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Northeast Nebraska Public Power District

Distributed Generation (DG) Policies and Procedures Manual

A Guide to the Interconnection of
Distributed Generation with the
Electric System of
Northeast Nebraska Public Power District

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Section 1 - Introduction

1.01 Objective

This document is an administrative and technical manual that specifies the requirements of the Northeast Nebraska Public Power District ("NNPPD") for the interconnection of Distributed Generation (DG) facilities to the NNPPD electric system. The primary objective of this manual is to ensure a safe, efficient and consistent approach for all interconnections.

The requirements stated in this manual are applicable for all DG facilities operated in parallel (also known as closed transition) with the electrical transmission and distribution facilities owned and/or operated by NNPPD. The interconnection requirements of this manual do not apply to generation that is physically and mechanically incapable of closed transition operation (parallel operation) with the utility. A traditional emergency engine-generator installed with an open transition automatic transfer switch is an example of equipment for which the requirements of this manual do not apply.

These requirements are intended to achieve the following:

1. Ensure the safety of the general public and NNPPD personnel.
2. Minimize possible damage to the property of the general public, NNPPD customers, and NNPPD system.
3. Permit the DG Operator to install and operate generating equipment in parallel with the NNPPD electric system in a manner that is safe and reliable.
4. Minimize adverse operating conditions and affects on/to the NNPPD electric system, its customers, and other utility systems interconnected with NNPPD.

NNPPD reserves the right to revise this manual at any time and the DG Operator is solely responsible for complying with any such revised manual.

1.02 Regulatory Compliance and Interconnection Requirements

It is the responsibility of the DG Operator to obtain any and all permits and jurisdictional approvals and to comply with all applicable codes.

The DG Operator needs to work closely with NNPPD to keep up-to-date on the interconnection requirements.

The requirements to interconnect generation may vary depending upon:

1. The interconnection voltage
2. Direction of power flow at the interconnection
3. Classification of the proposed generation

In most cases, NNPPD requires a Professional Electrical Engineer to certify drawings, tests, settings, or other documentation. The Professional Engineer's seal shall be valid for the state in which the project is being constructed. The DG Operator should review

this manual and coordinate with NNPPD to determine all certification requirements to avoid unnecessary delays.
This manual does not provide specific interconnection expense cost data to the DG Operator, as proposed DG facilities must be evaluated on a case-by-case basis. NNPPD will examine the impact of a proposed facility and evaluate costs for NNPPD system modifications, DG facility service modifications, or other required action during the 'application' phase. Specific interconnection expense cost data will be addressed during this process.

1.03 Responsibility

The application process described in this manual concludes with NNPPD approving or disapproving a parallel generation interconnection. Prior to issuing its decision, NNPPD shall complete an engineering and operational review of the interconnection to ensure the NNPPD system will be protected and can be maintained and NNPPD does not anticipate other NNPPD customers will be adversely affected by operation of the parallel generation.

NNPPD is not liable or responsible for DG Operator's equipment or the DG facility electrical system (or the protection of either). The DG Operator is solely responsible for protecting its equipment to prevent damage from faults, imbalances, out-of-phase reclosing, or other disturbances on the NNPPD system. Additionally, the DG Operator shall be responsible to protect NNPPD property, public safety, and NNPPD personnel due to failure of the DG system.

1.04 Enforcement

By entering into the process of obtaining approval of the parallel generation of its DG facility from NNPPD, the DG Operator agrees to comply strictly and completely with all requirements of this manual and all applicable laws, regulations, and industry codes related to the DG facility. NNPPD shall be entitled to enforce the requirements of this manual and to obtain relief from any breach by the DG Operator of its requirements in any manner provided by law and shall be entitled to all available remedies, including money damages and equitable relief.

Section 2 - General

2.01 Adverse Effect

The DG Operator/NNPPD interconnection shall not adversely affect the utility's other customers. Possible adverse effects to other utility customers include (but are not limited to):

1. Reduction in quality of electric service.
2. Higher cost of electricity.
3. Expenditure of NNPPD capital for interconnection without benefit to other customers.

4. Infringement of NNPPD Wholesale Power Purchase/Delivery Contract Commitments.

2.02 Accreditation of Generation

Accreditation provides a uniform accounting method that assures the use of consistently attainable data for utility system planning and operations. NNPPD may accredit the generation with the regional transmission operator and/or reliability council.

Accredited DG facilities are required to operate under additional rules and regulations that are beyond the scope of this manual. NNPPD must meet criteria for accreditation by the responsible agency with jurisdiction over the requirements for accreditation. At this time, the Mid-Continent Area Power Pool (MAPP) is the responsible accrediting agency. NNPPD will follow all policies, procedures, requirements, criteria and the like issued by MAPP or any successor agency, regional RTO, or reliability council having authority in accrediting the DG Operator generation.

2.03 Interconnection Hazards

Proper operation of two independent power sources such as the utility source and a nonutility generation source in closed transition results in a parallel operation of the two systems. The electrical attributes of both systems must be identical prior to and during the period of parallel operation. Any attempt to interconnect the two power systems while they do not share identical attributes will result in problems ranging from tripping of the circuit breaker at the interconnection point to severe equipment damage and hazardous conditions for personnel on both sides of the interconnection. The requirements of this manual apply to all distributed generation, except those physically and mechanically incapable of closed transition operation with the utility.

2.04 Islanding

Automatic and manual switching arrangements on the NNPPD transmission and distribution system are based on the premise that, upon opening a line or section of the NNPPD system, it becomes de-energized. Distributed generation equipment that remains energized and interconnected to the isolated portion of the system or reconnects before service restoration, creates a hazardous condition for utility employees and the general public, and for this reason, NNPPD does not allow DG facilities to operate as an island on the NNPPD system. The DG facility must automatically isolate itself from the de-energized portion of the NNPPD system in the event of an NNPPD outage.

2.05 Protective Equipment

NNPPD requires the installation of protective equipment that shall be designed and tested to protect the electrical systems and personnel of the DG Operator, NNPPD, and the general public under all operating and maintenance conditions. These requirements are also applicable to automated open transition switchgear capable of closed transition operations via programming or logic changes.

For the reasons outlined above, the interconnection of generation with a utility for parallel operation is required to meet specific technical requirements. Several site-specific factors will determine the technical requirement unique to the proposed DG installation.

Descriptions of agreements between NNPPD and the DG Operator within this manual shall not be construed as modifying any existing agreements that establish rights and obligations for both NNPPD and the DG Operator.

Section 3 - Classification of the DG Interconnection

NNPPD categorizes interconnected (parallel) generation into three general classifications. These are Class I, II, and Ill. The major factors to be considered in the determination of the interconnection class include the point of utility interconnection, the generator ratings, the generation type, and the number of generators interconnected on the electrical service. Classification of the facility shall be determined by NNPPD, based upon DG facility application information provided by the facility DG Operator.

The Class I interconnection classification includes induction generators, line commutated power converters, and any other generating equipment that must be energized by the utility system to operate (excluding microturbine type generation). The VAR requirements of any induction generator interconnected to the NNPPD system shall be supplied locally by the DG facility. NNPPD may, at its option, charge the DG facility for VAR impacts on the NNPPD system (see Section 11 - Generation Equipment, ‘Induction Generators’).

The DG Operator shall purchase, install, and maintain the required protective equipment for Class I interconnections where the protective equipment integral to the generation unit does not meet NNPPD requirements (see Section 14 - Protective Equipment in this manual). The equipment requirements are dependent upon the ‘type’ of Class I interconnection. NNPPD has two ‘types’ of Class I interconnection. The corresponding ‘type’ equipment requirements are as follows:

3.01 Class I ‘Type A’ Interconnections:

This classification includes induction generators or generators with line commutated power converters rated 50 kW or below, single-phase or three-phase.

NNPPD does not require a separate interconnection disconnect or interconnection breaker for devices classified as Class IA, provided each generation unit has an NNPPD-accessible, outdoor unit disconnect switch and a unit mounted output breaker operated by the required protective relays. NNPPD will determine requirements for protective functions/relaying on a site-specific or equipment-specific basis. Note: Should NNPPD operate (open) the unit disconnect switch during an NNPPD circuit outage, the opening of this switch should not affect the generator, other than cause it to cease to generate, as a utility source is required for generator operation.

3.02 Class I 'Type B' Interconnections:
Consist of all other induction generators or generators with line commuted power converters rated greater than 50 kW, except those determined to require a Class II interconnection, and any other generating equipment that must be energized by the utility system to operate (excluding microturbine type generation). DG Operator shall furnish kVARs equal to a minimum of 90% of the estimated reactive requirement of the generator installation.

NNPPD will determine requirements for protective functions/relaying on a site-specific basis. An interconnection disconnect and an interconnection breaker shall be required.

