailed specification and with the Customer's Company-approved drawings and details of the interconnection. Such inspections shall be conducted at a mutually agreeable time.

The Company will approve and grant permission for interconnection when the Customer's plans satisfy the goal of affecting a safe, reliable and efficient interconnection.

The Customer shall provide advance written notice to the Company of any proposed change in electrical equipment associated with the interconnection, and the Company shall promptly inform the Customer whether the contemplated changes are acceptable, consistent with the goal of conducting a safe, reliable and efficient interconnection.

5.0 FORFEITURE OF PARALLEL OPERATION

Allowing the Customer to operate the Distributed Energy Resource in parallel with the Company's electric system is contingent upon obtaining design approval from the Company and maintaining the equipment in accordance with the latest recognized rules, regulation and practices as specified by the Company. In addition, the Customer shall keep an up-to-date log of routine maintenance performed and operational transactions on equipment affecting the Customer's interconnection with the Company's system. The Company may interrupt or terminate the parallel operation agreement with the Customer for conditions such as:

a) Hazardous or unsafe operation.

b) Usage of unapproved generating or protective equipment.

c) Protective devices bypassed.

d) Failure of the Customer to maintain equipment and/or perform periodic testing on protective devices to applicable Company requirements or to keep a set of acceptable records on the operation/maintenance of equipment.

e) Any other condition(s) which adversely affects the quality of service or service reliability of the Company's other Customers.

Resumption of the parallel operation will be allowed only after approval has been obtained from the Company.

6.0 AREAS OF CONCERN

Some technical concerns of connecting DER to the Company include: network interconnections, recloser operations and substation fault duty.

In the network design, the network protector which interconnects the primary distribution system and the secondary grid is designed to prevent power flow from the secondary to the primary feeders. Consequently, sending power into the primary system is possible through the network protectors, but system modifications are required to achieve reverse power flow. The Customer is responsible for the modification costs.

Manual or automatic recloser operations of switching devices on auto-loop systems could cause disruption of service to Customers and may cause damage to the Customer's generator due to reclosing out-of-phase, unless proper protection is installed at the Customer's expense. Operation of distributed storage and generation may be affected by the automatic reclosing schedule adopted by the Company for their distribution circuits.

The Company's distribution substations are subject to fault duty limitations. Adding generation to the distribution system increases the amount of fault current imposed on the substations. Exceeding the fault duties at the substations as a result of DER will not be permitted and alternate methods of interconnection must be explored where this limit has been reached.

Multiple service facilities may be supplied to the Customer from a multibank transformer installation. These service installations, or takeoffs, may be either cable with limiters or bus detail with fuses. To assure that the reliability and proper protection are maintained in these service facilities, the Customer is not permitted to:

a) Parallel secondary takeoffs from a common facility.

b) Parallel secondary facilities supplied from separate locations.

c) Exceed the ampacity rating of any service facility.

d) Create an unbalanced loading condition in excess of 5% between phases of a service.

The Company's distribution system shall be designed and operated such that loss of the Customer's generator(s) shall not create overloads and/or undervoltage conditions.

7.0 TECHNICAL REQUIREMENTS

7.1 Overview of Issues Related to Interconnection

Customer generation connected to the distribution system can cause a variety of system impacts including steady state and transient voltage changes, harmonic distortion, and increased fault current levels. Generation systems of 5 MW or less, which individually on higher capacity feeders may not cause very serious impacts, can, on weaker circuits, in aggregation or in special cases (such as lightly loaded networks), significantly impact the Company's distribution system. The system impact studies in some cases will be needed to identity system impacts and the upgrades needed to address these issues. For larger Customer generation units over 5 MW, there is generally a need for site-specific system studies no matter where on the system the Customer is connecting.

At the time the Company's distribution system was designed and installed, the requirements of interconnecting distributed generation were not envisioned. There are a wide range of issues associated with the interconnection of DER to the electric distribution system. Among these are:

- Increased fault duty on Company circuit breakers
- Interference with the operation of protection systems
- Harmonic distortion contributions
- Voltage regulation and flicker on the system and impact on step voltage regulation equipment
- Ground fault overvoltages
- Islanding
- System restoration
- Power system stability
- System reinforcement
- Metering

It is important for the Company to closely examine all aspects of the interconnection Customer generation to the electric distribution system so that any negative impacts can be avoided and assure that the Customer generation will have only a positive or, at least, neutral impact on the system performance. It is the intent of any interconnection studies to avoid negative impacts (reliability, safety etc.) on either the Company system, the DER Customer's service or other nearby services by identifying the impact and determining the required equipment upgrades that can be installed to mitigate the issue(s).

Connecting Customer generation to the low voltage network poses some issues for the Company. The generation can cause the power flow on network feeders to shift (reverse) causing network protectors within the network grid to trip open. No synchronous generators are permitted for interconnection to the Company's secondary voltage grid networks. Small induction and inverter based generators may be allowed on the secondary voltage grid networks on a case-by-case basis. Connection of generators on the spot networks is permitted also on a case-by-case basis.

Because of the severe safety and potential equipment damage issues associated with feeding power into a de-energized distribution system, a major design consideration of any Customer generator installation is that THE GENERATOR SHALL NOT ENERGIZE A DEENERGIZED COMPANY CIRCUIT. The protection system shall be designed with interlocks and proper protective functions to ensure that there is proper voltage, frequency and phase angle conditions between the Customer's and Company's systems before the generator is permitted to parallel.

Because of the potential interference with reclosing on radial and auto-loops feeders and/or restoration operations on the utility system, AUTOMATIC RECLOSING OF THE CUSTOMER'S INTERTIE CIRCUIT BREAKER IS NOT PERMITTED.

The Company's distribution substations are subject to fault duty limitations. Adding generation to the distribution system increases the amount of fault current imposed on the substations. Exceeding the fault duties at the substations as a result of DER will not be permitted and alternate methods of interconnection have been presented for use by the Customer when designing their interconnection where this limit has been reached.

7.2 Design Criteria

From the perspective of interconnection, there are three main types of Customer generation systems that interface to the power system. These include:

- Induction Generators
- Static Power Converters
- Synchronous Generators

Each type has its own specific characteristics regarding synchronization equipment, protective functions, starting practices, and electrical operating behavior. Whether the generation is less than 5 MW and covered under the SIR guidelines or larger than 5 MW and covered under the requirements herein, specific common interface requirements will always apply. There may also be additional specific requirements that may be identified as part of any interconnection review that is performed for a specific location. These specific requirements are discussed later in this specification.

In order for inverter equipment to be certified as acceptable for interconnection to the utility system without additional protective devices, the interface equipment must be equipped with the minimum protection functions (outlined later in this manual for each type of interface) and tested in compliance with most current applicable version of IEEE 1547 or Underwriter's Laboratories UL-1741, "Inverters, Converters and Controllers for Use in Independent Power Systems."

7.2.1 Design Classification

Interconnected Customer generation is classified with respect to the following:

a) Generator rating
b) Rate classification
c) Interconnection type

Examples of the various Customer generation design classifications are shown in Table 2.

Where multiple generators are connected to the Company's distribution system through a single service, the appropriate classification will be based on the aggregate ratings of the generators.

7.2.2 Grounding

The Customer shall utilize a grounding interface to the Company's system that is compatible with and appropriate for the grounding needs of the Company's distribution system. Proper grounding is critical because without a proper grounding approach, dangerous or damaging conditions could arise in the operation of the generator that could cause problems for the distribution system and connected loads. Grounding influences the nature of ground fault overvoltages, harmonics, fault level contributions, and the potential for ferroresonance.

In order to assess the generator grounding design as it appears to the Company's distribution system the generator grounding design must include details describing the neutral grounding arrangement of the generator and the winding configuration/grounding arrangement of any interface transformers. In cases where the Customer wishes to use its existing step-down transformer that has been serving their load as the interface to the Company distribution system, it is important to recognize that an existing transformer that is perfectly suitable for serving load at a site may not always be satisfactory to serve as a generator interface transformer because it may not provide proper grounding with respect to the Company distribution system. The installation of a generator at a Customer site may necessitate replacing the existing transformer with a new transformer that has appropriate grounding or adding a dedicated second transformer for the generator.

Depending on where it ties into the Customer's system, a generator installation may need to provide grounding that complies with all applicable requirements of the National Electrical Safety Code (NESC), National Electric Code (NEC) and the Company. The proper method of generator system grounding to be used with a particular power system interconnection point is unique for each installation. Table 3 indicates the Company's distribution system grounding methods.

7.2.3 Harmonic Requirements

The maximum total and individual harmonic distortion for voltage and current injected by the Customer's equipment and loads at the point of common coupling (PCC) shall meet IEEE Std.519 and IEEE Std.1547 guidelines. A facility causing harmonic interference is subject to being disconnected from the Company system until the condition has been corrected.

For non-certified equipment installations, the Customer is required to measure harmonics before and after the interconnection is established. Non-certified equipment is that does not meet IEEE 519 and IEEE1547 guidelines. The Customer shall submit the results of these tests to the Company for review. If necessary, the Customer will be required to make all corrections to avoid harmonic problems.

7.2.4 Voltage Regulation and Voltage Flicker

Parallel operation of Customer generation has an influence on the distribution system voltage levels by changing the current levels on the system. The amount of influence depends on the size and nature of the Customer's generation system as well as how it is operated and the characteristics of the distribution system. The Company has two main voltage regulation concerns:

- Avoiding objectionable voltage flicker
- Maintaining the steady state distribution system voltage within the proper operating limits.

Voltage Flicker: Voltage flicker is a sudden change in voltage (that occurs in seconds or fractions of a second) that can cause objectionable changes in the visible output of lighting systems. Sudden changes in the state of a power generator can cause flicker. Examples include starting/stopping of generators, output-steps, periodic oscillations in output caused by generator prime move governor hunting and misfiring, fluctuation of wind and PV system outputs, and many other factors. The Company requires that any Customer energy producing equipment connected to the system must not (at the PCC) exceed the limits of voltage flicker as defined by the maximum permissible voltage fluctuation shown for the borderline of visibility curve in IEEE Std. 519-1992 and, where applicable, the Con Edison flicker specification (see Graph 1). This requirement is necessary to minimize complaints by other Customers.

Steady State Voltage Regulation: Steady state voltage is the voltage of the power system over a sustained period of time usually defined as anywhere from about 1 to 3 minutes or longer in duration. The operation of the generator should not cause the Company's distribution system voltage to go outside of the steady state voltage limits. ANSI Std.C84.1-1995 defines the steady state voltage limits for AC power systems in North America. In addition, the Public Service Commission establishes service voltage limits for the Company. The Company shall require that the Customer generator be operated in a manner that does not cause the voltage regulation to go outside the applicable limits. In addition, operation of the generator shall not cause undo hunting and interference with the normal operation of the Company's voltage regulation equipment.

7.2.5 Reliability and Power Quality

The Customer generation shall in no way degrade the reliability or power quality of the distribution system.

7.2.6 Power Factor

If the average power factor of the Customer (including the effects of the generator current), as measured at the PCC is less than 0.9, then the method of power factor correction necessitated by the installation of the generator, if any, will be negotiated with the utility as a commercial item. For Reactive Power (VAR) requirements, the Customers shall refer to the applicable Company's rate "Service Classification" under the Special Provisions section to determine the kilovar charges. For a more detailed discussion of power factor requirements see also the specific generator requirements in Sections III, IV and V of this specification.

7.2.7 Islanding

Under no circumstances will a Customer generator be allowed to sustain an island condition with any part of the Company distribution system beyond the PCC. The Customer generator must be equipped with protection to sense a possible island and disengage from the Company distribution system within a time frame required by IEEE Std.1547.

7.2.8 Metering Requirements

The need for additional revenue metering for non-net metered Customers will be reviewed on a case-by-case basis and shall be consistent with the requirements of the Public Service Commission.

For those Customers seeking net metering the Company will employ net energy metering arrangements to measure and charge for the net energy supplied by the Company. The Company will install the metering necessary to obtain the data required to credit the net-metered Customer for the kWhr supplied to the Company. If the Customer is billed under demand rates the Company will select a metering configuration that will enable it to credit the Customer for the kWHr supplied to the Company by the Customer and measure the peak kW delivered by the company to the Customer. If a Customer requests for additional metering not required by the Company those metering costs will be borne by the Customer.

For larger generator installations, the metering becomes more complex and may require equipment such as medium voltage PTs and CTs, fusing, support poles, various equipment housings, etc. As is necessary, the Company will prepare detailed metering schemes for each Customer. The Customer shall furnish, install and maintain mounting facilities for the Company's meters, metering transformers and meter devices, and provide suitable space and enclosures for such facilities.

The Customer shall furnish, install and maintain all wiring and miscellaneous equipment for revenue meters, metering transformers and meter devices (but not the meters, metering transformers and the meter devices themselves). If needed, the Customer shall install and connect revenue metering transformers for the initial installation and upon subsequent alterations to the primary cable or bus connections. The Customer shall furnish and install meter wiring between metering transformers and the revenue meters, but the Company will make the final connections to the meters. The Customer shall also furnish, install and maintain all wiring and miscellaneous equipment for demand metering devices and/or additional devices required in addition to watt-hour meters.

Meters and protective devices installed by the Customer for Customer use shall not be connected to the secondary of the Company's current or voltage transformers (potential transformers). For services connected to the Company's distribution system primary, metering transformers shall be connected on the incoming line side of the Customer's instrument transformers and energy consuming devices.

In cases where the Customer's meter location requires devices to be installed on the incoming side of the metering transformers, the installation of such devices shall be approved by the Company. Examples of such devices include neon indicators, phasing facilities or potential transformers for automatic circuit breaker operations. Details of requirements for high-tension connected equipment can be found in Company specification EO-2022.

No Customer equipment shall be installed in revenue metering compartments.

7.3 Operating Requirements

7.3.1 Maintenance of Customer's Equipment and Cable

The Customer shall perform periodic maintenance on circuit breakers, relays, transformers, generators, inverters, batteries, and other equipment to meet the Company's specifications unless the manufacturer recommends a more frequent schedule for maintenance.

In general, low tension Customers shall follow the manufacturer's recommendations and maintenance cycles and high tension Customers shall comply with the Company's Specification EO-4035 "Operation and Maintenance of Equipment on High Tension Customer's Premises." Failure by the Customer to perform periodic maintenance as required by the SIR and contractual agreements with the Company will result in a discontinuance of service until this requirement is satisfied.

The Customer shall provide written notification to the Company in the event the individual or firm responsible for maintenance of distributed generating equipment, breakers and/or relays is being replaced. Such written notification shall be given within seven business days and include the name, address and telephone number of the new individual or firm.

In the event it is necessary for the Customer to disconnect Company service, the Customer shall notify the Company's District Operator of the planned disconnection at least seven business days in advance of the disconnection.

When connections of new Customers or other work such as routine maintenance will interrupt service to a Customer, the Company will contact the Customer to arrange a mutually agreeable time, if possible, for such Company work to be performed. When interruption is required, service will be restored as quickly as possible.

The Company occasionally applies a high-potential proof test to check the condition of its feeders. That portion of the service equipment on the supply side of the first disconnecting device on the Customer's premises will be included in those high-potential proof tests.

7.3.2 Maintenance of Company's Equipment and Cable

Before work is to be performed on a Company feeder (normally done while the feeder is de-energized), an authorized Company representative will lock open (with Company padlock) the intertie circuit breakers or disconnect switches for all distributed generating Customers receiving service from that feeder.

7.3.3 Disconnecting Service

When requested by the Company, the Customer shall discontinue parallel operation:

- To eliminate conditions that constitute a potential hazard to utility personnel or the general public
- Pre-emergency or emergency conditions on the utility system
- A hazardous condition is revealed by a utility inspection
- Protective device tampering
- Parallel operation prior to utility approval to interconnect

7.3.4 System Operation Documentation

The Customer shall maintain an operating log at his facilities indicating changes in operating status (available or unavailable), maintenance outages, trip indications, manual events and other unusual conditions found during routine inspections. In the log, all relay targets are to be registered whenever a breaker operation occurs. At a minimum, this log shall include time, date, relay type, circuit number, phase, model number and description of disturbance. The Company shall have the right to review these logs, especially in analyzing system disturbances.

The Customer shall keep a set of updated drawings, which includes a one-line circuit diagram and system wiring diagrams of the installation's electrical facilities. These drawings shall be made available during the Company's periodic inspection.

The Customer shall promptly notify the Company of any circumstances endangering Company service. The Customer shall also notify the Company of any automatic operation of the intertie circuit breaker(s) or any other main protective device at the Customer's installation. The Customer shall inform the Company of the exact time of operation, breaker position (open or close), relay targets and condition of breaker control power.

The equipment on the Customer's premises causing the above operation shall not be reenergized until it is isolated, repaired or replaced, and until the Company has determined that the condition that caused such operation has been corrected. The Company shall make such determination promptly after the Customer notifies the Company that the equipment is ready to be reenergized.

