



**OPERATING, METERING, AND EQUIPMENT PROTECTION REQUIREMENTS**

**FOR**

**PARALLEL OPERATION OF**

**SMALL-SIZE GENERATING FACILITIES**

**GREATER THAN 300 KILOWATTS TO 1,000 KILOWATTS**

**ORANGE AND ROCKLAND UTILITIES, INC.**  
**390 West Route 59**  
**Spring Valley, NY 10977**  
**Revised January 30, 2001**

**OPERATING, METERING AND EQUIPMENT PROTECTION REQUIREMENTS  
FOR  
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**I. INTRODUCTION**

This document describes the minimum operating, metering and protective equipment which Orange and Rockland Utilities, Inc. (O&RU) requires for operation of its electric system in parallel with a generating source or sources with total output greater than 300KW to 1,000KW. These requirements have been established for the protection of life and property and are intended to assist owners of small-sized power generators (referred to hereafter as the Applicant) in evaluating their electrical generating system requirements.

**A. A Project Begins With the Following:**

1. When the Applicant has determined:
  - a. The type of generation (induction, synchronous or dc with inverter).
  - b. The generator rating.
  - c. The amount of power to be delivered to the O&RU system.
  - d. The location of his facility.
2. Then, O&RU will determine:
  - a. The location(s) where the Applicant's facility may be connected to the O&RU system.
  - b. The ability of O&RU's facilities to accept the additional input of power.
  - c. The modifications necessary to O&RU's facilities.
  - d. The requirements for voltage regulation and power factor control.

These considerations may result in requirements other than the general requirements provided in this document. The Applicant is encouraged to discuss his project with O&RU at the earliest possible date.

**B. It Is the Applicant's Responsibility to:**

1. Design, install operate and maintain all necessary equipment for connection to the O&RU system, unless otherwise stated in a contractual agreement.
2. Comply with all applicable local, state and federal rules, regulations and codes.
3. Submit specifications and detailed plans for the installation of the control and protective devices to O&RU for review and written approval prior to their installation and preferably before purchase.

**C. Initial Parallel Operation Will Be Performed Only After O&RU Has:**

1. Inspected the completed installation.
2. Received and review signed reports for relay and functional trip tests. These tests must show that the protective equipment has been field tested by applying secondary currents and/or voltages at the proper frequencies. This will indicate if the equipment will operate at the specified setting and within the tolerance given in the manufacturer's instruction bulletin.
3. Given written approval as stated in the appropriate power-purchase or paralleling agreement.
4. Given verbal approval through the designated O&RU facility immediately prior to paralleling with the O&RU system.

These items are required to determine that the Applicant's equipment can be safely connected to O&RU's system. O&RU may disconnect the facility from the O&RU system at any time if it is found that the facility is unsafe or causes interference with O&RU's system or its customers.

**II. EQUIPMENT REQUIREMENTS**

## **A. Metering**

For an Applicant desiring to sell power to O&RU, O&RU shall approve, provide, install, own and maintain all facilities necessary to accommodate O&RU metering. All meters and recording devices shall be provided by O&RU at the Applicant's expense.

Meters shall be equipped with detents to prevent reverse registration so that deliveries to and from the Applicant's equipment can be separately recorded and treated as separate transactions under the applicable rate of rate schedule. There should be an approved watt-hour meter with register at each "IN" and "OUT" point shown in Figures #1 and #2.

1. The metering assemblies shall consist of instrument transformers, control cables, test switches and the watt-hour meters with registers. Each register shall display KW-hours, 15 minute block interval indicating the maximum KW and also a display of the cumulative KW. It shall also display the non-coincidental maximum leading or lagging KVA. Provisions shall be made to provide energy data pulses to a recording device.

Instrument transformers, the watt-hour meters and the registers must be approved for revenue metering applications by the New York Public Service Commission for New York customers.