3.03 Class II

Class II interconnections include generation equipment that operates independent of the utility, with rated capacity at or below 5 MW, and is interconnected to the utility at or below 15,000 volts.

Interconnections with synchronous generators or generators with self-commutating power converters are typically defined as Class II interconnections. Class II interconnections also typically apply to the interconnection of direct energy converters, most inverters, induction generators with an adequate local VAR supply, and all microturbines (whether capable of operation independent of the utility or not).

The DG Operator shall purchase, install, and maintain the required protective equipment (see Section 14 - Protective Equipment in this manual) for all Class II interconnections. This equipment includes:

- an interconnection disconnect at each interconnection point.
- an interconnection breaker for each interconnection point.
- protective functions/relaying in accordance with NNPPD requirements.

NNPPD may waive the interconnection breaker and protective relaying requirements for 'momentary' closed transition interconnections - refer to the Section 10 - Duration of Parallel Operation section of this manual to determine if the load transfer equipment meets the 'momentary' classification.

3.04 Class Ill

Class Ill interconnections are for any interconnection in excess of 15,000 volts, are typical for generation in excess of 5 MW, and may also apply where medium and high voltage generation equipment (>600V) is used. NNPPD will evaluate and specify the requirements for Class Ill interconnections on a site-specific basis. Class Ill interconnections may require, as a minimum, all requirements for a Class II interconnection. Class Ill facilities will often require an interconnection directly into the NNPPD transmission system. Class Ill DG facilities are typically intended to be 'accredited' generation facilities, and if so, may include additional requirements from a regional RTO or reliability council.

Section 4 - Listing and Description of the Various NNPPD Forms

NNPPD uses several forms to facilitate the process for Distributed Generation Interconnection between a DG Operator and NNPPD. The various forms are listed below with a short description. A copy of each is included in a later section of this manual. Note: These forms may change from time to time; therefore interested parties should obtain the most current copy of these forms from NNPPD for review.

4.01 Application for Distributed Generation (DG) Interconnection
This is the form to be used by a DG Operator to notify NNPPD of the desire to install generation that will operate in closed transition with the NNPPD electric system. The DG Operator uses this form to transmit information about the intended installation.

4.02 Interconnection and Service Agreement
This Agreement outlines the specifics of the physical interconnection between the facilities of NNPPD and the DG Operator and any financial and facility requirements of each of the Parties.

4.03 Energy Purchase Agreement
This Agreement specifies the conditions and parameters under which NNPPD will purchase the output of the facility owned by the DG Operator.

4.04 Avoided Cost Rate Schedule
An appropriate schedule applicable to the intended DG installation size and use criteria which specifies the compensation made to the DG Operator for all generation purchased by NNPPD under the Energy Purchase Agreement.

Section 5 - Requirements for Closed Transition Operation

5.01 General

Any operation of generation in closed transition with the NNPPD system requires a signed and executed 'Interconnection and Service Agreement' between NNPPD and the DG Operator. The agreement stipulates the terms of the interconnection; such as the class of interconnection, types of power transaction, duration of interconnection, protection requirements, etc. Prior to execution of the agreement, the DG Operator must have obtained a NNPPD-approved 'Application for Distributed Generation (DG) Interconnection'. The installation must be inspected and approved by NNPPD for parallel operation. Parallel operation without a signed Interconnection and Service Agreement, or failure to comply with the terms of the agreement, may result in termination of the utility service.

Upon review of the DG applicant's design for the proposed parallel installation, NNPPD may require changes to the protection scheme, interconnection point, or other items. NNPPD may not allow the use of certain equipment grades or manufacturer's products. NNPPD will notify the applicant, in writing, of NNPPD approval. The applicant should not release DG equipment for manufacture or begin installation of DG equipment until this approval has been received.

5.02 Periodic Testing

See Section 14 - Protective Equipment in this manual for testing and verification schedules for protective equipment.

NNPPD requires periodic testing and verification of all DG-utility interconnections. The test(s) shall verify the interconnection functions as originally approved by NNPPD. The interconnection equipment shall be tested for conformity with the initial, 'as installed' test requirements.

Except where exempted by NNPPD, the testing shall be certified by a Professional Electrical Engineer registered in the state where the project is being constructed. The engineer shall be selected by the DG Operator and all engineering services shall be performed at the DG Operator's expense. The DG Operator shall also reimburse NNPPD for the direct, actual expenses incurred by NNPPD as a result of testing. An example of such expenses would be reimbursement for a NNPPD crew or technician to 'stand by' during testing to be available in the event problems arise.

The DG Operator shall keep all test results on file for review by NNPPD. These tests may be required to be submitted as part of the renewal process, so files should be maintained for a minimum of the period between renewals. Refer to Section 6 - The Approval Process for DG Installations for renewal requirements.

5.03 NNPPD Access to DG Facility Equipment

By submitting a completed 'Application for Distributed Generation (DG) Interconnection', and as part of the terms of the 'Interconnection and Service Agreement', the DG Operator agrees to allow NNPPD access to the DG facility under both normal and emergency conditions for the purpose of inspection and to witness testing of the interconnection equipment.

Under normal conditions, NNPPD intends to provide advance notice of all site visits and will coordinate such visits with the DG Operator or the DG Operator's representative. However, emergency conditions would require NNPPD access to the DG facility without advance notice.

5.04 Utility Service Termination Clause

By submitting a completed 'Application for Distributed Generation (DG) Interconnection', and as part of the terms of the 'Interconnection and Service Agreement', the DG

Operator agrees to the following:

A) NNPPD shall have the right to require the DG Operator to immediately disconnect, or cause to be disconnected, the generation facility without advance notice or liability if:

- there are any changes or alterations to the DG facility equipment which are unapproved by NNPPD
- in NNPPD's sole judgment, the facility has not incorporated necessary features for automatically counteracting the effect of anticipated possible sources of failure (fail-safe design)
- the facility causes any electrical and/or communication problem(s) with other NNPPD customers
- the facility may pose a risk to NNPPD employees, customers or the general public

B) The failure of the DG Operator to comply with any of the covenants or obligations contained herein shall give NNPPD the right to terminate its agreement with the DG Operator and to recover from the DG Operator the cost and expenses incurred by NNPPD.

C) The agreement shall be subject to all of the NNPPD service regulations, rate schedules, and written policies regarding interconnection (except as modified by the agreement) and shall be subject to such changes or modifications as NNPPD Management or Board of Directors may from time to time make in the service regulations, rate schedules, and interconnection policies.

The above clause is applicable to all distributed generation operating in parallel with the NNPPD system, including generation discovered to exist on the NNPPD system without the DG Operator having initiated or successfully completed the NNPPD agreements for DG installations.

5.05 Nontransferable Agreements for Change of DG Operatorship or Modified Facilities

Executed 'Application for Distributed Generation (DG) Interconnection', 'Interconnection and Service Agreement', 'Energy Purchase Agreement', and all related documents are not transferable to parties, DG facilities or DG equipment other than those identified in the documents.

If the DG facility undergoes a change of DG Operatorship, or the facility is modified, any existing agreements between the previous DG Operator and NNPPD are considered null and void. The new DG Operator, or the DG Operator of a modified DG facility, does not have NNPPD permission for closed transition operation and shall be subject to the terms of the 'Utility Service Termination Clause' above. Such circumstances will require the execution of new forms of the above documents. Refer to Section 6 - The Approval Process for DG Installations renewal requirements for additional information.

5.06 Interconnection Expenses

NNPPD maintenance and operation procedures are based on a single source serving the electric distribution system. Interconnection of additional generation or other modifications to the electric system will necessitate modification to these procedures. Often, the introduction of DGs to the utility system requires capital expenditures for additional utility equipment. These modified procedures and additional utility equipment increase NNPPD costs without providing benefits to its other utility customers. In such cases, the expenses for additional NNPPD procedures, equipment, maintenance, labor, and other related costs that are over and above the expenses for a nongeneratinq customer shall be paid to NNPPD by the DG Operator.

These reimbursable costs are separate from DG Operator obligations to purchase, install, and maintain NNPPD required interconnection equipment installed at the DG facility, as well as the cost of professional engineering services and maintenance testing to satisfy NNPPD requirements.

The following expense categories are examples of items reimbursable to NNPPD:

1. Telemetry installation, tests, maintenance, parts, and related labor
2. Operating expenses, including communication circuits
3. Study, analysis, and related expenses
4. Modifications to the NNPPD system including related material and labor
5. Protective device (NNPPD owned) installation/equipment cost & related labor
6. NNPPD costs for DG facility design review, equipment inspections, and witness testing
7. Programming costs to incorporate generation data into NNPPD energy management system

Changes to the NNPPD system or the addition of other DG facilities in the vicinity may require modifications to the existing DG facility interconnection. If such changes are required, the existing DG facility shall be subject to future charges for these modifications.