7.3.5 Circuit Breaker and Switching Operations

The Customer's interconnection tie and/or generator circuit breaker(s) shall open to separate the Company's and Customer's facilities, for faults on either the Company's incoming supply feeder(s), low-voltage service or the Customer's equipment.

The circuit breakers shall also be opened automatically when the Company's incoming feeder(s) or low voltage service(s) is de-energized for scheduled work.

The intertie circuit breaker shall be closed manually and only after the Company's operating authority has determined that the situation which caused the breaker to open no longer requires the breaker to remain open. The operating authority shall make such determination promptly after the customer notifies the operating authority that the breaker is ready for closing.

7.3.6 Maintenance of Grounds

FOR THE PROTECTION OF PERSONNEL, ONLY AUTHORIZED COMPANY PERSONNEL SHALL GROUND OR REMOVE GROUNDS FROM INCOMING COMPANY PRIMARY FEEDER (S). If grounding of the Company feeder(s) is required, the Customer shall contact the Company's District Operator. All other switching within the Customer's premises shall be performed by qualified employees of the Customer. The Customer shall notify the Company's District Operator at least fifteen business days before Customer switching is planned so that the Company can determine whether its personnel are required to supervise the switching activities. A shorter notice period will be acceptable where such switching is necessary to restore service to the Customer.

7.3.7 Telephone Communications

The Company shall be provided with a 24-hour direct telephone access to the Customer's facility for communications regarding emergency operation of Company primary feeders and Customer-owned equipment that is energized directly from these feeders.

Each Customer shall have provision for a telephone service between the Company and the Customer or the Customer's generating facility.
All other communications shall be between the Customer and the Customer Project Manager (CPM), unless otherwise designated.

7.3.8 Company Access, Inspection and System Emergencies

Company access to the Customer's interconnection equipment and the generator circuit breaker will be required for maintenance of Company equipment, routine inspection, and in emergency situations. In cases other than emergencies, reasonable advance notice of the need for access will be given to the Customer. Only Company personnel bearing Company identification cards and authorized representatives of the Customer should be permitted access to vaults, rooms, manholes or enclosures containing on-site generating and/or interconnection equipment.

a) Company Access - The Company will require access to Customer premises to maintain splices connecting the Company and Customer's cables, and to maintain meters, metering devices, and current and voltage transformers used for metering.

b) Inspection - Where there is parallel operation, the Company or its authorized representative reserves the right to inspect, at reasonable intervals, the Customer's generator operation, equipment, testing procedures, measurement records and maintenance and operating logs. Customers failing to follow the Company-approved relay testing procedures, or properly keep records of operations, maintenance schedule and test results, will be required to cease parallel operation or to take Company service through isolated (non-parallel) operation.

c) System Emergencies - In case of emergency, where service is in imminent danger of interruption, or where there exists a condition which imminently endangers life, property or the Company service; the Company may disconnect and lock open the interconnection circuit breakers or the Customer's distributed generating equipment. Where possible the Customer shall be given advance notice of such disconnections under these emergency circumstances. Service shall be restored to the Customer as soon as system conditions permit.

8.0 ELECTRICAL DISTRIBUTION SYSTEM

The distribution system supplies power to the Company's low voltage network Customers and radial Customers from area substations at the 4kV, 13kV, 27kV and 33kV primary service voltage levels. The majority of Customers receive Low Tension (low voltage) service directly at the distribution system secondary voltage levels of 120/208V; 120/240V or 265/460V, while a small percentage of High Tension (high voltage) Customers receive power at primary service voltage levels.

The two major types of distribution systems in Con Edison's system are the radial non-network and network designs. Radial systems have a single high voltage feeder feeding energy from the substation to numerous distribution transformers tapped along the feeder. The distribution transformers step the voltage down from primary voltage to low voltage service and serve a specific number of Customers to maintain system reliability. Networks have multiple primary feeders feeding several parallel network transformers that feed energy into a low voltage distributed grid (grid network type) or local building bus (isolated or spot network) where the Customer is connected. Thousands of low voltage Customers are served off of each low voltage grid network connection. Typically, Customer generation will be connecting via the Customer's existing service and therefore, they will be connecting to one of these types of distribution systems.

For most interconnections, the voltage level, system configuration, and design requirements of the generator will be dictated by the type of distribution system to which it is connected (network or radial), the Customer's service voltage level, the DER equipment rating and type, and the electrical characteristics of the distribution system connection point and generator. There are many different voltage levels on the system (See Table 1 in Section VII).

Additionally, Con Edison does not allow dedicated interconnections via Con Edison owned breakers or busses at distribution Area Substations, including but not limited to for example the Fresh Kills 33kV Area Substation. Con Edison will consider Customer interconnection requests to the distribution system must conform to requirements outlined in this specification.

From a reliability standpoint, service in each area is categorized by the Company relative to the number of allowable coincidental primary feeder failures without interrupting the Customer. These failures are defined as CONTINGENCIES. A FIRST contingency service area is one in which only one incoming feeder can be out of service at a given time. In a SECOND contingency area, two feeders can be out of service coincidentally without affecting service. Therefore, to ensure service, a minimum of two (2) incoming feeders are required for a first contingency area and a minimum of three (3) incoming feeders are required for a second contingency area. The contingency level at the point of generation interconnection will have an influence on the generator design since for the generator impact studies it may be necessary to model system performance in each of the different contingency modes. Network systems will have the highest contingency and are usually the most complex in which to interconnect, while radial systems the lowest contingency and in many cases easier to interconnect with.

Furthermore, Con Edison's network reliability depends on the ability to promptly repair feeder outages, with a focus on peak demand time frames. Feeder outages require crews to visit the High Tension (HT) locations prior to processing the feeder. If Con Edison must wait for access to unstaffed/remote locations, there is an increased risk to the network reliability with delayed feeder restoration. All customers are impacted by outages and reliability indices are negatively reflected in utility performance metrics.

For these reasons, **HT designs** (EO-2022) **shall** be reserved for applications where loads are sufficiently significant to preclude service from a low-tension grid, i.e., High Tension is for projects that exceed the capability of the Company's low-tension service, except for projects leveraging the Offset Standby Tariff, which currently requires HT interconnection. Projects connecting to the non-network (overhead) system may use EO-10215 High Tension Metering Enclosure (HTME) design.

II - CUSTOMER INTERFACE PROCEDURES

1.0 APPLICATION PROCESS

It is the Company's objective that the process be completed in a timely manner and affords the lowest cost to the Customer. Additionally, emphasis is placed on the need to preserve safety, reliability, power quality and operational efficiency of the Company distribution system. In order for the Customer to receive approval to interconnect Distributed Energy Resource (DER) facilities to the Company's power distribution system, Customer's will be required to follow the appropriate application process for interconnection.

1.1 Customers Installing DER with a Capacity of Less than (<) 5 MW

1.1.1 For interconnection of new DER facilities with a nameplate rating of 5 MW or less as aggregated on the Customer side of the point of common coupling (PCC). The process outlined in the latest revision of the New York State Public Service Commission's Standardized Interconnection Requirements (SIR) and SIR Application Process shall be used. Additional information can be found at the Con Edison Distributed Energy Resource website.

1.1.2 For modifications involving existing Customer Distributed Energy Resource facilities that have a nameplate rating of 5 MW or less as aggregated on the Customer side of the PCC interconnecting to the Company distribution system shall also follow the SIR process outlined above in paragraph 1.1.1.

1.2 Customers Installing DER with a Capacity Greater than (>) 5 MW

1.2.1 Customers installing new Distributed Energy Resources or making service modifications to accommodate Distributed Energy Resource with capacity over 5 MW as aggregated on the Customer side of the PCC is considered large generation and does not fall under the mandated SIR guidelines. For these interconnections the Customer will follow the approval process set forth in this procedure. Exceptions to this practice where applicable to all interconnections will be identified herein.

1.2.2 **Application Procedure**

In general, four steps will be followed in the process of application for interconnection to the Company's distribution system; A. Service & Interconnection Request, B. Feasibility Review, C. Interconnection Kickoff Meeting, D.Signed standards specification.

a) **Service & Interconnection Request –** The customer will need to submit two requests with Con Edison; 1. Submit a service request via Project Center & 2. Submit a generation interconnection request for DER via Power Clerk**.** The customer will first receive a service determination from the company's customer engineering department. The customer may request preliminary meeting to discuss the service determination, if necessary. The customer may need to revise their design depending on the Company's service determination ruling.

b) **Preliminary meeting with the company-** The customer should ask for a meeting with the Company to begin preliminary discussions with their existing documentation including one-line diagrams, Customer's facility design, modes of operation, protective schemes, and a system operating document which should detail the normal and contingency modes of operation and define all primary service disconnect switch and circuit breaker operating positions.
The customer shall send it to Con Edison via Power Clerk prior to the meeting for a preliminary review The Company's Distribution Engineering High Tension Group. The engineering department will comment on basic revisions necessary for review acceptance. The engineering department will inform the customers if all required documentation has been submitted to begin formal review of the project.

c) **Feasibility Review by the Company-** Once all required documentation is submitted and accepted by the Company, the Engineering department will perform a feasibility review of the Customer's completed Application for interconnection with the associated documentation and provide the Customer with a written assessment of the technical requirements of the proposed interconnection and provide the customer with an estimate of the company related interconnection details and associated cost estimate. Depending on complexity, a written response detailing the outcome of the preliminary review can take up to 60 business days. The company's response to the customer's application will include preliminary comments on design required for compliance and acceptance. In these discussions, the Company will explain the interconnection procedure and as part of this process.

d) **Interconnection Kickoff Meeting -** After completing the feasibility review of the Customer's One-Line diagram, the CPM will schedule a meeting between Con Edison's engineering group and the customer's engineering staff to discuss Con Edison's high tension service requirements and any site-specific issues. During the course of this meeting, the customer's project schedule and expected completion date will be discussed with respect to how the company-related portions of the project can be optimally sequenced. At this meeting, the customer is expected to present a signed copy of the Company's specification EO-2022 and/or EO-2115 which commits the Customer to meet the Company's standards. If for a period of three years after the Customer signs the detailed specification, the Customer has not commenced construction of the interconnection, and still wishes to interconnect, the Customer shall resubmit the detailed specification to the Company for revalidation.

e) **Receipt of Detailed Design Specifications** –

1. Site-Specific Design Specification - Following receipt of the formal application and three-line diagram (or one-line diagram clearly indicating three balanced phases), the Company will prepare detailed design specification for each Customer based upon documents submitted by the Customer and the requirements outlined in this general guide. The Company's detailed specification shall remain valid for three years. If for a period of three years after the Customer signs the detailed specification, the Customer has not commenced construction of the interconnection, and still wishes to interconnect, the Customer shall resubmit the detailed specification to the Company for revalidation.

2. Site-Specific Operations and Maintenance Specification – The Company will prepare a site-specific operations and maintenance specification for this DER Customer interconnection. This specification will include any unique details as identified by the Customer in their description of operation as well as all switching modes of operation. A list of Customer key personnel that the Company may contact in the event of an emergency, with their respective telephone numbers shall be included in the final version of the Customer's System Operation Specification.

3. These specifications will be reviewed and signed by both the

Company and the Customer prior to Company acceptance for interconnection is granted and shall be updated as required. The Customer shall sign two copies of the Company's detailed specifications and return them to the Company.

f) **Customer's Detailed Design Package** - Prior to the Customer's submittal of detailed design documents and drawings, the Company will provide equivalent and feeder(s) impedances at the point of interconnection.

1.2.3 The Customer shall submit for Company review:

a) A short circuit - relay coordination study taking into account the Company's system and the Customer's service.

b) Final protection design and detailed specifications' descriptions of all protection devices and all accessories the Customer intends to purchase. This submission shall include:

1. For Customers using capacitor banks for power-factor correction, the proposed control circuit design of the capacitor switching to ensure prevention of excessive reactive compensation and/or over voltages.

2. A description of generation load control for compatibility and safety of the proposed interconnecting operation with the Company system.

3. Specifications for circuit breakers and protective devices, relay coordination studies, relay setting specification and relay test procedures.

4. A full set of wiring and schematic diagrams marked "FINAL" and sealed by a New York State licensed Professional Engineer.

5. Schematic ac diagrams must be checked by the Customer in order to verify correct connections, and polarity for all power transformers, differential and directional relays. Wiring diagrams shall agree with the schematic diagrams and be verified by the Customer to be correct prior to equipment installation.

6. Circuit breaker DC control schematics

7. The Control (DC) battery distribution system design (if

applicable)

c) System Impact Studies – prior to the finalization of the design the Customer will perform studies including voltage regulation studies to identify the impact upon the distribution system as a result of the parallel operation of their DER. The Company will provide to the Customer the pertinent distribution system information to facilitate the Customer's efforts. The results of these studies will be submitted to the Company for review.

d) Detailed drawings of the proposed DER interconnection design and details of the equipment the Customer proposes to purchase and install.

e) Any equipment required to measure, collect and obtain data necessary to determine operating characteristics of such installation served under the particular service classification.

f) A Description of Operation under normal, contingency and emergency evolutions.

1.2.4 Specifications Approval:

In order to fulfill the detailed interconnection specification requirements, the Customer shall ensure that all additional information requested by the Company in the "ADDENDUM TO APPLICATION FOR SERVICE: APPLICATION FOR NET METERING OR STANDBY SERVICE AND/OR BUY-BACK SERVICE" is completed.

1.2.4.1 Additional documentation to be attached shall include a three-line diagram (or one line diagram that clearly indicates three balanced phases) of the Customer's installation including the interconnecting feeder(s). It shall show the existing and proposed classification(s); type and capacities of generation, and protection requirements; and it shall set forth transformer and/or interconnecting cable capacities; fuse or circuit breaker ratings and normal operating status, maximum kW generator output, the Customer's maximum connected load and the estimated maximum kVA and kW demand.

1.2.4.2 DER Customers must also submit an operating specification for their facilities. The specification shall include a description of the new plant and how it will be operated during both normal and contingency/emergency scenarios and shall include such items as: switching, interlocking, grounding, start-up and shutdown of the facility and contingency modes of operation. This documentation will become the basis for the Company-prepared detailed specification.

1.3 Application Review Schedule

The time frames for the application process and level of requirements may be extended compared to the Distributed Energy Resource system that fall under the SIR guidelines due to increase complexity of interconnection issues related to larger generators. Company review of Customer submittals should be completed in four (4) to six (6) weeks from time of receipt of submittal under normal circumstances. The review by the Company will be focused upon ensuring a safe and reliable interconnection that does not affect the safety and reliability to Company personnel and other Customers.

1.4 Service at Primary Voltage

It is important to note that for Customer's receiving service at high tension voltage levels will be required to design their high tension service to meet the Company requirements for high tension service as detailed in the latest revision of EO-2022 and operate the high tension service according to the general details delineated in Company specification EO-4035.

1.5 Emergency (Standby) Generators

This application process and its requirements do not apply to generation equipment that will never operate in parallel with the Company distribution system. As an example, this includes emergency standby generators with break-before-make transfer switches and any other generation sources that operate independently of any connection to the distribution system and have no provision for such connection (even for a short period of time).

1.6 Review of Customer's Plant

The Company shall have the option to inspect construction work during the construction/installation phase of the project to ensure the installation's compliance with Company's requirements. Such inspections shall be scheduled in advance.

Before interconnected operations commence, the Company will inspect the Customer's facilities to determine Customer compliance with all drawings and equipment specifications upon which the interconnection is based.

1.7 Pre-operational testing (Trip Checks)

To ensure that the protection and control requirements are acceptable, the Company will witness the verification testing performed by the Customer. Such testing shall be performed by the Customer after completion of the project and shall be performed by Customer personnel using a Customer developed and Company approved testing procedure. Such testing shall be scheduled at a mutually agreeable time.

1.8 Detailed O&M Specification

The Company will prepare and deliver to the Customer for their review and signature a site-specific operations and maintenance specification (O&M Spec). This O&M spec will identify the communication channels and operating procedures to be followed by the Customer when operating their DER in parallel with the distribution system. Preparation of the detailed O&M specification should, under normal circumstances, be completed in 4-6 weeks after the Company has received from the Customer the data necessary to complete the detailed specification. This specification will be reviewed and signed by both the Company and the Customer prior to Company acceptance for interconnection is granted. The Customer shall sign two copies of the Company's detailed specification and return them to the Company. The Company's detailed specification shall remain valid for the life of the DER project and subject to revision as necessary.

1.0 INTRODUCTION

An induction generator operates on principles identical to an ac induction motor, except that in normal operation it has a speed of rotation *slightly greater than* the synchronous speed of the 60 Hz power system. The induction generator, because it has “slip” in relation to the 60 Hz utility system voltage, is often referred to as an “Asynchronous” generator” because it is never quite synchronized with the utility (Company’s) distribution system. Induction generators do not have an exciter and they cannot normally sustain a stable island on their own so they are not used for generator plants that must provide power on a standalone basis. They are, however, commonly used in power plants that only need to operate in parallel with another source (such as the utility system). In general, induction generators have unique characteristics as follows:

- Induction generators operate in an asynchronous fashion with respect to the utility system voltage so when first connecting to the Company’s distribution system it does not require precise alignment of frequency and phase angle. However, speed matching to near synchronous speed may still be required for some cases.

