



**FACILITY CONNECTION
REQUIREMENTS**

FAC-001-2



Facility Connection Requirements

Preface: All connections to the Arizona Public Service Company (APS) electric system, including APS self-build facilities, must be in compliance with all applicable APS Transmission Standards, Electric Service Standards, Planning Standards and Operating Policies of the North American Electric Reliability Council (NERC) or its successor, as administered by the Western Electricity Coordinating Council (WECC) or its successor.

The Introduction to Section I.C of the NERC Planning Standards states that:

“All facilities involved in the generation, transmission, and use of electricity must be properly connected to the interconnected transmission systems to avoid degrading the reliability of the electric systems to which they are connected. To avoid adverse impacts on reliability, generation and transmission owners and electricity end-users must meet facility connection and performance requirements as specified by those responsible for the reliability of the interconnected transmission systems.”



I INTRODUCTION AND SUMMARY

These Facility Connection Requirements address NERC, WECC and APS requirements for interconnection of generation facilities, transmission facilities and end-user facilities. Specifically, the Facility Connection Requirements identify technical requirements and other applicable regulatory requirements for connecting transmission lines, large loads and generation resources to the APS Transmission System.

Purpose. The primary purpose of these connection requirements is to ensure the safe operation, integrity and reliability of the APS Transmission System. These Facility Connection Requirements do not specifically address contractual matters, such as costs, ownership, scheduling, and billing. Also, Transmission Service is not addressed by these Facility Connection Requirements and should be requested from APS through the APS Open Access Same-Time Information System (OASIS) independently of any inter connection requests. Please refer to APS's OASIS, <http://www.oatioasis.com/azps/index.html>, or contact APS Transmission Operations for more information on the interconnection process, business practices, contractual matters or transmission service.

Defined Terms. In these Facility Connection Requirements, the terms APS, Control Area, APS Transmission System, and Company all refer only to APS Transmission Operations Department and the APS Transmission System. Interconnection proposals from APS Marketing and Energy Affiliates or from other non-Transmission departments within APS are handled in the same manner as those originating from third parties. The term 'Requester' refers to a utility, developer or other entity that requests a new or modified connection for a line, load or generation resource. The term "Project" refers to a request to interconnect a generating resource, transmission line or a load that may impact the APS Transmission System.

Submission of Interconnection Projects. Projects are generally submitted by a Requester, but may also be submitted by an interconnecting utility. APS evaluates and studies each Project individually, as it was described in the request and determines impacts to the APS Transmission System facilities. For generation interconnections, the Requester must follow the Generation Interconnection Requirements for large or small generator interconnections, as applicable, that are included in APS's Open Access Transmission Tariff (OATT). Specific interconnection requirements for a Project resulting from the study process will be provided to the Requester when the study is finalized. Generally, all costs for integrating the Project are borne by the Requester.

Interconnection Studies. Interconnection studies may include a preliminary plan of service for physical and communications interconnections. Physical laws that govern the behavior of electric systems do not recognize the boundaries of electric facility ownership. Therefore, the electric power systems must be studied without regard to ownership to develop a properly designed interconnection that can assure safe operation, integrity and reliability of the APS Transmission System. The final study may include analysis of short-circuit fault duties, transient voltages, reactive power requirements, stability requirements, harmonics, safety, operations, maintenance and prudent electric utility practices.



Other Applicable Standards. These Facility Connection Requirements are not intended to be design specifications or an instruction manual, and the information presented may change periodically based on industry events, regulatory requirements, evolving standards and practices or for other reasons. The technical requirements stated herein are consistent with APS's current internal practices for system additions and modifications. These requirements are generally consistent with principles and practices of the NERC, WECC, Institute of Electrical and Electronics Engineers (IEEE) and American National Standards Institute (ANSI). The standards of the above-listed organizations are also subject to change and when applicable, the most recent version of such standards shall apply to each interconnection request. Also, much of the information in these Facilities Connection Requirements refers to APS's Large Generator Interconnection Procedures (LGIP) as provided in APS's OATT.

