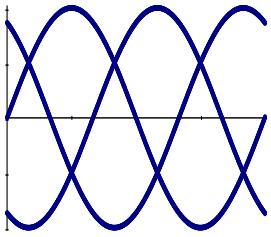
CHUGACH
POWERING ALASKA'S FUTURE

Interconnection and Operating Guidelines For Non-Utility Generation

Up to 5,000 kVA



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For any questions regarding these guidelines, contact Chugach's Distribution Support Engineering Department at 907-563-7494.

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PREFACE

Chugach Electric Association, Inc. (Chugach) has developed these guidelines with careful consideration of the many technical and operational issues involved with interconnecting non-utility generation to the Chugach distribution systems. Given the complex and technical nature of the subject, Chugach has striven to maintain a high level of understandability throughout this document, in order to meet the needs and interests of our consumers and customers.

Many of the requirements contained in this document are based on highly technical engineering concepts and practices. To aid in understanding the requirements and criteria contained in these, Chugach encourages the user to obtain the assistance of a qualified engineering professional with specific expertise in the areas of electrical supply systems, power system protection, and generation and control.

These guidelines are subject to revision, at any time, by Chugach Electric Association, Inc. Revisions are subject to review and approval by the Regulatory Commission of Alaska.

SECTION 1: INTRODUCTION

110 How the Guidelines are Organized

Chugach Electric Association, Inc. (Chugach) recognizes the desire that some members have to generate their own electricity on-site while maintaining electrical connection with the Chugach system. This set of guidelines contains the general requirements and technical operating parameters for interconnecting non-utility generation and co-generation with the Chugach system.

In order to better understand the scope and focus of Chugach's *Interconnection and Operating Guidelines for Non-Utility Generation (Interconnection Guidelines)*, this section presents a summary of each section within the complete document.

Section 1: Introduction provides an overview of Chugach's operating policy regarding non-utility proposals for interconnection with the Chugach electrical system. This section also contains key information, operational concepts and characteristics for both separate-operating and parallel-operating generation systems. To aid the reader in understanding Chugach's classification system, this section also provides general descriptions and definitions of the different classes of interconnected non-utility generation, as defined for the purposes of these guidelines.

Section 2: Interconnection Process and Application Procedures follows with a description of the step-by-step process through which the specific requirements for safe and reliable interconnection are determined and implemented. While each proposal will be unique in its characteristics, this section provides the Applicant with an understanding of how a) applications are processed, b) specific interconnection requirements are assessed, c) interconnection projects are coordinated with Chugach, and d) authorization for interconnected operation is obtained. Applications for Interconnection are included as appendices to these guidelines.

Section 3: Interconnected Operating Criteria contains the operational criteria, limits, and requirements that apply to any non-utility generation facility operating in parallel with the Chugach electric system.

Section 4: General Requirements addresses the general requirements for interconnecting with the Chugach system, including design requirements and design information regarding interconnecting non-utility generation facilities.

Section 5: Interconnection Equipment Requirements contains a general overview of the required equipment and protection settings for general interconnection, as well as those specific to each class of facility.

120 Operational Policy for Interconnected Non-Utility Generation

It is the operating policy of Chugach to provide authorization for non-utility generating facilities to interconnect and operate in parallel with the Chugach electric system, provided this can be done without adverse effects to Chugach consumers, personnel, equipment, or system operations. This document provides the general guidelines and requirements to allow such interconnection and operation possible.

In these guidelines, interconnection is defined as the electrical connection of non-utility generation facilities with the Chugach electrical system. As used in this document, non-utility generation is defined as any electrical generation source not owned or operated by Chugach. Non-utility generating facilities can be classified either as separate or parallel operating systems. Separate operation denotes operating generation without the capability of sending or receiving power from the Chugach system. Parallel operation is the condition where non-utility generation operates while electrically connected to the Chugach system; under this condition, electric power can either flow from the Chugach system to the non-utility facility or vice versa.

Within these guidelines, the term 'Producer' is used to refer to the owner(s) of non-utility generating facilities, or agents acting on their behalf, who have been authorized by Chugach to interconnect and operate generation in parallel with the Chugach electric system. Also in these guidelines, an 'applicant' is defined as an individual or party who has applied for the interconnection of non-utility generation with the Chugach system.

The operation of non-utility generation in parallel with the electrical supply grid poses important safety concerns for Chugach personnel and equipment. The safe, reliable operation of the Chugach system, for all Association members, is of the utmost importance to Chugach. Accordingly, any interconnected non-utility generating facility must meet all applicable federal, state, and local safety codes and regulations, in addition to the specific guidelines and requirements contained in these guidelines. Chugach strongly recommends (and in some cases, may require) that those applying for interconnection obtain the services of an engineering professional, expert in the design of wiring and protection systems, including control and protection systems for generating equipment interconnected with electric grids.

Electrical distribution systems are inherently complex in design; each proposal to interconnect to the system will be unique in geographic location, operational characteristics, and impact to the electrical grid. All proposals must therefore be analyzed to determine the specific technical operating criteria and utility interface requirements.

The purpose of the Chugach interconnection process is to provide a thorough but expedient method by which the applicant can obtain authorization for a safe and reliable interconnection with the Chugach electrical system.

It should be noted that the requirements contained in these guidelines represent the minimum that Chugach applies in evaluating and installing its own generation resources to the system. Chugach's philosophy towards interconnecting non-utility generation is to work with the Applicant to ensure that the safe, reliable performance of the Chugach system is maintained as we assist in the process of utilizing non-utility generation technologies to meet the energy requirements of consumers.

This document shall not be construed as modifying any agreements that exist to establish the rights and obligations of both Chugach and the applicant.

130 Separate Operation

The requirements contained in the Interconnection Guidelines generally do not apply to 'separate operating' non-utility generating systems. Typically, separate operating systems include small emergency generating units for residential use, and certain uninterruptible power systems (UPS), which do not energize the Chugach system in their normal course of operation.

Within the context of these guidelines, a 'separate operating' system is defined as a generating system, which has no capability or possibility of connecting and operating in parallel with the Chugach system. Generally, a separate system is comprised of power generating equipment and switching apparatus located on the owner's site or property, which are designed and intended for use as an emergency, stand-by, or stand-alone power system. Chugach requires that these systems transfer load (either from Chugach system to the customer's separate system, or vice-versa) via *open-transition* switching.

For separate systems, which utilize open-transition switching, the requirements in these guidelines do not apply. Standards and requirements for such systems can be found in Chugach's *Electrical Service Standards & Requirements*. Open-transition switching is accomplished by employing either an automatic or manual transfer switch which *does not* allow the customer's generation to be electrically connected with the Chugach system (i.e., breaks contact with one source before the making contact with the other). Open-transition switching ensures that the customer's generation will be electrically disconnected prior to transferring the customer's load to or from the Chugach supply and electrical system.

Most uninterruptible power supply (UPS) systems do not specifically meet the separate system criteria. However, if they are not capable of back feed into the Chugach system, they can be classified as a separate system. If back feed is possible for such a system, it must meet Chugach's requirements for parallel operation.

If there is a question about whether the Applicant has a separate system, Chugach shall review the transfer scheme and advise as to whether it meets the open-transition requirements. This review may include approval of drawings and equipment specifications, as well as field inspection of the transfer scheme.

140 Parallel Operation

Parallel operation is defined as the condition where non-utility generation operates while electrically connected to the Chugach system. Under this condition, electric power can flow from the Chugach system to the Producer's facility and/or from the Producer's facility into the Chugach system. In other words, two-way power flow between the two systems is possible under this operating condition.

For the parallel operation of a non-utility generation facility, the interconnection must be implemented in such a way that system disturbances do not result in portions of the Chugach system becoming islanded with the Producer's facility.

150 Islanding

Within the context of these guidelines, islanded operation (or "islanding") denotes the condition where the Producer's generation energizes a portion of the Chugach electrical grid that has become electrically separated from the rest of the Chugach system. For safety and quality reasons, no Producer may island any portion of the Chugach system, unless provided expressed approval and authorization by Chugach (see *Subsection 530: Islanded Operation*).

Of primary concern are the possible dangers, which may be presented to Chugach personnel under islanding conditions. Chugach line crews must have the assurance that any section of the Chugach system is de-energized prior to work and will not be re-energized until there is confirmation that they are physically clear of the system. Under an islanded condition, Chugach cannot provide assurance to its personnel that all portions of the island are de-energized

Another equally important concern is the responsibility Chugach has to deliver electrical service within the proper ranges (voltage, frequency, etc.) to its consumers. If a portion of the Chugach system were to become islanded and energized by non-Chugach generation, Chugach would no longer control the quality, safety, and integrity of the electrical service delivered to its consumers.

160 Classification of Non-Utility Generation Installations

In order to evaluate proposed interconnections to the electrical system, Chugach categorizes Producer–owned generation systems into four general classes – *Classes A, B, C, and D*. This system is based upon industry-accepted methodology for assessing the possible impacts that interconnected facilities may have on the system. Criteria for classification include the maximum capability of the facility (output capacity in kVA), the type of generating system and characteristics (synchronous generator, induction generator, power converter system, etc.), the 'stiffness ratio' of the facility in relation to the Chugach electrical system, and system electrical characteristics at the point of interconnection.

One measure used to determine the potential impact is the *stiffness ratio* at the point of interconnection. This stiffness ratio is the ratio of the available electric system fault current at the interconnection point to the maximum-rated current of the Producer's facility. Used throughout the industry, this ratio indicates the capability of a particular generator to influence system voltages and operating characteristics. For any given point on the system, the higher the ratio, the lower the probability that the Producer may contribute to system disturbances or adversely affect nominal system voltage levels.

To obtain the minimum interconnection equipment requirements associated with a particular class of facilities, please refer to *Section 4: Interconnection Equipment Requirements*.

161 Class A Facilities

Non-utility generator installations of 10-kVA output or less, where the system stiffness ratio is at least 100, are identified as Class A installations. Interconnection requirements for Class A installations are typically the most moderate of all the classes.

In general, Class A installations are most applicable to residential and/or small commercial on-site power supply applications and are not expected to affect Chugach primary electrical distribution feeder devices. Class A installations are rarely capable of significantly altering local voltages on adjacent distribution facilities, and the relatively small-sized generators are not capable of supporting large islands on the primary electrical system.

162 Class B Facilities

Non-utility generator installations of 10 kVA to 100 kVA, where the stiffness ratio is at least 50, are identified as Class B installations.

As with Class A installations, the probability of interference with Chugach consumers and electrical distribution system equipment is relatively low, but the risk is sufficient to warrant moderate interconnection requirements. Class B installations generally do not significantly influence primary electrical feeder devices, but can alter primary and/or secondary voltages. Thus, islanded operation with the Chugach system is of greater potential concern than with Class A installations.

163 Class C Facilities

Non-utility generator installations of 100 kVA to 1,000 kVA, where the stiffness ratio is at least 30, are identified as Class C installations.

Given the larger capacity of Class C facilities (relative to Classes A and B), the potential to island large sections of the Chugach electric system is of much

greater concern. In addition, Class C installations can significantly influence primary feeder devices and operations. Accordingly, the probability of interference with Chugach consumers and system equipment is high enough to necessitate more stringent interconnection requirements

164 Class D Facilities

Non-utility generator installations of 1,000 kVA to 5,000 kVA, where the stiffness ratio is at least 20, are identified as Class D installations.

This size of installation and available fault contribution can present a major risk to system safety and operations. The effect on Chugach system voltages and equipment, due to unacceptable constant or transient conditions from the installation, can be serious. Due to the capacity of Class D facilities, islanding is of major concern to Chugach. Accordingly, greater levels of interconnection protective equipment are required for Class D systems.

Class D installations require detailed and careful system studies to determine the amount and degree of interconnection and interface requirements, as they are capable of having a major influence on the Chugach connecting feeder(s), adjacent feeders, and substations.

SECTION 2: INTERCONNECTION PROCESS AND APPLICATION PROCEDURES

210 Objectives

This portion of the interconnection guidelines contains an overview of the process and required procedures to interconnect Producer-owned generation with the Chugach system. It also provides both administrative and technical guidelines to assist the applicant in obtaining interconnection with the Chugach electrical system in an efficient and consistent manner.

A Producer intending to operate generation in parallel with the Chugach system is required to complete an "Initial Application for Operation of Producer-Owned Generation." The time required to complete the process generally depends on the complexity of the proposed project. The applicant must provide Chugach with a complete design package, so that Chugach may classify the generating system, review the interconnection facilities, and analyze the impact of the proposed interconnection on the Chugach system. Projects using previously submitted designs, which have been satisfactorily "type-tested", usually move through the process steps more quickly. Several of the process steps may be satisfied with an initial application, based on the detail and completeness of the application and supporting documentation submitted by the applicant. However, proposed, type-tested systems do not preclude the applicant from providing Chugach with a complete design package.

220 Authority

The state regulatory agency having authority over the supply of electrical service requires Chugach to provide safe, adequate, efficient, and reasonable service. Chugach's interconnection requirements comply with Chugach's Tariff as filed with and approved by the Regulatory Commission of Alaska, as well as Chugach's Electrical Service Standards & Requirements. Any party desiring to interconnect and operate non-utility generation in parallel with the Chugach electrical system must comply with the requirements contained in these Interconnection Guidelines.

230 Process Review and Responsibilities

The following process is designed to provide the Applicant with an understanding of the information and steps necessary to allow Chugach to review the Applicant's proposal and provide authorization for interconnection in a reasonable and expeditious manner.

240 Cost Reimbursement

Chugach will estimate its costs related to the applicant's proposed interconnection. The applicant will be responsible for full payment of the costs Chugach would not have incurred but for the applicant's interconnection.

Step 1: Preliminary Coordination & Application

Procedure	Description	Estimated Duration
A. Initial Communication	The initial communication could range from a general inquiry via telephone, to an appointment with Chugach for general discussion and submittal of an Initial Application. To schedule an appointment, contact Chugach's Engineering Services Division.	Typically 1 day.
B. Data Collection	From the initial communication, or subsequent meetings with Chugach, the applicant should have a clear definition of the required technical data and information regarding the proposed interconnection. To help expedite application processing, Chugach will also provide guidance as to whether both the Initial and Final Applications should be submitted before commencement of application processing. To note, additional information may become necessary during *Step 2: Application Processing*. Chugach will coordinate with the applicant, in an expedient manner, to resolve any additional information issues.	Variable, depending on project and/or class of Facility.
C. Application Submittal and Review	When the applicant files the completed application, Chugach will perform a brief review of the submittal to determine if any additional information is required. The applicant will be responsible for payment of processing fees, as required, to cover Chugach's administrative costs. Within five business days of receiving the application(s), Chugach will respond in writing to the applicant, noting receipt of the application. If no discrepancies are noted, application processing will begin upon receipt of processing fees from the applicant.	Typically 5 business days.

Step 2: Application Processing

Procedure	Description	Estimated Duration
A. Application Processing - Class A and B Facilities	Application processing generally involves: *a)* Payment of processing fees (*see Step 1, C*). *b)* Performance of system analyses and studies, as required, to assess specific interconnection requirements and necessary system modifications; *c)* Determination of facility-specific operating parameters. *d)* Assessment of any specific requirements in addition to the general requirements outlined in the Interconnection Guidelines.	Typically, not to exceed 30 calendar days.
B. Application Processing - Class C and D Facilities	Application processing generally involves: *a)* Payment of processing fees (*see Step 1, C*). *b)* Performance of system analyses and studies, as required, to assess specific interconnection requirements and necessary system modifications; *c)* Determination of facility-specific operating parameters; *d)* Determination of specific telemetry and control requirements; *e)* Review and assessment of applicable code and standards issues associated with the proposed interconnection.	Generally, up to 42 calendar days.
C. Response to Application	Chugach will provide a written response regarding the proposed interconnection. This will include notice of any facility-specific interconnection requirements, and will address any outstanding issues or cost items, which the applicant may be responsible for.	

Step 3: Interconnection Design Review & Coordination

Procedure	Description	Estimated Duration
A. Draft Final Design Submittal	The applicant will develop a draft final interconnection design based on the information in Chugach's Response to Application and submit it to Chugach for review and coordination to develop the final design. In its "Response to Application" *(see Step 2, Procedure C*) Chugach, will provide definition on specific content necessary in the draft final design package.	Applicant's responsibility.
B. Final Design Review and Coordination	This procedure involves Chugach's review and coordination of the submitted final design. Chugach may assign a Project Manager, responsible for design review, project schedule coordination (with Chugach), and any necessary system modifications. If system modifications are necessary to accommodate the proposed interconnection, a Chugach work order shall be initiated to perform these modifications, billable to the Applicant. A preliminary cost estimate will be provided to the applicant prior to finalization of the work order design. After Chugach approves the final interconnection design, a 'Provisional Interconnection Agreement' can be executed between the Applicant and Chugach, and construction can proceed.	Variable; dependent on scope of project.

Step 4: Construction, Inspection, and Acceptance

Procedure	Description	Estimated Duration
A. Provisional Interconnection Agreement	With Chugach approval of the applicant's final design, and written agreement that the applicant will bear all costs associated with Chugach system modifications (as necessary), Chugach will authorize construction of the interconnection via the Provisional Interconnection Agreement. This agreement allows the applicant to proceed with construction and to perform subsequent testing to ensure that the interconnection is safe, adequate, and reliable.	Dependent upon Parties.
B. Construction and Final Inspection	The applicant may proceed with interconnection construction, coordinating with Chugach for periodic inspections, and final interconnection inspection. Periodic inspections (and final inspection) will be performed, at the discretion of Chugach, to ensure that that the interconnection facilities meet the specifications of the approved final design	Variable.
C. Final Acceptance and Cost Reconciliation	Following the completion of construction, Chugach will proceed with interconnection functional acceptance testing, as needed, to ensure that the protection system set points, synchronizing capabilities, and power quality are acceptable under the full range of facility operating characteristics. Prior to provision of the Final Interconnection Agreement the Applicant shall reimburse Chugach for all costs associated with application processing, and/or system modification work orders.	Variable.
D. Final Interconnection Agreement	With completion of Final Interconnection Acceptance and Cost Reconciliation, the final agreement can be executed between the Applicant and Chugach.	Dependent upon parties.