Also, a DG installation results in increased utility maintenance costs in the event of an extended outage on the utility circuit that serves the DG facility to safeguard NNPPD repair crews. NNPPD will isolate the DG facility from the NNPPD system by opening the interconnection disconnect(s) before restoring service to the disabled circuit. NNPPD will return to the DG facility and close the interconnection disconnect(s) after the utility circuit is restored. These additional steps are only required for facilities with interconnected generation, but potentially delay restoration of service to all customers of the utility circuit. Costs associated with these additional steps shall be reimbursed by the DG Operator to NNPPD.

The DG Operator is also responsible for any ongoing monthly charges, such as telephone bills associated with DG facility-to-NNPPD voice or data communications, incidental to operation and monitoring of the DG facility.

Upon receipt and review of the 'Application for Distributed Generation (DG) Interconnection' application, NNPPD will inform the DG facility applicant of potential NNPPD expenses requiring reimbursement. In most cases NNPPD will require 100% of requested reimbursement funds in the form of a front-end deposit, prior to the execution of NNPPD work. Unused funds will be refunded to the depositor at project completion.

5.07 Contact Information

With interconnected generation, DG facility equipment events may impact the NNPPD system and/or NNPPD system events may impact the DG facility. Consequently, communication between the two parties becomes very important.

For Class I 'type A,' some Class I 'type B,' and smaller Class II installations, NNPPD requires daytime and nighttime phone numbers for emergency contact purposes. Minimal additional DG Operator contact information is required. The contact person(s) should contact NNPPD at (___) ___-____ whenever the NNPPD electric system has a service interruption affecting their generation equipment.

For some Class I 'type B', larger Class II, and Class Ill installations, NNPPD requires a 24 hour/day, 365 day/year phone number for after hours and emergency contact purposes. The designated DG facility contact person(s) should have responsibility for and authority over operation of the generation and be able to provide information regarding facility events, equipment status, and relay target and alarm information upon NNPPD request. Also, the contact person(s) should notify NNPPD whenever:

1. Problems with generation equipment are detected that could result in mis-operation of generation protection or other generation equipment.
2. The generation has tripped off-line during parallel operation with the NNPPD system.
3. Generation equipment problems are believed to have resulted in an outage to a portion of the NNPPD system.
4. The DG facility intends to initiate abnormal switching to parallel the generation with the NNPPD system.

Under certain circumstances, NNPPD may determine additional contacts are required.

Section 6 - The Detailed Approval Process for DG Installations

This section clarifies the process for connecting Class I, Class II, and/or Class Ill generators to the NNPPD electric system.

6.01 New Installations

The DG Operator must complete and execute three documents with NNPPD prior to beginning operation of the generation equipment:

- An NNPPD-approved Application for Distributed Generation (DG) Interconnection
- An Interconnection and Service Agreement.
- An Energy Purchase Agreement.

For the DG Operator, or their representative, the following steps are involved in the process for new DG installations (for 'accredited' generation facilities, see Section 2 - General Policy in this manual, as the additional steps required for such facilities are not addressed below):

1. Obtain current copies of the NNPPD DG Manual and review the documents to become familiar with all requirements.
2. Contact NNPPD representatives at (___) ___-____, to discuss with you the proposed generation installation and any requirements including: submittal requirements, protective equipment (including relay) requirements, metering and/or telemetry requirements (typical of Class II and Ill). Professional Electrical Engineer certification is normally required on submittals; the engineer must have a valid license for the state where the project is being constructed, and for possible preapproval of a manufactured system. Early discussions with NNPPD can avoid misunderstandings and delays in the approval/installation.
3. Assemble all DG equipment information, installation drawings, and other information. Complete and sign an 'Application for Distributed Generation (DG) Interconnection', submit the application with all material assembled, and await NNPPD response. Allow a minimum of 30 days for NNPPD review of this application.
4. Supply any additional materials or respond to any questions regarding the installation as requested by NNPPD.
5. Classification of the facility shall be determined by NNPPD, based upon DG facility application information provided by the facility DG Operator.
6. If further NNPPD studies are not required, protective equipment, metering, and other requirements may be finalized and the process continues below. If further NNPPD studies are required (typical of larger Installations), the approval process is delayed at this point until the completion of the study phase. Note: such studies, if required, may take an extended period for completion, and will usually require execution of study agreements between the applicant and NNPPD. Study agreements and study results will address issues of reimbursement of NNPPD by the DG applicant (see Section 5 - Requirements for Closed Transition Operation, 'Interconnection Expenses').
7. Receive approval of 'Application for Distributed Generation (DG) Interconnection' application from NNPPD.
8. Release orders for, and/or purchase of, any switchgear or DG equipment to be purchased for the installation.
9. Submit DG facility relay settings to NNPPD for review, if not already submitted.
10. Complete construction of the DG facility and any required preoperational tests.
11. Notify all parties and NNPPD that facility is ready for parallel operational test

and arrange date and time.

12. Complete the performance/demonstration tests with NNPPD personnel/representatives present.
13. Submit copies of the final protective device settings and final one-line/power riser diagram to NNPPD (PE stamp typically required).
14. Have the 'Interconnection and Service Agreement' executed by all Parties' and reimburse NNPPD for any unpaid interconnection expenses.
15. Have the 'An Energy Purchase Agreement' executed by all Parties

6.02 DG Installation Renewals

General reviews of the DG installation are periodically necessary, and are required for modified DG facilities and for new DG Operators as follows:

Simple Renewal

If no modifications have been made to the DG equipment or facility electric service entrance, and the facility has not had a change of DG Operator or control, contact NNPPD (if NNPPD has not contacted the facility), and:

- Obtain a current copy of the NNPPD DG Manual and review the manual to become familiar with all updated operational requirements.
- Submit any documentation (with PE seal, except where exempted by NNPPD) of required periodic tests; see Section 5 - Requirements for Closed Transition Operation, Periodic Testing in this manual.
- Be aware NNPPD may require the existing DG equipment or facility be modified to meet the requirements of the latest DG Manual, and following said modifications, complete the performance/demonstration tests as required with NNPPD personnel/representatives present.

Renewals for Modified DG Equipment. Facilities or New DG Operators

If the facility electric service or DG equipment has been or will be modified, or if the facility will undergo a change of DG Operatorship or control, NNPPD should be contacted at the earliest possible date prior to the modifications or changes. This will allow a joint review of the facility to determine what revisions, if any, will be required to allow the DG to continue operation.

If the facility electric service or DG equipment will be or has been modified, it will be necessary for NNPPD to review all modifications for compliance with current NNPPD requirements. For minor modifications, NNPPD will evaluate the impact of the modifications against NNPPD DG requirements. If the modifications involve expansion of the existing DG capacity or major modifications to the facility electric service or DG equipment, NNPPD will evaluate the changes in a similar manner to the approach taken for Section 6.01 - New Installations above.

If the facility or DG equipment has or will undergo a change of DG Operatorship or

control, but has not and will not be modified, the new facility DG Operator shall apply for new 'Interconnection and Service Agreement' and 'Energy Purchase Agreement'. This will require the new DG Operator to complete the following items:

- Obtain current copies of the NNPPD DG Manual, the 'Interconnection and Service Agreement' and 'Energy Purchase Agreement' and review the documents to become familiar with all requirements.
- Have NNPPD verify the previous Classification of the DG equipment as defined in the DG Manual (Class I, II, or Ill, import only or export, kW level) and any existing operating restrictions, by examination of previous approvals/records.
- Verify with NNPPD the existing installation and classification, any submittal and periodic testing requirements and PE certification. Submit documentation (with PE seal, except where exempted by NNPPD) of required periodic tests. Periodic tests are discussed in Section 5 - Requirements for Closed Transition Operation, Periodic Testing in this manual.
- Supply any additional materials or respond to any questions regarding the installation as requested by NNPPD.
- Verify DG facility protection equipment matches facility and NNPPD records, and such records are in the possession of the new DG Operator.
- Be aware NNPPD may require the existing DG equipment or facility be modified to meet the requirements of the current DG Manual.

Upon meeting all NNPPD requirements, NNPPD will forward to the DG Operator copies of the new 'Interconnection and Service Agreement' and 'Energy Purchase Agreement' for execution by the DG Operator, after which the DG Operator will forward a completely executed copy of the documents to NNPPD

Section 7 - Metering

7.01 Revenue Metering

NNPPD uses two styles of metering equipment for traditional utility 'revenue' metering: socket meters and instrument transformer meters. Socket meters are a series-connected measurement device and, therefore, are an integral part of the power circuit - removal of the meter interrupts the power flow. Socket meters usually are not rated over 320 Amps. For capacities beyond 320 Amps, or voltage in excess of 480 volts instrument transformer meters are typically installed. When instrument transformer meters are used, a current transformer and a potential transformer send an output signal to the peripheral meter, thus the meter is not an integral part of the power circuit.