II. REQUESTING AN INTERCONNECTION OF NEW FACILITIES

Parties may request interconnection of a transmission line, load or generation facility to the APS Transmission System. For any of these requests, APS should be contacted as early as possible in the planning process. An interconnection study must be performed to determine the required additions and modifications to APS's substations, transmission lines, and control and communications circuits to accommodate the proposed interconnection. The inclusion of Project facilities within APS's Control Area may also be requested by contacting the Supervisor - Interconnection Development, 400 N 5th Street, Phoenix, AZ 85004.

Requests for transmission service are addressed by APS's current OATT and are not included in this document.

A. Requesting an Interconnection

1. Generation Request

Requests for new generation interconnections will be consistent with the process for interconnection outlined in the APS's OATT. Where applicable for generation interconnection requests, the specific timeline, queuing, and submission requirements in the OATT will be followed. Requests for interconnection require significant information regarding the Project. Specifics of required information as well as more information about the generation interconnection process and necessary forms are available on APS's OASIS.

2. Transmission Request

Requests for new transmission interconnections are initiated by completion of the request form which can be found on APS's OASIS. No application fee is required. A scoping meeting will be held to fully discuss the request and all aspects of the proposed interconnection. A study agreement will follow which will require a deposit of 50% of the estimated study cost.

3. End-User Request

Information regarding APS's electric service requirements for new End-User (load) connections, applicable tariffs, project initiation information requirements and contact numbers may be found on APS's *Construction Corner* web site (www.aps.com). Submittal of project



information to APS's customer service representative will start the communication and evaluation process.

B. Notification of Interconnection

The process of providing notification of an interconnection request is evaluated for each interconnection request. The process can be different for each type of request and the general requirements are detailed below.

1. Generator Interconnection

After an application for a generator interconnection has been submitted and a study agreement is signed, the general information regarding the project is posted on the generation interconnection queue on APS's OASIS site. Information included in this posting, among other information, is the location of the requested interconnection point, size of the project, and fuel source. Also, the project may be reported to the Southwest Area Transmission (SWAT) sub-regional planning group.

2. Transmission Interconnection

After an interconnection request involving transmission facilities has been accepted by APS, it shall be reported to SWAT and/or WECC at the first opportunity by the Requester or APS. This may include, but is not limited to, providing a project summary at a SWAT meeting or inclusion of the project in the WECC Significant Additions report. If the Project is requesting interconnection to facilities that are jointly owned, but operated by APS, notification of the request shall be sent to each owner.

3. End-User Interconnection

Notification for an end-user interconnection request will be evaluated as applicable to the specific interconnection request. Some customers request that an end-user interconnection request initially remain confidential. However, an end-user interconnection request into transmission facilities will require some notification at SWAT and/or WECC before a final plan-of-service is completed.

C. Coordination of Interconnection Studies

The transmission planning process for the proposed new facility must also accommodate coordinated joint studies with other affected interconnected transmission system owners. Once a new facility is considered feasible for interconnection, the Requester shall notify the SWAT sub-regional planning group and/or WECC, as applicable to the specific interconnection request. SWAT has been recognized as an appropriate forum to carry out the task of coordinating transmission plans among the transmission providers in the Southwest.

The SWAT sub-regional planning group provides an appropriate technical forum of regional transmission providers who can review proposed facility plans and readily identify concerns, issues and impacts. The regional transmission providers and Requesters can work together to develop the most



efficient transmission plan that will accommodate the proposed project and meet regional reliability criteria. Dependent upon the type and scope of the interconnection request, a transmission planning study performed by either APS or others will need to be reviewed and endorsed by the appropriate SWAT subcommittee. Depending on the location of the proposed project, there may need to be review by multiple subcommittees on a coordinated basis.

D. Interconnection Studies

The transmission planning process is an important first step in the determination of interconnection feasibility. The transmission planning studies will identify impacts, deficiencies, available capacity, operational problems or interconnection facility concerns and evaluate potential solutions. A proposed interconnection must not degrade the reliability or operating flexibility of the existing power system. The proposed interconnection must comply with all NERC and WECC Reliability and Planning Criteria.