2. Metering requirements for the delivery of power to O&RU fall under three general classifications, depending upon the contractual arrangements:
  - a. Surplus Sale. Only the Applicant's excess generation is delivered to the O&RU system after the Applicant first meets his own normal service requirements.  
  
Meter(s) will be required to measure the Applicant's surplus generation delivered into the O&RU system.
  - b. Simultaneous Purchase and Sale. The entire net output of the Applicant's

generation facility is delivered to the O&RU system while O&RU simultaneously supplies all of the Applicant's normal electric service requirements.

Meter(s) will be delivered to measure the net generation delivered to the O&RU system.

- c. No Sale. Should the Applicant desire not to sell power to O&RU, but only to operate in parallel, the Applicant may do so under the terms of a special agreement. In such cases, metering will not be required for the measurement of power delivered into the O&RU system.

Figures in 1 and 2 show typical time-of-delivery metering for simultaneous purchase and sale and surplus installation.

3. Metering requirements for the delivery of power to the Applicant (O&RU billing) shall be in accordance with the applicable electric tariffs on file with the authorized by the New York Public Utilities Commission. For a simultaneous purchase and sale agreement, auxiliary metering shall be required to measure energy supplied to the Applicant for his generator auxiliary load when his generator is not operating and during periods of generator startup and shutdown.

**B. Protective and Control Devices**

Minimum protection requirements are necessary for sale and reliable parallel operation of both the Applicant's equipment and O&RU's electric system. While most commercially available generators are equipped with some protective and control devices, additional equipment may be required to permit parallel operations with the O&RU system depending on the location, type and size of the generator.

See Figures 1 and 2 for typical protection schemes.

1. All generators must have:
  - a. A disconnect device.

A disconnect device must be provided as means of electrically isolating the O&RU system from the generator and to establish working clearance for maintenance and repair work in accordance with O&RU safety rules and practices. This disconnect device may be located in the main interconnection line or in the generator connecting line provided it is wired directly into the main interconnection line on the O&RU side of the Applicant's main distribution bus.

The disconnect device will be installed by O&RU at the Applicant's expense if it is to be located in O&RU-owned wiring. If the device is to be located in the Applicant's wiring, it must be furnished and installed by the Applicant.

In either case, the disconnect device is subject to the following requirements:

1. Only devices specifically approved by O&RU for this purpose may be used.
  2. The device shall be physically located for ease of access and visibility to O&RU personnel. When installed in the Applicant's wiring, the device shall normally be located in close proximity to the metering.
  3. O&RU personnel shall inspect and approve the installation before parallel operation will be permitted.
  4. The device enclosure and operating handle (when present) will be kept locked at all times with O&RU padlocks.
  5. Only O&RU personnel shall operate the device.
  6. The Applicant is responsible for all labor and material costs to maintain, repair or replace the disconnect device.
- b. A circuit breaker with overcurrent protection on each phase.

A circuit breaker allows the Applicant's generation equipment to be separated from the O&RU system.

This breaker must have sufficient interrupting capacity to interrupt maximum available fault current at its location.

c. Over and under voltage protection.

This protection is used to trip the circuit breaker when the voltage is not within the relay settings.

The overvoltage protection is set to initiate a trip of the circuit breaker with a time delay when the voltage is equal to or above 120 percent of normal.

The undervoltage protection is set to initiate a trip of the circuit breaker with a 10 second time delay when the voltage is equal to or below 80 percent of normal. The relays used for this protection should be utility grade.

d. Over and underfrequency protection.

This protection is used to trip the circuit breaker when the frequency varies from the nominal of 60Hz.

1. Overfrequency protection is set to initiate a trip of the circuit breaker, after a 1-second time delay, when the frequency is equal to or above 62Hz.
2. Underfrequency protection is set to initiate a trip of the circuit breaker, after a 6 cycle time delay, when the frequency is equal to or below 58.5Hz.

Frequency protection is not required for generators connected to the O&RU system through a solid-state inverter which is line-commutated. The relays used for this protection should be utility grade.

e. A dedicated transformer which serves only the Applicant.