The anticipated sale of electricity to and purchase of excess generation from a DG Operator's facility leads to special metering requirements. Such transactions require metering equipment that is capable of separately recording the import and export energy flows, and in some cases, more extensively on an interval basis.

Meters used on closed transitions have a detent mechanism that only allows energy measurement in one direction, import or export. NNPPD automatically installs the import-detent meter for typical electric service. Export-detent meters are required for closed transition installations where customers may sell the excess generation back to NNPPD. Additional metering may be required to measure all DG facility generation for the calculation needed to establish the total requirements of the DG Operator and the amounts of power and energy, if any, to be sold to NNPPD.

NNPPD will determine the meter requirements for the facilities on a case-by-case basis, and will be responsible for the installation of the import and export (adjacent to one another) for socket metering installations, or for the installation of the import and export meter test cabinet(s) (adjacent to one another) for instrument transformer metering installations, and any additional meter sockets/ meter test cabinet(s) required for sale of power and energy to NNPPD..

At the discretion of NNPPD, advanced, multi-function, bi-directional (import/export) socket meters may be installed in place of the separate import and export socket meters described above. NNPPD does not install meters or account for the DG facility generation/usage in any fashion (kWh to kWh) that would be construed as an exchange or trading of energy supplied to the DG Operator with the excess energy delivered by the DG Operator to NNPPD for DG facilities operating in closed transition.

Larger DG installations may require additional metering equipment, including recorders, additional metering accuracy CT's (possibly installed at the output of DG generation equipment), and telephone line(s) for NNPPD dial-up access to NNPPD equipment. Such requirements will be communicated to the DG Operator during the design stages of the project.

NNPPD will not install traditional 'revenue' metering at locations other than the facility service entrance location(s). Import and export revenue metering will be installed only at the service entrance interconnection point.

7.02 Check Metering

NNPPD 'check' metering/sub-metering may be required at the generator output location when the DG facility participates in certain NNPPD generation credit programs. This type of metering is not considered traditional 'revenue' metering as described above.

7.03 Telemetry

Telemetry is the real-time, instantaneous monitoring of conditions at the DG facility by NNPPD. Telemetry is accomplished by interfacing DG facility equipment or systems with the NNPPD Energy Management System ('EMS').

NNPPD will determine any telemetry requirements for DG installations rated up to 300 kW. In most cases, telemetry is only required for DG facilities capable of generating 300 kW or greater. NNPPD will determine whether telemetry is required for a DG facility in the DG design review stage. Telemetry monitoring is not required for Class I 'Type A'

facilities.

For a DG facility capable of generating 300 kW or more, NNPPD requires the following values from the DG facility back to the NNPPD Energy Management System (EMS):

- the open/closed status of the DG facility's interconnection circuit breaker(s) or switch(es)
- the open/closed status of the DG facility's generation unit circuit breaker(s) and related tie breakers, interposing breakers, or switches
- the status of 'communications failure' alarms for equipment used to send trip signals from NNPPD to the DG facility.

For a DG facility capable of generating one (1) MW or more, NNPPD typically requires the following additional values from the DG facility back to the NNPPD Energy Management System (EMS):

- Instantaneous Amps at each NNPPD / DG facility interconnection
- Instantaneous Volts at each NNPPD / DG facility interconnection
- Instantaneous, directional MW/MVAR and hour ending MWH In and OUT at each NNPPD/DG facility interconnection
- Instantaneous MW/MVAR and hour ending MWH IN and OUT at each DG facility generator (or alternately a net value for a group of DG facility generators)

Under certain circumstances (usually involving 'accredited' DG facilities); regional transmission operators and/or regional reliability councils, or any equivalent thereof, may require installation of Automatic Generator Control ('AGC') equipment to permit remote control of DG facility generation. AGC requirements will typically be implemented through the telemetry system.

In some cases, NNPPD will require telemetry monitoring be accomplished using CTs, PTs, breaker contacts, and related monitoring equipment dedicated to the purpose. In other cases, NNPPD may allow some of the desired data to be supplied by revenue/billing meters, protection systems, check metering systems, or the DG facility's own monitoring and control system.

When telemetry is required, the DG Operator and NNPPD must coordinate the details of the required communications medium for telemetry. The DG Operator is responsible (directly or through reimbursement to NNPPD) to provide the communications path to NNPPD satisfaction. Some communications medium options (such as lease line telephone) involve ongoing monthly charges. Such charges are the responsibility of the DG Operator; see Section 5 - Requirements for Closed Transition Operation, 'Interconnection Expenses' in this manual.

Other technical and contractual issues may arise during the design and implementation of a telemetry system and will be addressed by all parties on a case-by-case basis. Examples of such issues include energy losses; energy scheduling; meter accuracy and reading; and billing and reporting of energy purchases.

Section 8 - Rates

8.01 All NNPPD rates for electric service to the DG Operator and any compensation for the generation output from the DG facility are established in NNPPD rate schedules, and are determined using the wholesale power and energy rates paid by NNPPD to its wholesale power supplier as their basis. NNPPD rate schedules are subject to change from time to time as said wholesale rates paid by NNPPD are modified, and any modifications are approved at the sole discretion of the NNPPD Board of Directors, and are compiled and available for review upon request.

8.02 Should NNPPD develop special generation programs, current DG Operators will be given the opportunity to participate in accordance with the terms of the selected program.

Section 9 - Interconnection Point

9.01 The interconnection point of NNPPD to any DG facility is the point at which the NNPPD system connects to devices, conductors, or equipment of the DG facility, as determined by NNPPD. This point will normally be the 'point of common coupling' as defined in 'IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems,' IEEE Standard 519. The service entrance voltage is typically defined by the voltage at this point. Note: DG facilities may not be able to meet NNPPD DG requirements if the generation is interconnected at points in the DG facility system other than the service entrance. The DG Operator must verify the interconnection point with NNPPD during the design stage.

Section 10 - Duration of Parallel Operation

10.01 The amount of time electric generation will operate in parallel (or 'closed transition') with the utility system will help determine the NNPPD requirements for the DG facility. For the purpose of this manual, closed transition operation is either momentary or sustained. Momentary closed transition – used only for synchronized closed transition transfer of DG facility load from one source to another source – interconnects the two power systems to remain interconnected indefinitely, as long as synchronous operation is maintained.

TYPE OF CLOSED TRANSITION OPERATION	DURATION OF PARALLEL OPERATION	NNPPD REQUIREMENTS FOR THE DG FACILITY
Momentary NNPPD	< 100 milliseconds	Synchronism check on transfers interconnection disconnect
Sustained	> 100 milliseconds	All NNPPD DG Manual requirements and additional requirements, as determined by NNPPD

NNPPD Determination as to whether the DG equipment to be installed is the

'momentary' type above or not shall be made by NNPPD. A DG facility design proposal using a 'closed transition transfer switch' may be approved as 'momentary.' DG transfer equipment approved as 'momentary' shall be designed, manufactured and listed for use as 'momentary' transfer equipment, and is not designed for 'sustained' parallel operation. DG transfer equipment which meets the 'momentary' requirements above, but which relies on programmable electronic control means, and is capable of being re-programmed or otherwise altered to be capable of 'sustained' parallel operation, shall be considered 'sustained' type. Note: A 'momentary' type of operation is still closed transition operation, and as such is not approved for applications involving NNPPD network service (see Section 15 - NNPPD System Issues, 'Network Service' in this manual). Automated switchgear capable of closed transition operations via programming or logic changes shall meet the protective requirements and stipulations for sustained interconnections.

The 'momentary' interconnection, or closed transition transfer, can result in a large load suddenly being applied to the DG facility generation. This 'step-loading' can result in frequency and voltage disturbances that may be unacceptable to the DG facility load, therefore, the generator should be properly sized and selected to help prevent such power quality problems.

Section 11 - Generation Equipment

NNPPD requirements for the interconnection are dependent on many factors, including the technology or method of electric power production. Common types of electric generation equipment are discussed below.

11.01 Direct Energy Converters

Direct energy converters (DECs) are usually semiconductor-based devices that convert energy into DC (direct current) electricity.

Examples of direct energy converters include photovoltaic solar cells (converting sunlight directly into DC electricity), fuel cells and thermionic cells (converting heat energy directly into DC electricity).

Because the DC output of these devices is not compatible with AC (alternating current) electrical systems, an inverter is usually required for DC to AC conversion — see 'Inverters' below.