- The design of the induction generator (its lack of an exciter) makes it less likely to pose an islanding risk to the Company’s system than a synchronous generator. On the other hand, self-excitation still can occur in some special cases (causing ferroresonance) so the threat of islanding is not entirely removed and must be addressed as part of any induction generator interface design package.

- Induction generators gather the excitation current they need from the utility system (Company’s system) thereby consuming considerable reactive power from the system. This causes voltage drop and increased losses on the distribution system. In situations where system losses and voltage drop are significant, the induction generator may need provisions to correct its power factor to near unity.

- Induction generators cannot sustain an appreciable fault current for a fault at their terminals for a long time due to the collapse of excitation source voltage during the fault. However, they will inject a large amount of current for a short transient period of time and this can impact the power system.

Because of the characteristics of the induction generator described above, its protection and interface is somewhat different than that of the synchronous generator.

2.0 STARTING AND SYNCHRONIZATION

Induction generators may be connected to the distribution system and brought from a standstill up to synchronous speed (just as an induction motor is) if it can be demonstrated that the initial voltage drop measured at the point of common coupling is acceptable based on current inrush limits. The same requirements also apply to induction generators connected at or near synchronous speed using a speed matching relay approach because a voltage dip is present due to an inrush of magnetizing current even when the unit is connected at or near synchronous speed (albeit of shorter duration than starting from a standstill condition).

In order to assess voltage flicker, the expected number of starts per hour and maximum starting kVA draw data will need to be delivered to the utility company to verify that the voltage dip due to starting is within the acceptable flicker limits according to IEEE 519-1992 and, where applicable the Con Edison flicker curve requirements (see Graph 1).

Starting or rapid load fluctuations on induction generators can adversely impact the Company's distribution system voltage and cause noticeable voltage quality problems for Customers on the circuit. Corrective step-switched capacitors or other techniques may be needed to mitigate the voltage flicker and regulation issues that arise. These measures can, in turn, cause ferroresonance, which is a serious form of over-voltage condition that can damage equipment and loads on the system. If the Customer's design includes additional capacitors installed on the Customer side of the PCC, the Company will review these measures and may require the Customer to install additional equipment to reduce the risk of ferroresonance. Customers, who provide capacitor banks to minimize the voltage drop on the bus during starting of the generator, shall provide a way to automatically disconnect them from the generator terminals after the start up. The Customer shall perform and submit studies to demonstrate the impact of the capacitors on the system.

3.0 POWER FACTOR

Induction generators, unless corrected with capacitors, operate at relatively poor power factor due to the reactive excitation current drawn from the Company's power system. For induction generators falling within the 0 to 5 MW SIR guidelines, if the average power factor of the Customer (including the effects of the generator current), as measured at the point of interconnection (POI) is less than 0.9, then the method of power factor correction necessitated by the installation of the generator, if any, will be negotiated with the utility as a commercial item. For Reactive Power (VAR) requirements, the Customers shall refer to the applicable Company's rate "Service Classification" under the Special Provisions section to determine the kilovar charges. For induction generators larger than 5 MW, the Company will negotiate with the Customer the reactive requirements of the machine and expected power factor performance. Regardless of generator size, use of power factor correction capacitors must be approved by the utility to insure that issues related to self-excitation and ferroresonance are addressed.

4.0 PROTECTION

The Customer is responsible for tripping their generator intertie breaker and /or contactor and isolating their generator from the Company's distribution system in the event of an electric fault and/or abnormal voltage/frequency condition. The protective relaying requirements for a particular facility will depend on the type and size of the facility, voltage level of the interconnection, location on the distribution circuit, fault levels, and many other factors. IEEE Standard 1547 has specific tables with recommended default values for the trip settings of distributed generators.

4.1 Minimum Protective Devices

The absolute minimum protective relays that the Company will require for induction generators for any size generator will never be less than the relays mentioned below, and on a case by case basis it may be necessary for the utility to require additional protection.

a) Utility grade undervoltage relays (device 27) shall be connected phase to ground on each phase. These relays disconnect the Customer from the Company's distribution system during faults or when the Company feeder is out of service. The default trip settings should conform to IEEE Standard 1547 Table 1. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

b) Utility grade overvoltage relays (device 59) shall be connected phase to ground on each phase. The default trip settings should conform to IEEE Standard 1547 Table 1. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

c) Utility grade over- and under-frequency protection (devices 81/0 and 81/U) are used to trip the generator or intertie breaker upon detecting a frequency deviation outside of reasonable operating conditions. The default trip settings should conform to IEEE Standard 1547 Table 2. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

The above functions are the minimum Company required relaying functions per the SIR table of minimum requirements and per the context of IEEE 1547. However, it should be recognized that the Customer may be required, based on the outcome of a Site-Specific System Study or general technical review, to use protection settings other than the default settings described above, and add additional protection to facilitate proper operation of the Company's low voltage network system or radial distribution feeders depending on where the system is interconnected. Additional protection could take the form of phase and ground fault overcurrent relays, ground fault over-voltage relays, directional power and/or overcurrent relays, transfer trips, speed matching controls, lock-out functions, etc.

It is important to recognize that the protection functions mentioned above are specified by the Company with the objective to protect the *Company's electrical distribution system as well as its other Customers* from the effects of the Customer's generator. The Customer's generator may need voltage and current unbalance relays and various types of generator over-current relays to prevent overheating of the generator windings during unbalance and fault conditions. Certain forms of generator grounding may also be needed to reduce the level of ground fault current so that generator windings don't see excessive damaging forces during faults. DC backup power may be required for relay tripping functions depending on the size and criticality of the function.

To insure that both the utility system and the generator are protected, the Customer has the responsibility to install the Company designated relays and also work with the generator manufacturer or system integrator to use relays and grounding practices that are coordinated to protect the generator itself from damage during faults and other anomalies. Damage that occurs to a Customer generator as a result of failure to use appropriate protection and design practices is not the responsibility of the Company.

4.2 Stand Alone Capability/Mode Requirements

Generally no applicable are requirements for inductions motors are requested. Engineering will confirm during design acceptance

4.3 Transfer Trip

Generally no applicable are requirements for inductions motors are requested. The Engineering will confirm during design acceptance

5.0 GROUNDING

The appropriate grounding scheme to use for the induction generator is a function of the type of distribution system to which it is connected and other factors specific to each site. The four main concerns of the Company regarding the type of induction generator grounding to utilize are ground-fault overvoltages, ferroresonance, harmonics, and ground-fault current contribution/detection issues. There is a widely held misconception in the industry that because the induction generator does not normally self-excite, that the effects of ground fault overvoltages can be ignored since they would disappear quickly (transient decay). However, partial excitation can still exist on some phases during ground faults and because an induction generator might self-excite due to capacitors and because even without self-excitation, the transient decay period of its output can cause damage in just a few cycles, the grounding of induction generators and its potential impact must still be treated almost similar to a synchronous generator. This means the Company may need to specify effective (solid) grounding for an induction generator whenever there is a concern about ground fault overvoltages on a four wire multi-grounded neutral distribution system. When interconnecting to ungrounded or uni-grounded distribution systems an ungrounded or impedance grounded interface to the Company distribution system at the PCC will usually be specified. The final determination as to which ground configuration is most appropriate will be done on a case-by-case basis. It is important to recognize that the type of grounding referred to in this section is the grounding with respect to the utility distribution system which is a function of not just the generator grounding itself, but also the configuration of the interface transformer winding configuration and its ground connection.

6.0 COMMON DESIGN REQUIREMENTS

Many design requirements that the Customer must satisfy are common to all of the generator types (that is SPC, induction, and synchronous generator types). The common requirements include the disconnect switch, certification standards, power quality standards, IEEE 1547 voltage response tables, etc. See section-I of this manual for a discussion of the techincal requirements.

7.0 TYPICAL INTERCONNECTION DRAWINGS

Drawings No. 1 and 2, at the end of this manual represent typical interconnection design for induction generators and are presented as illustrative examples. Each project may have different requirements.

IV - STATIC POWER CONVERTERS (INVERTER) - TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

The static power converter (SPC), also commonly referred to as an inverter, provides the interface between direct current (dc) energy sources or variable high frequency sources and the 60 Hz power distribution system. Examples of generation systems employing SPC units include photovoltaic arrays, fuel cells, battery storage systems, some microturbines, and some wind turbines. Unlike an induction or synchronous generator that uses rotating coils and magnetic fields to convert mechanical into electrical energy, the SPC converts one form of electricity into another (i.e. dc to ac) and is typically controlled and protected by its internal microprocessor-based controller. The internal controller detects abnormal voltage, current and frequency conditions and quickly disables the injection of power into the system if limits are exceeded. It also controls synchronization and start-up procedures. While most small certified SPC units designed for grid parallel operation can rely totally upon their internal protection functions, larger and special feature SPC units may also require external protection/control functions.

When applying SPC units to the Company's distribution system there are some big differences compared to rotating machines. These include:

- SPC have no moving or rotating parts and utilize the on/off switching of solid state transistors to "synthesize" a 60 Hz ac waveform from the energy source.
- Due to the fast switching response of transistors, an SPC is usually able to stop producing energy much faster than a typical rotating machine (once the controller protection scheme identifies the need to interrupt flow of energy)
- The fault level contribution of SPC units are not usually as large as those from the same size (rating) induction or synchronous rotating type generator reducing the impact on Company equipment

  SPC units use embedded microprocessor controllers that control the switching and waveform synthesis, and also have embedded protection functions such as under/over voltage and under/over frequency. SPC also often employ an "active" anti-islanding capability (if they are listed per UL 1741 as a non-islanding inverter). This is a level of protection beyond that found in ordinary voltage and frequency based passive islanding protection. A "certified" SPC per UL1741 can eliminate the need for external utility grade relays for smaller systems

Because the use of SPC for DER is an emerging commercial technology, and is still going through a maturation process, the local, state and national regulations related to this are still evolving. Currently the IEEE 929-2000 for PV inverters, IEEE-1547, and UL-1741 standards serve as the national foundation for the most pertinent interconnection requirements for SPC units. The Company approach for interconnecting SPC (inverters) is consistent with these standards where they are applicable and consistent with the requirements of the SIR.

2.0 STARTUP AND SYNCHRONIZATION

Modern SPC units which are designed for grid-parallel operation operate as grid interactive synchronous sources and will synchronize their output with the utility system voltage to achieve proper and safe parallel operation. For most small SPC, such as UL 1741 certified PV inverters and fuel cell inverters, all of the start-up, control and synchronization logic and functions are built into the device. At the instant the SPC is physically connected to the grid, its voltage sensing and controller circuitry starts tracking the utility distribution voltage, phase angle and frequency. The transistors of the SPC are then triggered to begin switching to create a source current injection into the system that is synchronized with the utility system. As part of the start up process, many photovoltaic and other types of SPC units include a soft start-up feature that gradually ramps up to full output over several seconds following the moment of initial connection. This helps reduce voltage flicker compared to the approach of suddenly stepping to full output. The Company desires this type of soft start feature for SPC units and may not require it if the Site-Specific System Study shows the resulting flicker of a full step start is not an issue.

Some sophisticated SPC units operate in parallel with the utility system during normal conditions and as a secondary function can serve as stand-alone power for Customer load when the utility distribution system is disabled. If the Customer generator is to employ this type of "Advanced"
SPC configuration, it must be configured with the appropriate protection and synchronization equipment to transition to/from grid parallel operation in a safe and proper fashion. It must not energize any part of the utility system beyond the PCC when the voltage or frequency conditions are out of range. When the utility service is restored to within normal range it must use a Company approved method to resynchronize with the system prior to re-connecting.

3.0 POWER FACTOR

Essentially all modern SPC are self-commutating and pulse width modulated (PWM) devices which makes it possible for them to easily operate at a very high power factor when at full load (almost always in the vicinity of 1). Modern self-commutating and pulse width modulated SPC are quite capable of meeting the SIR requirement of an average 0.9 power factor at the PCC as long as the loads at the Customer's facility do not cause poor power factor. The normal mode of operation that the Customer is required to maintain is to operate the SPC as an essentially fixed power factor source close to unity. However, a benefit of some modern SPC designs is that some units can regulate the phase angle providing either leading or lagging VARs for voltage regulation purposes. In most cases, the Company does not allow this type of regulation to occur on the system by Customer generation but under some scenarios it can be of benefit to the system and may be allowed pending review by the Company. For SPC falling within the 0 to 5 MW SIR guidelines, if the average power factor of the Customer (including the effects of the generator current), as measured at the PCC is less than 0.9, then the method of power factor correction necessitated by the installation of the generator, if any, will be negotiated with the utility as a commercial item. For SPC larger than 5 MW, the Company will negotiate with the Customer the reactive requirements of the machine and expected power factor performance.

4.0 HARMONICS

Modern units generally use Pulse Width Modulation (PWM) with high switching frequency and this has been shown to produce an extremely high quality waveform within IEEE 519-1992 requirements – especially good in the lower order harmonics. Despite meeting this standard, in rare cases, higher frequency harmonics and noise that arise from inverters (SPC), can on occasion cause interference with other devices or power line carrier systems. While generally this is extremely rare, the Company reserves the right to require that the Customer should take corrective action or disable the system in the event of a noise problem after the system becomes operational. The Company requires that all inverters meet IEEE 519-1992 and IEEE 1547 Harmonic limit requirements.

5.0 PROTECTION

The Customer is responsible for tripping the Static Power Converter intertie breaker and /or contactor and isolating his generator from the Company's distribution system in the event of an electric fault or abnormal voltage/frequency condition. The protective relaying requirements for a particular SPC facility will depend on the type and size of the facility, voltage level of the interconnection, location on the distribution circuit, fault levels, and many other factors. IEEE Standard 1547 has specific tables with recommended default values for the trip settings of distributed generators. New York State also has specific requirements under the net metering law that applies to net metered PV inverter systems.

5.1 Minimum Protective Devices

The absolute minimum protective functions that the Company will require for Static Power Converters 20 MVA and less will never be less than the functions mentioned below, and for non-net metered systems on a case by case basis. It may be necessary for the utility to require additional protection. These functions could be by means of a utility grade relay controlling an interrupting device or, where applicable, by an imbedded relay function within the SPC controller if the SPC is certified. Minimum requirements are defined as follows:

a) Net Metered Customers
- Residential Net Metered PV systems SPC units and SPC under 50 kW rating These systems shall use an SPC that is certified under the most current approved version of UL1741 requirements and/or that is type tested and approved by NYS PSC for parallel interconnection with the utility system. This means that the unit has suitable under/over voltage and frequency relaying functions, active (dynamic) anti-islanding, and the other necessary requirements outlined under the net metering requirements and UL1741.
- Non-Residential Net Metered Customers

b) Non-net metered SPC Units or Units Greater than 50 kW
These units shall employ the minimum required protection functions consisting of type tested and/or certified equipment under the most current version of UL 1741, and/or where appropriate, utility grade relays as specified by the

Company. These functions shall include:

1. Undervoltage function (device 27) shall be performed phase to ground on each phase. These relays disconnect the Customer from the Company's distribution system during faults or when the Company feeder is out of service. The default trip settings should conform to IEEE Standard 1547 Table 1. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

2. Overvoltage function (device 59) shall be performed phase to ground on each phase. The default trip settings should conform to IEEE Standard 1547 Table 1. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

3. Utility grade over- and under-frequency protection (devices 81/0 and 81/U) are used to trip the generator or intertie breaker upon detecting a frequency deviation outside of reasonable operating conditions. The default trip settings should conform to IEEE Standard 1547 Table 2. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

The above functions are the minimum relaying functions per the SIR table of minimum requirements and per the context of IEEE 1547. However, it should be recognized that the Customer may be required, based on the outcome of a Site-Specific System Study or general technical review, to add additional protection to facilitate proper operation of the Company's low voltage network system or radial distribution feeders depending on where the system is interconnected.

Additional and external protection could take the form of phase and ground fault overcurrent relays, ground fault over-voltage relays, directional power and/or overcurrent relays, transfer trips, speed matching controls, lock-out functions, etc.

5.2 Stand Alone Capability/Mode Requirements

As mentioned earlier, some SPC units designed for grid parallel operation also have stand-alone capabilities, meaning that they can operate independently of the Company's distribution system. This type of arrangement is useful when the Customer desires to serve just the Customer load for power quality and reliability purposes if there should be a utility system power outage or abnormal voltage condition. Since under no circumstances is the Customer allowed to energize the Company distribution system beyond the PCC when voltage and frequency conditions are out of range, the SPC schemes with this type of stand-alone capability must have a suitable arrangement of switchgear and protective relays to isolate their island from the Company's distribution system when the voltage and frequency goes outside the IEEE 1547 limits (see Tables 1-2 in that standard). The intertie breakers and/or switchgear for this island shall be controlled by an appropriate scheme of relay functions that provide the necessary reliability, and control functions to detect abnormal utility conditions at the PCC, separate from the system and maintain a proper island for the Customer, and resynchronize and connect to the system after utility service is restored to the normal range. Depending on the type of equipment that is employed (size rating, voltage level etc.) the Company may require utility grade relays, dc backup power for the tripping functions, and various alarms. Re-connecting back into the system may not be allowed until the Company's district operator has approved for a manual reconnection.