The impedance of the dedicated transformer limits the fault currents on the generator bus from the O&RU system and also limits fault currents on the O&RU system from the generator. This requirement is site specific.

- f. A ground fault sensing scheme.

This scheme detects ground faults and trips the circuit breaker, thus prohibiting the Applicant's generator from continuously contributing to a ground fault.

This scheme must be able to detect ground faults between the O&RU system side of the dedicated transformer and O&RU's end of line.

A transformer-connected delta on the generator side and grounded wye on the system side, with appropriate relaying equipment, would provide a means of detecting system ground faults.

- 2. All generators greater than 400KW must have an impedance relay or an overcurrent relay with voltage restraint.

These relays are used to detect phase-to-phase and three-phase faults and initiate a generator circuit breaker trip. They must be located on the individual generator feeder.

- 3. Induction generator installations may require capacitors to be switched on to correct the generator output to near unity power factor. Capacitors on the generator terminals may be acceptable, but caution should be used since this increases the possibility of the generator becoming self-excited. If necessary, the ability to switch capacitors in stages to provide varying amounts of capacitance may be required.

- 4. Synchronous generators and induction generators designed to operate similar to synchronous generators must also have manual synchronization with relay supervision to synchronize with the O&RU system. Synchro-check relays (such as GE Model IJS), normally used for checking two voltages between which there is no slip, are not acceptable.

- a. At O&RU's determination, either:

1. A power factor regulator.

A power factor regulator may be required when it is desirable for the generator voltage to follow system voltage fluctuations while maintaining a specified power factor.

The regulator must be capable of maintaining a power factor setting within  $\pm 1.0$  percent at full load at any point between 90 percent lagging and 95 percent leading, and should have programmable capability to vary hourly settings.

or:

2. A voltage regulator is used to maintain the generator terminal voltage at a specified level.

The regulator must be capable of maintaining the generator voltage under steady-state conditions without hunting within  $\pm 0.5$  percent of any set point within an operating range of  $\pm 5.0$  percent of the rated voltage of the generator.

5. Single-phase generators must be connected in multiple units so that an equal amount of generation capacity is applied to each phase of a 3-phase circuit.
6. All generators shall comply with 1977 ANSI Standards C50.10 and C50.13 dealing with wave form and telephone interference.
7. It is recommended that the Applicant protect his three-phase equipment from negative sequence currents.

Certain conditions in the utility system may cause negative sequence currents to flow. It is the sole responsibility of the customer to protect his equipment from excessive negative sequence currents.

**C. O&RU System Modifications:**

O&RU will provide equipment and labor necessary to perform all system modifications

at the Applicant's expense under the terms of a special facilities agreement. The following modifications are required as noted:

For synchronous generators or other generators designed to operate similarly, O&RU's automatic restoration equipment will be prevented from operating until all generation on the Applicant side of the restoration equipment is off line.

Generator damage and system disturbance may result from the restoration of power by automatic restoration equipment to a line energized by an Applicant's generator.

Modifications will be required when the generator(s) have the capability of energizing a line when the O&RU system is disconnected. The Applicant's generator(s) will not be allowed to automatically re-energize O&RU's facilities.

**D. Direct Telephone Service:**

Direct telephone service from local telephone company must be provided so that operating instructions from O&RU can be given to the Applicant or any designated operator of his equipment.

**III. PERFORMANCE CRITERIA**

**A. Harmonic Requirements:**

The harmonic content of the voltage and current waveforms in the O&RU system must be restricted to levels which will not cause interference or equipment operating problems for O&RU or its customers. IEEE Standard 519 is O&RU Inc., Guidelines for Harmonic content. All applicants generating facilities must conform to these requirements. There are many methods that may be used to restrict harmonics. The preferred method is to install a transformer with at least one delta connection between the generator and the O&RU system. This transformer significantly limits the effect of voltage and current harmonics on O&RU's system.