11.02 Inverters

Inverters are typically solid-state microprocessor-controlled devices used to convert DC electricity into AC electricity of a desired voltage and frequency (usually 60Hz utility system frequency).

The inverter synthesizes the AC output waveform, which raises the following concerns

for NNPPD:

- The stability and quality of the inverter output waveform varies with inverter design. NNPPD is interested in the output characteristics of inverters operating in closed transition with the NNPPD system. Poor waveform quality from an inverter output can introduce undesirable harmonics to the electrical system of both the DG facility and NNPPD.
- Where the inverter gets its 'clock' signal for waveform synthesis can affect how the inverter reacts under certain conditions. An inverter with internal clock signal can operate independent of the utility, and issues of synchronism and operation as an island are raised. Voltage controlled inverters using the utility voltage waveform for timing do not usually create synchronism concerns, and usually cannot function independent of the utility.

11.03 Static Power Converters

Static Power Converters (SPCs) are typically solid-state microprocessor-controlled devices used to convert AC voltage at a frequency other than 60Hz to AC voltage at 60Hz system frequency. The devices usually consist of a rectifier input stage for AC to DC conversion, then an inverter output stage (see 'inverter' above) for conversion of the DC into 60Hz AC system voltage.

NNPPD concerns regarding SPCs usually include the concerns for inverters above.

Microturbine generators and some wind turbine generators typically utilize a SPC for conversion of high frequency AC power to 60 Hz AC power.

11.04 Generators

Generators convert mechanical, rotating shaft horsepower into electricity. The supply of shaft horsepower (or the 'prime mover') for a generator can be a turbine or a combustion engine. A source of mechanical power for a turbine might be steam, ignited gas (jet engine), water, or wind. A typical combustion engine fuel source might be oil, diesel, gasoline, methane or natural gas.

The electrical output of a generator is either AC (alternating current) or DC (direct current).

DC generators with inverters (see 'inverter' above) are used when the shaft RPM is not constant, as in some wind turbine and some water turbine applications.

AC generators can be single-phase or three-phase. AC generators are one of two types, induction or synchronous.

11.05 Induction Generators

Induction generators are very similar to induction motors- in fact; they are often started as a motor using utility power. Once started, the mechanical power source rotates the shaft of the generator in excess of the unit's 'motoring' speed, thus producing electrical energy. These units are typically smaller than 500 kW, and do not usually require synchronizing equipment for starting (because they are started as a motor, they achieve synchronous speed).

A typical application of an induction generator is for wind turbine use. Once the wind speed is high enough for generation, the turbine is started like a motor (using the generator). Next, the wind is allowed to try to drive the generator to produce power.

Induction generators can supply real power (kW) to the utility but require a reactive power source (VARs) for excitation. Utility supply of these leading VARs affects the utility voltage and results in unrecovered energy losses. (See Section 12 - Power Quality Restrictions for Generation in this manual for NNPPD VAR source and power factor requirements). Capacitors installed by the DG Operator and located on the generator side of the generator breaker are preferred for VAR support. VAR supply from location(s) other than the induction generator may impact the NNPPD protection requirements. Where VARs are supplied locally, the time required for decay of a generator's output for the NNPPD 'Loss of Utility' witness test may exceed NNPPD requirements.

11.06 Synchronous Generators

Synchronous generators use a DC field winding to provide the magnetic field in which the machine rotor will spin, thus generating electricity, and can supply both kW and VARs to their load (or to the utility system while operating in closed transition). They are capable of generating stable AC power while independent of, and isolated from, the utility system. The frequency of the generated electricity is determined by the shaft speed of the generator. The generated voltage, real power, and reactive power are dependent on the combination of shaft speed and field winding excitation.

Emergency generators using fossil fuel combustion engines are typically synchronous machines. The majority of distributed generation interconnected for parallel operation is three-phase, synchronous machines.

The real power (kW) output of the generator influences the protective relay scheme and the fault current rating of the switchgear.

The total power output of the generator and the excitation of the field winding determine the power factor of the generator.

The reactive power from the generator can affect system voltages.

The armature winding of three-phase generators can be wye or delta connected. This connection may influence a generator's fault current contribution.

The fault current available from the generator is a function of the rated power and the

generator impedance during a fault (i.e. reactance's, the sub-transient reactance, X^2d is typically used in calculations).

Section 12 - Power Quality Restrictions for Generation

12.01 Operating Limits

The following restrictions are provided for information only, and do not necessarily represent NNPPD requirements for a specific DG facility. NNPPD will determine specific operating limits during the course of the NNPPD facility approval process. NNPPD may change the operating limit requirements for a facility at any time during the process to prevent operation of the facility in a manner which is objectionable to NNPPD or its customers. In most cases, NNPPD requirements will be consistent with the latest version of IEEE P1547 'Standard for Interconnecting Distributed Resources with Electric Power Systems,' other applicable standards, and the following:

12.02 Voltage

The voltage regulation of the DG must be adequate to ensure any out-of-bound condition will be corrected to within the control limit within 2 seconds. The voltage control limits for the DG are the ANSI C84.1 'A' range limits *(*+/- 5%) for the service voltage (see Point of Common Coupling). The DG shall automatically disconnect from the NNPPD system after 2 seconds of operation outside of the voltage control limits.

12.03 Voltage Flicker

The DG operation shall not result in voltage flicker greater than 2% on the utility system at the point of common coupling.

12.04 Frequency Control

The frequency of the DG shall not deviate more than +/- 0.5 Hertz from the 60 Hertz base (59.5 Hz minimum - 60.5 Hz maximum). The DG shall automatically disconnect from the NNPPD system within 1 second if the frequency exceeds the 0.5 Hz limit.

12.05 Power Factor

DG facilities shall provide for their own reactive power needs. Non-exporting DG facilities shall operate the combined generation and load within a range of +90% to -90% power factor. Power factor charges specified in the NNPPD Rate Schedules will apply to power factors outside of this range.

All exporting DG facilities shall operate at unity power factor unless otherwise specified by NNPPD.

12.06 Harmonics

The total harmonic distortion (THD) of the current of an exporting DG shall not exceed 5%, measured at the point of common coupling. The harmonic spectrum shall not exceed the IEEE 519 limits specified in table 10.3 for the 5% THD category.

The total harmonic distortion of the voltage of a DG shall not exceed 5% at the point of common coupling.

The DG Operator is responsible for the installation and expense of any additional equipment needed to prevent an objectionable increase in the utility system voltage THD due to operation of the DG.

12.07 Export Power Requirements

The quality of the generated AC power depends on the construction of the generator or static power converter. Certain DG types may produce electrical waveforms that are not clean sinusoidal wave shapes. Low quality power is unacceptable for export to the utility.

Electrical generation exporting power to the utility must not contain more than 5% total harmonic distortion of current.

Where DG facilities intend to export power utilizing rotary type AC generators, the generators shall have a skewed rotor or winding pitch of approximately 2/3 to ensure clean AC production and low third harmonic generation. Generators exporting power through an DG Operator's delta-wye transformer (delta on the generator side) may be allowed to use other winding pitches as the delta winding should trap triple-n harmonics.) (This situation is most common with larger Class II or Class Ill DG facilities.)

Section 13 - Power Transfers

13.01 Determination of kW Levels

All parallel operation power levels are measured on a per service / per NNPPD circuit basis, with adjustment for power factor.

Parallel operation power levels are calculated based on the maximum generation scenario: all available DG facility generation (including possible future generation) operating in parallel with the NNPPD system.

Should a facility increase their generation capacity in the future, a new 'Interconnection and Service Agreement' and/or 'Energy Purchase may be required with NNPPD - see Section 6 - The Detailed Approval Process for DG Installations, or 'Renewals for Modified DG Equipment or Facilities' section. Where future DG facility modifications are anticipated, NNPPD will strongly recommend any DG equipment installed at present meet all requirements for the future DG facility — it will often be more cost effective for the DG Operator to install the required equipment initially than to add the necessary

equipment later.

Once power levels are determined and approved by NNPPD for a DG facility, the facility will be restricted from operation outside the established power transfer boundaries**.**

13.02 Import-only, Import/Export or Export-only

Power transfers between a DG facility and a utility can be import, export, or a combination of these types. 'Import' is the typical power transfer from utility to a customer (a customer imports' power from the utility). 'Export' is power transfer from a DG facility to utility (the facility 'exports' to the utility). The majority of the utility/customer interconnections are import only, where there is no on-site generation or only open-transition load transfer to a generator. 'Import/export' arrangements are typical of parallel-capable generation facilities with on-site generation.

Examples of import/export arrangements include wind or solar power generation. This type of arrangement will import power during heavy load periods when the on-site generation is unable to supply all the power requirements. During lightly loaded or no-load periods, portion of the on-site generation not used by the facility will be exported to the utility.