5.3 Required Use of Utility Grade of Relays

The Company does not require utility grade backup relays for less than 50 kW SPC systems that use the appropriate certified and/or type tested equipment. As SPC units become larger however, the need for utility grade backup relays becomes more critical. For larger SPC the Company may require a set of backup utility grade relays and switchgear to isolate the Customer's generation system even though the SPC has its own internal functions. The exact threshold where this becomes critical depends on the application and will be determined on a case-by-case basis.

5.4 Transfer Trip

In some cases the Company may require some sort of transfer trip to provide more reliable islanding protection than is afforded by local voltage and frequency windowing relay functions alone (For example, DER connected directly to high tension feeders.) While an SPC unit with active-anti-islanding is unlikely to island with the utility system given its local protection functions, one that has the capability to serve the local Customer as a stand-alone unit during a utility system interruption would need the active islanding protection disabled and thus must rely only upon passive voltage and frequency protection functions. In certain cases larger units in this class might need a transfer trip function.

6.0 GROUNDING

The appropriate grounding scheme to use for the SPC interfaced generator is a function of the type of distribution system to which it is connected and other factors specific to each site. The main concerns of the Company regarding the type of SPC grounding to utilize are ground-fault overvoltages, ferroresonance, harmonics, dc- current injection, and ground-fault current contributions/detection issues. The Company may need to specify effective or solid grounding for an SPC generator whenever there is a concern about ground fault overvoltages on a four wire multi-grounded neutral distribution system. When interconnecting to ungrounded or uni-grounded distribution systems an ungrounded or impedance grounded interface to the Company distribution system at the PCC will usually be specified. The final determination as to which ground configuration is most appropriate will be done on a case-by-case basis. It is important to recognize that the type of grounding referred to in this section is the grounding with respect to the utility distribution system which is a function of not just the generator grounding itself, but also the configuration of the interface transformer winding configuration and its ground connection.

7.0 COMMON DESIGN REQUIREMENTS

Many design requirements that the Customer must satisfy are common to all of the generator types (that is SPC, induction, and synchronous generator types). The common requirements include the disconnect switch, certification standards, power quality standards, voltage response tables, etc. See section-I of this manual for a complete discussion of the technical requirements.

8.0 TYPICAL INTERCONNECTION DRAWINGS

Drawings 3 and 4 are interconnection drawings of typical SPC arrangements for electrical capacity of 500 kW or less. For larger units, additional requirements may be required by the company. The relay devices, except for the reverse power relays, are functional representations of the package protection of the unit. These drawings are presented as illustrative examples and each project may have different or additional requirements.

V - SYNCHRONOUS GENERATORS- TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

Synchronous generators are rotating energy conversion machines capable of operating as stand alone power sources (running independently of any other source). They also can operate in parallel with other sources (such as a utility distribution system) if they are properly synchronized to those sources and have appropriate protection/controls. In general, synchronous generators have the following characteristics from an interconnection standpoint:

- The integral exciter and exciter controls of a synchronous generator allow it to operate as a stand alone source. This is particularly useful for customers that desire DER installations that can serve the dual function of stand alone (standby) power unit and also grid parallel operation. Extra care in the anti-island protection is required with these units

- Synchronous generators can adjust their excitation levels to vary the reactive output of the machine. A high level of excitation can make the unit produce reactive power for the utility system (appear capacitive). A low level can make the unit consume reactive power from the system (appear inductive). The power factor can be adjusted anywhere from substantially leading (capacitive) through unity to substantially lagging (inductive) making this technology very versatile for voltage regulation and VAR support applications for both the Customer and the utility system.

- Synchronous generators, unlike induction generators, must be precisely synchronized with the utility system at the instant of connection and during operation. This means matching the frequency, phase angle and voltage magnitude within certain tight tolerances at the instant of interconnection of the Customer's tie breaker in order to avoid damage to or problems with the generator or utility system equipment. The unit's speed must be controlled in appropriate fashion once it is connected so that it does not slip out of synchronism. If the unit slips out of synchronism and is not immediately separated from the system equipment damage or power quality problems could occur.

Synchronous generators, due to their exciters can sustain fault currents for much longer than an induction generator (assuming the exciter energy source is separately derived). This makes fault protection more critical on a synchronous unit than on an induction unit.

2.0 STARTING AND SYNCHRONIZING

The frequency, phase angle and voltage magnitude difference between the generator and the Company's distribution system at the moment of connection must be no more than allowed in IEEE 1547 (see Table 5 in that document). This is a requirement of the Company because failure to connect within the indicated tolerances could cause a significant voltage and current perturbation on the Company's distribution system that could impact the power quality of other Customers. In extreme cases, where the tolerances are widely violated, distribution system outages could be triggered, damage to

Company equipment could occur and/or the Customer generator could be severely damaged.

The prime mover (turbine or internal combustion engine) for the synchronous machine needs to be started and the generator needs to be brought up to synchronous speed prior to completing the synchronizing process described in the paragraph above. To do this, the prime mover may use the generator (acting temporarily as a motor) or other motorized auxiliary equipment to start the prime mover and get the unit up to synchronous speed. However, the Company requires that any starting equipment deriving its starting power from the utility system must not cause voltage flicker or voltage regulation problems on the Company distribution system. As part of the design review, the starting process is assessed to make sure that it does not cause unacceptable voltage flicker on the Company system. In order to assess voltage flicker from starting a synchronous generator, if the starting method draws power from the utility system, then the Customer shall submit the expected number of starts per hour and the maximum starting kVA draw data to the utility to verify that the voltage dip due to starting is below the visible flicker limit as defined by IEEE 519-1992 and, where applicable, the Con Edison flicker specification (See Graph 1)

No synchronizing across Company distribution system equipment is allowed. This includes network protectors, switches and other devices. Interlocks with upstream disconnect switching devices may be required.

3.0 OUTPUT FLUCTUATIONS

While the machine is running and connected to the power distribution system, the output power must not be allowed to fluctuate in a manner that causes objectionable voltage flicker or voltage regulation problems on the Company's distribution system. The Customer shall maintain and operate the generation facility such that any intentional and/or unintentional power output fluctuations do not cause flicker that exceeds the visible flicker limit as defined by IEEE 519-1992 and, where applicable, the Con Edison flicker requirements (see Graph 1).

4.0 POWER FACTOR & REACTIVE POWER CONTROL

The synchronous generator output, due to its exciter controls, can be adjusted to near unity power factor and can even provide reactive support if needed. For synchronous generators falling within the 0 to 5 MW SIR guidelines, if the average power factor of the Customer (including the effects of the generator current), as measured at the point of generator interconnection is less than 0.9, then the method of power factor correction necessitated by the installation of the generator, if any, will be negotiated with the utility as a commercial item. For Reactive Power (VAR) requirements, the Customers shall refer to the applicable Company's rate "Service Classification" under the Special Provisions section to determine the kilovar charges. For generators larger than 5 MW, the Company will negotiate with the Customer the reactive requirements of the machine and expected power factor performance.

Unless otherwise required by the Company, the synchronous generator will operate in a "voltage following" mode where it operates at near unity power factor and it will not directly attempt to regulate the voltage by adjusting the VAR output (either leading or lagging).

If the Customer does not wish to use a voltage following approach and instead wants to use reactive-current based regulation either to help reduce the Customer reactive demand or improve voltage regulation, then the control scheme, generator reactive current capability ratings and settings will be reviewed by the Company to insure that they are compatible with the Company distribution system at the point of connection. The Company will grant permission for this approach if it is feasible at the site where it is applied. Use of this method will be approved only if it can be shown that the settings will not cause voltage regulator hunting effects, degradation of voltage conditions on the feeder, and nuisance trips of the generator due to reactive current overloads. Voltage regulation schemes using the reactive current regulating capabilities of synchronous generators can be helpful to both the Customer and the Company.

5.0 PROTECTION

The Customer is responsible for tripping the generator intertie breaker and /or contactor and isolating the generator from the Company's distribution system in the event of an electric fault and/or abnormal voltage/frequency condition. The protective relaying requirements for a particular facility will depend on the type and size of the facility, voltage level of the interconnection, location on the distribution circuit, faults levels, and many other factors. IEEE Standard 1547 has specific tables with recommended default values for the trip settings of distributed generators.

5.1 Minimum Protective Devices

The absolute minimum protective relays that the Company will require for Synchronous generators will never be less than the relays mentioned below, and on a case by case basis it may be necessary for the Company to require additional protection. Synchronous generators need more protection than induction generators and this is reflected in the minimum requirements below:

a) Utility grade undervoltage relays (device 27) shall be connected phase to ground on each phase. These relays disconnect the Customer from the Company's distribution system during faults or when the Company feeder is out of service. The default trip time settings should conform to IEEE Standard 1547 Table 1. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

b) Utility grade overvoltage relays (device 59) shall be connected phase to ground on each phase. The default trip time settings should conform to IEEE Standard 1547 Table 1. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

c) Utility grade over- and under-frequency protection (devices 81/0 and 81/U) are used to trip the generator or intertie breaker upon detecting a frequency deviation outside of reasonable operating conditions. The default trip time settings should conform to IEEE Standard 1547 Table 2. However, for generation greater than 50 kW the Company may require different settings on a case-by-case basis as needed.

d) Utility grade synchronism-check relay (device 25C) operates when the Customer generator and the Company's distribution system is within the desired limits of frequency, phase angle and voltage. IEEE 1547 Table 5 has specific settings that the Company may require. The Company also may require other settings on a case-by-case basis as needed.

e) Ground fault detection. Use either a utility grade non-directional ground overcurrent relay (device 51N) for wye-connected systems or a utility grade zero sequence overvoltage relay (device 59N) for delta-connected systems. This detects Company system ground faults and trips the generator offline.

f) Utility grade phase overcurrent relays. Three phase-overcurrent relays (device 50/ 51) or Three-phase, voltage-controlled/restraint overcurrent relays (device 50V/51V) trips on a desired value of overcurrent flowing out of the Customer's generator that is coordinated with thermal damage characteristics of the machine windings.

The above functions are the minimum Company required relaying functions for a synchronous generator per the SIR minimum requirements and per the context of IEEE 1547. However, it should be recognized that the Customer may be required, based on the outcome of a Coordinated Electric System Interconnection Review (CESIR) or general technical review, to add additional protection to facilitate proper operation of the Company's low voltage network system or radial distribution feeders depending on where the system is interconnected. Additional protection could take the form of directional power and/or overcurrent relays (device 32 or 67), transfer trips, lock-out functions (device 86), backup relays, etc. The protection scheme could also require a dc battery relay tripping source with appropriate alarm and/or protection should it fail.

It is important to recognize that the protection functions mentioned above are specified by the Company with the objective to protect the Company's electrical distribution system as well as its other Customers from the effects of the Customer's generator. However, the Customer should be aware that their generator may itself also be damaged by voltage or current anomalies and the Customer may need additional protection beyond what is specified by the Company to protect their own generator plant. For example, unbalanced voltage (device 47) and current relays (device 46) would have little impact on the protection of the Company distribution system, but could be crucial to the generator to protect it from overheating in an unbalanced voltage or current condition.

To insure that both the utility system and the generator are protected, the Customer has the responsibility to install the Company designated relays and also work with the generator manufacturer or system integrator to use relays and grounding practices that are coordinated to protect the generator itself from damage during faults and other anomalies. Damage that occurs to a Customer generator as a result of failure to use appropriate protection and design practices is not the responsibility of the Company.

5.2 Transition Protection from grid parallel to stand alone mode

Customers that want to transition their generation system from grid-parallel to standalone operation for power quality and reliability purposes when the Company supplied power is unavailable at the PCC can do this with a synchronous generator if the appropriate protection and isolation is provided. This type of operation is allowed as long as the Customer generator does not energize any portion of the Company's system beyond the PCC during the system outage or abnormal voltage conditions. This type of arrangement requires the Customer to have anti-islanding protection by monitoring the intertie point (PCC) with appropriate relaying functions that will operate an isolation device (tie circuit breaker) at the PCC. The islanding protection would consist of voltage and frequency window relays per IEEE 1547
Tables 1 and 2 trip settings or other modified settings if required by the Company.

5.3 Required Use of Utility Grade of Relays

Only relays that are certified (type tested) or utility grade will be accepted for protection of the interconnection and the generator. Relays may be single function or multifunction packages, and they can be mechanical, solid state or microprocessor based types as long as they satisfy the utility grade or type tested (certification) specifications. Modern microprocessor multifunction relays designed for generator protection that satisfy the required utility grade specifications have recently become much more cost effective (compared to earlier products of a decade ago) and are available from a variety of vendors.

5.4 Transfer Trip

The Company may require a transfer trip to provide more reliable islanding protection than is afforded by local voltage and frequency windowing relays alone. Islanding cannot be allowed under any circumstances on the Company's system and the Company must use extra caution in the design of the interconnection for these generators.

6.0 GROUNDING

The appropriate grounding scheme to use for the synchronous generator is a function of the type of distribution system to which it is connected and other factors specific to each site. The four main concerns of the Company regarding the type of synchronous generator grounding are ground-fault overvoltages, ferroresonance, harmonics, and ground-fault current contribution/detection issues. The Company may need to specify effective or solid grounding whenever there is a concern about ground fault overvoltages on a four wire multi-grounded neutral distribution system. Ungrounded or impedance grounded installations might be specified in other circumstances (such as when interconnecting to ungrounded or uni-grounded distribution systems). The final determination as to which ground configuration is most appropriate must be done on a case-by-case basis.

7.0 HARMONICS

The company requires that the Customer maintain harmonic distortion levels at the PCC in accordance to IEEE 519-1992 and IEEE 1547 (see Table 3 in that document). While synchronous generators are relatively distortion free from a positive sequence voltage perspective, the characteristics of these machines can create zero sequence harmonic voltages that appear in the zero sequence path (neutral). They can also exacerbate certain harmonics that are created by load currents. These harmonics can occasionally be problematic depending on the machine design and loads at the Customer facility. With certain transformer arrangements, some harmonic distortion can find its way from the Customer to the utility system and vice versa. As part of any CESIR design package review, practices will be recommended by the Company that have shown the best results in mitigating harmonics in a particularly situation. These include specifying a generator winding arrangement with a 2/3 pitch (as opposed to a full pitch where the magnetic field poles span a rotational distance equal to that of the stator winding area), providing special grounding to limit the flow of zero sequence harmonics, the use of interface transformers with windings that block the flow of harmonics, and harmonic filters. Some of the solutions that are appropriate also must be balanced against the grounding needs of the generator and so must be addressed on a case-by-case basis.

8.0 STABILITY

In order to assure continued operation of the Distributed Energy Resource source and minimize impacts to existing Customers during system disturbances, the stability of the Customer’s generator may need to be investigated for larger units in this class or aggregations of many smaller units.

Instability occurs when systems are subject to disturbances. While all generator types can have stability issues, rotating synchronous generators, in particular, owing to their electromechanical nature and the characteristics of synchronizing torques/inertia effects are the most likely of the three types of units to experience stability related issues. Stability problems can cause loss of synchronism (forcing the generator to trip offline) or build up of rotor oscillations that lead to power quality and/or reliability problems. Examples of contributing factors to the problem are:

a) Load swings
b) Switching operations
c) Short circuits
d) Loss of utility supply
e) Motor starting
f) Hunting of synchronous machines
g) Periodic pulsation applied to synchronous systems

Power system stability studies are essential for planning and designing a Distributed Energy Resource installation. The method of determining the stability limits of a system is elaborate and must take into account all the factors affecting the problem including the characteristics of all machines, exciting systems, governors, inherent regulation, grounding and circuit breaker response time. The Company may require a stability study part of a Site Specific System Study.

9.0 COMMON DESIGN REQUIREMENTS

Many design requirements that the Customer must satisfy are common to all of the generator types (that is SPC, induction, and synchronous generator types). The common requirement include the disconnect switch, certification standards, power quality standards, voltage response tables, etc. See section 1 of this manual for a complete discussion of the common requirements.

10.0 TYPICAL INTERCONNECTION DRAWINGS

Drawings No. 5, 6, 7, 8, 9, 10 and 11, at the end of this manual, represent typical interconnection design for various types synchronous generators. Each project may have different requirements. These drawings are presented as illustrative examples and each project may have different or additional requirements.

REVISION: 11	**FILE:**
This revision updates Section 4.5.2 Inverter settings for abnormal frequency and voltages are added.	Application and Design Manual No. 4 Field Manual No. 16 Section 4

VI – CUSTOMER AGREEMENT

IN WITNESS WHEREOF, the Customer agrees to meet the requirements set forth by the Utility for the purpose of interconnection of Distributed Energy Resources. This agreement is executed by the customer's duly authorized officers or agents on the day and year first written below.