SECTION 3: GENERAL REQUIREMENTS

310 Design Requirements

311 Design Documentation and Information

For Chugach review and reference purposes, the Producer shall submit the following information and design documentation with the interconnection application(s) (Refer to *Appendix I: Applications for Interconnection*). In certain cases, such as smaller-class facilities, some submittal requirements may be waived, at Chugach's discretion. All of the Producer's interconnection final design plans and drawings shall be approved by an electrical engineer, registered and recognized as a Professional Engineer in the State of Alaska. This approval shall be indicated by the presence of the engineer's professional seal on all drawings and documents.

A. One-Line Diagram

This is a schematic electrical drawing with sufficient detail to show the major elements of the facility electrical connections, interconnection and protective equipment, and point of interconnection to the Chugach electrical system. The diagram should include the following:

- Generating equipment
- Circuitry of the facility, to include conductor types, sizes, and bus electrical ratings
- Metering points and instrument transformers (as applicable)
- Interconnection transformer
- Relays and circuit breakers/interrupting devices
- Switchgear (as applicable)
- Utility circuitry at the point of interconnection

B. Three-Line Diagram (as required)

This schematic electrical drawing shall represent all three phases and neutral connections of the interconnected facility circuits, showing potential transformer (PT) and current transformer (CT) ratios and details of their configuration, including relays, meters, and test switches.

C. Relay, Metering, and Telemetering Functional Drawing

This diagram shall indicate the functions of the individual relays, metering, and telemetering equipment, if any. For simpler systems, such as some Class A facilities, the one-line diagram and the functional diagram can be combined.

D. Paralleling Device Control Drawings

These drawings shall show the conditions, relays, and instrument transformers that cause all switchgear and/or circuit breakers applied to the interconnecting facility to open or close. The source of power for each control should be clearly indicated in the drawings. For simpler systems, such as Class A facilities, these control drawings can be incorporated in the one-line diagram.

E. Facility Grounding Drawings

These drawings shall indicate ground wire sizes, bonding, and connections, as well as the number, size, and type of electrodes, and spacing. The Producer's grounding scheme shall conform to IEEE Std. 1547, Part 4.1.2: Integration with Area EPS Grounding.

In addition to the above, the Producer shall provide to Chugach any additional design information or documents pertaining to the interconnected facility, as requested.

312 Protective Systems and Equipment

Control and protection designs for facilities proposed to operate in parallel with the Chugach system must be approved by Chugach prior to approval for interconnection with the Chugach electric grid.

The specific design of the protection system depends on the generator type, size, and other site-specific considerations. The Producer must meet Chugach requirements, and all designs and equipment must conform to the National Electrical Code, the National Electrical Safety Code, IEEE standards, and all federal, state, local, and municipal codes.

When proposing protective devices for the protection of the Chugach system, the applicant shall submit a single-line drawing of this equipment to Chugach for approval of the interconnection protective functions and equipment (see *Section 311: Design Documentation and Information*). Any changes required by Chugach must be made prior to final acceptance, and Chugach must be provided with dated copies of the final drawings. ***To eliminate unnecessary costs and delays, the final design should be submitted to, and approved by Chugach prior to ordering equipment and the commencement of construction***.

Chugach will approve only those portions of the Producer's system designs, which apply to the interconnection with, and protection of, the Chugach system. Chugach may comment on other areas, which appear to be incorrect or deficient, but will not assume responsibility for the correctness of protection pertaining to the Producer's system.

In order to gain approval for interconnected operation, At the completion of construction the Producer shall demonstrate to designated Chugach personnel conformance to the testing specifications and requirements contained in IEEE Standards 1547 and 1547.1 for all protective and control systems associated with the Producer's interconnection equipment. The Producer shall provide documentation of test results, protective relay settings, and control system settings to Chugach.

313 Chugach System Modifications

Any modification to the Chugach electric grid, such as the installation of additional equipment, reconductoring of all or a portion of the connecting Chugach line, or reconfiguration of Chugach protection systems necessary to permit in-parallel operation with the Chugach electric grid, will be performed by Chugach.

Where such Chugach system modifications are required to allow the interconnection of the Producer's facilities, Chugach will perform these modifications, at the Producer's expense, providing all labor, materials, and equipment necessary.

320 Design Information--Chugach System

321 Standard System Voltages

Chugach's standard system voltages conform to ANSI C84.1 standards, and are outlined as follows. All distribution circuits, both secondary and primary, are effectively grounded. Specific voltage requirements and limits for Producer's generation are described in *Section 5: Interconnected Operating Requirements*.

- Distribution Secondary Voltages:

  Single-phase, 120/240 volts, 3 wire
  Single-phase, 240/480 volts, 3 wire
  Three-phase, 120/208 volts, 4 wire, grounded wye
  Three-phase, 277/480 volts, 4 wire, grounded wye

- Distribution Primary Voltages:

  Single-phase, 7200 volts
  Single-phase, 14,400 volts
  Three-phase, 2,400/4,160 volts, 4 wire, grounded wye
  Three-phase, 7200/12,470 volts, 4 wire, grounded wye
  Three-phase, 14,400/24,900 volts, 4 wire, grounded wye

- Transmission Voltages:

  34,500 volts, three-phase
  115,000 volts, three-phase
  138,000 volts, three-phase
  230,000 volts, three-phase

330 Induction Generators

Induction generators require varying amounts of reactive electric power (VArs) in order to produce real electric power (watts). Due to this consumption (or absorption) of VArs, induction generators inherently operate at leading power factors. It is the responsibility of the Producer to provide all reactive support or compensation to maintain power factors within the limits specified in *Section 570: Power Factor Requirements*, when operating in parallel with the Chugach electric grid. Reactive support for required power factor correction may be provided by the Producer's installation of Chugach approved reactive compensation devices, or through contractual agreement with Chugach to provide ancillary services to the Producer.

340 Power Converter Systems

Reactive power supply requirements for converter systems are similar to those for induction generators, and the general guidelines discussed in Section 330 apply.

Chugach requires that power converter systems conform to the requirements contained in IEEE Standard 1547 and 1547.1, and that such systems for interconnected generation sources meet the recommended limits for current, voltage, and harmonic distortion contained in IEEE Std. 519, Sections 10 and 11. If the Producer's converter system(s) is found to interfere with the Chugach electric grid, Chugach consumers, or other power producers, the Producer may be required to install adequate electrical filtering to bring the voltage and current outputs to acceptable levels. Converters that have been tested and certified by an independent laboratory, such as Underwriters' Laboratories (UL), to be non-islanding, and meet the recommended limits contained in IEEE Std. 519, Sections 10 and 11, may be interconnected to the Chugach system as-is.

For units rated less than 100 kW, it is usually acceptable to have the frequency and voltage protective functions built into the electronics of the converter if the set points of those functions meet IEEE Std. 1547 criteria, are tamperproof, and can be easily and reliably tested.

SECTION 4: INTERCONNECTION EQUIPMENT REQUIREMENTS

410 Introduction

In order to simplify the process for determining the interconnection equipment necessary to operate non-utility generation in parallel with the Chugach electric system, Chugach has developed this section, which outlines the minimum interconnection requirements for each class of Producer-owned facilities.

As a minimum, Chugach requires that all of the Producer's interconnection equipment and facilities meet the requirements contained within IEEE Std. 1547, Part 4.1: General Requirements.

420 Overview of Required Equipment

This overview of required equipment and devices provides general descriptions as to the components, including functionality, purpose, and responsibilities by both the Producer and Chugach regarding ownership, installation, and maintenance.

Specific requirements for each classification of Producer-owned interconnected generation can be found in *Section 430: Interconnection Equipment Requirements By Class*.

421 Metering Requirements

For all classifications of parallel generating facilities, Chugach requires that separate "In-and-Out Metering" be utilized to capture the real power flows (watt-hours) into and out of a Producer's facility.

It is the Producer's responsibility to provide, install, and maintain all facilities necessary to accommodate Chugach metering. Chugach shall provide all meters at the Producer's expense. Depending upon the specific application, required metering may also include the following:

- VAr-hour metering
- Real power (watt) demand metering
- Reactive power (VAr) demand metering
- Time-of-delivery metering

422 Interconnection Disconnect Device

A Chugach approved manual disconnect device must be provided as a means of electrically isolating the non-utility generating facility from the Chugach system, and establishing working clearances for maintenance and repair work in accordance with Chugach safety rules and practices.

This manual disconnect device must be securable and readily accessible by Chugach personnel, and provide visible verification of disconnection from the Chugach electric grid. For connections to the Chugach transmission grid, a tap line switch may also be required if, in Chugach's judgment, sufficient tap line exposure exists to warrant it.

In all cases, unless expressed written permission is provided by Chugach, the disconnect device shall be located on the Chugach side of the interconnection point. At the Producer's expense, Chugach shall install the device and assume ownership and maintenance responsibilities. Only devices specifically approved by Chugach shall be used.

The manual disconnect device must be physically located for ease of access and visibility to Chugach personnel. The disconnect device shall be identified with a Chugach-designated switch number plate.

The disconnect device shall not be used by the Producer to make or break parallels between the Chugach system and the Producer's generator(s). The device enclosure and operating handle (when present) must be kept locked at all times with Chugach padlocks.

Disconnect devices must meet the following minimum physical requirements for approval by Chugach:

- Must be located near the facility metering;
- Must be externally operable without exposing the operator to contact with live parts and, if power-operable, of a type that can be opened by hand in the event of a supply failure;
- Must provide a visible-break indication, showing whether in the open or closed position;
- Must have ratings not less than the load and fault current to be carried;
- For disconnect equipment energized from both sides, a marking shall be provided to indicate that all contacts of the disconnect equipment may be energized;
- Must be gang-operated if three-phase;
- For outdoor installations, disconnect devices must be weather-proof or designed to withstand exposure to weather;
- Must be lockable in both the open and closed positions.

423 Interconnection Transformer

Functionally, the interconnection transformer is no different from any other service transformer, which transforms Chugach's nominal voltages from one level to another. What distinguishes this device from a standard service transformer is that it must serve to interconnect the Producer's generating facilities to the Chugach system.

Of major concern to Chugach is the possibility that adverse power quality or service interruptions may be experienced by Chugach consumers, which are served by the same transformer that interconnects the Producer's generating facilities. Under certain conditions, the utilization of a dedicated interconnection transformer may be required to limit such adverse conditions.

A dedicated transformer, as defined in these guidelines, is one that is dedicated to serving the Producer's facility; no other Chugach consumers shall be connected on the secondary side of the transformer. The purpose of a dedicated transformer is to minimize any adverse impacts to Chugach consumers, which may result from the parallel operation of Producer-owned facilities.

Generally, for smaller installations (Class A and B facilities), a dedicated transformer will not be required. However, this will be evaluated on an individual basis for each Applicant requesting to interconnect to the Chugach system.

For Class C and D facilities, a dedicated transformer will be required in all cases. For these sizes of facilities, there will typically be a dedicated Chugach transformer in place if the Producer's facility contains existing loads served by Chugach. Where this is not the case, a dedicated interconnection transformer will need to be installed.

The specific conditions under which a dedicated transformer is required are addressed for each class of facilities in this section of the guidelines. Where a dedicated transformer is required to allow the interconnection of the Producer's facility(s), the Producer will be responsible for the associated labor and equipment costs.

424 Protection and Control Devices

Certain protective functions and control equipment are necessary to ensure that both the safety and reliability of the Chugach system are maintained. While the Producer is responsible for the installation and maintenance of such equipment, it should be noted that the required equipment outlined in this section apply *only* to the protection of the Chugach system, not the Producer's facilities. Typically, the minimum protective and control equipment

requirements for all classifications of Producer-owned facilities are as follows:

- Paralleling Device (controlled switchgear and/or circuit breaker)
- Anti-Islanding Protective Functions

  Overvoltage Protective Relaying

  Undervoltage Protective Relaying

  Overfrequency Protective Relaying

  Underfrequency Protective Relaying
- Synchronization Protection:

  Synchronous Generators: Automatic Synchronizing with Relay Supervision

  Induction Generators: Speed Matching Relaying

  Power Converter Systems: Conform to the requirements of IEEE Standard 1547, Parts 4.1.3 and 5.1.2.C.

Due to the impact that larger facilities can have on the Chugach system, additional requirements can be necessary for such facilities, including but not limited to:

- System Fault Protection Functions

  Ground Overcurrent Protective Relaying

  Phase-fault Protective Relaying
- Transfer Trip Capability
- Export Power Control Equipment

  Voltage Regulator/Power Factor Controller

  Direct Digital Control (Chugach SCADA Control)

  Power System Stabilizer

425 Telemetry and Monitoring Requirements

Telemetry generally involves the communication of measured outputs from the Producer's generating facility to Chugach. This can include variables such as the status of equipment and controller functions, as well as plant output data (voltage, real and reactive power, power quality, etc.). Typically, variables are transmitted with the aid of a communication channel that permits the measurement to be interpreted at a distance from the primary detector.

For smaller facilities, such as Class A and B installations, data telemetry is generally not required.

For the larger classifications of facilities (Classes C and D), telemetering of data to include interconnection status, power flows (real and reactive power) and voltage will be required.

For specific telemetering requirements, refer to *Section 430,Interconnection Equipment Requirements by Class.*

426 Operational Data Logging

Typically, operational data logs include recorded information on generating unit operations such as the following:

- Key operational parameters such as voltage, real and reactive power, frequency, etc.;
- Protective equipment operations (circuit breaker trips, protective relay targets, etc.);
- Time and nature of communications with Chugach Power Control Department personnel.

For smaller sized facilities, such as Classes A and B, operational data logging is not required, but when such data is available or maintained by the Producer, it shall be provided to Chugach upon request.

For Class C and D facilities, a seven (7) day digital data logger is required. For specific parameter recording requirements, refer to *Subsection 430: Interconnection Equipment Requirements by Class*, for Class C and D facilities.

427 Export Power Control Equipment

For cases where the Producer and Chugach formulate a Power Purchase Agreement for export power from the Producer's facility, special control equipment may be necessary depending upon the specific performance terms of the agreement.

Generally, special control equipment will not be necessary for relatively smaller generating facilities such as Class A and B facilities. Having larger generating capability and capacity, Class C and D facilities may export substantial amounts of power into the Chugach distribution system, thus these classes of facilities may require export power control equipment. This equipment may include Voltage Regulation Control, Power Factor Controllers, and Power System Stabilizers, depending on the specific

determination. Refer to the specific requirements for Class C and D under *Subsection 430* for further information.

428 Protection & Control System Testing Conformance

In all cases, the Producer's protective relays and controls systems associated with the interconnection shall adhere to the requirements contained in IEEE Std. 1547.1

To allow performance and verification of functional testing as required, these systems shall have accessible sensing inputs or testing terminal blocks, or acceptable equivalents as determined by Chugach.

430 Interconnection Equipment Requirements By Class

430A: Equipment Requirements - Class A Facilities

I. Application of Minimum Requirements – Class A Facilities

This portion of the Interconnection Guidelines addresses the general minimum interconnection equipment necessary for Class A generating facilities. Specific requirements for each individual proposed facility may vary, depending on factors such as the location of the interconnection, the number and proximity of adjacent Chugach consumers, and the characteristics of the facility proposing to interconnect to the Chugach system.

Chugach has developed these minimum requirements based on the following assumptions as to the nature of the electric system at the point of interconnection, and the utilization of the Producer's energy:

1. The total non-utility generating capability (kVA), singular or aggregate, on the interconnecting Chugach feeder is less than 10 percent of the averaged annual hourly peak demand (kVA) for that feeder.

2. Interconnections to the Chugach distribution system are typically made at Chugach's standard secondary voltages on individual secondary circuits.

3. The Producers' generation is generally sized to meet all or a portion of the Producer's load at the point of interconnection.

4. Class A installations are assumed to connect only to single-phase portions of the Chugach system.

Where proposed interconnections fall outside of the above parameters, modifications to the minimum requirements may be necessary in order to

maintain the safety, reliability, and operational performance of the Chugach system.

II. Metering Requirements – Class A Facilities

In general, Chugach only requires in/out watt-hour metering for Class A facilities. Metering facilities shall be installed as shown in Figures A-1 and A-2.

III. Interconnection Disconnect Device – Class A Facilities

An approved manual disconnect device is required for all Class A installations (Refer to *Subsection 422: Interconnection Disconnect Device,* and Figure A-1).

IV. Interconnection Transformer – Class A Facilities

Generally, for Class A installations, a dedicated transformer for interconnecting the Producer's facility is not required. However, under certain conditions the utilization of a dedicated transformer may be required. Examples of such conditions would include the following:

1. The Producer's total rated generating capability is at or above the rating of the existing Chugach transformer serving the Producer's facilities.

2. The Producer's electrical system characteristics differ from Chugach's standard distribution voltages and configurations (Refer to *Subsection 321: Standard System Voltages*).

3. The Producer's facility adversely impacts the quality of power delivered to adjacent Chugach secondary distribution system consumers (Refer to *Section 5: Interconnected Operating Requirements*).

Where the installation of a dedicated transformer is required, the Producer will be responsible for all labor and material costs associated with the installation.

V. Protection and Control Devices – Class A Facilities

The general interconnection protective and control requirements for Class A installations are as follows:

1. Paralleling Device

a) A Chugach-approved circuit breaker is required to allow separation of the Producer's generation from the Chugach system during fault conditions.

b) This device must be capable of withstanding 220% of the Chugach system voltage at the point of interconnection must have sufficient interrupting capacity to interrupt the maximum available fault current at its location, and be locked out when operated by the protective relays required for interconnection.

2. Over/Under Voltage Protection

The Producer's overvoltage and undervoltage interconnection protective functions shall detect voltage at the point of interconnection, and shall open the paralleling device within the times specified in the table below, if the voltage is within the stated ranges.

Voltage Range [V] (% of nominal voltage[a])	**Clearing Time[b] (seconds)**
V < 50%	0.16
50% ≤ V < 88%	2.00
110% < V < 120%	1.00
V ≥ 120%	0.16

[a] Nominal system voltages stated in ANSI Std. C84.1-1995, Table 1.
[b] Maximum clearing time

3. Over/Under Frequency Protection

The Producer's over-frequency and under-frequency interconnection protective functions shall open the paralleling device within the times specified in the table below, if the frequency is within the stated ranges.