The DG Operator and NNPPD must come to an understanding on the issue of whether the DG facility is to be used for import-only, import/export, or export-only power transfers with NNPPD. The type of power exchange intended to occur between the DG facility and NNPPD will determine the protection and metering requirements for the facility.

Unless otherwise agreed between NNPPD and the DG Operator, the amounts of excess power and/or energy generated by the DG facility will be sold to NNPPD under the terms and conditions outlined in the 'Energy Purchase Agreement' between the Parties.

The following examples are intended to describe different operating scenarios requiring various operating parameters:

13.03 Import-only

DG facility kW capacity = Total DG kW capacity
DG facility export level = 0 kW

As an example:

A DG facility has facility load peak of 1800 kW and generation capacity of 1500 kW, but the facility load averages 1400 kW. The facility has plans for future load growth.

With up to 300 kW shortfall between their peak load and available generation, the facility decides to operate such that up to 100% of their load is curtailable (with some load shed under worst case conditions).

Because the facility is designated for import-only, it is restricted electrically and by agreement from exporting power to the NNPPD system during those times when their load is less than the 1500 kW of available generation.

13.04 Import-only, Import/Export or Export-only

DG facility kW level available for parallel = Total DG kW capacity
less the operation facility load

The determination of the DG facility export power level for import/export facilities often will require economic analysis on the part of the DG Operator or their consultant. NNPPD rate programs, the amount of DG capacity vs. the DG facility load, and the cost of additional NNPPD-required DG equipment (based on the export power level) are all determining factors in the export level determination.

DG facility export level = ? kW (to be determined through economic analysis)

As an example:

A DG facility has a peak load of 1500 kW and generation capacity of 2000 kW. The facility has no plans for future load growth. The facility may be capable of an export level of 500 kW, but may opt to limit their export level to 300 kW to avoid the cost of additional protective relay requirements for export levels above 300 kW.

13.05 Export-only

By definition an export-only facility will export most or all of its DG capacity to the utility, so the facility level for parallel operation and the facility export level are basically equivalent to the DG kW capacity.

DG facility kW available for parallel = Total DG kW capacity (typically) operation
DG facility export level = Total DG kW capacity (typically)

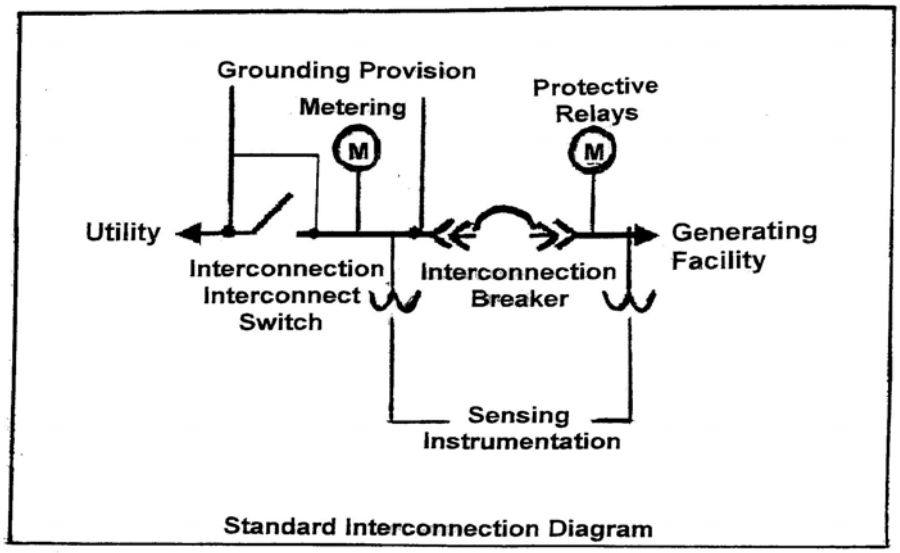
Note: the examples above apply to Class I, II, and Ill facilities. Changes in power magnitudes do not change the meaning of ‘Import-only’, ‘Import/Export’, and ‘Export-only’.

Section 14 - Protective Equipment

For Class I ‘type A’ interconnections, NNPPD does not require a separate interconnection disconnect or interconnection breaker, provided each generation unit has an NNPPD-accessible, outdoor unit disconnect switch and a unit mounted output breaker operated by the required protective relays. Protective functions and relaying to protect the NNPPD electric system from failure of the DG facility shall be determined by NNPPD. Note: should NNPPD operate (open) the unit disconnect switch during an NNPPD circuit outage, the opening of this switch should not affect the generator, as the

utility source is required for generator operation.

Closed transition operation of distributed generation (DG) on the NNPPD system will normally require the installation of certain 'protective' equipment. This equipment is purchased, installed and maintained by the DG Operator. This section does not describe the conditions under which protective equipment is required, refer to Section 3-Classification of the DG Interconnection for this information, but outlines the requirements for such equipment and the conditions of its use.



The typical installed location of an interconnection disconnect switch, interconnection breaker, NNPPD revenue metering, and protective relaying is indicated in the 'Standard Interconnection Diagram' below. As each DG facility is approved on a case-by-case basis, actual installed equipment locations may vary.

Where "grounding provisions" are indicated in the diagram, NNPPD requires a means be provided for temporary installation of NNPPD grounding cables. The grounding cables are intended for protection of NNPPD personnel during repair or maintenance operations, and consist of clamp and cable assemblies used to temporarily connect a conductor to ground. NNPPD will review proposed protective equipment for these required features.

Interconnection protective equipment owned by the DG facility should be maintained and inspected by the DG Operator according to the equipment manufacturer's recommendations and/or industry standards. Procedures should be established for visual and operational inspections and for equipment maintenance and testing. Equipment maintained and inspected should include, but not be limited to:

- Circuit Breaker(s)
- Protective Relaying
- Control Batteries

NNPPD maintains the right to review maintenance, calibration and operation data of all protective equipment for the purpose of protecting the NNPPD system and other NNPPD customers. The DG Operator is responsible for providing the necessary test accessories (such as relay test plug, instruction manuals, wiring diagrams, etc.) required to allow NNPPD to test these protective devices.

14.01 Interconnection Disconnect

Each interconnect disconnect switch must meet the following requirements:

- Be rated for the service voltage and phasing (i.e. single or three-phase).
- Be rated not less than the ampacity rating of the service entrance equipment.
- Be manually operable and simultaneously open all ungrounded conductors.
- The interrupting rating shall be suitable for the available fault current from either the utility or DG source(s) (whichever is greater).
- The switch will be load break type with arc arrestors, and provide a visible means of verifying the switch contacts are in the open position with the switch enclosure open. Switch designs requiring removal of plates, covers or partial disassembly of the switch to provide visual access to the contacts, are not acceptable to NNPPD.
- The switch enclosure NEMA rating shall be appropriate for the specific application and installed location.
- The switch shall have provisions for padlocking the switch in the open and closed position and shall accommodate a standard NNPPD padlock, to be provided by NNPPD.
- The switch must have provisions for grounding alt phase conductors and neutrals (on both sides of contacts) to a proper grounding conductor/electrode within the switch enclosure. NNPPD must be able to close and secure the disconnect door or cover with the ground jumpers in place.

Note: The switch is not required to be fused. Fused switches are not restricted, but removal of the fuses shall not be required to meet the 'visible means of open switch position' described above.

Each interconnect disconnect switch shall be installed as follows:

- The switch enclosure (if conductive) and switch grounding provisions will be grounded in accordance with the NEC and local codes.
- A grounding bar or other grounding point shall be provided within the switch enclosure for termination of NNPPD grounding cables. The grounding point shall allow the NNPPD grounding cables to be installed with the switch in the open position and the switch door closed and locked.
- The switch shall be installed in a location readily accessible to NNPPD personnel (i.e. be erected so as to be a drive-up location). Locked fences or other permanent barriers shall not restrict NNPPD access to the switch.

Fences may be secured with a chain and series connected NNPPD and DG Operator padlocks, so either NNPPD or the DG Operator has access without the other present. Where NNPPD has approved switch locations within dedicated, interior vaults or switch rooms (always with direct exterior access), NNPPD will typically provide door lock hardware (keyed for NNPPD) with interior panic bar for installation within a DG Operator-provided steel door. The door construction, location, etc. must meet NNPPD approval.

- The switch will normally be installed on the secondary side of the NNPPD service transformer. This will be at or before the interconnection point, on the line side of the NNPPD revenue metering equipment and the customer main disconnect. In this location, when open, it will electrically separate the DG facility electrical system from the NNPPD system (excluding the neutral conductor).
- Where installed in the vicinity of similar disconnect switches, the switch shall be clearly labeled as the Interconnection Disconnect Switch so as to be readily identifiable by NNPPD personnel.