Company:____

Authorized Representative: ________________________________

Title: ____

Date: ____

1.0 APPLICATION REQUIREMENTS

Prior to equipment installation, the customer shall submit the equipment and generating system description per the attached Application for Distributed Energy Resource Operation forms to the Company for approval. All pertinent forms shall be completed, signed and sealed by the Customer or their representative as approved by the Company. The required information is necessary for the Company to properly review the project. Then a customer expresses a definite commitment to install a generator for the purpose of parallel interconnection operation with the Company's utility service, he shall prepare a request using Power Clerk**.**

1.1 Three-Line Diagram

The three-line diagram (or one-line diagram clearly indicating three balanced phases) shall be prepared by a licensed Professional Engineer with experience in this discipline.

The three-line diagram shall be submitted for each application for parallel operation with the Company system. The drawing(s) shall show existing and proposed facilities at the customer's location. For the initial submittals a distinction shall be made between existing facilities, modifications to existing facilities and new equipment. The drawing(s) shall show as a minimum, the items indicated below. A separate three-line diagram is required for each location. "Typical" drawings or manufacturers' catalog cuts are not acceptable for a three-line diagram.

Drawing content on the initial submittal should include the following information:

1.1.1 **Major Components:** All buses, cables, breakers, fuses, transformers, etc. All equipment must be uniquely identified.

1.1.2 **Equipment Ratings:**

a) Generator

- Capacity
- Voltage
- Power Factor
- Type (Synchronous, Induction)
- Manufacturer
- Winding Connection (Delta, Wye)
- Grounding Equipment Ratings
- Sub-transient Reactance

b) Bus Work

- Voltage
- Ampacity
- Manufacturer/Model

c) Circuit Breakers

- Continuous Current Ratings
- Short Circuit Interrupting Ratings
- Close and Latch Current Ratings
- Manufacturer/Model

c) Fuses

- Current Ratings
- Manufacturer/Model
- Indicate if Current Limiting

e) Disconnect/Ground Switches

- Current Ratings
- Indicate if Lockable
- Manufacturer/Model

f) Transformers

- Capacity Ratings
- Cooling/Temperature Ratings
- Voltage Ratings
- Voltage Taps
- Impedance

- BIL
- Winding Connection (Nameplate)
- Grounding Facilities and Ratings

1.1.3 **Estimated and/or Existing Monthly Load Data:**

- Without Generation, Last 3 Years, if applicable
- Maximum Facility Demand, Last 3 years, From billing
- Contract Demands
- Minimum Facility Monthly Demand, Last 3 years, From billing
- Facility Minimum Daily Demand

1.1.4 **Protective Relaying & Metering cut sheets**

- ANSI Relay Designation
- ct & vt Ratios and Accuracy Class

1.1.5 **Relay Breaker Tripping Scheme**

- Relay Function Description
- Relay Manufacturer & Model
- Relay Set Points

1.1.6 **Generator Leads**

- Impedance
- Type of Circuits
- Number of Circuits

1.2 Generation Data

A customer shall fill out and submit the data forms applicable to the type(s) of generation for the project. Induction Generator, Synchronous Generator and Inverter data sheets are included in this handbook.

The customer shall provide the reactive power requirements of the induction generator over its entire operating range.

The appropriate form(s) shall be completed for every unit proposed for interconnection, even if they have the same characteristics. The applicable form should contain as much information as possible. This will greatly reduce unnecessary delays to obtain missing data.

1.3 Short-Circuit and Relay Coordination Study

The Customer shall supply a short-circuit and relay coordination study for the facility in addition to the information required on the attached “Protective Equipment - Data & Test Record” form. It is recognized that the data required in this section may not be available at the time of the application, but it is the Customer’s responsibility to make it available for final approval.

The study should include:

1.3.1 Short-circuit current calculations for a relay study. Short-circuit currents to predict the operation of various overcurrent protective devices.

1.3.2 Relay current-tap and time-dial setting

- Relays on transformer feeders
- Relays on single motor feeders
- Relays on incoming lines and feeders with miscellaneous load
- Residually-connected ground-fault relays
- Ground-fault relays in series with generator or transformer neutral
- Intertie relays

1.3.3 Graphical Proof of Device Coordination

a) Coordination of relays and other devices in series including:

- Time-delay relays
- Fundamental rules for coordination of Time-delay relays
- Time-delay direct-acting circuit breaker trips and fuses
- Instantaneous devices (relays and direct-acting trips) and consider the following:

1. Effect of fault current decay due to generator-current decrement on relay performance.

2. Effect of current transformer saturation on relay behavior.

b) Coordination of Overcurrent Devices

- Coordination of primary fuses and secondary feeder circuit breakers.
- Coordination of primary fuses and transformer main secondary circuit breakers.
- Generator coordination - Utility and load circuit breakers.

1.3.4 Effect of Wye-Delta and Delta-Wye connected transformers on overcurrent protective device coordination.

A relay test report form (Protective Equipment - Data & Test Record - Form 6) is attached and shall be used for submitting data information for each relay installed on the Customer system or supplied by the Customer.

1.4 Generation Load Data

- Daily, monthly, seasonal, shoulder and annual load profiles showing highest 30 minute maximum demand (kW)
- Scheduled maintenance periods
- List of equipment with ratings to be switched to Company supply during downtime. Show estimated highest 30 minute maximum demand (kW)
- Contract Demand _____ ____ kW

1.5 Load to be Supplied by Company

- List of equipment with ratings
  Highest maximum 30 minute demand (kW)
- Contract Demand __________ kW
- Estimated daily, monthly, seasonal, shoulder and annual load profiles showing highest 30 minute maximum demand (kW)

2.0 APPLICATION REQUIREMENTS- ATTACHMENTS

The following attachments are part of this appendix:

Forms:

No. 1 – Application for Distributed Generation (DG) Operation
No. 2 – Induction Generation Data
No. 3 – Synchronous Generator Data
No. 4 – Excitation System Data
No. 5 – Inverter Data
No. 6 – Protective Equipment Data & Test Record

Drawings:

No. 1 - Low-Tension Induction Generators - Preferred Arrangement
No. 2 - Low-Tension Induction Generators - Alternate Arrangement
No. 3 - Static Power Converter - Parallel Operation
No. 4 - Static Power Converter - With Stand Alone Capability
No. 5 - Low-Tension Synchronous Generators, Non-Isolated Operation - Preferred Arrangement
No. 6 - Low-Tension Synchronous Generators, Non-Isolated Operation - Alternate Arrangement
No. 7 - Low-Tension Synchronous Generators with Stand Alone Capability
No. 8*- High Voltage (13 kV, 27 kV and 33 kV) Single Feeder Buy Back Service
No. 9*- High Voltage (13 kV, 27 kV and 33 kV) Single Feeder Supplementary Service

NOTE: (*) This interconnection scheme could be upgraded to provide second contingency restoration capability either manual or automatic (break-before make) transfer switching to an alternate Company supply or emergency generator. In this case, appropriate interlocks must be installed to preclude:

a) Tying two systems out-of-phase with each other; and
b) Inadvertent energization of the Company's high tension feeder.

2.0 INDUCTION GENERATOR DATA

Location: ______________________________

Manufacturer_______________________ Unit No. _______________________________

Serial No._________________________ Type __________________________________

RATED OUTPUT

__________________ kVA

__________________ kW

__________________ kV

__________________ Amp

__________________ HP

__________________ PF

Locked Rotor____________________________Amp

Magnetizing Inrush
Current if Energized
at Synchronous Speed___________________Amp

Synchronous Speed_____________________RPM

Efficiency___________________%

Frequency___________________Hz

Rotor Resistance (Rr):___________p.u. * Stator Resistance (Rs):_______________p.u. *

Rotor Reactance (Xr):_____________p.u. * Stator Reactance (Xs):_______________p.u. *

Magnetizing
Reactance (Xm):________________p.u. *

Short-Circuit
Reactance (Xd"):____________________p.u. *

Generator and Turbine Inertia WR^2 ______________________lb. ft. ^{2}

Inertia Constant on Machine Base Hc_________________________MW Sec/MVA

Exciting Current:____Amp

Reactance Power Required: (a)___________________________________kVAR @ No Load

(b)____kVAR @ Rated Load

Frequency of Starts:__________________Per Minute _______________________ Per Hour

* *Per Unit Based on Own kVA Rating*

FORM - 1

G.A.-7615 4/90

3.0 SYNCHRONOUS GENERATOR DATA

Location: ________________________

Manufacturer___________________________Unit No. _________________________

Serial No.______________________________Type ___________________________

RATED OUTPUT

________________________	kVA	Number of Phases	________________________
________________________	kW	Damper (Amortisseur) Winding	____________
________________________	kV	Winding Connection	____________________
________________________	Hz	Neutral Grounded?	____________________
________________________	RPM	Gnd Resistance____________________ohms	
________________________	Amp	Type	_________________________________
________________________	PF		
________________________	% Eff.		

		IN PER UNIT ON RATED MACHINE kVA AND kV
Direct Axis Unsaturated Synchronous Reactance	Xd	________________
Quadrature Axis Unsaturated Synchronous Reactance	Xq	________________
Direct Axis Transient Reactance at Rated Current	X'di	________________
Direct Axis Transient Reactance at Rated Voltage	X'dv	________________
Quadrature Axis Transient Reactance at Rated Current (*where applicable)*	X'qi	________________

FORM - 2

SYNCHRONOUS GENERATOR DATA - Cont'd

IN PER UNIT ON RATED
MACHINE kVA AND kV

Directed Axis Subtransient Reactance at Rated Current	X"di	________________
Quadrature Axis Subtransient Reactance at Rated Current	X'qi	________________
Direct Axis Subtransient Reactance at Rated Voltage	X"dv	________________
Quadrature Axis Subtransient Reactance at Rated Voltage	X"qv	________________
Negative Sequence Reactance	X_2	________________
Zero Sequence Reactance	X_0	________________
Stator Leakage Reactance at Rated Voltage	Xlv	________________
Stator Leakage Reactance at Rated Current	Xli	________________
Potier Reactance	Xp	________________
Positive Sequence Resistance	R_1	______ @ _____°C
Zero Sequence Resistance	R_0	______ @ _____°C
Negative Sequence Resistance	R_2	______ @ _____°C
Direct-Axis Transient Open-Circuit Time Constant	Td'o	____Sec. @ ____°C
Direct Axis Subtransient Open-Circuit Time Constant	Td"o	____Sec. @ ____°C
Quadrature-Axis Transient Open-Circuit Time Constant	Tq'o	____Sec. @ ____°C
Quadrature-Axis Subtransient Open-Circuit Time Constant	Tq"o	____Sec. @ ____°C
Short-Circuit Time Constant of Armature Winding	Ta	____Sec. @ ____°C
Generator & Turbine Inertia	WR^2	_____ Lb. $ft.^2$
Inertia Constant on Machine Base	Hc	_______ MW Sec/MVA
Saturation Curve No. on Open Circuit		______________________
Saturation Curve No. for Rated Stator Current at 0 PF lag		______________________
"V" Curve No.		______________________

FORM – 2

4.0 EXCITATION SYSTEM DATA

Manufacturer ____

Station________________________________Unit # ______________________________

Type of Excitation System IEEE Type 1.________2.________3.________4. _________

Voltage Response ____

Mfr./Exciter Type ____

Mfr./Regulator Type ____

Saturation Curve No. on Open Circuit ____

Saturation Curve No. for Rated Armature Current _______________________________

FORM - 3

5.0 INVERTER DATA

Manufacturer ____

Reference Number, Type or Style ____

Type: Line – Commutated ____________________________________

Self – Commutated ____________________________________

Serial Number ____

Nameplate Rating ____________________________________

Harmonic Characteristics:

% Total Harmonic Voltage Distortion * ________________________________

% Total Harmonic Current Distortion * ________________________________

* Estimated (or measured) percent distortion of the fundamental (60 Hz) waveform at the interconnection point. Also submit any certified test reports or manufacturer's data.

FORM - 4

conEdison

6.0 PROTECTIVE EQUIPMENT - DATA & TEST RECORD

LOCATION **VOLTAGE** **PROTECTION ON**

C. T. RATIO	P. T. RATIO	

KIND OF PROT.	RELAY ELE-MENT	SPECIFIED SETTINGS							RELAY		AVERAGE LEFT SETTINGS							REMARKS
		PRIM.	TIME	SECONDARY				DATE	TYPE &	ELE-	PRIM	TIME	SECONDARY				DATE	
		AMP.	SEC.	VOLT	AMP.	DEG.	OHMS	ISSUED	SER. NO.	MENT	AMP.	SEC.	VOLT	AMP	DEG.	OHMS	TESTED	

ADDITIONAL SPECIFICATIONS

*PERIODIC TEST

	SEE LETTER ENG. FILE SHEET NO. ITEM NO.	ISSUED BY Senior Engineer, Distribution Engineering SECTION MANAGER SYSTEMS ENGINEERING DEPARTMENT	SETTING COMPLETED GENERAL SUPERVISING ENGINEER

VII – UTILITY REFERENCE TABLES

1.0 TABLE 1: DISTRIBUTION SYSTEM SERVICES

Service District	Service Type %		Predominant Service Voltages		Predominant Distribution System Configurations	
	Underground	**Overhead**	**Primary**	**Secondary**	**Primary**	**Secondary**
Bronx	88	12	27 kV; 13 kV; 4 kV	120/208 V	Radial; Auto Loop	Network
Brooklyn	91	9	27 kV; 4 kV	120/208 V	Radial; Auto Loop	Network
Manhattan	100	0	13 kV	120/208 V; 265/460 V	Radial	Network
Queens	86	14	27 kV; 4 kV	120/208 V	Radial; Auto Loop	Network
Staten Island	49	51	33 kV; 13 kV; 4 kV	120/208 V; 120/240 V	Radial; Auto Loop	Radial
Westchester	56	44	13 kV; 4 kV	120/208 V; 120/240 V	Radial; Auto Loop; Primary Transfer	Radial

2.0 TABLE 2: EXAMPLES OF DG CLASSIFICATION

Drawing No	Generation Type	Service Classification	Interconnection Type
1	Induction	Standby	LT- Preferred Arrangement
2	Induction	Standby	LT- Alternate Arrangement
3	Converter	Standby	SPC-Parallel
4	Converter	Standby	SPC- Stand Alone
5	Synchronous	Standby	LT- Non Isolated Operation-Preferred
6	Synchronous	Standby	LT- Non Isolated Operation-Alternate
7	Synchronous	Standby	LT- with Stand Alone Capability
8	Synchronous	Buy Back	HV-Single Feeder (13, 27 and 33 kV)
9	Synchronous	Buy Back	HV-Single Feeder (13, 27 and 33 kV)

3.0 TABLE 3: COMPANY'S SYSTEM GROUNDING METHODS

System Nominal Voltage *	Phase / #Wire	Transformer Connection Primary / Secondary	Grounding Method
120 / 208 208Y / 120	3 Phase / 4 Wire	Delta / Wye-Ground	Multi-grounded Solid Neutral
265 / 460 480Y / 277	3 Phase / 4 Wire	Delta / Wye-Ground	Multi-grounded Solid Neutral
2,400 / 4,160 4,160Y / 2,400	3 Phase / 4 Wire	Wye-Ground / Wye-Ground	Multi-grounded Solid Neutral
13,800	3 Phase / 4 Wire	Delta / Wye **	Ungrounded
27,000	3 Phase / 4 Wire	Delta / Wye **	Ungrounded
33,000	3 Phase / 4 Wire	Delta / Wye **	Ungrounded

* Refers to transformer secondary side
** Transformer Wye Neutral grounded via reactor