Frequency Range [*f*] (Hz)	**Maximum Clearing Time (seconds)**
f > 60.5	0.16
f < 59.5	0.16

4. Synchronization Protection

For parallel operation, the Producer's facilities shall meet the requirements pertaining to synchronization specified within IEEE Std. 1547, Parts 4.1.3 and 5.1.2. Specific equipment requirements are as follows:

a) Synchronous Generator Interconnection

Synchronous generators operated in parallel with the Chugach electric system are required to have automatic relay supervision (Device No. 25) to verify synchronism for permissive closure of the interconnection circuit breaker. Manual synchronizing systems

are not approved for interconnected operation with the Chugach system.

b) Induction Generator Interconnection

Due to the 'slip' inherent to induction generators, synchronous operation cannot be precisely maintained when operating in parallel with the Chugach system. Therefore, Chugach requires that speed-matching relaying (Device No. 15) be utilized, set to permit breaker (or contactor) closing when generator speed is maintained above 95 percent of the Chugach system synchronous speed at the point of interconnection.

c) Power Converter Interconnection

Power converter systems that produce a fundamental voltage before the paralleling device is closed are capable of stand-alone operation, thus shall be tested to meet the requirements as outlined in IEEE Std. 1547, Part 5.1.2.A. All other power converter based systems shall meet the requirements contained in IEEE 1547, Part 5.1.2.C.

5. Ground Fault Protection

In general, Class A facilities may interconnect to the Chugach system without the provision of ground fault protection to limit contributions to ground faults on the Chugach system. However, in accordance with IEEE 1547, Part 4.2.1, the Producer's interconnection equipment must be demonstrated to cease energization of, and disconnect from the Chugach system under fault conditions.

VI. Telemetry and Monitoring – Class A Facilities

1. Telemetry

A telephone or data line service at the metering point is required for Chugach's meter telemetry. This line may be shared or dedicated; monthly charges will be paid by the non-utility generator.

2. Monitoring

Typically, Chugach will not require power quality monitoring for Class A facilities. However, where Chugach determines that there is either a potential or an indication that the output from the Producer's facility can adversely affect the standard performance of the Chugach electric system, or the quality of power delivered to Chugach consumers, power quality monitoring will be required.

VII. Operational Data Logging – Class A Facilities

For Class A facilities, Chugach generally will not require the installation of operational data logging equipment. However, as available or maintained by the Producer, such logs will be made available to Chugach upon request.

VIII. Export Power Control Equipment – Class A Facilities

Generally, for Class A facilities, control equipment for export power is not required. In certain cases, depending upon the specific contractual agreement between Chugach and the Producer, additional control equipment may be necessary to control the amount and quality of export power. Such cases will be reviewed on an individual basis.

IX. Equipment Requirements Summary – Class A Facilities

Table 5-A
Interconnection Equipment Requirements Summary
Class A Facilities (10 kVA and Less)

Equipment	Requirement
All Installations	
Approved Disconnect Means	Required
Dedicated Transformer	Not Required (See Note 1)
In/Out Metering	Required
Paralleling Device	Required
Undervoltage Protection	Required
Overvoltage Protection	Required
Underfrequency Protection	Required
Overfrequency Protection	Required
Ground Fault Protection	Not Required (See Note 2)
Transfer Trip Capability	Not Required
Phase-fault Protection	Not Required
Telemetry Capability	Required
Power Quality Monitoring	See Note 3
Export Power Control Equipment	See Note 3
Voice and Data Communication Capability	Required (See Note 4)
Operational Data Logging	Not Required
Synchronous and Similar Type Generators	
Automatic Synchronizing w/ Relay Supervision	Required
Induction Generators	
Speed Matching Relaying	Required
Power Converters	
Automatic Synchronizing w/ Relay Supervision	See Note 5

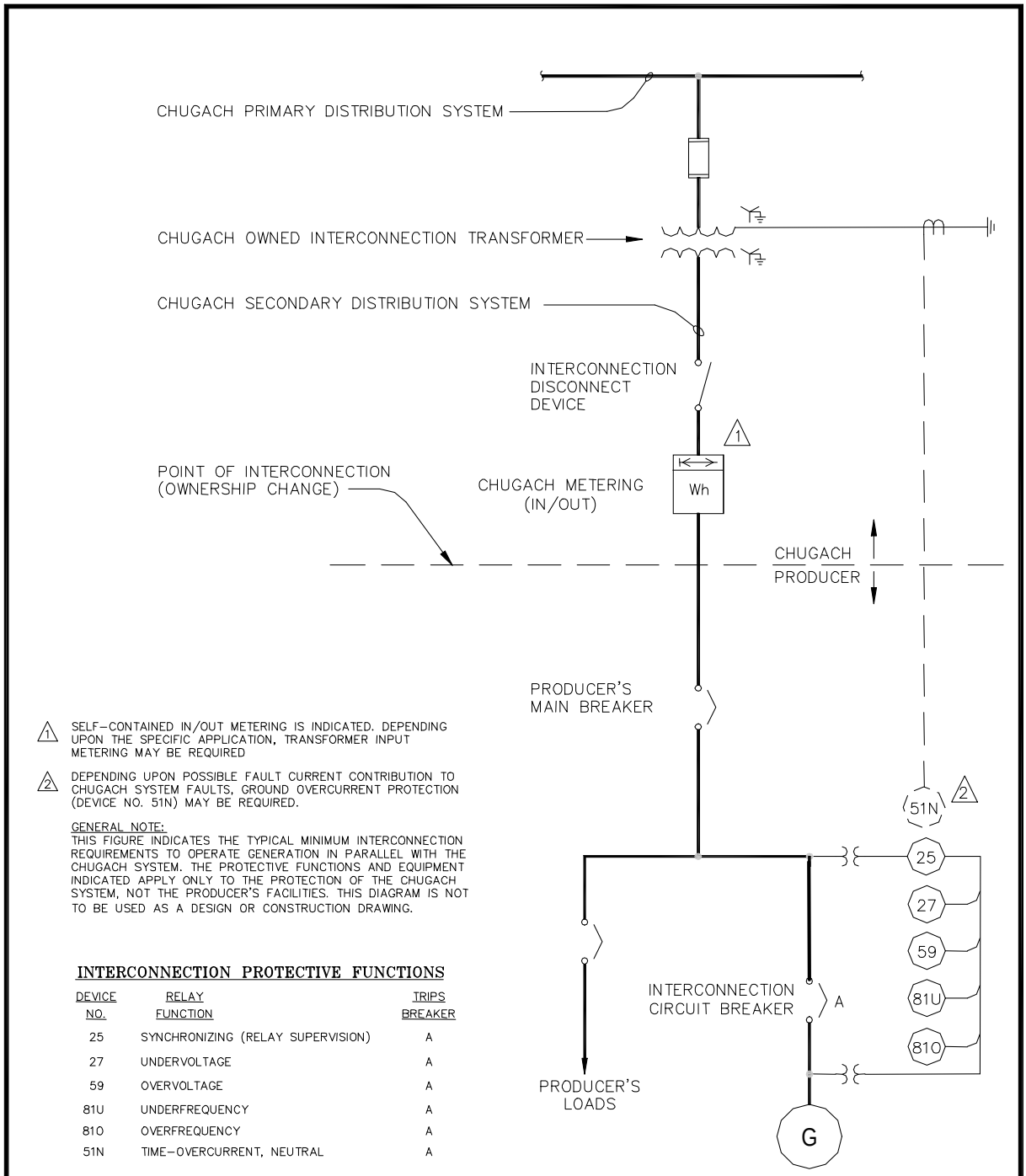
Note 1: Generally, a dedicated transformer will not be required. However, the requirement will depend on specific facility characteristics.

Note 2: Ground fault protection is generally not required for Class A facilities, but facility must meet IEEE 1547, Part 4.2.1

Note 3: Requirements will depend on specific contractual agreements, and will be assessed on an individual basis.

Note 4: A 24-hour contact phone number must be provided to Chugach. Typically, data communications capability will not be required.

Note 5: Typically not required for power converters, however the requirement will be evaluated on an individual basis.



INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
810	OVERFREQUENCY	A
51N	TIME-OVERCURRENT, NEUTRAL	A

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Dir., Engineering Svcs. Div.:_____

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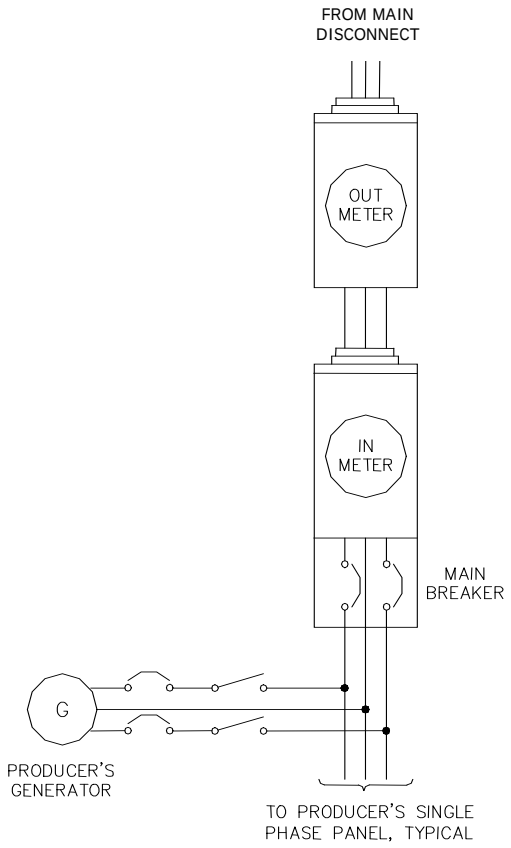
FIGURE A-1

TYPICAL SECONDARY SYSTEM INTERCONNECTION CLASS A FACILITIES (10KVA AND LESS)

DRAWING NUMBER NUG_FIGA-1 SHEET 1 OF 1



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& Support _____

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FIGURE A-2

TYPICAL METERING DIAGRAM
CLASS A FACILITIES (10KVA AND LESS)

DRAWING NUMBER NUG_FIGA-2 SHEET 1 OF 1

430B: Equipment Requirements - Class B Facilities

I. Application of Minimum Requirements – Class B Facilities.

This portion of the Interconnection Guidelines addresses the general minimum interconnection equipment necessary for Class B generating facilities. Specific requirements for each individual proposed facility may vary, depending on factors such as the location of the interconnection, the number and proximity of adjacent Chugach consumers, and the characteristics of the facility proposing to interconnect to the Chugach system.

Chugach has developed these minimum requirements based on the following assumptions as to the nature of the electric system at the point of interconnection, and the utilization of the Producer's energy:

1. The total non-utility generating capability (kVA), singular or aggregate, on the interconnecting Chugach feeder is less than 15 percent of the averaged annual hourly peak demand (kVA) for that feeder.

2. The Producer's generation is generally sized to meet all or a portion of the Producer's load at the point of interconnection.

3. Interconnections to the Chugach distribution system are typically made at Chugach's standard secondary voltages on individual secondary circuits (Refer to Figure B-1).

Where proposed interconnections fall outside of the above parameters, modifications to the minimum requirements may be necessary in order to maintain the safety, reliability, and operational performance of the Chugach system.

II. Metering Requirements – Class B Facilities

In general, Chugach only requires in/out watt-hour metering for Class B facilities. Additional metering requirements will depend on the specifics of the contractual agreements between Chugach and the Producer.

III. Interconnection Disconnect Device – Class B Facilities

An approved manual disconnect device is required for all Class B installations (Refer to *Subsection 422: Interconnection Disconnect Device*, and Figure B-1).

IV. Interconnection Transformer – Class B Facilities

Generally, for Class B installations, a dedicated transformer for interconnecting the Producer's facility is not required. However, under certain conditions the utilization of a dedicated transformer may be required. Examples of such conditions would include the following:

1. The Producer's total rated generating capability is at or above the rating of the existing Chugach transformer serving the Producer's facilities.

2. The Producer's electrical system characteristics differ from Chugach's standard distribution voltages and configurations (Refer to *Subsection 321: Standard System Voltages*).

3. The Producer's facility adversely impacts the quality of power delivered to adjacent Chugach secondary distribution system consumers (Refer to *Section 5: Interconnected Operating Requirements*).

Where the installation of a dedicated transformer is required, the Producer will be responsible for all labor and material costs associated with the installation.

V. Protection and Control Devices – Class B Facilities

The general interconnection protective and control requirements for Class B installations are as follows:

1. Paralleling Device

a) A Chugach approved circuit breaker is required to allow separation of the Producer's generation from the Chugach system during fault conditions.

b) This device must be capable of withstanding 220% of the Chugach system voltage at the point of interconnection, must have sufficient interrupting capacity to interrupt the maximum available fault current at its location, and be locked out when operated by the protective relays required for interconnection.

2. Over/Under Voltage Protection

The Producer's overvoltage and undervoltage interconnection protective functions shall detect voltage at the point of interconnection, and shall open the paralleling device within the times specified in the table below, if the voltage is within the stated ranges.

Voltage Range [V] (% of nominal voltage[a])	Clearing Time[b] (seconds)
V < 50%	0.16
50% ≤ V < 88%	2.00
110% < V < 120%	1.00
V ≥ 120%	0.16

[a] Nominal system voltages stated in ANSI Std. C84.1-1995, Table 1.
[b] For generators with base ratings up to 30 kW, maximum clearing times; for base ratings greater than 30 kW, default clearing times.

3. Over/Under Frequency Protection

The Producer's over-frequency and under-frequency interconnection protective functions shall open the paralleling device within the times specified in the table below, if the frequency is within the stated ranges.

Generator Base Rating	Frequency Range [*f*] (Hz)	Clearing Time[a] (seconds)
≤ 30 kW	*f* > 60.5	0.16
	f < 59.5	0.16
> 30kW	*f* > 60.5	0.16
	f < {59.8 – 57}	Adjustable 0.16 to 300[b]
	f < 57	0.16

[a] For generators with base ratings up to 30 kW, maximum clearing times; for base ratings greater than 30 kW, default clearing times.
[b] Chugach shall provide specific clearing times for each Producer interconnection.

4. Synchronization Protection

For parallel operation, the Producer's facilities shall meet the requirements pertaining to synchronization specified within IEEE Std. 1547, Parts 4.1.3 and 5.1.2. Specific equipment requirements are as follows:

a) Synchronous Generator Interconnection

Synchronous generators operated in parallel with the Chugach electric system are required to have automatic relay supervision (Device No. 25) to verify synchronism for permissive closure of the interconnection circuit breaker.

- Manual synchronizing systems are not approved for interconnected operation with the Chugach system.

b) Induction Generator Interconnection

Due to the "slip" inherent to induction generators, synchronous operation cannot be precisely maintained when operating in parallel with the Chugach system. Therefore, Chugach requires that speed-matching relaying (Device No. 15) be utilized, set to permit breaker (or contactor) closing when generator speed is maintained above 95 percent of the Chugach system synchronous speed at the point of interconnection.

c) Power Converter Interconnection

Power converter systems that produce a fundamental voltage before the paralleling device is closed are capable of stand-alone operation, thus shall be tested to meet the requirements as outlined in IEEE Std. 1547, Part 5.1.2.A. All other power converter based systems shall meet the requirements contained in IEEE 1547, Part 5.1.2.C.

5. Ground Fault Protection

In general, Class B facilities with a total generating capability less than 40 kVA may interconnect to the Chugach system without the provision of ground fault protection to limit contributions to ground faults on the Chugach system. However, in accordance with IEEE 1547, Part 4.2.1, the Producer's interconnection equipment must be demonstrated to cease energization of the Chugach system to which it is connected under fault conditions on the Chugach system.

Class B facilities with a total generating capability greater that 40 kVA may be required to provide ground fault protection (Device 51N), depending upon the possible fault current contribution from the Producer's facilities to Chugach system ground faults. The requirement will be determined on an individual basis by Chugach.

VI. Telemetry and Monitoring – Class B Facilities

1. Telemetry

A telephone or data line service at the metering point is required for Chugach's meter telemetry. This line may be shared or dedicated; monthly charges will be paid by the non-utility generator.

2. Monitoring

Generally, Chugach will not require power quality monitoring for Class B facilities. However, where Chugach determines that there is either a potential or an indication that the output from the Producer's facility can adversely affect the standard performance of the Chugach

electric system, or the quality of power delivered to Chugach consumers, power quality monitoring will be required.

VI. Operational Data Logging – Class B Facilities

For Class B facilities, Chugach generally will not require the installation of operational data logging equipment. However, as available or maintained by the Producer, such logs will be made available to Chugach upon request.

VII. Export Power Control Equipment – Class B Facilities

Generally, for Class B facilities, control equipment for export power is not required. In certain cases, depending upon the specific contractual agreement between Chugach and the Producer, additional control equipment may be necessary to control the amount and quality of export power. Such cases will be reviewed on an individual basis.