Each Interconnect Disconnect Switch is subject to the following conditions:

- Shall not serve a dual role as both the NNPPD-required interconnect disconnect switch and the NEC-required service disconnecting means, as additional NEC service entrance overcurrent protection devices will not be allowed to bypass the NNPPD interconnection disconnect switch.
- Is under the sole control of NNPPD, unless NNPPD should release the switch for DG Operator operation. The DG Operator shall not remove any NNPPD padlocks or NNPPD safety tags. NNPPD will be allowed unrestricted access to the switch and will operate the switch under conditions and at times deemed appropriate by NNPPD. Examples of conditions under which NNPPD may operate the switch include:
  - NNPPD performing maintenance work on the NNPPD system.
  - NNPPD system emergency.
  - Discovery of a condition involving the DG facility’s equipment or operation which threatens the NNPPD system.
  - Failure of the DG facility to provide maintenance and testing reports when required.
  - The DG facility’s generating equipment interferes with other NNPPD customers or with the operation of the NNPPD system.
  - The DG facility’s generating equipment or protective devices are discovered to have been modified without the approval of NNPPD.
  - Discovery of parallel operation of unapproved generating equipment.
- Use of the switch is to provide positive separation of the DG source from the NNPPD system to effect maintenance or repairs to the NNPPD system. NNPPD will normally attempt to notify the DG Operator or operator prior to operation of the switch, but NNPPD reserves the right to operate the switch without DG Operator notification.
  - If NNPPD should not open the Interconnection Disconnect Switch, such act shall not serve to relieve the DG Operator of any liability for

injury, death or damage attributable to the negligence of the DG Operator.

- Desire of the DG Operator to operate the switch for maintenance, testing, or construction purposes shall require them to contact NNPPD for temporary removal of the padlock. The DG Operator or the DG Operator's representative will operate the switch for these conditions. Upon completion of their activities, the DG Operator shall notify NNPPD to reinstall the padlock with the switch in either the open or closed position, as left by the DG Operator. For reoperation of the switch, the DG Operator shall contact NNPPD to repeat the process.

14.02 Interconnection Breaker

Each interconnection breaker must meet the following requirements:

- Circuit breaker construction is normally required for the interconnection breaker.

- Be draw-out type with provisions for locking the cubicle with the breaker open and in the unracked position. Provisions shall be made to open the voltage sensing circuits when the draw-out breaker is in the open position (i.e. fused cutouts).
- Be rated for the service voltage and phasing.
- Carry an ampacity rating not less than that required, in accordance with the National Electrical Code (NEC).
- Be designed to open all ungrounded conductors simultaneously.
- Be rated for the available fault current from either the utility or DG source(s) (whichever is greater).
- The breaker enclosure shall be suitable for its installed environment.
- The breaker shall have provisions for grounding all phase conductors and neutrals to a proper grounding conductor/electrode, as indicated in the 'Standard Interconnection Diagram'. If a grounding rack is provided (for draw-out breakers) to meet this requirement, the rack should be stored and available at the breaker location.
- For three-phase service, the trip and close coils of the breaker shall be direct current (DC) type.

Each interconnection breaker shall be installed as follows:

- The breaker shall normally be the first breaker on the customer side of the NNPPD revenue meter.
- While the actual protective functions/relaying required for each DG facility must be determined, the protective functions/relaying required shall normally monitor conditions at this breaker and operate this breaker in the event a trip is required.

Each interconnection breaker is subject to the following conditions:

- When a trip signal is received from NNPPD to open the DG facility interconnection breaker, the signal is intended to supplement, but not

replace, protective relaying installed at the DG facility. The failure of the NNPPD signal to open the interconnection breaker shall not serve to relieve the DG Operator of any liability for injury, death or damage attributable to the negligence of the DG Operator.

- Where a draw-out interconnection breaker is installed, if required, a crane shall be provided and available at all times at the breaker location for use with draw out breakers and/or test racks.
- If a draw-out type interconnection breaker is not provided, when NNPPD must perform work requiring the breaker path to be visibly open and the breaker grounding provisions utilized (as indicated in the 'Standard Interconnection Diagram'), NNPPD may require. 1) All DG facility generation unit disconnects be visibly open and locked (by NNPPD) in the open position. Or 2) the interconnection breaker be physically unbolted and removed from its installed location, and later reinstalled at the completion of NNPPD work, by a qualified electrician at the expense of the DG Operator.
- While the actual protective functions/relaying required for each DG facility must be determined, the breaker is required to have synchronization capability, to open for abnormal frequency conditions, and to open for any loss of utility voltage. These requirements help prevent the electric generation from back feeding and energizing the utility system in the event of an NNPPD outage. The breaker can only be closed if the utility voltage is nominal and stable and the synchronism check relay permits.

14.03 Protective Functions \ Relaying

DG facility electrical system designs often include two groups of protective relays. One group is assigned the task of protecting the utility system from the DG (these relays usually operate the interconnection or main service breaker). A second group is responsible for the protection of the DG facility generation equipment (these relays usually operate the main generator breaker(s)). Where relay information, settings, drawings, etc. are to be submitted to NNPPD for review, only the information pertaining to this first group is required. The DG applicant submits the generator relay settings to NNPPD for reference purposes only. The DG Operator or their representative should note careful setting coordination is required between these two relay groups. This coordination ensures proper operation of the customer side system. Some interconnections will not include a separate relay group for utility side protection. The generation protection group will also provide utility-side protection (by tripping the main generator breaker or through shutdown of the inverter output of a direct energy converter).

NNPPD protective relay requirements become more stringent in proportion to the potential impact of a DG facility on the NNPPD system (and other NNPPD customers). This manual should only be considered a guide in regard to protective relaying, NNPPD will determine specific protective relay requirements during the DG facility design review stage. Upon review of the DG applicant's design for the proposed parallel installation, NNPPD may require changes to the protection scheme. NNPPD may refuse the use of certain protection methods, equipment, equipment grades or manufacturers products.

NNPPD retains the right to approve or reject the type of protective relays/devices used and the relay settings. The relays may be microprocessor based, solid-state or electromechanical construction. While not required, NNPPD highly recommends consideration is given to microprocessor based relaying in place of electromechanical or solid state relaying, especially microprocessor based relays designed specifically for protection of the utility-DG interconnection point. In many cases multiple protective device functions can be combined in a smaller, less expensive package, resulting in savings for the DG Operator.

NNPPD requires the protective functions/relaying operate as intended under all conditions, including for a loss of the normal power source serving the protection scheme. The DG facility protection system shall account for this possibility in its design, and utilize a DG power supply with battery backup or other means of assuring proper operation for all conditions.

Many solid state or microprocessor-based relays are capable of external indication of a relay internal failure or alarm condition. NNPPD may require such relays to trip the interconnection (or generation) breaker immediately upon relay alarm or failure indication, or act to prevent parallel operation of generation with NNPPD until such time as the alarm or failure condition is corrected.

The relays shall monitor all ungrounded conductors. For example, protection of a three-phase system using single-phase relaying is unacceptable.

The DG Operator is responsible for synchronization of DG facility generation to the NNPPD System. The DG facility must be in synchronism with the utility system just prior to closing the appropriate DG facility sync-protected circuit breaker (often the interconnection breaker) and during the entire period of parallel operation. Protection function 25 (synchronism check) is required below.

NNPPD does not allow islanding of DG facilities on the NNPPD system. The DG facility must isolate itself from the NNPPD system in the event of an NNPPD outage. This fact shall be taken into consideration in the setting of DG facility protective relays, so the interconnection breaker opens as soon as possible after sensing the utility source has been lost.

Protective relays can generally be categorized into two major groups: industrial grade and utility grade. Industrial grade may be considered PLC’s or protection functions integral to the control system of small generation equipment. NNPPD requires DG facilities with net generation above 50 kW use utility grade relays (meeting IEEE/ANSI C37.90 design standards). Utility type test switches shall be installed in conjunction with utility grade relays.

Class I interconnections, inverter type generation equipment rated up to 10 kW, single-phase and manufactured and listed for use in parallel with utility electrical service must comply with the requirements of ANSI/IEEE 929. Requirements include minimum 25, 27,

59, 81O, and 81U protection functions.

Minimum protection function requirements, regardless of class or size, include minimum 25, 27, 59, 810, and S1U protection functions.

Other functions, which NNPPD may require, include (but are not limited to): 21, 32 (three-phase), 46, 67 (all phases), 67G/67N, and 68. NNPPD may also require the following items:

- spare dry contacts in the DG generation control system for tripping and/or monitoring of the DG facility
- communications channel(s) with communications equipment
- a remote-trip system (NNPPD sends a signal to trip the DG facility interconnection breaker)
- duplicate/redundant/backup relays
- or other specialized equipment

Communications channel(s) may consist of power line carrier, leased telephone line, pilot wire circuit, fiber optic cable, radio, or other means (note this channel may be separate from communications channels required to meet other NNPPD requirements, such as metering or telemetry).