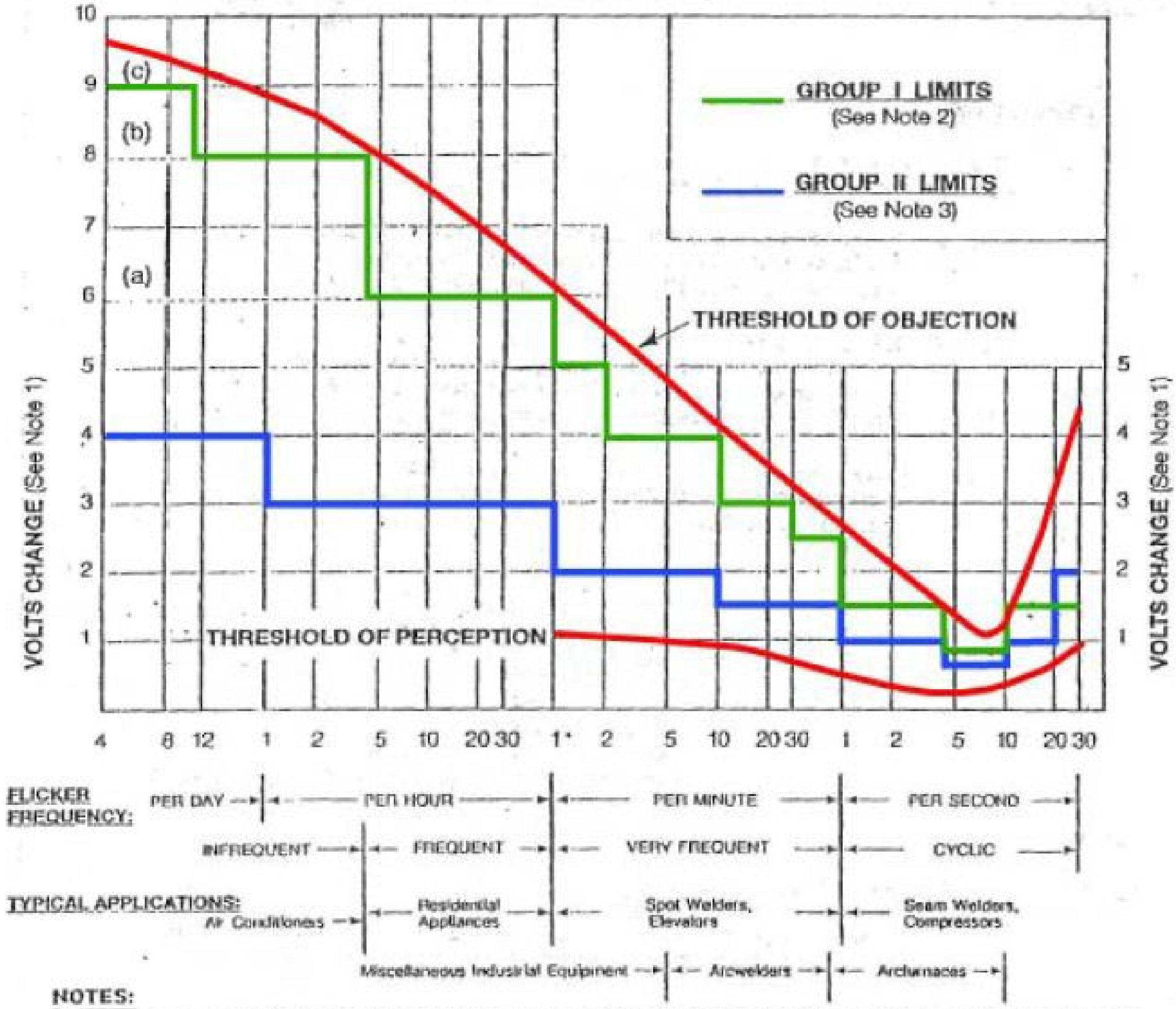
4.0 TABLE 4: TOLERANCES

Test Parameter	Tolerance of Specified Settings
Current	± 5%
Voltage	± 5%
Time	± 5%
Frequency	± 0.05 Hz
Phase Angle	± 3 Degrees

5.0 TABLE 5: SERVICE VOLTAGE FLICKER

SERVICE VOLTAGE FLICKER LIMITS CHART

(See Note 1)



NOTES:

1. These limits are for 120 volt circuits during normal operating conditions. They also apply to services supplied by closely associated transformers (three or more banks) under first contingency only. For first contingency elsewhere within the network area, multiply Chart values by a factor of 1.5. Flicker limits for 265 volt applications are obtained when multiplying the Chart values by a factor of 2.2.

2. **Group I Limits** apply, in general, to residences, small apartment houses, small stores and industrial establishments, as follows:

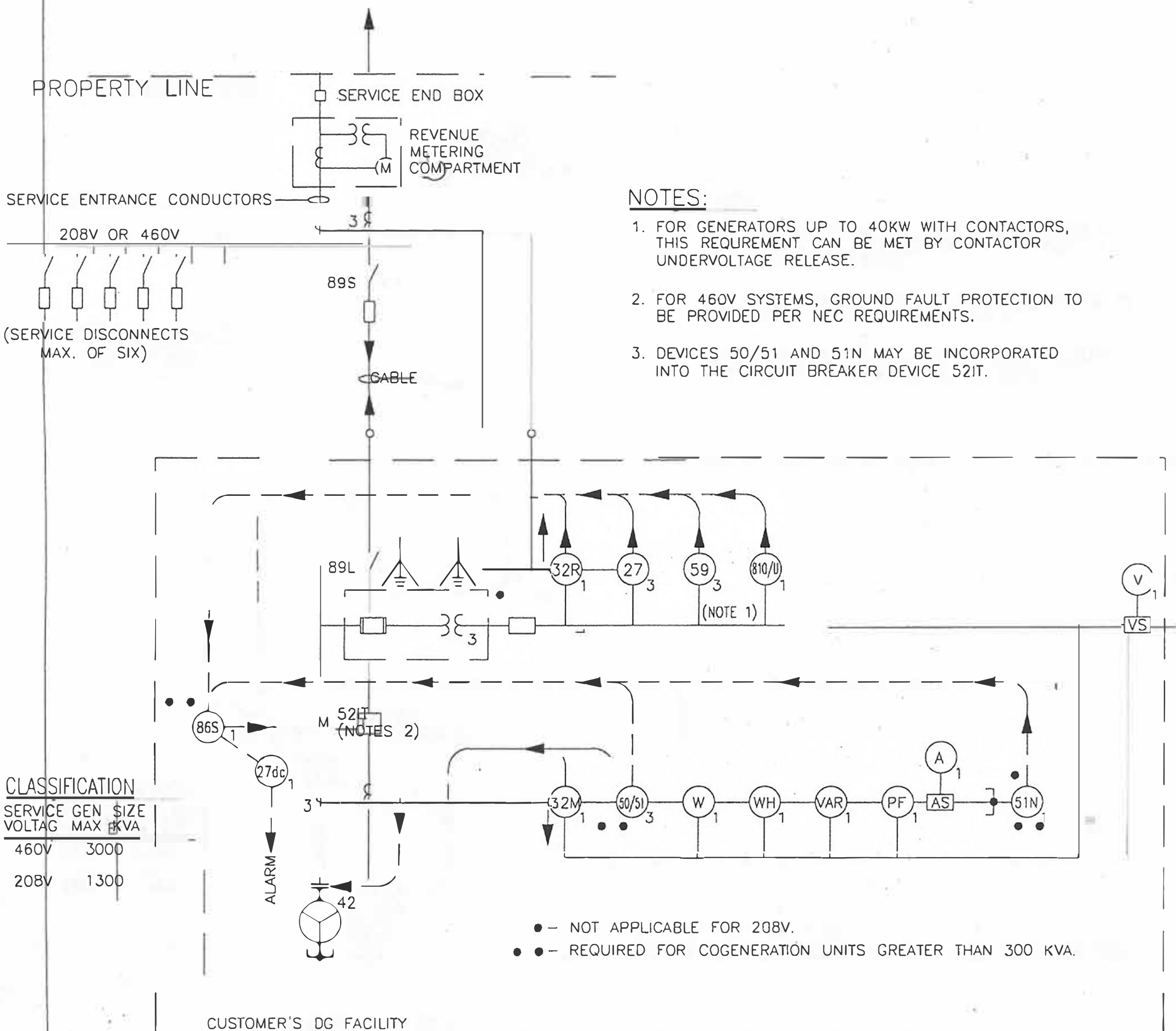
   (a) A 6-volt flicker is permissible for infrequently started appliances if the service supplies more than one customer.

   (b) An 8-volt flicker is permissible during the start-up of air conditioners or other infrequently started appliances, provided the service supplies only one customer.

   (c) A 9-volt flicker is permissible for fire pumps and other occasionally started equipment, and also for apparatus started not more often than once in two hours, if little or no lighting is involved.

3. **Group II Limits** apply to services supplying extensive amount of lighting load and affecting relatively large groups of people such as office buildings, hotels, theaters, large stores, large apartment buildings, etc. Group II Limits should also be used for equivalent 120 volt flicker on 2.4 and 4 kv primary feeders.

LOW–TENSION INDUCTION GENERATORS – PREFERRED ARRANGEMENT



NOTES:

1. FOR GENERATORS UP TO 40KW WITH CONTACTORS, THIS REQUREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.
3. DEVICES 50/51 AND 51N MAY BE INCORPORATED INTO THE CIRCUIT BREAKER DEVICE 52IT.

● – NOT APPLICABLE FOR 208V.

● ● – REQUIRED FOR COGENERATION UNITS GREATER THAN 300 KVA.

CLASSIFICATION

SERVICE VOLTAG	GEN SIZE MAX KVA
460V	3000
208V	1300

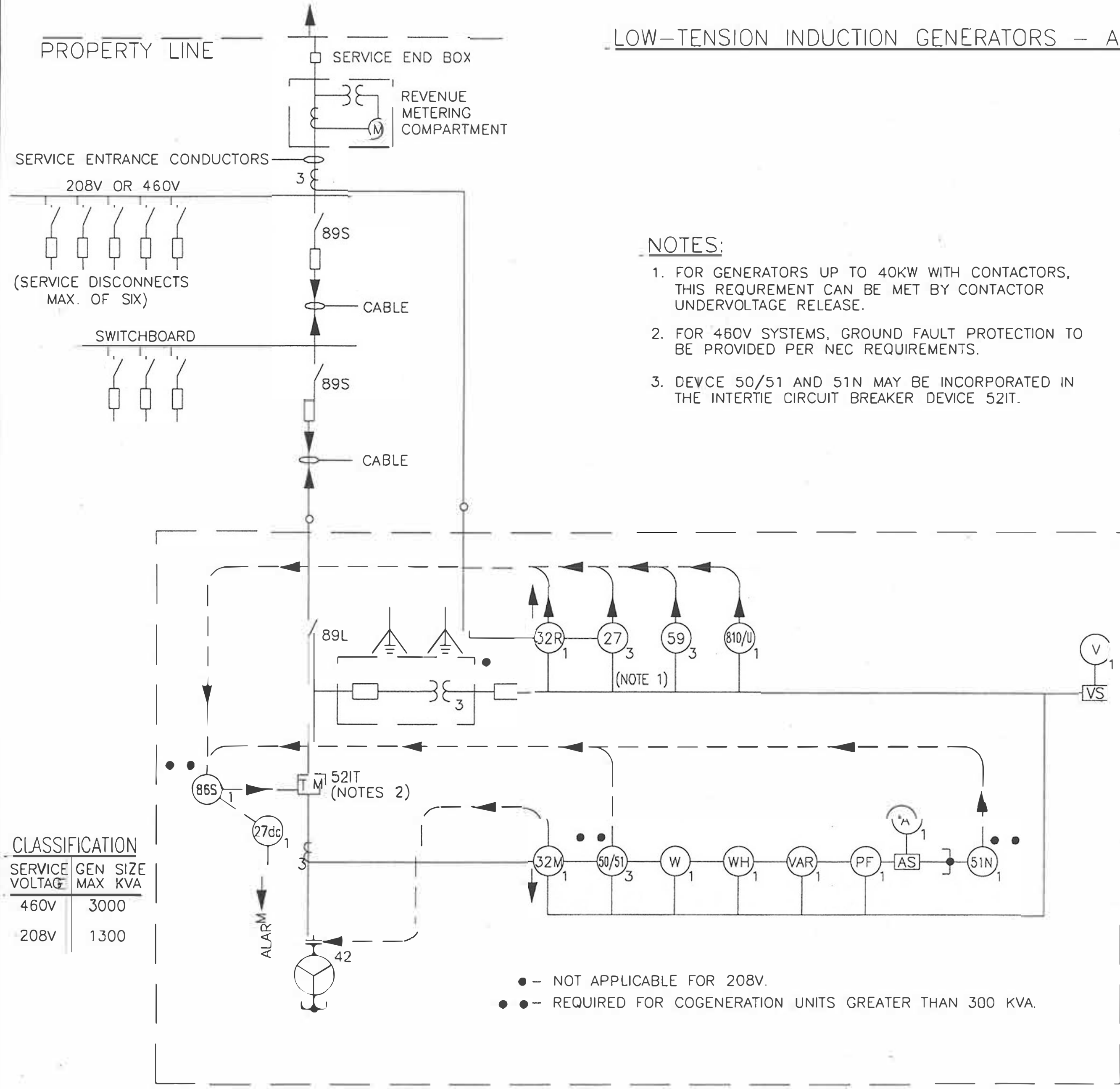
DEVICE LEGEND

DEVICE NO.	FUNCTION
27	UNDERVOLTAGE
32M	ANTI–MOTORING
32R	3–PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51N	GROUND OVERCURRENT
51V	OVERCURRENT, VOLTAGE RESTRAINT
52	CIRCUIT BREAKER
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR METER
TM	THERMO–MAGNETIC
V	VOLTAGE METER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

DRAWING No. 1

UTILITY REFERNCE DRAWING No. 2

LOW–TENSION INDUCTION GENERATORS – ALTERNATE ARRANGEMENT



● – NOT APPLICABLE FOR 208V.

● ● – REQUIRED FOR COGENERATION UNITS GREATER THAN 300 KVA.

NOTES:

1. FOR GENERATORS UP TO 40KW WITH CONTACTORS, THIS REQUREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.
3. DEVCE 50/51 AND 51N MAY BE INCORPORATED IN THE INTERTIE CIRCUIT BREAKER DEVICE 52IT.

CLASSIFICATION

SERVICE VOLTAGE	GEN SIZE MAX KVA
460V	3000
208V	1300

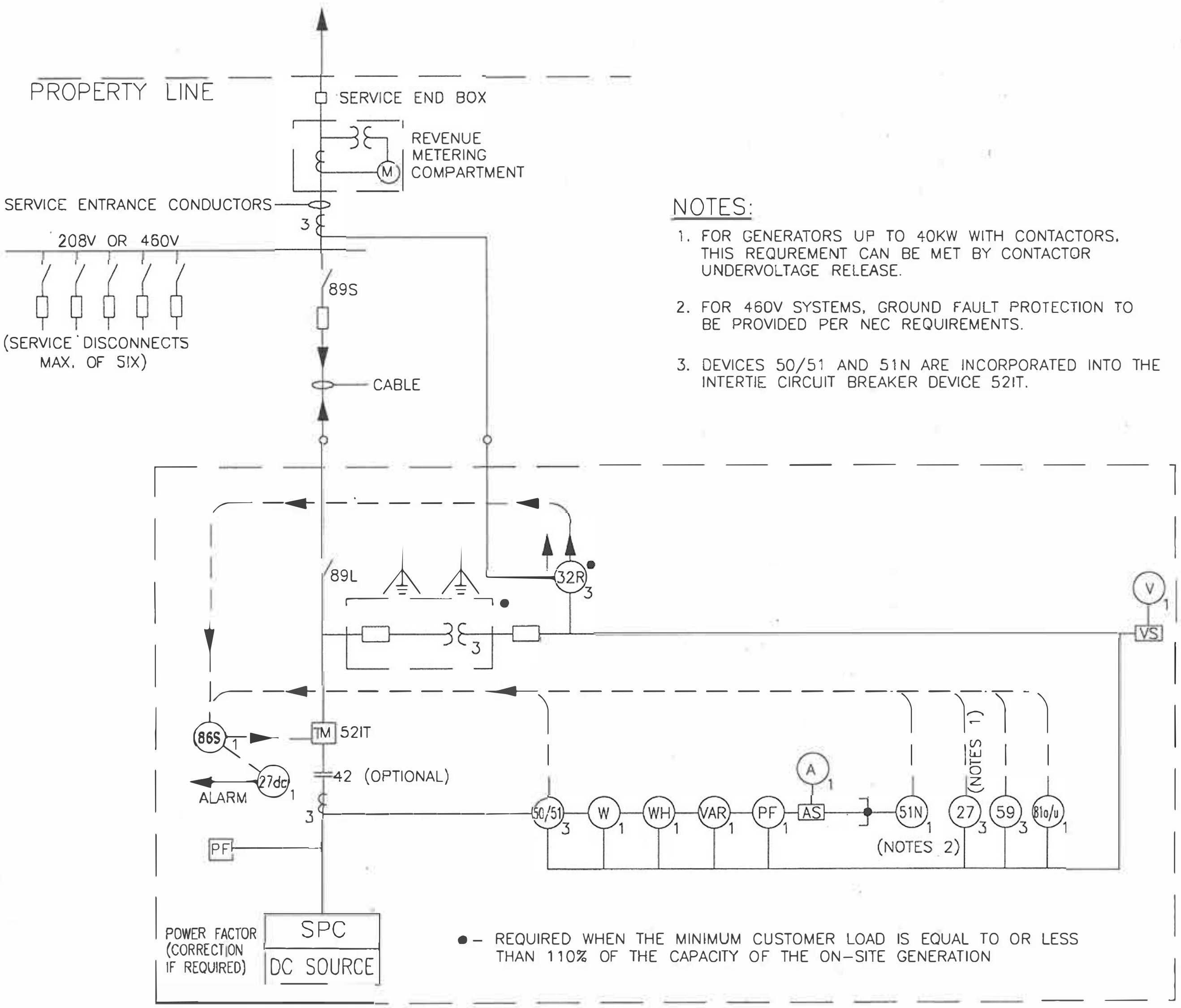
DEVICE LEGEND

DEVICE NO	FUNCTION
27	UNDERVOLTAGE
32M	ANTI–MOTORING
32R	3–PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51N	GROUND OVERCURRENT
51V	OVERCURRENT, VOLTAGE RESTRAINT
52	CIRCUIT BREAKER
59	OVERVOLTAGE
810/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR
TM	THERMO–MAGNETIC
V	VOLTAGE METER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

DRAWING No. 2

STATIC POWER CONVERTER – PARALLEL OPERATION

MAXIMUM 500 KW – STANDBY SERVICE



NOTES:

1. FOR GENERATORS UP TO 40KW WITH CONTACTORS, THIS REQUREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.
3. DEVICES 50/51 AND 51N ARE INCORPORATED INTO THE INTERTIE CIRCUIT BREAKER DEVICE 52IT.