Table 5-B
Interconnection Equipment Requirements Summary
Class B Facilities (10 kVA to 100 kVA)

Equipment	Requirement
All Installations	
Approved Disconnect Means	Required
Dedicated Transformer	Not Required (See Note 1)
In/Out Metering	Required
Paralleling Device	Required
Undervoltage Protection	Required
Overvoltage Protection	Required
Underfrequency Protection	Required
Overfrequency Protection	Required
Ground Fault Protection	Not Required (See Note 2)
Transfer Trip Capability	Not Required
Phase-fault Protection	Not Required
Telemetry Capability	Required
Power Quality Monitoring	See Note 3
Export Power Control Equipment	See Note 3
Voice and Data Communication Capability	Required (See Note 4)
Operational Data Logging	Not Required
Synchronous and Similar Type Generators	
Automatic Synchronizing w/ Relay Supervision	Required
Induction Generators	
Speed Matching Relaying	Required
Power Converters	
Automatic Synchronizing w/ Relay Supervision	See Note 5

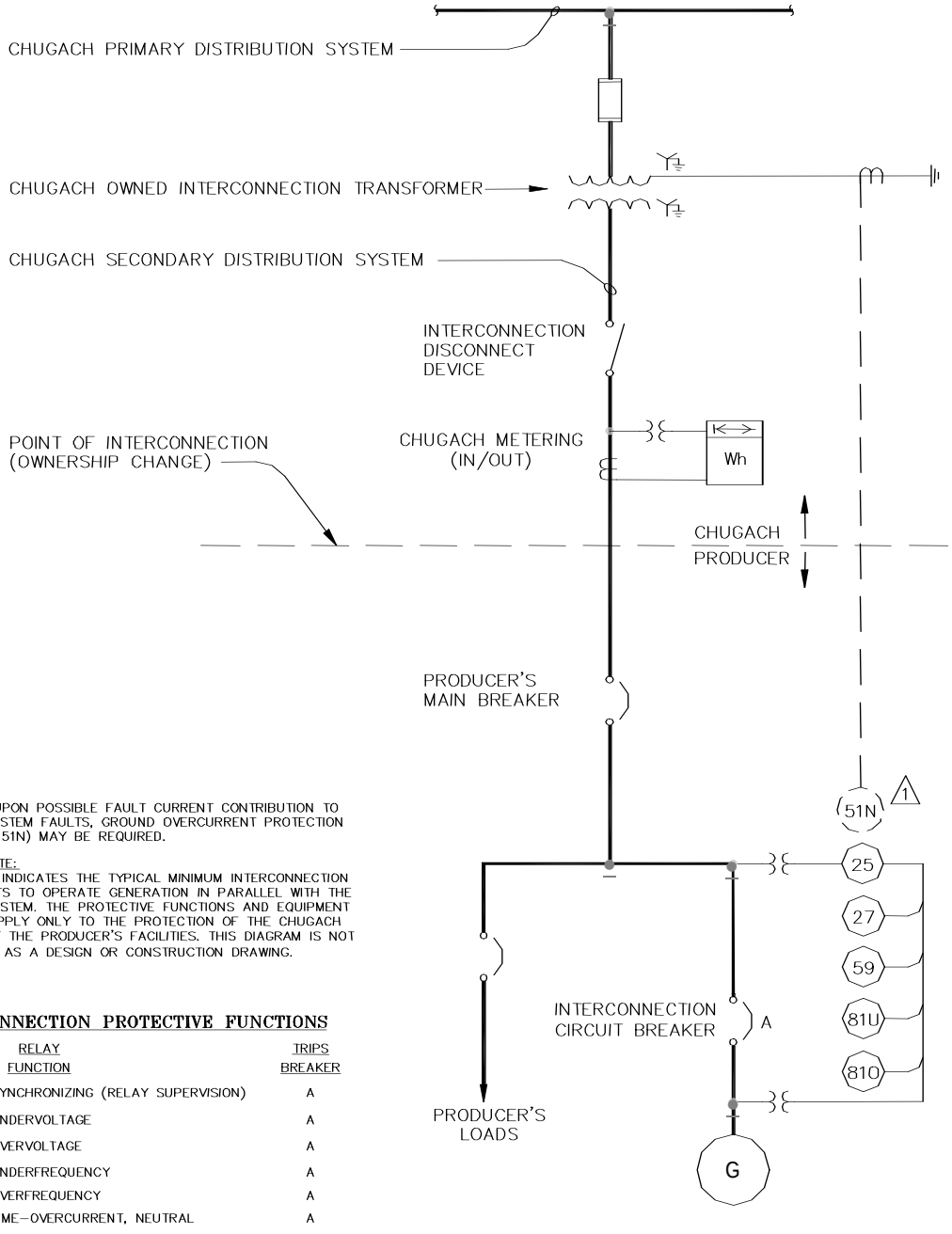
Note 1: Generally, a dedicated transformer will not be required. However, the requirement will depend on specific facility characteristics.

Note 2: Ground fault protection is generally not required for Class B facilities rated 40 kVA and lower. Specific requirements will be reviewed and determined on an individual basis.

Note 3: Requirements will depend on specific contractual agreements, and will be assessed on an individual basis.

Note 4: Voice communications capability required. Typically, data communications capability will not be required.

Note 5: Typically not required for power converters, however the requirement will be evaluated on an individual basis.



⚠1 DEPENDING UPON POSSIBLE FAULT CURRENT CONTRIBUTION TO CHUGACH SYSTEM FAULTS, GROUND OVERCURRENT PROTECTION (DEVICE NO. 51N) MAY BE REQUIRED.

GENERAL NOTE:
THIS FIGURE INDICATES THE TYPICAL MINIMUM INTERCONNECTION REQUIREMENTS TO OPERATE GENERATION IN PARALLEL WITH THE CHUGACH SYSTEM. THE PROTECTIVE FUNCTIONS AND EQUIPMENT INDICATED APPLY ONLY TO THE PROTECTION OF THE CHUGACH SYSTEM, NOT THE PRODUCER'S FACILITIES. THIS DIAGRAM IS NOT TO BE USED AS A DESIGN OR CONSTRUCTION DRAWING.

INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
81O	OVERFREQUENCY	A
51N	TIME-OVERCURRENT, NEUTRAL	A

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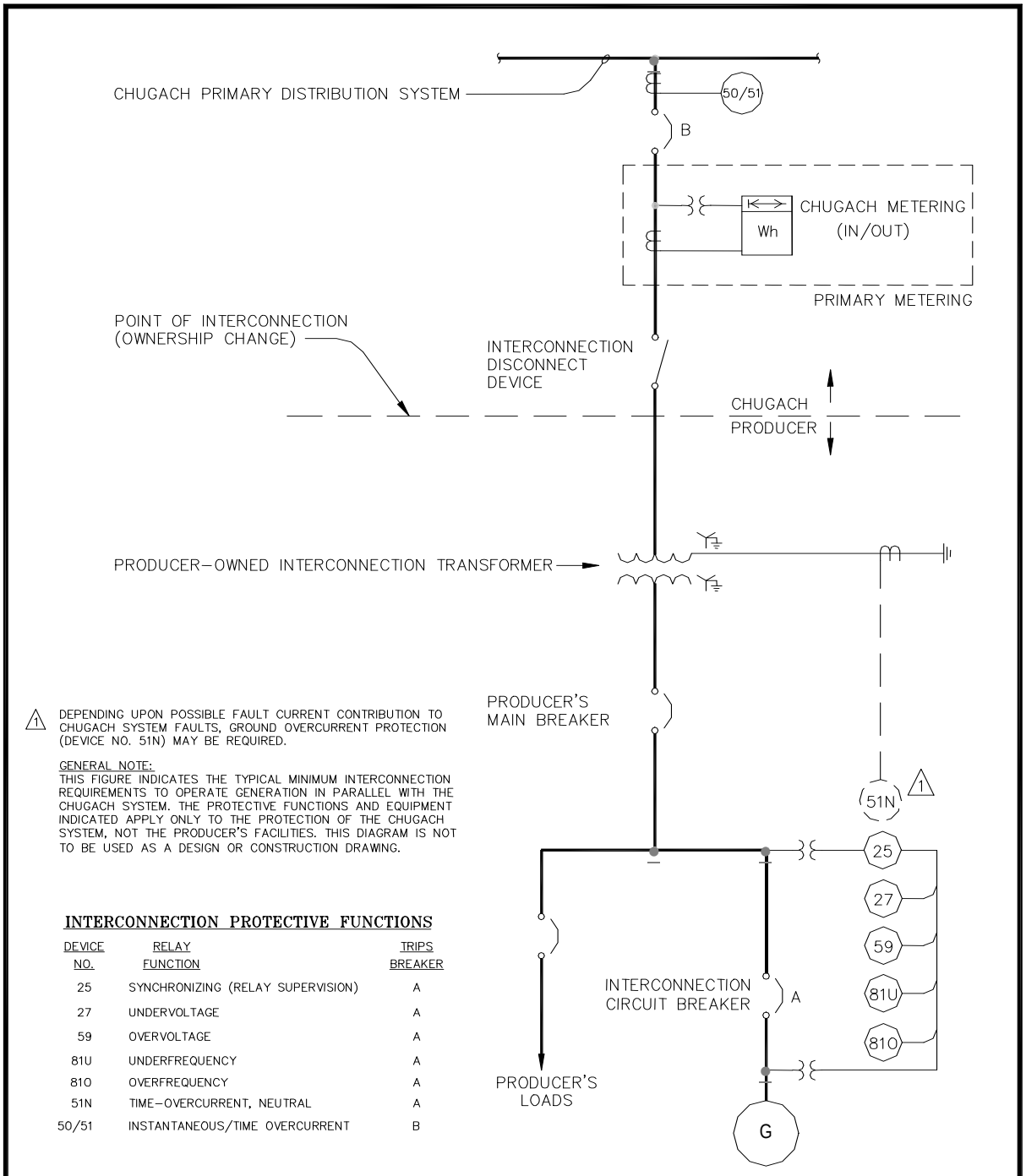
FIGURE B-1
TYPICAL SECONDARY SYSTEM INTERCONNECTION
CLASS B FACILITIES (10KVA TO 100KVA)

DRAWING NUMBER NUG_FIGB-1 SHEET 1 OF 1



1 DEPENDING UPON POSSIBLE FAULT CURRENT CONTRIBUTION TO CHUGACH SYSTEM FAULTS, GROUND OVERCURRENT PROTECTION (DEVICE NO. 51N) MAY BE REQUIRED.

GENERAL NOTE:
THIS FIGURE INDICATES THE TYPICAL MINIMUM INTERCONNECTION REQUIREMENTS TO OPERATE GENERATION IN PARALLEL WITH THE CHUGACH SYSTEM. THE PROTECTIVE FUNCTIONS AND EQUIPMENT INDICATED APPLY ONLY TO THE PROTECTION OF THE CHUGACH SYSTEM, NOT THE PRODUCER'S FACILITIES. THIS DIAGRAM IS NOT TO BE USED AS A DESIGN OR CONSTRUCTION DRAWING.

INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
81O	OVERFREQUENCY	A
51N	TIME–OVERCURRENT, NEUTRAL	A
50/51	INSTANTANEOUS/TIME OVERCURRENT	B

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FIGURE B-2

TYPICAL PRIMARY SYSTEM INTERCONNECTION
CLASS B FACILITIES (10KVA TO 100KVA)

DRAWING NUMBER NUG_FIGB–2 SHEET 1 OF 1

430C: Equipment Requirements - Class C Facilities

I. Application of Minimum Requirements – Class C Facilities

This portion of the Interconnection Guidelines addresses the general minimum interconnection equipment necessary for Class C generating facilities. Specific requirements for each individual proposed facility may vary, depending on factors such as the location of the interconnection, the number and proximity of adjacent Chugach consumers, and the characteristics of the facility proposing to interconnect to the Chugach system.

Chugach has developed these minimum requirements based on the following assumptions as to the nature of the electric system at the point of interconnection, and the utilization of the Producer's energy:

1. The total non-utility generating capability (kVA), singular or aggregate, on the interconnecting Chugach feeder is less that 20 percent of the averaged annual hourly peak demand (kVA) for that feeder.

2. The Producer's generation is generally sized to meet all or a portion of the Producer's load at the point of interconnection.

3. Interconnections to the Chugach distribution system are typically made at Chugach's standard secondary voltages on individual secondary circuits (Refer to Figure C-1).

Where proposed interconnections fall outside of the above parameters, modifications to the minimum requirements may be necessary in order to maintain the safety, reliability, and operational performance of the Chugach system.

II. Metering Requirements – Class C Facilities

In general, the minimum required Chugach metering for Class C facilities is in/out watt-hour metering. Additional metering requirements, such as reactive power energy metering (VAr-hour), real or reactive power demand metering, or time-of-delivery metering will depend on the specifics of the contractual agreements between Chugach and the Producer.

III. Interconnection Disconnect Device – Class C Facilities

An approved manual disconnect device is required for all Class C installations (Refer to *Subsection 422: Interconnection Disconnect Device,* and Figure C-1).

IV. Interconnection Transformer – Class C Facilities

Chugach requires that a dedicated transformer be utilized to interconnect all Class C installations with the Chugach system.

In cases where an existing Chugach transformer serves the Producer at the proposed interconnection point, that transformer may serve as the dedicated transformer, provided the following conditions are met:

1. The Producer's maximum generating capacity (kVA) does not exceed the nominal rating of the transformer.

2. No other Chugach consumers are served by the existing transformer.

Where the installation of a dedicated transformer is required, the Producer will be responsible for all associated labor and material costs.

V. Protection and Control Devices – Class C Facilities

The general interconnection protective and control requirements for Class C installations are as follows:

1. Paralleling Device

a) A Chugach approved circuit breaker is required to allow separation of the Producer's generation from the Chugach system during fault conditions.

b) This device must be capable of withstanding 220% of the Chugach system voltage at the point of interconnection, must have sufficient interrupting capacity to interrupt the maximum available fault current at its location, and be locked out when operated by the protective relays required for interconnection.

2. Over/Under Voltage Protection

The Producer's overvoltage and undervoltage interconnection protective functions shall detect voltage at the point of interconnection, and shall open the paralleling device within the times specified in the table below, if the voltage is within the stated ranges.

Voltage Range [V] (% of nominal voltage[a])	**Clearing Time[b] (seconds)**
V < 50%	0.16
50% ≤ V < 88%	2.00
110% < V < 120%	1.00
V ≥ 120%	0.16

[a] Nominal system voltages stated in ANSI Std. C84.1-1995, Table 1.
[b] Default clearing times.

3. Over/Under Frequency Protection

The Producer's over-frequency and under-frequency interconnection protective functions shall open the paralleling device within the times specified in the table below, if the frequency is within the stated ranges.

Frequency Range [*f*] (Hz)	**Clearing Time[a] (seconds)**
$f > 60.5$	0.16
$f < \{59.8 – 57\}$	Adjustable 0.16 to 300[b]
$f < 57$	0.16

[a] Default clearing times.
[b] Chugach shall provide specific clearing times for each Producer interconnection.

4. Synchronization Protection

For parallel operation, the Producer's facilities shall meet the requirements pertaining to synchronization specified within IEEE Std. 1547, Parts 4.1.3 and 5.1.2. Specific equipment requirements are as follows:

a) Synchronous Generator Interconnection

Synchronous generators operated in parallel with the Chugach electric grid are required to have automatic relay supervision (Device No. 25) to verify synchronism for permissive closure of the interconnection circuit breaker.

Manual synchronizing systems are not approved for interconnected operation with the Chugach system.

b) Induction Generator Interconnection

Due to the "slip" inherent to induction generators, synchronous operation cannot be precisely maintained when operating in parallel with the Chugach system. Therefore, Chugach requires that speed-matching relaying (Device No. 15) be utilized, set to permit breaker (or contactor) closing when generator speed is maintained above 95 percent of the Chugach system synchronous speed at the point of interconnection.

c) Power Converter Interconnection

Power converter systems that produce a fundamental voltage before the paralleling device is closed are capable of stand-alone operation, thus shall be tested to meet the requirements as outlined in IEEE Std. 1547, Part 5.1.2.A. All other power converter based

systems shall meet the requirements contained in IEEE 1547, Part 5.1.2.C.

5. Ground Fault Protection

Ground Fault Protection is required for all Class C facilities. This protection (Device No. 51N) senses phase-to-ground faults on the Chugach system and initiates tripping of the interconnection circuit breaker in order to prohibit continuous contribution to such faults from the Producer's facilities.

The Producer shall provide an appropriate ground fault protection scheme and coordinate with Chugach on trip settings. Prior to authorization for interconnected operation, Chugach shall review and approve the ground fault protection scheme and trip settings.

6. Phase-Fault Protection

Phase-Fault Protection is required for all Class C facilities. This protection senses phase-to-phase or three-phase faults on the Chugach system and initiates tripping of the interconnection circuit breaker in order to prohibit continuous contribution to such faults from the Producer's facilities.

Voltage-restrained overcurrent relaying (Device No. 50/51V), or impedance relaying (Device No. 21), is required for phase-fault protection. Prior to authorization for interconnected operation, Chugach shall review and approve the phase-fault protection scheme and trip settings.

VI. Telemetry and Monitoring– Class C Facilities

1. Telemetry

A telephone or data line service at the metering point is required for Chugach's meter telemetry. This line may be shared or dedicated; monthly charges will be paid by the non-utility generator.

2. Monitoring

Power quality monitoring will be required in cases where Chugach determines that there is either a potential or an indication that the output from the Producer's facility can adversely affect the standard performance of the Chugach electric system or the quality of power delivered to Chugach consumers.

Depending upon the specific requirements, the monitoring system may be required to detect and record such disturbances as waveform distortions, electrical noise, voltage sags or swells, frequency

deviations, and harmonic distortions. The requirement for power quality monitoring will be determined by Chugach on an individual basis.

VII Operational Data Logging – Class C Facilities

All Class C generating facilities are required to have and maintain a seven (7) day digital data logger which records volts, watts, VArs, frequency, and the status of key system informational elements, including relay targets and interconnection circuit breaker trip operations. The data logger shall provide a standard time stamp for tracked variables, including date and time of day (HH:MM:SS). Chugach shall have the right to review these logs, especially in analyzing system disturbances.

VIII. Export Power Control Equipment – Class C Facilities

For cases where the Producer and Chugach formulate a Power Purchase Agreement, the following equipment may be necessary in accordance with the terms of the specific contract:

1. Voltage Regulator/Power Factor Controller

The Producer may be required to utilize either an approved voltage regulator or power factor controller in order to control voltage within specified limits.

Where a voltage regulator is utilized for this purpose, it must be capable of maintaining the nominal Chugach interconnection point voltage under steady-state conditions, without hunting, and within ±0.5 percent of the required set point (as directed by Chugach).

Where a power factor controller is utilized, it must be capable of maintaining the power factor setting within ±1.0 percent, at full load, at any point between 90 percent lagging and 95 percent leading. For export power to the Chugach distribution system, a power factor of 1.0 is generally preferred.

The Producer's generation may be required to follow a Chugach specified voltage or VAr schedule on an hourly, daily, or seasonal basis depending on the specific terms of the power purchase contract. The Producer shall coordinate with Chugach Power Control Center for specific operational instructions and issues.

2. Direct Digital Control

Direct digital control (supervisory control) of unit output from Chugach's Power Control Center may be required if the unit is to be dispatchable by Chugach under agreement.

3. Power System Stabilizer

A power system stabilizer (PSS) control system may be required to provide necessary stability to the electrical system when system power oscillations occur.

The necessity of a PSS will depend on the generator capacity and characteristics, the location of the interconnection to the Chugach system, and the system voltage level at the point of interconnection.