Any harmonic problems will be handled on a complaint basis. A facility causing harmonic interference is subject to being disconnected from the O&RU system until the

condition has been corrected. If the cause of the problem is traceable to the Applicant's facilities, all costs associated with determining and correcting problems will be at the Applicant's expense.

**B. Governor Recommendation:**

It is recommended that synchronous generator prime movers have a Governor and that its characteristics be set to provide a five percent droop characteristic (ie, 0.15Hz change in the governor speed will cause a five percent change in the generator load). Governors must be operated unrestrained to regulated system frequency.

**C. Power Factor Requirements:**

All generation sources must be capable of operating continuously at any power factor between 90 percent lagging and 95 percent leading with a voltage level at any point within  $\pm 5.0$  percent of rated voltage. The value and the extent of the ability to vary the power factor is dictated by the system requirements at the location of the generation source. This information will be given to the Applicant by O&RU.

**D. Generator Connection to the O&RU System:**

Connecting a generator to the O&RU system must not cause harmful voltage fluctuations. Refer to O&RU's Rule No. 2 (Description of Service) filed with the New York Public Utilities Commission (NYPUC). A facility causing such harmful voltage fluctuations is subject to being disconnected from the O&RU system until the condition has been corrected.

**IV. OPERATING AND MAINTENANCE PROCEDURES**

**A. All Generators Must Have:**

1. A daily operations log:

A log must be kept for information on unit availability, maintenance outages, circuit breaker trip operations requiring a manual reset, relay targets and unusual events. O&RU shall have the right to review these logs, especially in analyzing

system disturbances.

2. Operating schedules:

The voltage-var schedule, voltage regulator settings and transformer ratio tap settings will be supplied to the Applicant by O&RU.

This information is necessary to ensure proper coordination of voltages and regulator action.

## V. SUMMARY

### EQUIPMENT REQUIREMENTS AND RECOMMENDATIONS

<u>ITEM</u>	<u>MACHINE SIZE GREATER THAN 300KW AND TO 1,000KW</u>
<b><u>All Generators:</u></b>	
Disconnect Device	Required
Dedicated Transformer	Required
Metering <sup>(1)</sup>	Required
Circuit Breaker	Required
Undervoltage Protection	Required
Overtoltage Protection	Required
Overfrequency Protection	Required
Underfrequency Protection	Required
Ground Fault Detection Scheme	Required
Direct Telephone Service	Required
 <b><u>Synchronous &amp; Similar Type Generators:</u></b>	
Governor	Recommended
Automatic Synchronizing	Recommended
Manual Synchronizing With Relay Supervision	Required
Voltage or Power Factor Regulator	Required

(1) Required only when the Applicant desires to sell power to O&RU under a power purchase agreement.

**APPLICATION  
FOR ATTACHMENT OF PARALLEL GENERATION  
EQUIPMENT 300 KVA TO 1000KVA  
TO THE ELECTRIC SYSTEM OF  
ORANGE AND ROCKLAND UTILITIES IN NEW YORK STATE**

**Customer:**

Name: \_\_\_\_\_ Phone: (\_\_\_\_) \_\_\_\_\_

Address: \_\_\_\_\_ Municipality: \_\_\_\_\_  
\_\_\_\_\_

**Consulting Engineer or Contractor:**

Name: \_\_\_\_\_ Phone: (\_\_\_\_) \_\_\_\_\_

Address: \_\_\_\_\_  
\_\_\_\_\_

**Estimated In-Service Date:** \_\_\_\_\_

**Existing Electric Service:**

Capacity: \_\_\_\_\_ Amperes Voltage: \_\_\_\_\_ Volts  
Service Character: ( )Single Phase ( )Three Phase  
Secondary 3 Phase Transformer Connection ( )Wye ( )Delta

**Location of Protective Interface Equipment on Property:**  
(include address if different from customer address)  
\_\_\_\_\_