● – REQUIRED WHEN THE MINIMUM CUSTOMER LOAD IS EQUAL TO OR LESS THAN 110% OF THE CAPACITY OF THE ON-SITE GENERATION

SPC = STATIC POWER CONVERTER FOR PHOTOVOLTIAIC ARRAYS, FUEL CELLS, MICROTURBINES, WINDMILLS, BATTERIES, ETC.

DEVICE LEGEND

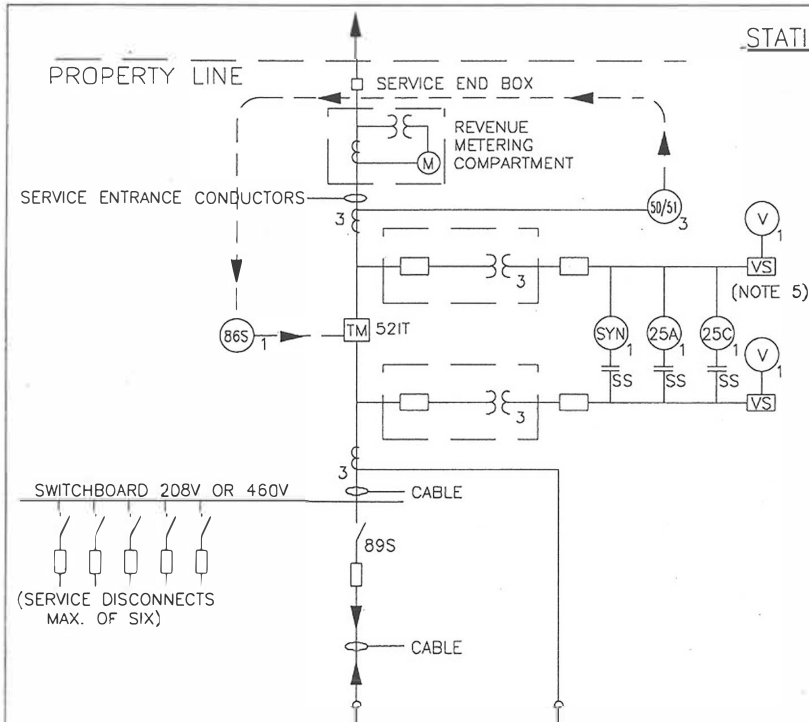
DEVICE NO.	FUNCTION
27	UNDERVOLTAGE
32R	3-PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51N	GROUND OVERCURRENT
52	CIRCUIT BREAKER
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR METER
TM	THERMO-MAGNETIC
V	VOLTAGE METER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

DRAWING No. 3

UTILITY REFERNCE DRAWING No. 4

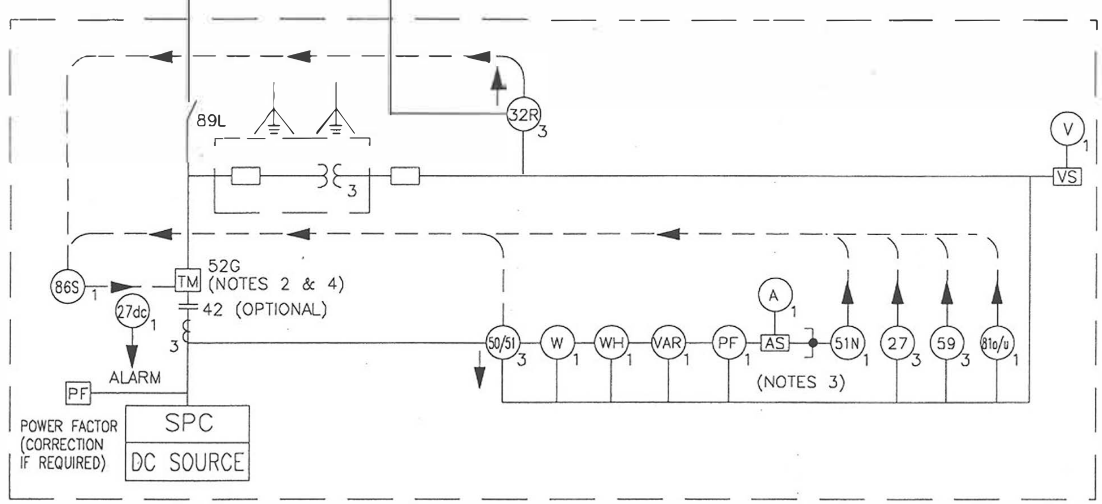
STATIC POWER CONVERTER – WITH STAND ALONE CAPABILITY

MAXIMUM 500 KW – STANDBY SERVICE



NOTES:

1. FOR GENERATORS UP TO 40 KW WITH CONTACTORS, THIS REQUIREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR LOCATIONS WHERE COGENERATION IS SUPPLIED VIA NETWORK PROTECTORS AND THERE IS NO TIE TO THE GRID NETWORK PROTECTORS ARE TO BE INTERLOCKED WITH 52IT TO BLOCK RECLOSING OF PROTECTORS IF ALL NETWORK PROTECTORS ARE OPEN.
3. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.
4. FOR GENERATORS UP TO 40 KW WITH CONTACTORS, THE BREAKER 52G IS NOT REQUIRED.
5. PROVIDE LIVE LINE–DEAD BUS PERMISSIVE CLOSING OF 521T, IF SYNCHRONIZING FACILITIES ARE NOT PROVIDED FOR TIE BREAKER.
6. DEVICES 50/51 AND 51N MAY BE INCORPORATED INTO THE INTERTIE CIRCUIT BREAKER DEVICE 52IT.



SPC = STATIC POWER CONVERTER FOR PHOTOVOLTIAIC ARRAYS, FUEL CELLS, MICROTURBINE, WINDMILLS, BATTERIES, ETC.

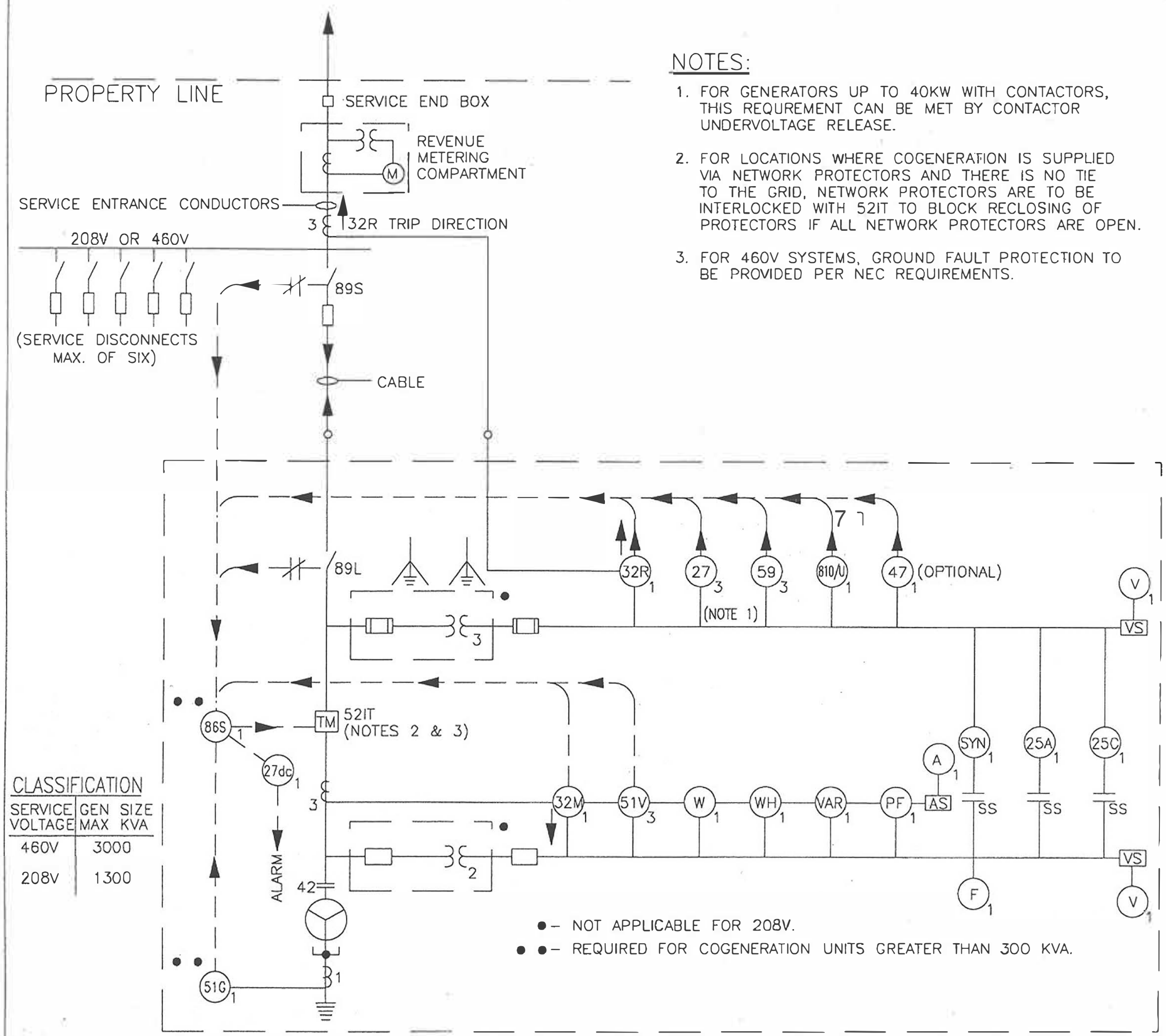
DEVICE LEGEND

DEVICE NO.	FUNCTION
25A	AUTO SYNCHRONIZER
25C	SYNCHROCHECK
27	UNDERVOLTAGE
32R	3-PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51N	GROUND OVERCURRENT
51V	OVERCURRENT, VOLTAGE RESTRAINT
52	CIRCUIT BREAKER
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR METER
SS	SYNCHRO-SWITCH
SYN	SYNCHRONOSCOPE
TM	THERMO-MAGNETIC
V	VOLT METER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

DRAWING No. 4

UTILITY REFERNCE DRAWING No. 5

LOW TENSION SYNCHRONOUS GENERATORS
NON-ISOLATED OPERATION – PREFERRED ARRANGEMENT



NOTES:

1. FOR GENERATORS UP TO 40KW WITH CONTACTORS, THIS REQUREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR LOCATIONS WHERE COGENERATION IS SUPPLIED VIA NETWORK PROTECTORS AND THERE IS NO TIE TO THE GRID, NETWORK PROTECTORS ARE TO BE INTERLOCKED WITH 52IT TO BLOCK RECLOSING OF PROTECTORS IF ALL NETWORK PROTECTORS ARE OPEN.
3. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.

CLASSIFICATION

SERVICE VOLTAGE	GEN SIZE MAX KVA
460V	3000
208V	1300

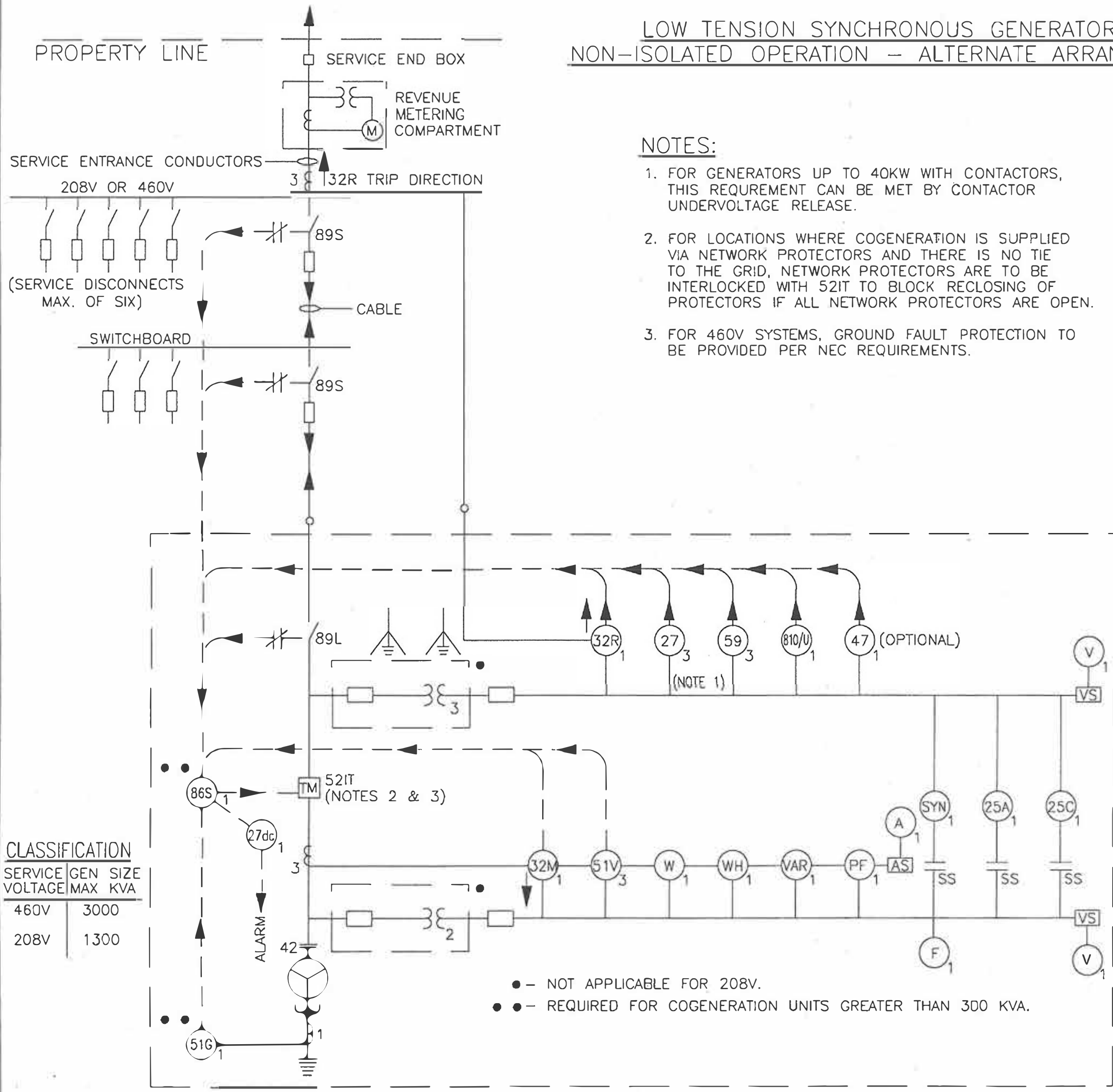
DEVICE LEGEND

DEVICE NO.	FUNCTION
25A	AUTOSYNCHRONIZER
25C	SYNCHROCHECK
27	UNDERVOLTAGE
32M	ANTI-MOTORING
32R	3-PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51G	GROUND OVERCURRENT
51V	OVERCURRENT, VOLTAGE RESTRAINT
52	CIRCUIT BREAKER
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR METER
SYN	SYNCHRONOSCOPE
SS	SYNCHRO-SWITCH
TM	THERMO-MAGNETIC
V	VOLTMETER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

DRAWING No. 5

UTILITY REFERNCE DRAWING No. 6

LOW TENSION SYNCHRONOUS GENERATORS
NON-ISOLATED OPERATION – ALTERNATE ARRANGEMENT



NOTES:

1. FOR GENERATORS UP TO 40KW WITH CONTACTORS, THIS REQUREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR LOCATIONS WHERE COGENERATION IS SUPPLIED VIA NETWORK PROTECTORS AND THERE IS NO TIE TO THE GRID, NETWORK PROTECTORS ARE TO BE INTERLOCKED WITH 52IT TO BLOCK RECLOSING OF PROTECTORS IF ALL NETWORK PROTECTORS ARE OPEN.
3. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.