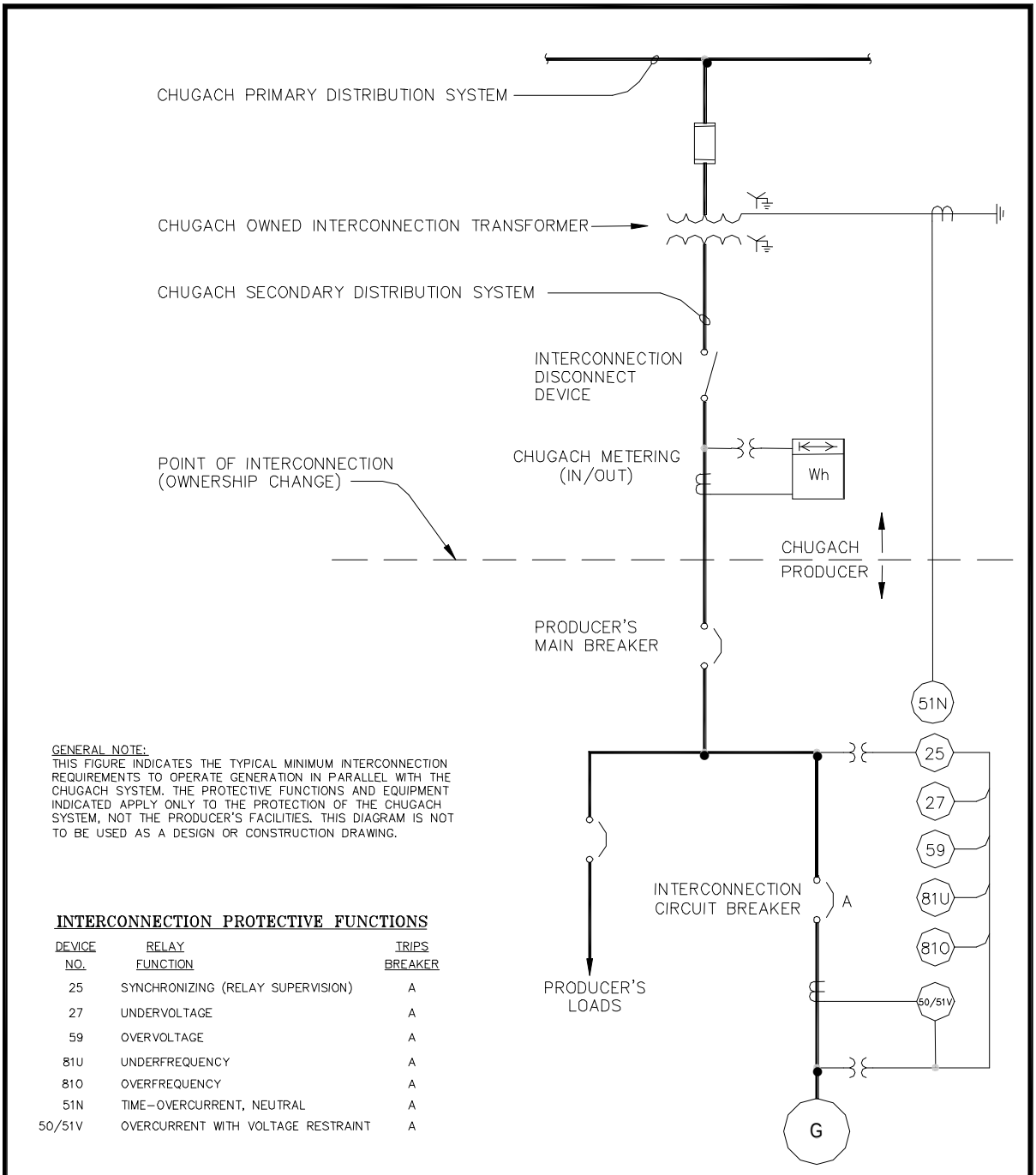
Table 5-C
Interconnection Equipment Requirements Summary
Class C Facilities (100 kVA to 1,000 kVA)

Equipment	Requirement
All Installations	
Approved Disconnect Means	Required
Dedicated Transformer	Required
In/Out Metering	Required
Paralleling Device	Required
Undervoltage Protection	Required
Overvoltage Protection	Required
Underfrequency Protection	Required
Overfrequency Protection	Required
Ground Fault Protection	Required
Transfer Trip Capability	Not Required
Phase-Fault Protection	Required
Telemetry Capability	Required
Power Quality Monitoring	See Note 1
Export Power Control Equipment	See Note 1
Voice and Data Communication Capability	Required
Operational Data Logging	Required (See Note 2)
Synchronous and Similar Type Generators	
Automatic Synchronizing w/ Relay Supervision	Required
Induction Generators	
Speed Matching Relaying	Required
Power Converters	
Automatic Synchronizing w/ Relay Supervision	See Note 3

Note 1: Requirements will depend on specific contractual agreements and will be assessed on an individual basis.

Note 2: A seven (7) day digital data logger is required; refer to Subsection 5.3.3.7 for specific requirements.

Note 3: Typically not required for power converters, however the requirement will be evaluated on an individual basis.



GENERAL NOTE:
THIS FIGURE INDICATES THE TYPICAL MINIMUM INTERCONNECTION REQUIREMENTS TO OPERATE GENERATION IN PARALLEL WITH THE CHUGACH SYSTEM. THE PROTECTIVE FUNCTIONS AND EQUIPMENT INDICATED APPLY ONLY TO THE PROTECTION OF THE CHUGACH SYSTEM, NOT THE PRODUCER'S FACILITIES. THIS DIAGRAM IS NOT TO BE USED AS A DESIGN OR CONSTRUCTION DRAWING.

INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
81O	OVERFREQUENCY	A
51N	TIME-OVERCURRENT, NEUTRAL	A
50/51V	OVERCURRENT WITH VOLTAGE RESTRAINT	A

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Mgr., Dist. Standards & Support _____
Dir., Engineering Svcs. Div.: _____

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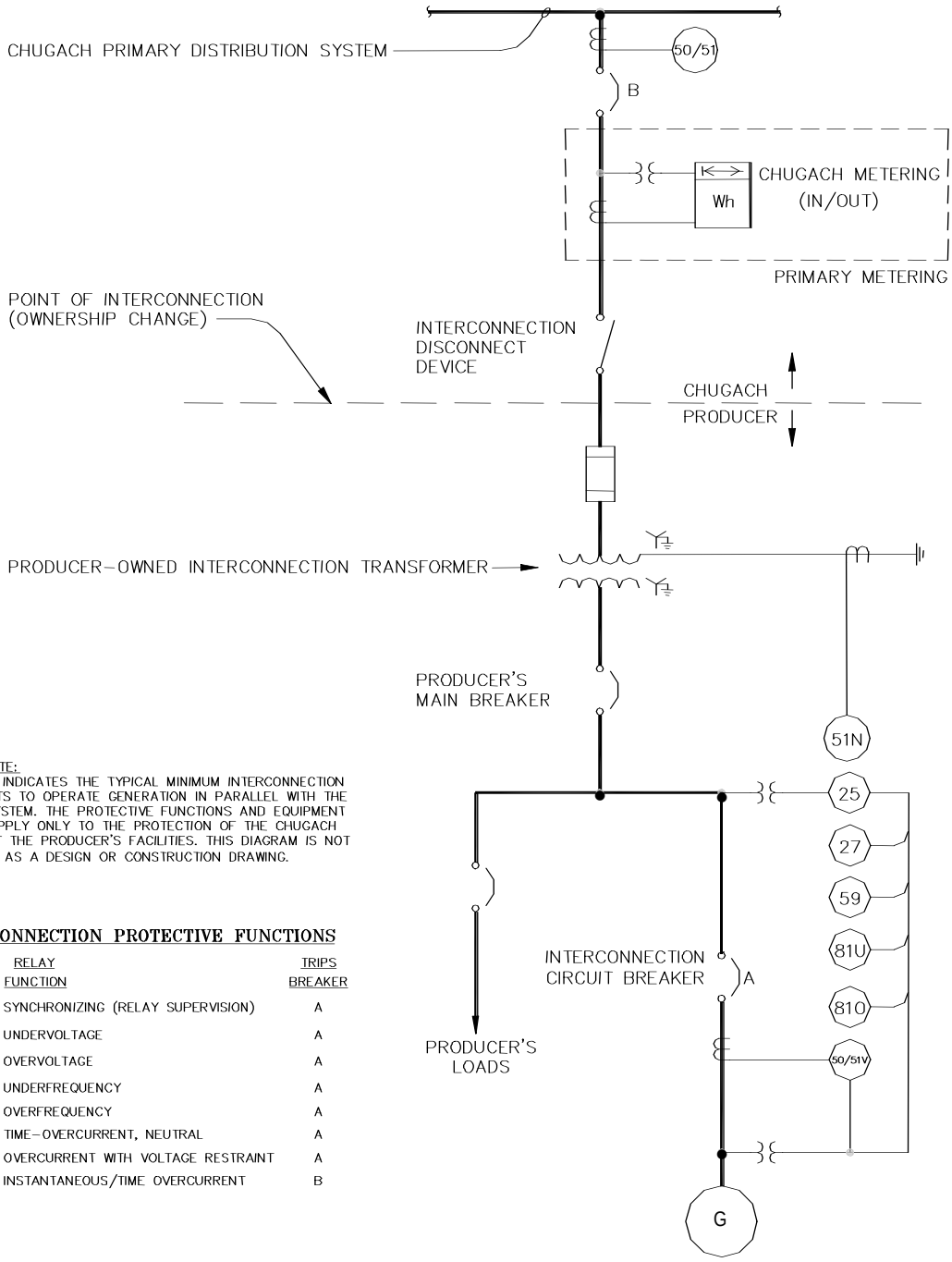
FIGURE C-1
TYPICAL SECONDARY SYSTEM INTERCONNECTION
CLASS C FACILITIES (100KVA TO 1000KVA)

DRAWING NUMBER NUG_FIGC-1 SHEET 1 OF 1



GENERAL NOTE:
THIS FIGURE INDICATES THE TYPICAL MINIMUM INTERCONNECTION REQUIREMENTS TO OPERATE GENERATION IN PARALLEL WITH THE CHUGACH SYSTEM. THE PROTECTIVE FUNCTIONS AND EQUIPMENT INDICATED APPLY ONLY TO THE PROTECTION OF THE CHUGACH SYSTEM, NOT THE PRODUCER'S FACILITIES. THIS DIAGRAM IS NOT TO BE USED AS A DESIGN OR CONSTRUCTION DRAWING.

INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
81O	OVERFREQUENCY	A
51N	TIME-OVERCURRENT, NEUTRAL	A
50/51V	OVERCURRENT WITH VOLTAGE RESTRAINT	A
50/51	INSTANTANEOUS/TIME OVERCURRENT	B

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Mgr., Dist. Standards & Support _____

Dir., Engineering Svcs. Div.: _____

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FIGURE C-2

TYPICAL PRIMARY SYSTEM INTERCONNECTION
CLASS C FACILITIES (100KVA TO 1000KVA)

DRAWING NUMBER NUG_FIGC-2 SHEET 1 OF 1

430D: Equipment Requirements - Class D Facilities

I. Application of Minimum Requirements – Class D Facilities

This portion of the Interconnection Guidelines addresses the general minimum interconnection equipment necessary for Class D generating facilities. Specific requirements for each individual proposed facility may vary, depending on factors such as the location of the interconnection, the number and proximity of adjacent Chugach consumers, and the characteristics of the facility proposing to interconnect to the Chugach system.

Chugach has developed these minimum requirements based on the following assumptions as to the nature of the electric system at the point of interconnection and the utilization of the Producer's energy:

1. The total non-utility generating capability (kVA), singular or aggregate, on the interconnecting Chugach feeder is less that 25 percent of the averaged annual hourly peak demand (kVA) for that feeder.

2. The Producer's generation is generally sized to meet all or a portion of the Producer's load at the point of interconnection.

3. Interconnections to the Chugach distribution system are typically made at Chugach's standard distribution primary voltages of 7.2/12.47 kV or 14.4/24.94 kV (Refer to Figure D-2).

Where proposed interconnections fall outside of the above parameters, modifications to the minimum requirements may be necessary in order to maintain the safety, reliability, and operational performance of the Chugach system.

II. Metering Requirements – Class D Facilities

In general, the minimum required Chugach metering for Class D facilities is in/out watt-hour metering. Additional metering requirements, such as reactive power energy metering (VAr-hour), real or reactive power demand metering, or time of delivery metering will depend on the specifics of any contractual agreements between Chugach and the Producer.

III. Interconnection Disconnect Device – Class D Facilities

An approved manual disconnect device is required for all Class D installations (refer to *Subsection 422: Interconnection Disconnect Device*, and Figure D-2).

IV. Interconnection Transformer – Class D Facilities

Chugach requires that a dedicated transformer be utilized to interconnect all Class D installations with the Chugach system.

For cases where an existing Chugach transformer serves the Producer at the proposed interconnection point, that transformer may serve as the dedicated transformer, provided the following conditions are met:

1. The Producer's maximum generating capacity (kVA) does not exceed the nominal rating of the transformer.

2. No other Chugach consumers are served by the existing transformer.

Where the installation of a dedicated transformer is required, the Producer will be responsible for all associated labor and material costs.

V. Protection and Control Devices – Class D Facilities

The general interconnection protection and control requirements for Class D installations are as follows:

1. Paralleling Device

a) A Chugach approved circuit breaker is required to allow separation of the Producer's generation from the Chugach system during fault conditions.

b) This device must be capable of withstanding 220% of the Chugach system voltage at the point of interconnection, must have sufficient interrupting capacity to interrupt the maximum available fault current at its location, and be locked out when operated by the protective relays required for interconnection.

2. Over/Under Voltage Protection

The Producer's overvoltage and undervoltage interconnection protective functions shall detect voltage at the point of interconnection, and shall open the paralleling device within the times specified in the table below, if the voltage is within the stated ranges.

Voltage Range [V] (% of nominal voltage[a])	**Clearing Time[b] (seconds)**
V < 50%	0.16
50% ≤ V < 88%	2.00
110% < V < 120%	1.00
V ≥ 120%	0.16

[a] Nominal system voltages stated in ANSI Std. C84.1-1995, Table 1.
[b] Default clearing times.

3. Over/Under Frequency Protection

The Producer's over-frequency and under-frequency interconnection protective functions shall open the paralleling device within the times specified in the table below, if the frequency is within the stated ranges.

Frequency Range [*f*] (Hz)	**Clearing Time[a] (seconds)**
$f > 60.5$	0.16
$f < \{59.8 – 57\}$	Adjustable 0.16 to 300[b]
$f < 57$	0.16

[a] Default clearing times.
[b] Chugach shall provide specific clearing times for each Producer interconnection.

4. Synchronization Protection

For parallel operation, the Producer's facilities shall meet the requirements pertaining to synchronization specified within IEEE Std. 1547, Parts 4.1.3 and 5.1.2. Specific equipment requirements are as follows:

a) Synchronous Generator Interconnections

Synchronous generators operated in parallel with the Chugach electric grid are required to have automatic relay supervision (Device No. 25) to verify synchronism for permissive closure of the interconnection circuit beaker.

Manual synchronizing systems are not approved for interconnected operation with the Chugach system.

b) Induction Generator Interconnection

Due to the "slip" inherent to induction generators, synchronous operation cannot be precisely maintained when operating in parallel with the Chugach system. Therefore, Chugach requires that speed-matching relaying (Device No. 15) be utilized, set to permit breaker (or contactor) closing when generator speed is maintained above 95 percent of the Chugach system synchronous speed at the point of interconnection.

c) Power Converter Interconnection

Power converter systems that produce a fundamental voltage before the paralleling device is closed are capable of stand-alone operation, thus shall be tested to meet the requirements as outlined in IEEE Std. 1547, Part 5.1.2.A. All other power converter based

systems shall meet the requirements contained in IEEE 1547, Part 5.1.2.C.

5. Ground Fault Protection

Ground Fault Protection is required for all Class D facilities. This protection (Device No. 51N) senses phase-to-ground faults on the Chugach system and initiates tripping of the interconnection circuit breaker in order to prohibit continuous contribution to such faults from the Producer's facilities.

The Producer shall provide an appropriate ground fault protection scheme and coordinate with Chugach on trip settings. Prior to authorization for interconnected operation, Chugach shall review and approve the ground fault protection scheme and trip settings.

6. Phase-Fault Protection

Phase-Fault Protection is required for all Class D facilities. This protection senses phase-to-phase or three-phase faults on the Chugach system and initiates tripping of the interconnection circuit breaker in order to prohibit continuous contribution to such faults from the Producer's facilities.

Voltage-restrained overcurrent relaying (Device No. 50/51V) or impedance relaying (Device No. 21) is required for phase-fault protection. Prior to authorization for interconnected operation, Chugach shall review and approve the phase-fault protection scheme and trip settings.

7. Transfer Trip Capability

Transfer trip capability is required to allow Chugach system protection to disconnect the Producer's facility in order to ensure that Chugach system protection operates properly during system faults or disturbances. The Producer shall provide a dedicated, isolated voice grade fiber-optic communications circuit for this purpose.

VI. Telemetry and Monitoring – Class D Facilities

1. Telemetry

All Class D facilities are required to have equipment to continuously telemeter data to the Chugach Power Control Center via approved data communications lines provided by the Producer. Telemetering of generation and transmission data is required to enable the system dispatchers to continually monitor the power system from Chugach's Power Control Center.

As a minimum, the following data and measurements shall be telemetered to Chugach:

- Energy Flows (kWh)
- Real Power Flows (kW)
- Reactive Power Flows (kVAr)
- Voltage at Point of Interconnection
- Paralleling Device (Interconnection circuit breaker) status

2. Monitoring

Power quality monitoring will be required in cases where Chugach determines that there is either a potential or an indication that the output from the Producer's facility can adversely affect the standard performance of the Chugach electric system or the quality of power delivered to Chugach consumers.

Depending upon the specific requirements, the monitoring system may be required to detect and record such disturbances as waveform distortions, electrical noise, voltage sags or swells, frequency deviations, and harmonic distortions. The requirements for power quality monitoring will be determined by Chugach on an individual basis.