**Energy Producing Equipment/Inverter Information:**

Manufacturer: \_\_\_\_\_  
Model No. \_\_\_\_\_ Version No. \_\_\_\_\_  
( )Synchronous ( )Induction ( )Inverter ( )Other \_\_\_\_\_  
Rating: \_\_\_\_\_ kW Rating: \_\_\_\_\_ kVA  
Rated Output: VA Rated Voltage: Volts  
Rate Frequency: Hertz Rated Speed: RPM  
Efficiency: % Power Factor: %  
Rated Current: Amps Locked Rotor Current: Amps  
Synchronous Speed: RPM Winding Connection:  
Min. Operating Freq./Time:  
Generator Connection: ( )Delta ( )Wye ( )Wye Grounded  
System Type Tested (Total System): ( )Yes ( )No; attach product literature  
Equipment Type Tested (i.e. Inverter, Protection System):  
( )Yes ( )No; attach product literature  
One Line Diagram attached: ( )Yes  
Installation Test Plan attached: ( )Yes

**For Synchronous Machines:**

Submit copies of the Saturation Curve and the Vee Curve  
( )Salient ( )Non-Salient  
Torque: \_\_\_\_\_ lb-ft Rated RPM: \_\_\_\_\_  
Field Amperes: \_\_\_\_\_ at rated generator voltage and current  
and \_\_\_\_\_ % PF over-excited  
Type of Exciter: \_\_\_\_\_  
Output Power of Exciter: \_\_\_\_\_  
Type of Voltage Regulator: \_\_\_\_\_  
Direct-axis Synchronous Reactance ( $X_d$ ) \_\_\_\_\_ ohms  
Direct-axis Transient Reactance ( $X'_d$ ) \_\_\_\_\_ ohms  
Direct-axis Sub-transient Reactance ( $X''_d$ ) \_\_\_\_\_ ohms

**For Induction Machines:**

Rotor Resistance ( $R_r$ ) \_\_\_\_\_ ohms Exciting Current \_\_\_\_\_ Amps  
Rotor Reactance ( $X_r$ ) \_\_\_\_\_ ohms Reactive Power Required:  
Magnetizing Reactance ( $X_m$ ) \_\_\_\_\_ ohms \_\_\_\_\_ VARs (No Load)  
Stator Resistance ( $R_s$ ) \_\_\_\_\_ ohms \_\_\_\_\_ VARs (Full Load)  
Stator Reactance ( $X_s$ ) \_\_\_\_\_ ohms  
Short Circuit Reactance ( $X''_d$ ) \_\_\_\_\_ ohms Phases:  
Frame Size: \_\_\_\_\_ Design Letter: \_\_\_\_\_ ( )Single  
Temp. Rise: \_\_\_\_\_ °C. ( )Three-Phase

**For Inverters:**

Manufacturer: Model:  
Type: ( )Forced Commutated ( )Line Commutated  
Rated Output: Amps Volts  
Efficiency: %

**Signature:**

\_\_\_\_\_  
CUSTOMER SIGNATURE TITLE DATE

**TYPICAL  
PROTECTION & METERING INSTALLATION  
FOR GENERATORS GREATER THAN 300KW TO 1000KW  
FOR SALE OF SURPLUS ENERGY TO O.&R.U.**