'Vector Jump/Step Frequency,' 47, 50, 50G, 50N, 51, 51G, 51N functions are not usually required by NNPPD, but if installed, settings information and curves are required to be included in submittals for review.

Section 15- NNPPD System Issues

15.01 Service Transformers

All new NNPPD three-phase service transformers, are wye—wye type (installed grounded wye - grounded wye). NNPPD will typically own and install wye-wye transformers for service to three-phase Class I DG interconnections (refer to Section 3 - Classification of the DG Interconnection in this manual). NNPPD prefers wye-wye service transformers for DG facilities for technical reasons, and will often want to replace or reconfigure transformers that are not wye-wye configuration.

Existing delta-delta or ungrounded wye-delta service transformers installed at DG facilities will require reconfiguration of the transformers to wye-wye or the installation of utility side voltage unbalance protection equipment. In some cases, upgrading of NNPPD transformer insulation levels and lightning arrester ratings to a higher voltage may be required. The DG Operator is responsible for the installation and material casts of such equipment (see Section 5 - Requirements for Closed Transition Operation, 'Interconnection Expenses' in this manual).

Class Ill interconnections typically use a wye-delta step-up transformer (DG facility owned, with delta on the generator side) for connection to the NNPPD electric system.

To provide isolation and minimize possible adverse effects on other NNPPD customers from DG facility generation, all DG facilities with three-phase electric service shall be connected to NNPPD through a dedicated service transformer. Such DG facilities may not share the secondary or load side of the NNPPD service transformer with other NNPPD customers.

DG facilities with single-phase electric service where the DG is utilizing nonsynchronous inverter technology requiring connection with the utility to maintain synchronous operation shall not be required to have a dedicated service transformer. All other single-phase DG installations will require a dedicated service transformer.

NNPPD will determine the transformer connection and grounding configuration required. While in the facility design stage, the DG Operator should always verify with NNPPD the details of the electric service (voltage, phase, ampere rating, etc.) and the service transformer winding configuration.

15.02 Automatic Reclosing

It is NNPPD practice to apply automatic reclosing of circuit protective devices in the substation to transmission and distribution circuits.

Existing automatic reclosing schemes for NNPPD distribution circuits assume the circuit is dead (de-energized) prior to reclosing. The protective relays and other controls do not employ voltage check, synchronization check, or phase checking functions. The introduction of a DG facility to an NNPPD circuit may require the addition of equipment and modification of the protection scheme to add these functions. The cost of this additional equipment and its installation are the responsibility of the DG Operator of the new DG facility (see ‘Interconnection Expenses’ in this manual). The added functions are intended to prevent reclosing of the NNPPD protective devices in the event a DG facility is energizing the NNPPD circuit by operating in an ‘islanding’ condition.

Those applying for DG facility approval will be informed when this equipment is required and the DG Operator is responsible for those costs.

The DG facility shall not energize a de-energized NNPPD circuit. It is the responsibility of the DG Operator to ensure the DG equipment does not allow operation in an ‘islanding’ condition. Should the utility source be lost or a fault occur on the utility side of the interconnection, the local DG generation must disconnect Itself from the NNPPD system by tripping the interconnection breaker prior to automatic reclosing of the NNPPD protective devices. NNPPD assumes no responsibility for damage to DG equipment due to out-of-phase reclosing.

The amount of reclosing time delay on NNPPD circuits varies depending on many factors. While in the facility design stage, the DG Operator should always verify (with NNPPD) reclosing details for each DG facility service.

15.03 Automatic Throw Over Service

ATO ('Automatic Throw Over') service is common to hospitals and some other types of customer facilities requiring a backup NNPPD circuit in the event of an NNPPD circuit outage. The required 15kV switchgear is typically NNPPD owned, pad-mount or 'metal-clad' (90" high sections), located near the facility service entrance, and is of either 'split bus' or 'common bus' design. The ATO is a programmable switch, allowing the transfer of customer load to an alternate 'backup' or 'emergency' circuit upon loss of the 'normal' NNPPD circuit.

Many technical issues arise when it is proposed that a Distributed Generation (DG) operate in closed transition with NNPPD while served from an ATO service. The NNPPD ATOs in service are not designed for use with DG facilities. NNPPD may require removal of an ATO device. The addition/expansion of facility generation may actually reduce the benefit from an ATO service.

ATO service is a complicating factor to the NNPPD DG approval process. Should modifications to the NNPPD system or equipment be required, the DG Operator is responsible for the labor and material costs of such modifications (see 'Requirements for Closed Transition Operation', 'Interconnection Expenses' in this manual).

15.04 Network Service

NNPPD does not allow DG operation in closed transition where the DG facility is served from any secondary network system, spot or grid. Both spot and grid network service may also be found in other parts of the NNPPD territory. While in the facility design stage, the DG Operator should always verify with NNPPD whether the facility is served from such a service.

Should modifications to the NNPPD system or equipment be required, the DG Operator is responsible for the labor and material costs of such modifications (see Section 5 - Requirements for Closed Transition Operation, 'Interconnection Expenses' in this manual).

15.05 Single-Phase Devices

NNPPD may require replacement of single-phase over current devices (line fuses, single-phase automatic circuit reclosers, single-phase line switches) on the NNPPD circuit between the NNPPD substation and the DG facility service entrance. These components would be replaced with three-phase devices to minimize the possibility of single-phasing a three-phase DG facility. If required, the cost of the removal of single-phase devices and the addition of three-phase devices (equipment and installation) are the responsibility of the DG Operator of the new DG facility (see 'Interconnection Expenses' in this manual). In some cases these single-phase devices will be left in place.

Regardless of whether any single-phase devices are replaced with three-phase devices, the DG Operator is responsible for protecting DG equipment from the effects of excessive negative sequence currents, system imbalance effects, or loss of utility phase/utility single-phase conditions. NNPPD assumes no responsibility for damage to DG equipment due to these effects.

Section 16 – Pre-Parallel Requirements

16.01 Refer to the terms of the 'Interconnection and Service Agreement' for requirements to be met prior to the actual parallel operation of DG facility generation with the NNPPD system. Copies of the agreement are available for review. Additional requirements not outlined in that document are as follows:

16.02 A copy of the final power riser diagram or one-line diagram indicating the DG installation on the DG facility electrical system shall be in NNPPD possession. The document shall note all bus voltages, conductor properties, generating equipment, interconnection point(s), and interconnection disconnecting device(s). Note:: NNPPD may require the final version of this document bear the stamp of a Professional Electrical Engineer registered in the state where the project is being constructed.

16.03 The following items are also required prior to execution of the 'Interconnection and Service Agreement'' All requirements are to be met prior to the NNPPD 'Witness Test' outlined in the agreement (Please allow sufficient time for NNPPD review prior to witness testing). Where any of the following items/tests have been performed at a pre-approved packaged paralleling equipment manufacturer's facility prior to shipping, documentation supporting this testing shall be submitted (NNPPD may accept the documentation in such cases, or may require factory tests be repeated at the installed equipment location). The DG Operator or representative shall complete all preoperational tests not performed by the factory (or factory tests repeated at the installed location). Such tests shall be documented, and if above 25 kW (total DG capacity) shall require the certification of a Professional Electrical Engineer registered in the state where the project is being constructed. The required items/tests are:

- NNPPD approved relay/device settings with any corresponding calculations and test points are to be in the possession of NNPPD.
- NNPPD approved AC and DC elementary drawings showing protective relay/device wiring connections are to be in the possession of NNPPD.
- All protective relays/devices shall have been electrically tested and calibrated according to the relay/device manufacturer's instruction manual.
- All protective relays/devices shall have the NNPPD-approved settings installed and proven using the submitted test point information to simulate fault conditions. These tests shall also trip the interconnection breaker (load is not required on the breaker) to prove each DG trip path.
- A final, organized copy of all settings with test points shall be in the possession of NNPPD and the DG Operator for use during future maintenance tests.

- Sensing instrumentation (current and voltage transformers) shall be ratio checked, polarity checked, continuity tested, and have the insulation integrity tested.

Section 17 – Sample Documents

Outlined in samples below is a list of the documents required for installation of distributed generation on the NNPPD system and made a part of this manual. DG Operators are encouraged to contact NNPPD for any updated versions of these documents.

Sample A - Application for Distributed Generation (DG) Interconnection

Sample B – Interconnection and Service Agreement

Sample C – Energy Purchase Agreement

Sample D - Avoided Cost Rate Schedule(s)