VII. Operational Data Logging – Class D Facilities

All Class D generating facilities are required to have and maintain a seven (7) day digital data logger which records volts, watts, VArs, frequency, and the status of key system elements, including the interconnection circuit breaker status operations and relay targets. The data logger shall provide a standard time stamp for tracked variables, including date and time of day (HH:MM:SS). Chugach shall have the right to review these logs, especially in analyzing system disturbances.

VIII. Export Power Control Equipment – Class D Facilities

For cases where the Producer and Chugach formulate a Power Purchase Agreement, the following equipment may be necessary in accordance with the terms of the specific contract:

1. Voltage Regulator/Power Factor Controller

The Producer may be required to utilize either an approved voltage regulator or power factor controller in order to control voltage within specified limits.

Where a voltage regulator is utilized for this purpose, it must be capable of maintaining the nominal Chugach interconnection point

voltage under steady-state conditions, without hunting, and within ±0.5 percent of the required set point (as directed by Chugach).

Where a power factor controller is utilized, it must be capable of maintaining the power factor setting within ±1.0 percent, at full load, at any point between 90 percent lagging and 95 percent leading. For export power to the Chugach distribution system, a power factor of 1.0 is generally preferred.

The generator may be required to follow a Chugach specified voltage or VAr schedule on an hourly, daily, or seasonal basis depending on the specific terms of the power purchase contract. The Producer shall coordinate with Chugach Power Control Center for specific operational instructions and issues.

2. Direct Digital Control

Direct digital control (supervisory control) of unit output from Chugach's Power Control Center may be required if the unit is to be dispatchable by Chugach under agreement.

3. Power System Stabilizer

A Power System Stabilizer (PSS) control system may be required to provide necessary stability to the electrical system when system power oscillations occur.

The necessity of a PSS will depend on the generator capacity and characteristics, the location of the interconnection to the Chugach system, and the system voltage level at the point of interconnection.

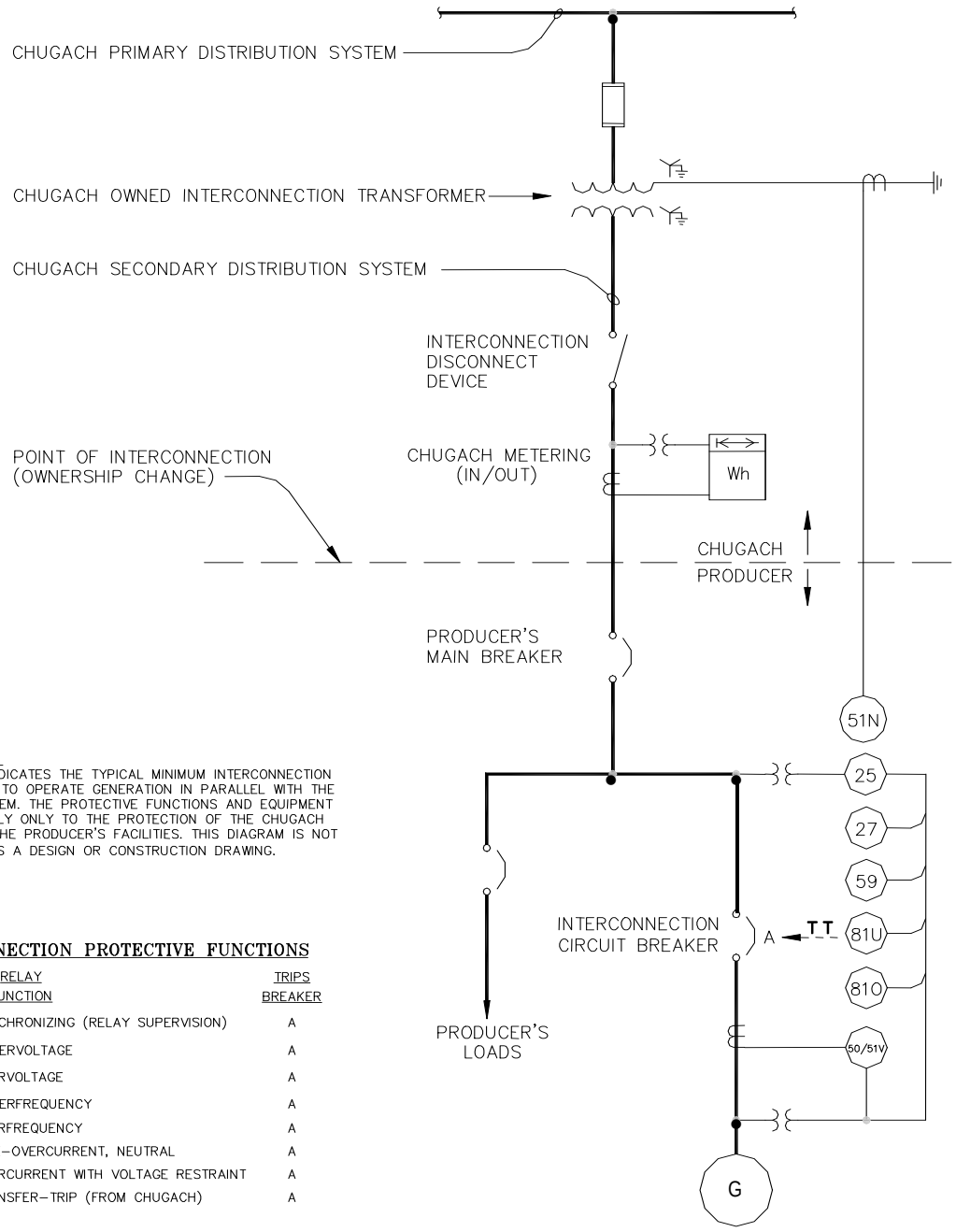
Table 5-D
Interconnection Equipment Requirements Summary
Class D Facilities (1,000 kVA to 5,000 kVA)

Equipment	Requirement
All Installations	
Approved Disconnect Means	Required
Dedicated Transformer	Required
In/Out Metering	Required
Paralleling Device	Required
Undervoltage Protection	Required
Overvoltage Protection	Required
Underfrequency Protection	Required
Overfrequency Protection	Required
Ground Fault Protection	Required
Transfer Trip Capability	Required
Phase-fault Protection	Required
Telemetry Capability	Required
Power Quality Monitoring	See Note 1
Export Power Control Equipment	See Note 1
Voice and Data Communication Capability	Required
Operational Data Logging	Required (See Note 2)
Synchronous and Similar Type Generators	
Automatic Synchronizing w/ Relay Supervision	Required
Induction Generators	
Speed Matching Relaying	Required
Power Converters	
Automatic Synchronizing w/ Relay Supervision	See Note 3

Note 1: Requirements will depend on specific contractual agreements and will be assessed on an individual basis.

Note 2: A seven (7) day digital data logger is required; refer to Subsection 5.3.4.7 for specific requirements.

Note 3: Typically not required for power converters, however the will be evaluated on an individual basis.



GENERAL NOTE:
THIS FIGURE INDICATES THE TYPICAL MINIMUM INTERCONNECTION REQUIREMENTS TO OPERATE GENERATION IN PARALLEL WITH THE CHUGACH SYSTEM. THE PROTECTIVE FUNCTIONS AND EQUIPMENT INDICATED APPLY ONLY TO THE PROTECTION OF THE CHUGACH SYSTEM, NOT THE PRODUCER'S FACILITIES. THIS DIAGRAM IS NOT TO BE USED AS A DESIGN OR CONSTRUCTION DRAWING.

INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
81O	OVERFREQUENCY	A
51N	TIME-OVERCURRENT, NEUTRAL	A
50/51V	OVERCURRENT WITH VOLTAGE RESTRAINT	A
TT	TRANSFER-TRIP (FROM CHUGACH)	A

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Standards Engineer: _____
Mgr., Dist. Standards & Support _____
Dir., Engineering Svcs. Div.: _____

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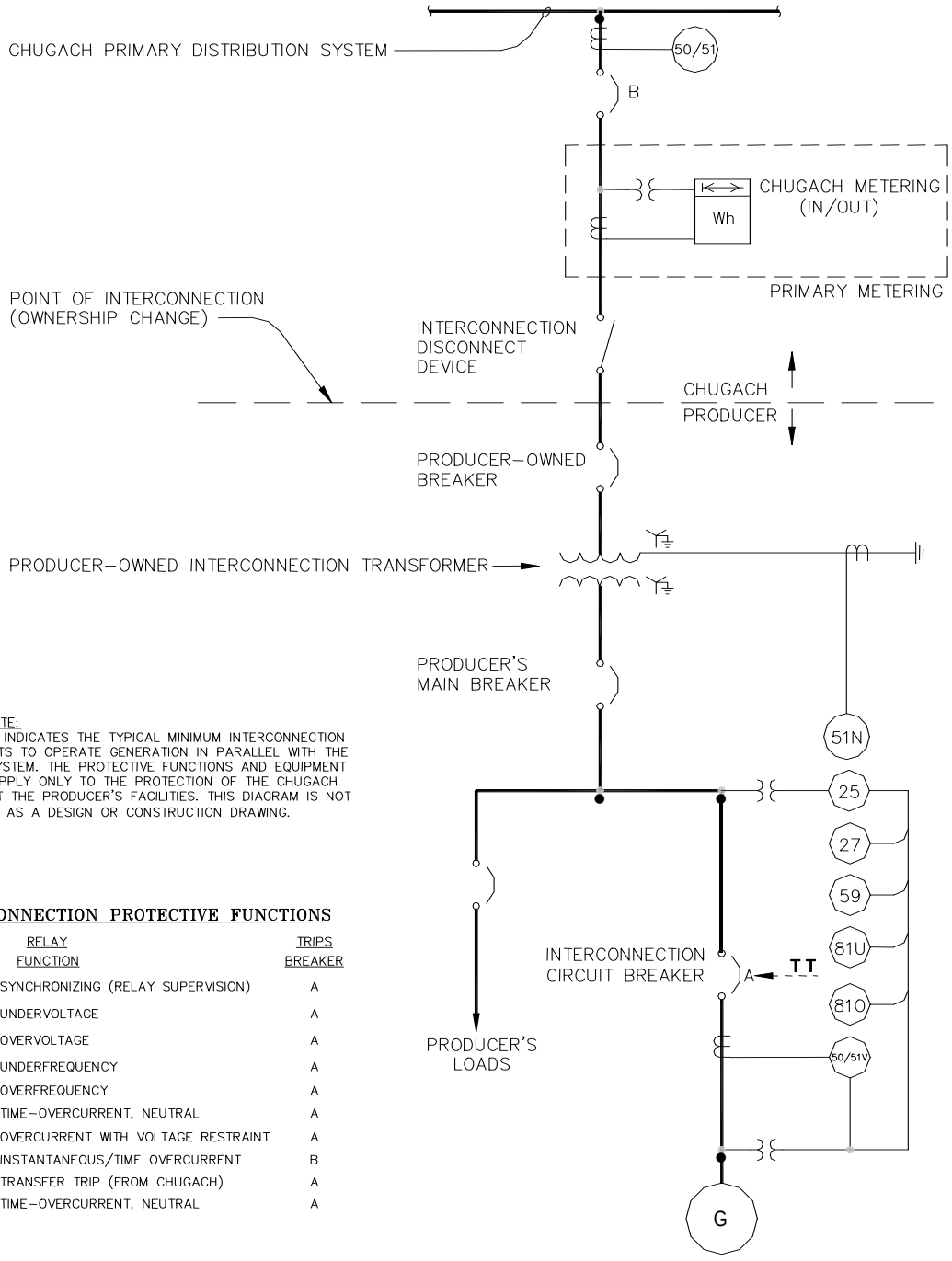
FIGURE D-1
TYPICAL SECONDARY SYSTEM INTERCONNECTION CLASS D FACILITIES (1000 KVA TO 5000KVA)

DRAWING NUMBER NUG_FIGD-1 SHEET 1 OF 1



GENERAL NOTE:
THIS FIGURE INDICATES THE TYPICAL MINIMUM INTERCONNECTION REQUIREMENTS TO OPERATE GENERATION IN PARALLEL WITH THE CHUGACH SYSTEM. THE PROTECTIVE FUNCTIONS AND EQUIPMENT INDICATED APPLY ONLY TO THE PROTECTION OF THE CHUGACH SYSTEM, NOT THE PRODUCER'S FACILITIES. THIS DIAGRAM IS NOT TO BE USED AS A DESIGN OR CONSTRUCTION DRAWING.

INTERCONNECTION PROTECTIVE FUNCTIONS

DEVICE NO.	RELAY FUNCTION	TRIPS BREAKER
25	SYNCHRONIZING (RELAY SUPERVISION)	A
27	UNDERVOLTAGE	A
59	OVERVOLTAGE	A
81U	UNDERFREQUENCY	A
81O	OVERFREQUENCY	A
51N	TIME–OVERCURRENT, NEUTRAL	A
50/51V	OVERCURRENT WITH VOLTAGE RESTRAINT	A
50/51	INSTANTANEOUS/TIME OVERCURRENT	B
TT	TRANSFER TRIP (FROM CHUGACH)	A
51N	TIME–OVERCURRENT, NEUTRAL	A

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Standards Engineer: _____

Mgr., Dist. Standards & Support _____

Dir., Engineering Svcs. Div.: _____

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FIGURE D-2

TYPICAL PRIMARY SYSTEM INTERCONNECTION
CLASS D FACILITIES (1000KVA TO 5000KVA)

DRAWING NUMBER NUG_FIGD–2 SHEET 1 OF 1

440 Voice and Data Communications

The capability to make direct verbal communications via telephone with the Producer or the operator of Producer's facility is required for all facility classifications. Voice communications must be provided so that operating instructions or notification of system conditions can be given to the Producer or any designated operator of the Producer's equipment as necessary. Accordingly, the Producer is required to provide a 24-hour accessible voice contact telephone number to Chugach.

For larger classifications of facilities, data communications capability is required so that electronic data and/or operating instructions can be transferred between Chugach and the Producer's facility as necessary.

450 Producer-Owned Electrical Distribution Systems

If the Producer owns, maintains, or constructs a primary electrical distribution or transmission system tap line (operated 7.2 kV and above), then, at the expense of the Producer, Chugach shall install, own, and maintain the following equipment at the tap point:

- Fault interruption protection device(s)
- Manual isolating disconnect(s),
- Metering installations
- Supervisory control equipment (as required)

SECTION 5: INTERCONNECTED OPERATING REQUIREMENTS

The general operating requirements and criteria contained in this section apply to all non-utility generation facilities interconnected to the Chugach electric system. Any Producer operating outside of these requirements, unless provided expressed permission by Chugach, will not be permitted to operate in parallel with Chugach and will be responsible for any and all remediation actions and associated costs prior to gaining approval for parallel operation. The consequences for failing to meet any of these requirements are immediate disconnection and payment of all associated costs.

510 Approval for Parallel Operation

The Producer may not commence parallel operation of generation facilities without final written approval from Chugach. Chugach shall have the right to require inspection or witness testing of the Producer's equipment or devices associated with the interconnection by qualified third parties.

520 Discontinuance of Parallel Operation

The Producer shall discontinue parallel operation when requested by Chugach:

- To facilitate maintenance, test, or repair of utility facilities;
- During system emergencies;
- When the Producer's generating equipment is interfering with Chugach consumers and/or other power producers connected to the Chugach electric grid;
- When an inspection of the Producer's generating equipment reveals either a lack of adequate equipment maintenance necessary to protect the Chugach electric grid or conditions that could be hazardous to the Chugach system.

530 Islanded Operation

Unless provided expressed approval by Chugach, non-utility generators are not allowed to operate in an islanded mode with any portion of the Chugach electric grid. Once the Chugach circuit(s) connecting the Producer's generating facility is de-energized, for any reason, the Producer shall disconnect from the Chugach electric grid and will not be permitted to reconnect to it until Chugach has re-energized its system, as detailed in Section 580.

540 Voltage Requirements

541 Voltage Levels & Fluctuations

Per IEEE Std. 1547, Parts 4.1 and 4.2, the Producer's voltage (at the point of interconnection) and interconnection equipment shall adhere to the ratings and recommendations contained in the current American National Standards Institute (ANSI) C84.1 Standard. When operating in parallel with the Chugach system, the Producer's voltage must be maintained within ±5 percent of the standard Chugach system voltage at the point of interconnection.

Voltage fluctuations may be noticeable as visual lighting variations (flicker) and can damage to, or disrupt the operation of electronic equipment. The Producer shall adhere to the requirements of IEEE Std. 1547, Part 4.3 regarding power quality.

542 Voltage Regulation and Reactive Power Requirements

Operation of the Producer's generator must not adversely affect the voltage regulation of the Chugach electric grid. Per IEEE Std. 1547, Part 4.1.1, the Producer shall not actively regulate Chugach system voltage at the point of interconnection, and shall not cause Chugach system voltage to deviate from the requirements within ANSI C84.1, Range A.

For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on the Chugach system. The generator reactive power requirements, voltage regulation, and transformer ratio settings will be jointly determined by Chugach and the Producer to ensure intersystem coordinating and operating capability. Producers are required to provide their own reactive power requirements in order to generate within the specified power factor range.

The parallel operation of the Producer's generating equipment with the Chugach system will not, under any circumstance, be permitted to cause any reduction in the quality of service being provided to Chugach consumers.

550 Generator Droop Requirements

Governor characteristics shall be set to provide a 5 percent droop characteristic (a 0.15 Hz change in the generator speed will cause a 5 percent change in the generator load). Governors must be operated unrestrained to ensure that droop will not exceed 5% and that system frequency is properly regulated.

560 Harmonics

Harmonic distortion is defined as the ratio of the root mean square (rms) value of the harmonic to the rms value of the fundamental voltage or current (refer to IEEE Standard 519). Distortion of the harmonic content of voltage and/or current

waveforms can cause telecommunication interference, disable solid-state equipment, overheat transformers, and create resonant overvoltages. In order to protect Chugach equipment and consumers from damage, harmonics must be maintained within acceptable limits.

The Producer shall not exceed the current harmonic limits contained in IEEE Std. 1547, Part 4.3.3. In addition, the Producer shall not produce voltage distortion in excess of the limits specified in IEEE Std. 519, Section 11.5. Chugach advises that the Producer consider and account for harmonics in the early stages of facility planning and design.