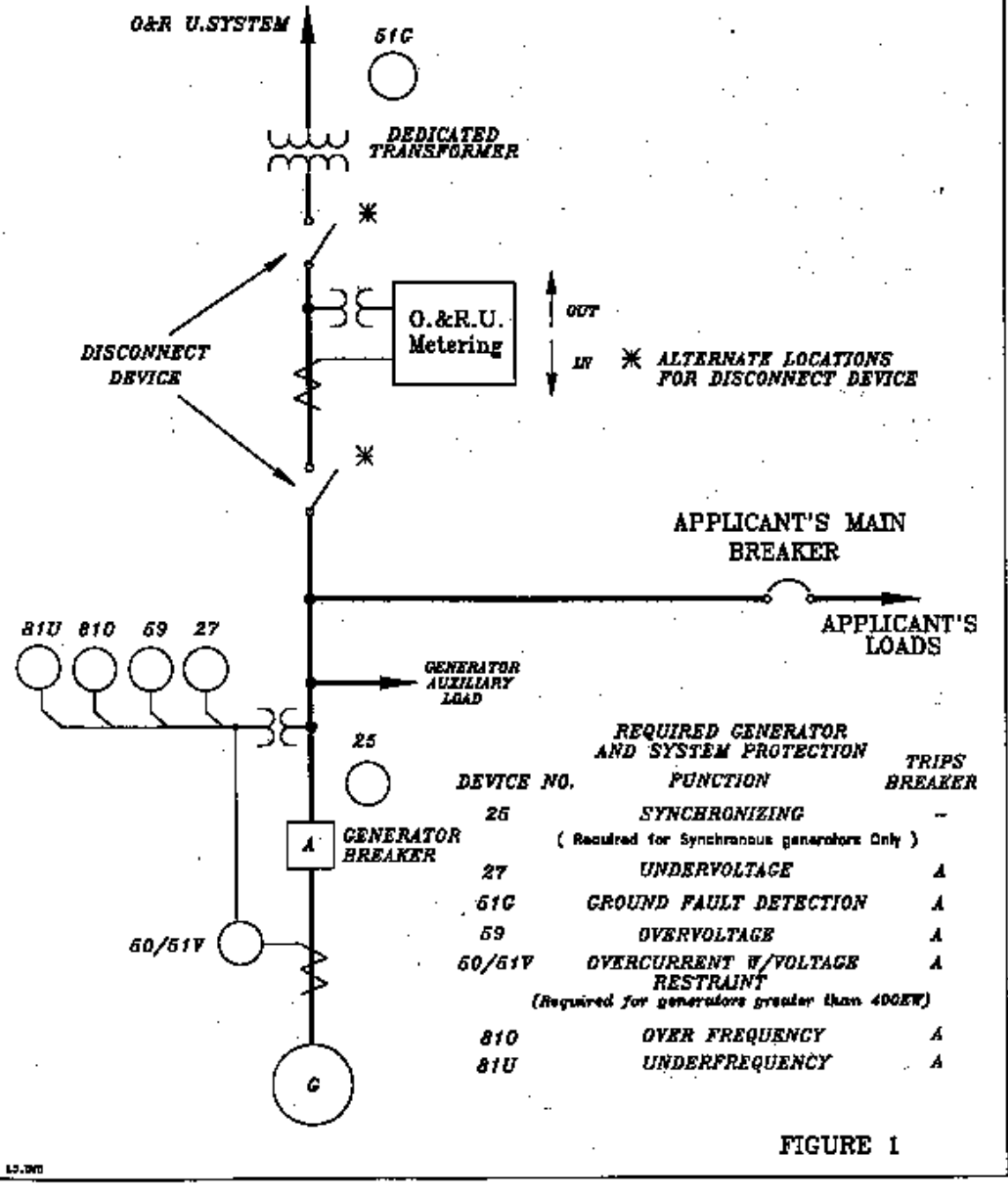
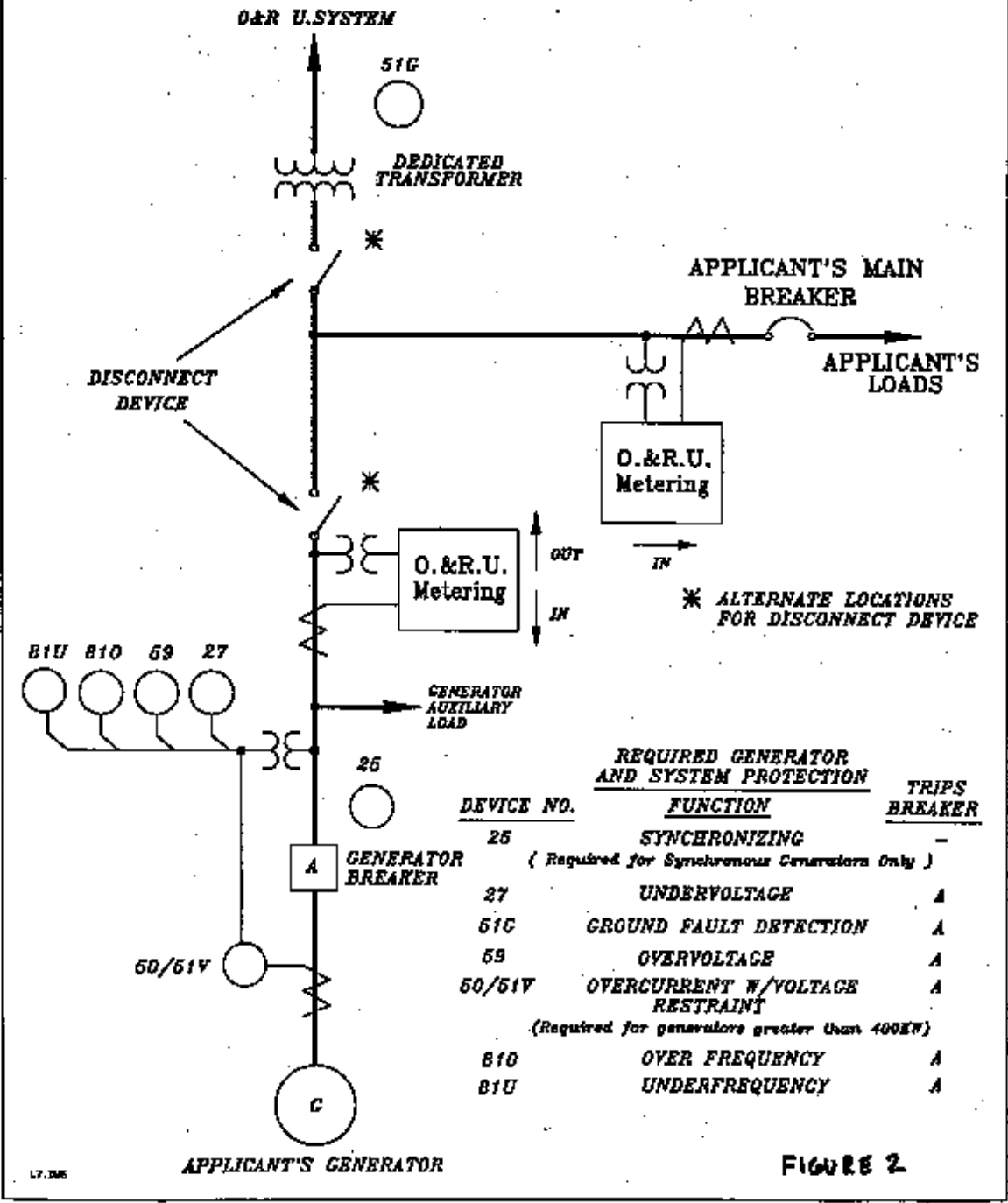


FIGURE 1

**TYPICAL PROTECTION & METERING INSTALLATION  
FOR GENERATORS GREATER THAN 300KW TO 1000KW  
FOR SIMULTANEOUS PURCHASE AND SALE**



DEVICE NO.	REQUIRED GENERATOR AND SYSTEM PROTECTION FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING <i>( Required for Synchronous Generators Only )</i>	-
27	UNDERVOLTAGE	A
51G	GROUND FAULT DETECTION	A
59	OVERVOLTAGE	A
50/51V	OVERCURRENT W/VOLTAGE RESTRAINT <i>(Required for generators greater than 400KW)</i>	A
810	OVER FREQUENCY	A
81U	UNDERFREQUENCY	A

**FIGURE 2**