DEVICE LEGEND

DEVICE NO.	FUNCTION
25A	AUTOSYNCHRONIZER
25C	SYNCHROCHECK
27	UNDERVOLTAGE
32M	ANTI-MOTORING
32R	3-PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51G	GROUND OVERCURRENT
51V	OVERCURRENT, VOLTAGE RESTRAINT
52	DRAWOUT CIRCUIT BREAKER
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR METER
SYN	SYNCHROSCOPE
SS	SYNCHRO-SWITCH
TM	THERMO-MAGNETIC
V	VOLTMETER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

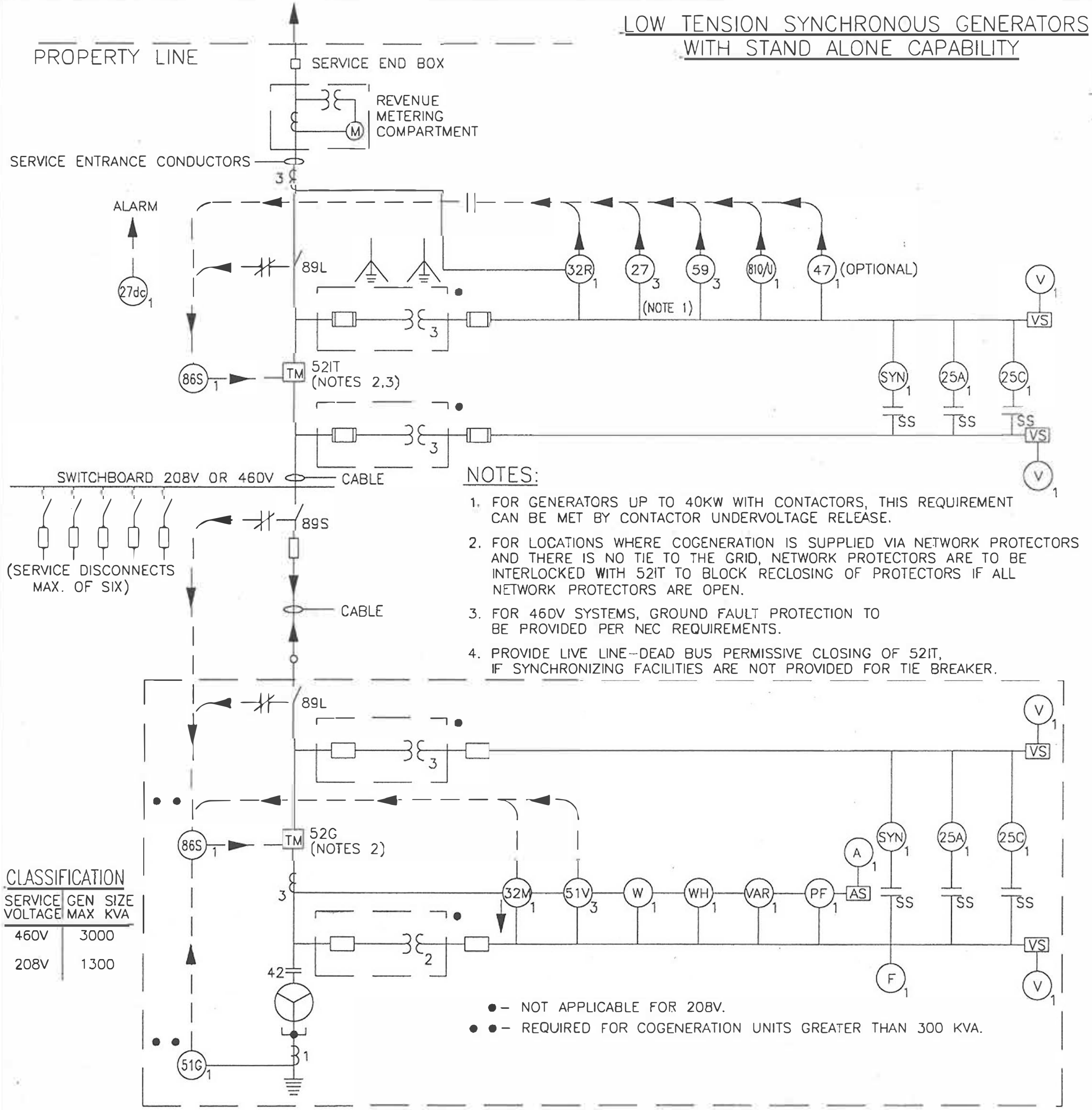
CLASSIFICATION

SERVICE VOLTAGE	GEN SIZE MAX KVA
460V	3000
208V	1300

DRAWING No. 6

UTILITY REFERNCE DRAWING No.7

LOW TENSION SYNCHRONOUS GENERATORS WITH STAND ALONE CAPABILITY



NOTES:

1. FOR GENERATORS UP TO 40KW WITH CONTACTORS, THIS REQUIREMENT CAN BE MET BY CONTACTOR UNDERVOLTAGE RELEASE.
2. FOR LOCATIONS WHERE COGENERATION IS SUPPLIED VIA NETWORK PROTECTORS AND THERE IS NO TIE TO THE GRID, NETWORK PROTECTORS ARE TO BE INTERLOCKED WITH 52IT TO BLOCK RECLOSING OF PROTECTORS IF ALL NETWORK PROTECTORS ARE OPEN.
3. FOR 460V SYSTEMS, GROUND FAULT PROTECTION TO BE PROVIDED PER NEC REQUIREMENTS.
4. PROVIDE LIVE LINE–DEAD BUS PERMISSIVE CLOSING OF 52IT, IF SYNCHRONIZING FACILITIES ARE NOT PROVIDED FOR TIE BREAKER.

CLASSIFICATION

SERVICE VOLTAGE	GEN SIZE MAX KVA
460V	3000
208V	1300

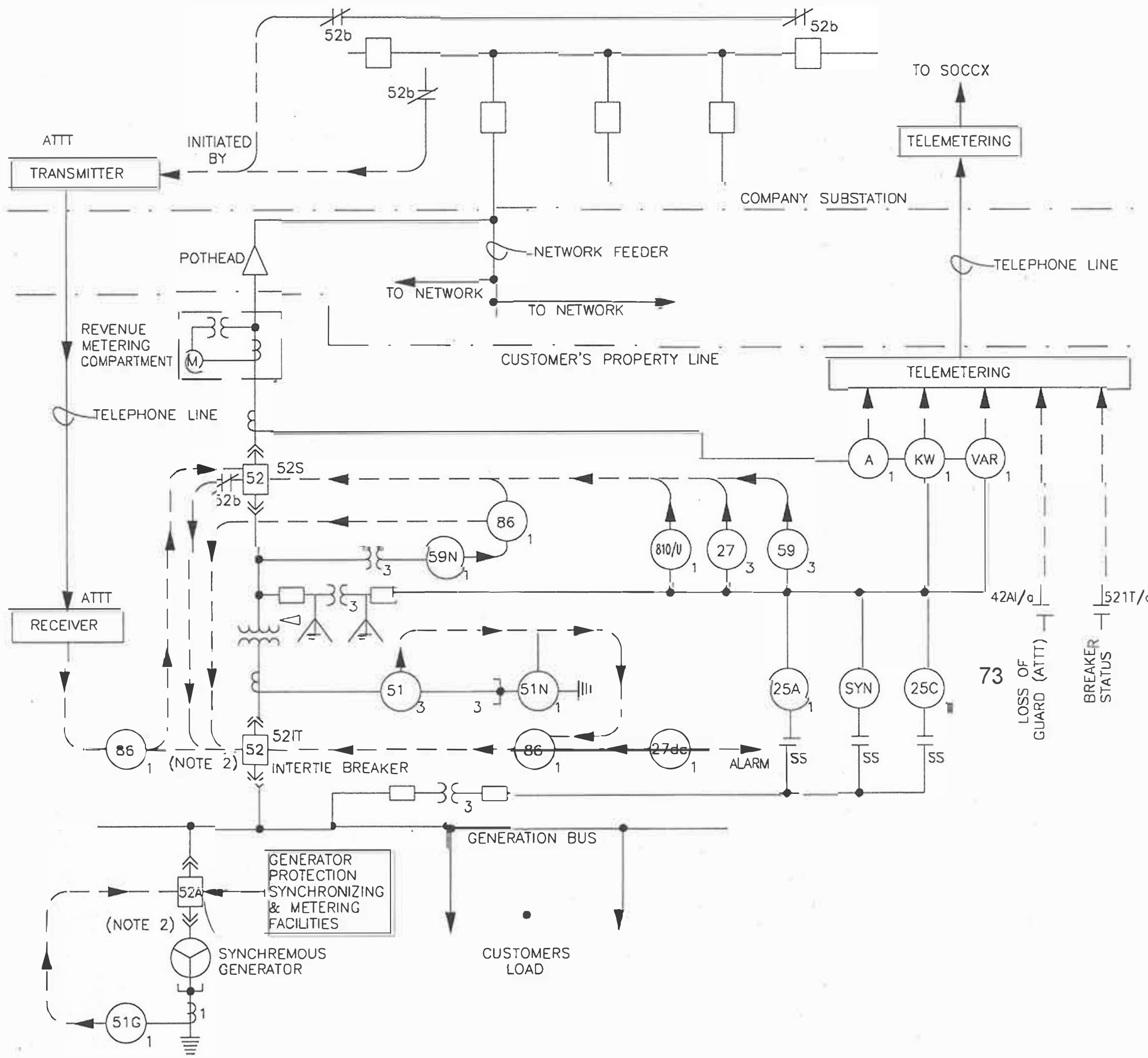
DEVICE LEGEND

DEVICE NO.	FUNCTION
25A	AUTO SYNCHRONIZER
25C	SYNCHROCHECK
27	UNDERVOLTAGE
32M	ANTI–MOTORING
32R	3–PHASE REVERSE POWER
42	CONTACTOR
47	PHASE SEQUENCE VOLTAGE
51G	GROUND OVERCURRENT
51V	OVERCURRENT, VOLTAGE RESTRAINT
52	CIRCUIT BREAKER
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
89L	LOAD MAKING/BREAKING PAD LOCKABLE SWITCH ACCESSIBLE TO CON EDISON
89S	LINE SWITCH
A	AMMETER
AS	AMMETER SWITCH
F	FREQUENCY METER
M	REVENUE METERING
PF	POWER FACTOR METER
SS	SYNCHRO–SWITCH
SYN	SYNCHRONOSCOPE
TM	THERMO–MAGNETIC
V	VOLTMETER
VAR	VAR METER
VS	VOLTMETER SWITCH
W	WATT METER
WH	WATTHOUR METER

DRAWING No. 7

UTILITY REFERNCE DRAWING No. 8

HIGH VOLTAGE (13KV,27KV AND 33KV) SINGLE FEEDER BUY BACK SERVICE



NOTES:

1. REFER TO CON ED SPEC EO–2022 FOR HIGH TENSION SERVICE REQUIREMENTS. BY CONTRACTOR UNDERVOLTAGE RELEASE.
2. SYNCHRONIZING FACILITIES MAY BE PROVIDED BY CUSTOMER AT THE INTERTIE OR AT THE GENERATOR BREAKER. CUSTOMER MUST PROVIDE LIVE LINE DEAD BUS PERMISSIVE CLOSING OF 521T IF SYNCHRONIZING EQUIPMENT IS LOCATED AT GENERATOR BREAKER (52A).
3. SUPERVISORY VOLTAGE CLOSING CONTROL EQUIPMENT IS REQUIRED FOR THIS FACILITY.
4. PROVIDE TELEMETERING FOR COGENERATION FACILITIES GREATER THAN 2 MW.

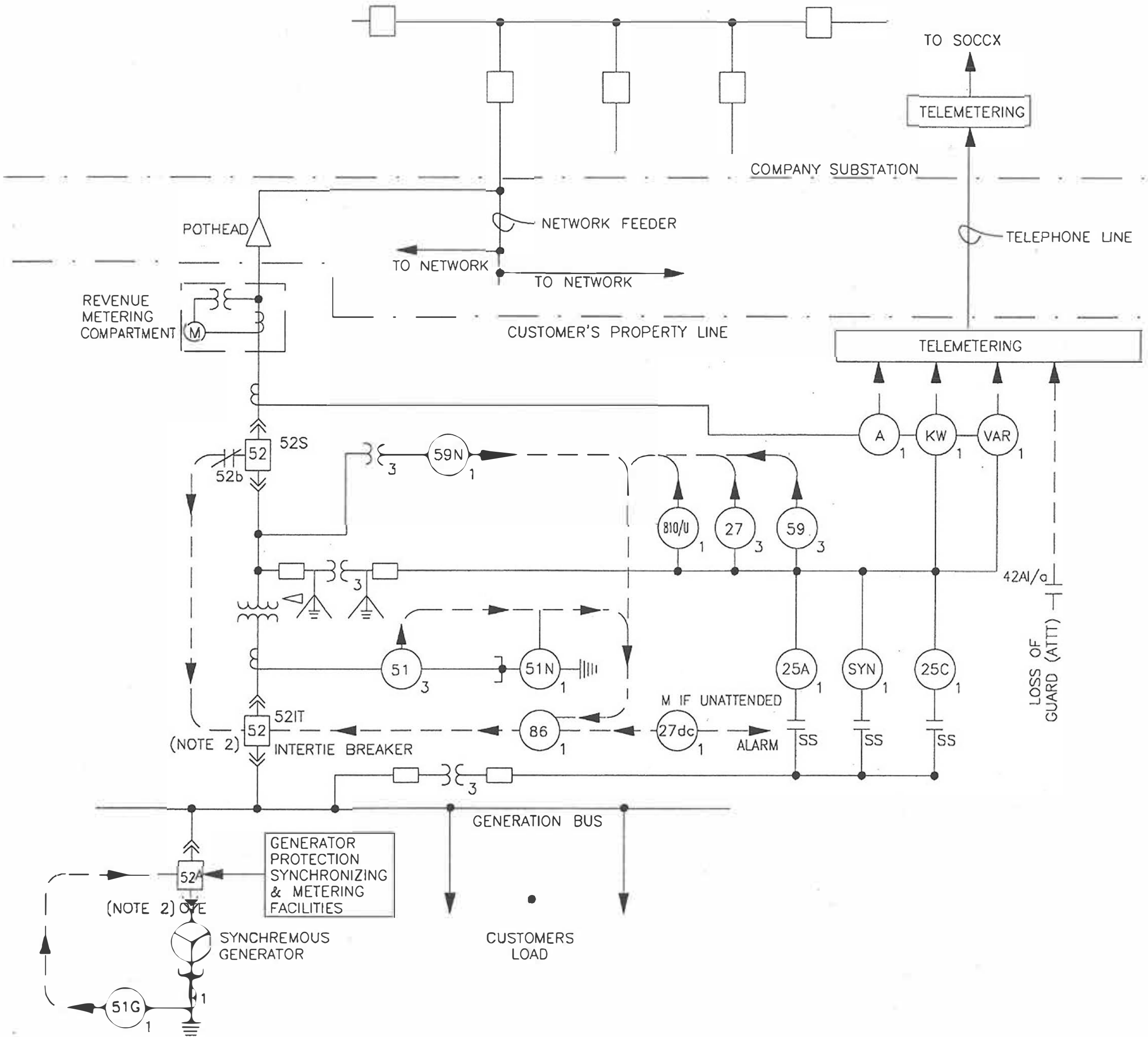
DEVICE LEGEND

DEVICE NO.	FUNCTION
25A	AUTO SYNCHRONIZER
25C	SYNCHROCHECK
27	UNDERVOLTAGE
51	OVERCURRENT
51N	GROUND OVERCURRENT
52	CIRCUIT BREAKER
59N	GROUND OVERVOLTAGE
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
A	AMMETER
KW	KILOWATT
H	REVENUE METERING
SS	SYNCHRO SWITCH
SYN	SYNCHRONOSCOPE
VAR	VAR METER

DRAWING No. 8

UTILITY REFERNCE DRAWING No. 9

HIGH VOLTAGE (13KV,27KV AND 33KV) SINGLE FEEDER SUPPLEMENTARY SERVICE



NOTES:

1. REFER TO CON ED SPEC EO-2022 FOR HIGH TENSION SERVICE REQUIREMENTS. BY CONTRACTOR UNDERVOLTAGE RELEASE.
2. SYNCHRONIZING FACILITIES MAY BE PROVIDED BY CUSTOMER AT THE INTERTIE OR AT THE GENERATOR BREAKER. CUSTOMER MUST PROVIDE LIVE LINE DEAD BUS PERMISSIVE CLOSING OF 512T IF SYNCHRONIZING EQUIPMENT IS LOCATED AT GENERATOR BREAKER (52A).
3. SUPERVISORY VOLTAGE CLOSING CONTROL EQUIPMENT IS REQUIRED FOR THIS FACILITY.
4. PROVIDE TELEMETERING FOR COGENERATION FACILITIES GREATER THAN 2 MW.

DEVICE LEGEND

DEVICE NO.	FUNCTION
25A	AUTO SYNCHRONIZER
25C	SYNCHROCHECK
27	UNDERVOLTAGE
32R	REVERSE POWER
51	OVERCURRENT
51N	GROUND OVERCURRENT
52	CIRCUIT BREAKER
59N	GROUND OVERVOLTAGE
59	OVERVOLTAGE
81O/U	OVER/UNDER FREQUENCY
86	LOCKOUT
A	AMMETER
KW	KILOWATT
H	REVENUE METERING
SS	SYNCHRO SWITCH
SYN	SYNCHRONOSCOPE
VAR	VAR METER

DRAWING No. 9