If excessive harmonic distortion is suspected, voltage and current distortion measurements will be performed to determine whether the Producer's equipment is a source of, or contributor to, excessive distortion. If the Producer's facility is found to be the source of excessive harmonic distortion, the Producer will be billed for the investigation costs, and will be held responsible for corrective action to bring the harmonic content within the referenced limits.

570 Power Factor Requirements

Chugach requires that all interconnected non-utility generation maintain power factors within the range of 0.95 lagging (supplying reactive volt-amperes) and 0.95 leading (absorbing reactive volt-amperes) at the point of interconnection. Generators operating with power factors outside of this range limit may be subject to reactive power supply charges, unless specific provisions are made in the interconnection agreement. Generally, Producers are responsible for providing reactive power necessary to maintain power factors within the specified range when operating in parallel with the Chugach electric grid. In certain cases, Producers may contract with Chugach for the provision of ancillary services for reactive power support in order to maintain operation within the specified limits.

580 Coordination with the Chugach Protective System

The proper coordination of the Producer's interconnection protective functions with the Chugach protection system is of critical importance to the safety and reliability of the electrical supply grid. Accordingly, parallel operation will not be authorized or allowed until all required interconnection protective functions and settings have been reviewed and approved by Chugach, and properly coordinated with the Chugach protective system. Specifics on required protective functions and settings can be found in *Section 4: Interconnection Equipment Requirements.*

Because most short circuits (faults) on overhead lines are of a temporary nature, Chugach employs the use of *automatic circuit reclosers* (ACR) to automatically reclose circuit breakers on faulted lines one or more times within a few electrical cycles after they have tripped. This practice improves the continuity of service to Chugach consumers by allowing temporary faults to clear before primary protective devices operate to de-energize all or portions of the circuit.

The protective relays specified by Chugach for parallel generation interfaces are intended to disconnect the Producer's generation from faulted or isolated lines before reclosing occurs.

To ensure that the Chugach protection system operates properly, the Producer's protective equipment shall be set to sense Chugach system fault conditions and discontinue parallel operation with Chugach before Chugach automatic circuit reclosing occurs. ***The Producer shall not resume parallel operation until:***

A) A period of five (5) minutes has transpired following the initial sensing of a fault condition, or,

B) Chugach provides authorization to resume parallel operation.

590 Maintenance & Testing

591 Interconnection Equipment Maintenance

The Producer shall maintain its interconnection and interface equipment in good order. Chugach reserves the right to inspect all such equipment at any time. Chugach also reserves the right to inspect the Producer's facilities whenever it appears that the Producer is operating in a manner unacceptable or hazardous to the integrity of the Chugach system, or outside of the operating limits specified in these guidelines or contained in the *Agreement for Interconnection*.

The Producer is responsible for ensuring and maintaining the safe, proper operational condition of all interconnection equipment located on the Producer's side of the interconnection. Maintenance records, procedures, and results shall be made available for Chugach's review and records as required. Depending upon the characteristics and utility of the facility, Chugach may elect to observe and inspect maintenance work in order to assure the safety and integrity of the interconnection.

For larger generation installations, such as Classes C and D, specific scheduling and interval requirements for interconnection equipment maintenance may be formulated within the *Agreement for Interconnection.*Such requirements may be based on equipment duty, number of operations, ambient conditions, etc.

The Producer must coordinate and schedule maintenance on interconnection equipment with Chugach to ensure the safety of Chugach personnel and to minimize the disruption of electric service to Chugach consumers.

592 Protective Systems Functional Testing

The Producer's facilities shall meet the testing criteria contained in IEEE Std. 1547.1 *"IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems'*, and the Producer shall grant Chugach the right to observe functional testing of the Producer's facilities.

Periodic functional testing of protective equipment (i.e., circuit breakers, switches, disconnect devices, protective relaying, etc.) shall be defined and coordinated with Chugach within the *Agreement for Interconnection* between Chugach and the Producer. Generally, functional testing of protective relay settings and interconnection circuit breaker operations shall be performed by the Producer every three (3) years. Documented test results must be provided to Chugach within five (5) working days after the completion of tests. The Producer is responsible to ensure that protective relaying and control systems have available and accessible sensing input terminals or test ports, in order to perform and validate functional testing (see *Section 428: Protection & Control System Testing Conformance*).

The Producer shall grant Chugach the right to review and modify the functional testing requirements, as necessary, during the life of the facility.

APPENDIX A. *APPLICATION FOR INTERCONNECTION: CLASS A AND B FACILITIES*

CHUGACH ELECTRIC ASSOCIATION, INC.

Interconnection Application for Non-Utility Generation: Class A and B Facilities

Who Should File This Application: Any association member wishing to operate electrical generation facilities, rated up to 100 kVA, interconnected and operating in parallel with the Chugach electric system. This application should be completed as soon as possible and returned to Chugach's *Engineering Services Division* in order to begin processing the request.

Application Use: This application is used by Chugach to perform an Interconnection Study to determine the specific interconnection requirements at the Applicant's proposed facility location. Should additional information be required perform this study, the Applicant shall provide such as requested by Chugach.

Further Action: The Preliminary Interconnection Study performed by Chugach will determine the need for submittal of a Final Interconnection Application for Non-Utility Generation.

OWNER/APPLICANT INFORMATION		
Company:		
Representative:	Phone Number:	Fax Number:
Title:		
Mailing Address:		

PROPOSED LOCATION OF GENERATING PLANT AND INTERCONNECTION
Address:

PROJECT DESIGN / ENGINEERING		
Company:		
Representative:	Phone Number:	Fax Number:
Title:		
Mailing Address:		

ELECTRICAL CONTRACTOR		
Company:		
Representative:	Phone Number:	Fax Number:
Title:		
Mailing Address:		

GENERATOR DATA		
Manufacturer		Model:
Type (Synchronous, Induction, Converter, etc.):		Phases (1 or 3):
Rated Output	Windings (Delta, Wye):	Frequency:
Rated Power Factor (%):	Rated Voltage (Volts):	Rated Current (Amperes):
Prime Energy Source (natural gas, steam, hydro., etc.):		

ESTIMATED LOAD INFORMATION			
The following information will be used to help properly design the Applicant interconnection. This information is not intended as a commitment or contract for billing purposes.			
Minimum anticipated load (generation not operating)	kW:		kVA:
Maximum anticipated load (generation not operating)	kW:		kVA:

ESTIMATED CONSTRUCTION START/COMPLETION DATES	
Start Date:	Completion Date:

DESCRIPTION OF PROPOSED INSTALLATION AND OPERATION

Attach a one-line diagram showing the Applicant's switchgear, transformers, and generation facilities. Provide a general description of the manner of operation of the generation (cogeneration, closed-transition peak shaving, open-transition peak shaving, emergency power, etc). Also, indicate the intended utilization of the interconnected generating facility (i.e., sell all or part of the produced power, ancillary services, and/or wheel power over Chugach facilities, etc.). If there is intent to sell power or provide ancillary services, define the target markets and locations, if available.

***SIGN OFF AREA*: NOTE: By signing this document, I agree to meet the terms and conditions presented in Chugach Electric Association, Inc.'s Interconnection Guidelines for Non-Utility Generation. I also recognize that any conditions of those guidelines that I do not meet must be approved and documented by Chugach Electric Association, Inc. prior to installation and connection to Chugach's system.**

_____ _____

Applicant Signature Date

Information below to be filled out by Chugach Representative

Chugach Representative:

Name of Project:

Chugach service point location (attach service map if available):

APPENDIX B. *APPLICATION FOR INTERCONNECTION: CLASS C AND D FACILITIES*

CHUGACH ELECTRIC ASSOCIATION, INC.

Interconnection Application for Non-Utility Generation: Class C and D Facilities

Who Should File This Application: Any association member wishing to operate electrical generation facilities, rated 100 kVA to 5000 kVA, interconnected and operating in parallel with the Chugach electric system. This application should be completed as soon as possible and returned to Chugach's *Engineering Services Division* in order to begin processing the request

Application Use: This application is used by Chugach to perform an Interconnection Study to determine the specific interconnection requirements at the Applicant's proposed facility location. Should additional information be required perform this study, the Applicant shall provide such as requested by Chugach

Design Information Submittal: In addition to the items listed in this form, please include the design information submittal items as outlined in *Section 411: Design Information & Documentation* of Chugach Electric Association's *Interconnection Guidelines for Non-Utility Generation*.

OWNER/APPLICANT INFORMATION		
Company:		
Representative:	Phone Number:	Fax Number:
Title:		
Mailing Address:		

PROPOSED LOCATION OF GENERATING PLANT AND INTERCONNECTION
Address:

PROJECT DESIGN / ENGINEERING		
Company:		
Representative:	Phone Number:	Fax Number:
Title:		
Mailing Address:		

ELECTRICAL CONTRACTOR		
Company:		
Representative:	Phone Number:	Fax Number:
Title:		
Mailing Address:		

ESTIMATED LOAD INFORMATION
The following information will be used to help properly design the Chugach-Customer interconnection. This information is not intended as a commitment or contract for billing purposes.
Minimum anticipated load (generation not operating) _____ kVA _____ Duration (indicate hours, minutes, etc)
Maximum anticipated load (generation not operating) _____ kVA _____ Duration (indicate hours, minutes, etc)

(Complete all applicable items. Copy this page as required for additional generators.)

SYNCHRONOUS GENERATION DATA

Unit Number:	Total number of units with listed specifications on site:			
Manufacturer:				
Type:	Manufacture Date:		Windings (Delta, Wye):	
Serial Number (each):				
Phases: 1 or 3	Speed (RPM):		Frequency (Hz):	
Rated Output (each unit) Kilowatt:			Kilovolt-Ampere:	
Rated Power Factor (%):	Rated Voltage (Volts):		Rated Current (Amperes):	
Field Voltage (Volts):	Field Current (Amperes):		Motoring Power (kW):	
Synchronous Reactance:	X_d:	X_q:	% on	kVA base
Transient Reactance:	X_d':	X_q':	% on	kVA base
Subtransient Reactance:	X_d'':	X_q'':	% on	kVA base
Negative Sequence Reactance:	X_2:		% on	kVA base
Zero Sequence Reactance:	X_o:		% on	kVA base
Neutral Grounding Impedance:	R_n:	X_n:	% on	kVA base

Inertia constant, H (joules/VA):

I^2t or K (heating time constant):

Exciter data:

Governor data:

Additional Information:

INDUCTION GENERATOR DATA

Unit Number:	Total number of units with listed specifications on site:	
Manufacturer:		
Type:	Manufacture Date:	Windings (Delta, Wye):
Serial Number (each):		Speed (RPM):

Rotor Resistance, R_r, (Ohms): Stator Resistance, R_s,(Ohms):

Rotor Reactance, X_r, (Ohms): Stator Reactance, X_s, (Ohms):

Magnetizing Reactance, X_m, (Ohms):

Design Letter:	Frame Size:	
Exciting Current:	Temp Rise (deg C):	H constant, (joules/VA):
Rated Output (kW):		
Reactive Power Required	kVAR (no load):	kVAR (full load):

If this a wound-rotor machine, describe any external equipment to be connected (resistor, rheostat, power converter, etc.) to rotor circuit, and circuit configuration. Describe ability, if any, to adjust generator reactive output to provide power system voltage regulation.

Additional Information:

PRIME MOVER (Complete all applicable items)		
Unit Number:	Type:	
Manufacturer:		
Serial Number:	Manufacture Date:	
Rated Horsepower (H.P.):	Max. Horsepower (H.P.):	Inertia constant, (lb.-ft^2):
Energy Source (fuel; hydro, steam, natural gas, etc.):		

TRANSFORMER (If applicable)			
Manufacturer:	kVA		
Date of Manufacture:	Serial No.		
High Voltage: kV	Connection: delta wye	Neutral solidly grounded?	
Low Voltage: kV	Connection: delta wye	Neutral solidly grounded?	
Transformer Impedance, Z:	% on	kVA base	
Transformer Resistance, R:	% on	kVA base	
Transformer Reactance, X:	% on	kVA base	
Neutral Grounding Impedance:	R_n: X_n:	% on	kVA base

POWER CONVERTER DATA (If applicable)		
Manufacturer:	Model:	
Date of Manufacture:	Serial No.	
Rated Power Factor (%):	Rated Voltage (Volts):	Rated Current (Amperes):
Converter Type (Ferro resonant, step, pulse-width modulation, etc.):		
Type of commutation: forced line	Minimum Short Circuit Ratio required:	
Minimum voltage for successful commutation:		
Current Harmonic Distortion:	Maximum Individual Harmonic (%):	
	Maximum Total Harmonic Distortion (%):	
Voltage Harmonic Distortion:	Maximum Individual Harmonic (%):	
	Maximum Total Harmonic Distortion (%):	

Describe capability, if any, to adjust reactive output to provide voltage regulation:

NOTE: *Attach all available calculations, test reports, and oscillographic prints showing inverter output voltage and current waveforms.*

POWER CIRCUIT BREAKER (If applicable)		
Manufacturer:	Model:	
Rated Voltage (kilovolts):	Rated Ampacity (Amperes):	
Interrupting Rating (Amperes):	BIL Rating:	
Interrupting Medium (vacuum, oil, gas, etc.)	Insulating Medium (vacuum, oil, gas, etc.)	
Control Voltage (Closing): (Volts) AC DC		
Control Voltage (Closing): (Volts) AC DC Battery Charged Capacitor		
Close Energy: Spring Motor Hydraulic Pneumatic Other		
Trip Energy: Spring Motor Hydraulic Pneumatic Other		
Bushing Current Transformer (Max ratio):		Relay Accuracy Class:
Multi Ratio? No Yes If yes, available taps:		

ESTIMATED CONSTRUCTION SCHEDULE	
Start Date:	Completion Date:

MISCELLANEOUS (Use this area and any additional sheets for applicable notes and comments).

***SIGN OFF AREA*: NOTE: By signing this document, I agree to meet the terms and conditions presented in Chugach Electric Association, Inc.'s Interconnection Guidelines for Non-Utility Generation. I also recognize that any conditions of those guidelines that I do not meet must be approved and documented by Chugach Electric Association, Inc. prior to installation and connection to Chugach's system.**

I agree to provide Chugach Electric Association, Inc. (Chugach) with any additional information, as requested or required, to process this application. I also agree to comply with Chugach's regulations and tariffs as amended. I certify that I am the owner, lessee, tenant, or agent of the premise where the service has been applied. I agree to provide safe and unobstructed access to premises for Chugach employees, pay applicable rates and abide by the terms and conditions as prescribed by the tariff for all present and future utility service.

The conditions under which a deposit will be required or waived are set forth in Chugach's operating tariff. I declare the information provided is true, accurate, and complete to the best of my knowledge and belief. The information contained in the application has been voluntarily submitted for the purpose of receiving electric service, and is understood upon presentation, this application becomes the property of Chugach.

Applicant Signature	Printed Name and Title	Date

The information submitted in this Application will remain active and valid for a period of 12 months from the date the Application is signed. If, after this 12-month period, Chugach does not receive a request for authorization to operate in parallel, or reasonable proof that the project is going forward, then the Applicant will be considered as "withdrawn" and the Application will be cancelled.

Information below to be filled out by Chugach Representative	
Chugach Representative:	Phone:
Name of Project:	
Chugach service point location (attach service map if available):	

APPENDIX C. *CODES AND STANDARDS*

Codes and Standards

This appendix is a partial list of codes and standards referenced in the Interconnection Guidelines.

The National Fire Protection Association:

- *The National Electrical Code* (NEC), (NFPA-70)

Institute of Electrical and Electronics Engineers (IEEE)

- ANSI/IEEE C37.90, *IEEE Standard for Relay Systems Associated with Electric Power Apparatus.*
- ANSI/IEEE C37.95, *IEEE Guide for Protective Relaying of Utility-Consumer Interconnections.*
- ANSI C62.1, *Surge Arresters for AC Power Circuits.*
- ANSI C84.1, *American National Standards for Electric Power Systems and Equipment Ratings (60 Hertz).* Establishes nominal voltage ratings and operating tolerances for 60 Hz electric power systems from 100 V through 230 kV.
- IEEE Std. 142, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.*
- IEEE Std. 242, *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.*
- IEEE 519, *IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.*
- ANSI/IEEE Std. 929, *Recommended Practice for Utility Interface of Photovoltaic (PV) Systems.*
- IEEE 1547, *Standard for Distributed Resources Interconnected with Electric Power Systems.*
- IEEE P1547.1 (IEEE P1589), *Draft Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.*
- IEEE P1547.2 (IEEE P1608), *Draft Application Guide for IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.*
- IEEE P1547.3, *Draft Guide for Monitoring Information Exchange and Control of DR Interconnected with Electric Power Systems.*
- IEEE P1561, *Draft Guide for Sizing Hybrid Stand-Alone Energy Systems.*

(Inter-) National Electrical Testing Association (NETA)

NETA promotes the independent electrical testing industry by establishing testing standards and specifications and training and certifying testing technicians.

National Electrical Manufacturers Association (NEMA):

A nonprofit trade association supported by the manufacturers of electrical apparatus and supplies. NEMA is engaged in standardization to facilitate understanding between the manufacturers and users of electrical products.

Underwriters Laboratories (UL):

UL is a private, not-for-profit organization that has evaluated products, materials and systems in the interest of public safety since 1894. UL has become the leading safety testing and certification organization in the U.S., and its label is found on products ranging from toaster ovens to inverters to some office furniture. Although UL writes the testing procedures, other organizations may do the actual testing and certification of specific products. In addition to UL, other testing labs such as ETL SEMKO (ETL), and the Canadian Standards Association (CSA) are widely recognized listing agencies for electrical components.

- UL Standard 1741, *Inverters, Converters and Controllers for Use in Independent Power Systems,* covers requirements and testing procedures for inverters, converters, charge controllers, and output controllers intended for use in stand-alone (not grid connected) or utility-interactive (grid connected) power systems. Utility interactive inverters and converters are intended to be installed in parallel with an electric distribution system to supply common loads. UL 1741 comports to IEEE Std. 929 to cover inverters used for sources other than photovoltaics, and to cover controllers that might provide similar capabilities for synchronous and induction machines.

- UL Standard 200, *Standard for Safety Stationary Engine Generator Assemblies,* covers stationary engine generator assemblies, including micro-turbines, rated at 600 volts or less.

Glossary

For industry standard definitions of electric industry terminology not contained in this glossary, please refer to the IEEE Standard Dictionary of Electrical and Electronic Terms, IEEE Std 100.

A

AC

The abbreviation for alternating current.

Abnormal Voltage

Voltage that is outside of the standard Chugach nominal voltage level.

Ampere (Amp)

The unit of current flow of electricity. It is the same with reference to electricity as is the number of gallons per minute when referring to the flow of water. One ampere flow of current is equal to one coulomb per second.

Automatic

Self-acting, operated by its own mechanism when actuated by some impersonal influence as, for example, a change in current strength; not manual; without personal intervention.

Automatic Circuit Recloser

(A) A self-controlled device for automatically interrupting and reclosing an alternating current circuit with a predetermined sequence of opening and reclosing, followed by resetting, hold closed or lockout (ANSI C37.60).

(B) A relay that controls the automatic reclosing and locking out of an AC circuit interrupter.

Automatic Control

An arrangement of electrical controls which provide for opening and/or closing in an automatic sequence and under predetermined conditions; the switches which then maintain the required character of service and provide adequate protection against all usual operating emergencies.

Available Fault Contribution

The maximum current that can be supplied to a fault (short-circuit).

B

Back feed

The ability of a device to introduce voltage and/or current onto the system that is normally the source.

Block-Loaded

Loading of a generator in discrete steps to a specific power level.

Breaker

See *'Circuit Breaker'*.

C

Capacity

(1) The amount of current, in amperes of electric current a wire will carry without becoming unduly heated; (2) The capacity of a machine, apparatus, or device, typically given in volt-amperes (VA) or watts, the maximum of which it is capable under existing service conditions; (3) The load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.

Circuit

An interconnection of electrical elements.

Circuit Breaker

A switching device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal conditions, such as those of a short circuit. Pertaining to interconnected operation, this is the 'paralleling device' referenced in IEEE Standard 1547.

Clearance (Working)

Permission to come into contact with, or to come in close proximity to, wires, conductors, switches, or other equipment which are normally energized at electrical potentials dangerous to human life. Conditions that must prevail before such permission can be granted are, in general, that the equipment or lines be completely isolated from all possible power sources and that all possible power sources be tagged by authorized personnel. Chugach's Power Control Department is the authorizing entity for all clearances on the Chugach system.

Cogeneration Facility

Equipment used to produce electric energy and forms of useful thermal energy (such as heat or steam)--used for industrial, commercial, heating, or cooling purposes--through the sequential use of energy.

Control and Protection

Control refers to the methods and means of governing the performance of the generating facilities. Protection refers to the system of devices used to detect abnormal operating conditions and to initiate tripping of apparatus.

Converter

A machine or device for changing alternating current (AC) power to Direct Current (DC) power or vice versa, or from one frequency to another.

Current

The flow of electric charge measured in amperes.

D

DC

The abbreviation for direct current. As ordinarily used, the term designates a practically nonpulsating current, such as the output of an electric battery.

Dead-End Structure

The structure on which a span of aerial conductors terminate or transition to an underground circuit.

Demand

The rate at which electric energy is delivered to or by a system; normally expressed in kilowatts, megawatts, or kilovolt-amperes.

Direct Transfer Trip

Transferal of a signal to trip circuit breakers at the remote end of a line.

Disconnect Device

A device whereby the conductors of a circuit can be disconnected from their source of supply (IEEE 100-1984).

Disturbance

An unplanned event (e.g., fault, sudden loss of load or generation, breaker operations, etc.) that produces an abnormal system condition.

Droop

The slope of the prime mover's speed-power characteristic curve. The speed droop, typically 5 percent, enables interconnected generators to operate in parallel with stable load division.

E

Electric Generator

A machine that transforms mechanical power into electric power. (Refer to Generator).

Electrical Supply Grid

The system of interconnected generation stations, transmission lines, and distribution systems used to deliver electric power.

Energize

To apply voltage to a circuit or piece of equipment; to connect a de-energized circuit or piece of equipment to a source of electric energy.

F

Fault

An unintentional short circuit on an electrical system, between phases or between phase(s) and ground, characterized by high currents and low voltages.

Fault Current

A current that flows from one conductor to ground or another conductor, owing to an abnormal connection (including an arc) between the two.

Feeder

A set of conductors originating at a main distribution center or substation, supplying one or more distribution branch circuits.

Flicker

Impression of fluctuating brightness or color, occurring when the frequency of the observed variation lies between a few hertz (cycles per second) and the flicker threshold (the frequency of intermittent stimulation of the eye at which flicker disappears).

Forced Outage

Any outage resulting from electrical equipment failure, a control systems malfunction, a design defect, operator error, or failure of mechanical systems integral to the electrical output of a generating facility. a breakdown of the mechanical or electrical equipment that fully or partially curtails the electrical output of the generating facility.

Frequency

The number of cycles occurring in a given interval of time (usually 1 second) in an electric current. Frequency is commonly expressed in hertz.

Frequency Deviation

A change in frequency from 60 hertz caused by a temporary imbalance of generation and load.

G

Gang-Operated

A multiple pole switch in which all poles are operated simultaneously.

Generating Facility

A plant wherein electric energy is produced from some other form of energy by means of a suitable converting apparatus, including the generation apparatus and all associated equipment owned, maintained, and operated by the Producer.

Generator

The physical electrical equipment that produces electric power. Sometimes used as a brief reference to a Producer.

Generator Reactive Power Capability

The amount of reactive power (VArs) that a generator can produce or absorb from the electric system to which it is connected.

Grid

A network of conductors, generally termed 'feeders', used for the distribution of electric power.

Ground

A term used in electrical work in referring to the earth as a conductor or as the zero of electrical potential (volts). For safety purposes, circuit conductors are grounded only while any work is being done on or near a circuit or piece of equipment in the circuit; this is usually called protective grounding.

Ground Fault

An unintentional electric current flow between one or more energized conductors and the ground.

H

Hertz (Hz)

The term denoting cycles per second or frequency.

Harmonic

A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency. For example, a component with a frequency that is twice the fundamental frequency is called the second harmonic.

Harmonic Distortion

Distortion of the fundamental sine wave of voltage or current due to the presence of harmonics. This value is defined as the ratio of the root mean square (rms) value of the harmonic content to the rms value of the fundamental quantity (IEEE 519-1992).

I

Instrument Transformer

A transformer that is intended to reproduce in its secondary circuit, in a definite and known proportion, the current or voltage of its primary circuit with the phase relationships substantially preserved. (IEEE 100-1984)

Interconnection

The physical electrical connection for parallel operation of the Producer's generating facility with the Chugach electric system.

Interrupting Capacity

The amount of current a switch or circuit breaker can safely interrupt.

Interruption

The loss of electrical supply to one or more consumers or facilities.

Inverter

A device that converts direct current (DC) power to alternating current (AC) power.

Island

A portion of the interconnected Chugach system that has become isolated due to the tripping of transmission system elements. ("Local" Island - A portion of the transmission system, often a single line, which is isolated from the main system and energized by a local generator.)

Islanded

Separated from the rest of the electrical supply grid.

K

Kilovolt (kV)

One thousand volts.

Kilovolt-Ampere (kVA)

The product of kilovolts times amperes. Used to refer to high voltage alternating current systems.

Kilovolt-ampere-reactive (kVAr)

A measure of reactive power that is required to regulate system voltage.

Kilowatt (kW)

An electrical unit of power that equals 1,000 watts.

Kilowatt-hour (kWh)

One thousand watts of energy supplied for one hour. A basic unit of electric energy equal to the use of 1 kilowatt for a period of one hour.

L

Leading Power Factor

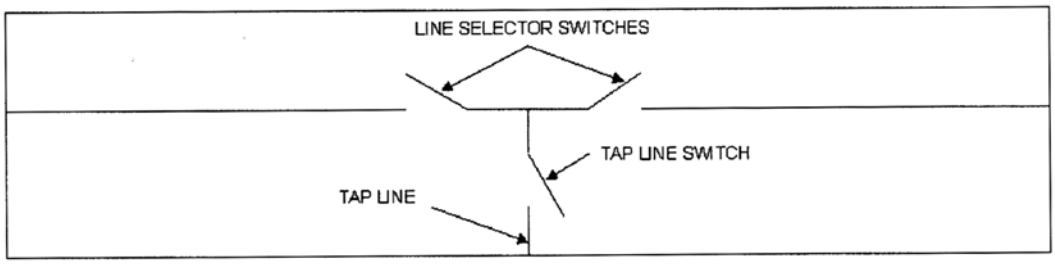
A 'leading' power factor occurs when reactive power flows in the opposite direction of real power. A generator with a leading power factor supplies real power (watts) while absorbing reactive power (VArs). Conversely, a load having a leading power factor absorbs real power while supplying reactive power.

Line

Normally thought of as the three conductors of an electric transmission or distribution circuit.

Line Selector Switch

A disconnect switch that is located in-line with a Chugach line at the point where the line is tapped.



Log

A computer file, book, or loose-leaf sheets for recording all station operations, clearances, readings, ratio reports, and other pertinent active daily data.

Losses

Energy that is dissipated before it accomplishes useful work.

M

Manual Disconnect Switch

A disconnect switch is a mechanical switching device used to disconnect a circuit from the source of power. A manual disconnect switch is operated non-automatically by the direct action of a person.

Megawatt (MW)

One million watts.

N

Neutral

The common point of a star connected transformer bank, a point normally at zero potential with reference to the earth.

Non-Utility Generation

Generation facilities that are owned and operated by a person or company other than an electric power supply utility.

O

Ohm

The standard unit of practical unit in resistance of an electric circuit; generally the resistance to the flow of electric current.

One-Line Diagram

An electrical schematic drawing, which represents the phases of a three-phase electrical system as a single line.

Open-Transition Mode

A method of switching generation from one system to another without connecting the two systems. This can be accomplished by employing a transfer switch with break before make contacts (breaks contact with one system before making contact to the other system).

Outage

A condition existing when a line or a station is de-energized.

Output

The energy delivered by a machine or piece of apparatus during its operation.

Overvoltage

Voltage higher than that desired or higher than that for which equipment in question is designed.

P

Paralleling Device

The switchgear or circuit breaker, which is controlled by the Producer's interconnection control system. This is the Producer's device, which establishes the physical electrical connection for parallel operation with the Chugach system.

Parallel Operation

The operation of a customer owned generator while electrically connected to the Chugach electric grid. Under this condition power can either flow from the Chugach system to the generating facility or vice versa. Parallel operation may be solely for the customer's operating convenience or for the purpose of delivering power to the Chugach electric grid.

Point of Interconnection

The point where the load or Producer's conductors or those of their respective agents meet the Chugach Power System (point of ownership change).

Power

The time rate of transferring or transforming energy.

Power Factor

The ratio of actual power to apparent power. Power factor is the cosine of the phase angle difference between the current and voltage of a given phase. The power factor is unity when the voltage and current are in phase. A "lagging" power factor is associated with a partially or wholly inductive load that "absorbs" positive reactive power. A "lagging" power factor is also associated with a generator that "delivers" positive reactive power. A "leading" power factor is associated with a capacitive load that "delivers" or a generator that "absorbs" positive reactive power. Refer to Reactive Power.

Primary

Normally considered as the high voltage winding of a substation or a distribution transformer; any voltage used for transmission of electric power as contrasted with lower voltages for the immediate supply of power locally, such as secondary distribution circuits, or distribution systems within a building.

Producer

One who produces electrical power and energy. In the context of Chugach's Interconnection Guidelines, the term Producers typically refers to the owner and/or operator of non-utility generation.

Protection

All of the protective relays and other equipment which is used to open the necessary circuit breakers to clear lines or equipment when faults or unacceptable operating conditions develop within the power system.

Protective Devices

Devices used to protect equipment during abnormal conditions. This would include protective relays, whose function is to detect power system conditions of an abnormal or dangerous nature. It would also include circuit breakers or other interrupting devices used to protect the generator, associated equipment, and the electrical system to which the generation is interconnected.

Protective Relay

A device whose function is to detect system faults, defective lines or apparatus, or other power system conditions of an abnormal or dangerous nature and to initiate appropriate control circuit action.

R

Reactive Power

The component of total volt-amperes in an alternating current circuit where the voltage and current are out of phase by ninety electrical degrees. It is measured in units of volt-amperes reactive (VAr), kVAr, or MVAr. It represents the power involved in the alternating exchange of stored energy in inductive and capacitive electromagnetic fields. Although this type of power supplies no useful energy, it is an inherent requirement for all alternating current power systems. By convention, positive reactive power is "absorbed" by an inductance and "generated" by a capacitance. Reactive power transferred over time is measured in VAr-hours (VArh). Refer to Power Factor.

Reactive Volt-Amperes (VArs)

See Reactive Power.

Real Power

The component of total volt-amperes in an electric circuit where the voltage and current are in phase. It is also called active power and is measured in watts (W), kW, or MW. This is the electrical power associated with useful energy, including mechanical work and heat. Real power used or transmitted over time is measured in kilowatt-hours (kWh) or MWh.

Real Time (data)

Data reported as it happens, with reporting (update) intervals no longer than a few seconds.

Reclose

To again close a circuit breaker after it has opened by relay action.

Reconductoring

Replacing the conductor in an existing line. Typically, this involves replacement within higher capacity conductor, or installing an additional conductor in a line.

Relay

A device that is operative by a variation in the condition of one electric circuit to affect the operation of another device in the same or in another electric circuit.

Resonant Overvoltages

Overvoltages caused by harmonics that correspond to a natural resonant frequency of the system.

S

Secondary

The winding of a transformer, which is normally operated at a lower voltage than the primary winding.

Secondary Distribution System

A low voltage alternating current system, which connects the secondaries of distribution transformers to the Consumer's services.

Separate

Generation that is operating without the ability to send or receive power from the Chugach system.

Separate System

A generating system, which has no capability or possibility, or connecting and operating in parallel with the Chugach system.

Setting (Protective Relay)

The values of current, voltage, or time at which a relay is adjusted.

Shared Secondary

The condition which occurs when a Producer interconnects with Chugach on the secondary side of a distribution transformer, and other customers may also be connected to the secondary side of the same transformer.

Short Circuit

An abnormal connection (including an arc) of relatively low impedance, whether made accidentally or intentionally, between two points of different potential (IEEE 100-1984).

Single-Line Drawing

See One-Line Diagram.

Solid-State Equipment

Equipment that contains electronic components that do not use vacuum or gas filled tubes. Discrete semiconductors (e.g., transistors, diodes, etc.), integrated circuits, or other static components such as resistors and capacitors are used for the electrical functioning of the equipment. Note: Equipment that uses a cathode ray tube for display purposes, such as a television or computer monitor, may still be considered solid-state if the other components within the equipment are solid-state.

Step-Up Transformer

A transformer in which the secondary winding has more turns than the primary, so that the secondary delivers a higher voltage than is applied to the primary.

Stiffness Ratio

The ratio of system available fault current at the point of interconnection to the full load rated output current of the installation.

Supervisory Control

A system by which equipment is operated by remote control at a distance by means of some type of code transmitted by wire or electronic means.

Switch

A device for making, breaking, or changing the connections in an electric circuit.

System

The entire generating, transmitting, and distributing facilities of an electric supply utility.

System Emergency

A condition on a utility's system, which is likely to result in imminent significant disruption of electric service to consumers. or is imminently likely to endanger life or property.

T

Tap Line Switch

A disconnect switch that is located in a tap line at the place where the tap line taps into a Chugach line. See Line Selector Switch.

Telemetry (Telemetering)

Measurement with the aid of a communication channel that permits the measurement to be interpreted at a distance from the primary detector.

Total Harmonic Distortion (THD)

The ratio of the root mean square (rms) value of the harmonic content to the rms value of the fundamental quantity, expressed as a percent of the fundamental (IEEE 519-1992).

$$THD = \sqrt{\frac{sum\ of\ \ squares\ of\ \ amplitudes\ of\ \ all\ \ harmonics}{square\ of\ \ amplitude\ of\ \ \ fundamental}} \times 100\%$$

Transfer Trip

A form of remote trip in which a communication channel is used to transmit the trip signal from the relay location to a remote location.

Transformer

An electric device, without continuously moving parts, in which electromagnetic induction transforms electric energy from one or more other circuits at the same frequency, usually with changes of value of voltage and current.

Transient

A change from the steady-state condition of voltage or current, or both. Transients can be caused by a lightning stroke, a fault, or by switching operation, such as the opening of a disconnect, and may be readily transferred from one conductor to another by means of electrostatic or electromagnetic coupling (IEEE 100-1984).

Transmission Line

A line used for electric power transmission. Distinguished from a distribution line by voltage. Typically in the Alaskan power transmission system, lines rated 69 kV and above are transmission lines.

Trip Indication

A display or indication that a circuit breaker has tripped. This indication can be in the form of relay targets, annunciator alarms, sequence-of-events recorder logs, SCADA alarms, etc.

U

Undervoltage Protection

Upon loss or reduction of voltage, the protection device, which interrupts power to the main, circuit and maintains the interruption.

Uninterruptible Power Supply (UPS)

A power conditioning and supply system that provides a continuous source of power to equipment (e.g., computer systems) during short-term power outages or surges.

V

VAr (var)

A unit of measurement of reactive power. It is an expression of the difference between current and voltage sine waves in a given circuit where:

$$\text{var} = \sqrt{(\text{va})^2 - (\text{watt})^2}$$

Volt

The difference of electric potential between two points of a conductor carrying a constant current of one ampere, when the energy dissipated between these points is one watt. Analogously, this is comparable to the pounds per square inch pressure in a fluid system.

Volt-Ampere (VA)

A unit of apparent power in an alternating current circuit. Equal to the product of volts and amperes without reference to the phase difference, if any. Whenever there is any phase difference between voltage and current, the true power in watts is less than the apparent power in volt-amperes.

Voltage Regulation

The control of generator terminal voltage to a predetermined value. This is accomplished using a voltage regulator that controls the amount of current flowing into the generator field winding, which in turn affects the output voltage of the generator.

W

Watt

The unit of power in the International System of Units (SI). In electrical terms, the watt represents is the unit of real electric power.

Watt-Hour (Wh)

A measure of real electric power (watts) produced or consumed over a period of hour.

Watt-Hour Meter

An instrument which measures and/or records electrical power over time.