APS will conduct or review system impact studies required to evaluate the system impact of a proposed interconnection on the reliability and capability of the transmission system. These studies can require considerable time and effort, depending on the size of the Project and its potential system impacts. Any costs to conduct or review system impact studies are the responsibility of the requesting party. The system impact studies will include, but are not limited to powerflow, dynamic stability, short circuit studies, Sub-synchronous Resonance (SSR), and Electro-magnetic Transients Program (EMTP) studies if deemed necessary. Evaluation of alternatives to the proposed interconnection, such as lower voltage construction, alternative interconnection points, reactive support facilities, or upgraded facilities, may be requested. Powerflow analysis will require 10-year load and resource growth projections and the planned facilities needed to satisfy all long term transmission service requirements. If the studies indicate that additions or upgrades to the existing transmission system are necessary, APS will conduct or review facilities studies, at the expense of the requesting entity, to determine the cost of additions or upgrades and the time frame for implementing system additions or upgrades. Technical issues associated with the Project, such as voltage regulation, machine dynamics, metering requirements, protective relaying, and substation grounding will also be addressed as required in development of the preferred plan of service.

III. GENERAL FACILITY CONNECTION REQUIREMENTS

APS's facility connection requirements will address, but are not limited to, the following:

1. Coordination of joint studies of new facilities and their impacts on the interconnected transmission systems.
2. Notification of new or modified facilities to others (those responsible for the reliability of the interconnected transmission systems) as soon as feasible.
3. Voltage level and MW and MVAR capacity or demand at point of connection.
4. Breaker duty and surge protection.
5. System protection and coordination.
6. Metering and telecommunications.
7. Grounding and safety issues.
8. Insulation and insulation coordination.
9. Voltage, Reactive Power, and power factor control.
10. Power quality impacts.
11. Equipment Ratings.
12. Synchronizing of facilities.



13. Maintenance coordination.
14. Operational issues (abnormal frequency and voltages).
15. Inspection requirements for existing or new facilities.
16. Communications and procedures during normal and emergency operating conditions.

Each of the items listed above will be addressed in APS's study (ies), as applicable to the specific interconnection request. More general requirements are detailed below.

A. Transmission and Substation Facilities

Interconnections to APS's Transmission System may require that one or more of APS's transmission lines be looped through the Requester's facilities or to be sectionalized with the addition of switching equipment. The design and ratings of these facilities shall not restrict the capability of the lines and APS's contractual transmission path rights.

1. Transmission Line Designs

Transmission line designs, for transmission lines interconnecting into APS's facilities, shall meet the requirements of APS's transmission line design standards including, but not limited to, satisfaction of the requirements of OSHA.

2. Substation Facilities

Substation facilities that interconnect with APS's transmission facilities must meet APS's substation design and construction standards and must be designed to the applicable requirements of ANSI and IEEE Standards. Electrical equipment in the substation must be sized to carry the full current rating of the intercepted transmission path, and all interrupting devices, such as circuit breakers shall have interrupting capability sufficient to satisfactorily interrupt the maximum short circuit currents that may occur at the location of the interconnection including margin for circuit breaker duty and DC offset.

3. System Protection and Control Schemes

System protection and control schemes are coordinated to provide for safety and equipment protection and to minimize disruption of services during disturbances. Interconnections generally require the addition or modification of such protection and control schemes. The new protection must be compatible with the existing protective relay schemes and shall not degrade the dependability or security of existing protective relay schemes. The protection scheme will also ensure there are no problems with being out of synchronization when closing breakers.

Interconnected generation facilities will be required to participate in the APS and WECC under frequency and over frequency program. There are several acceptable settings in the program from which to choose. Interconnected End-Users are required to participate in the APS and WECC under frequency program and the APS automatic under voltage load shedding program.



B. Insulation Coordination

Power system equipment is designed to withstand voltage stresses associated with expected operation. Adding or connecting new facilities may change equipment duty, and may require that equipment be replaced or switchgear, telecommunications, shielding, grounding, or surge protection added to control voltage stress to acceptable levels. Voltage stresses, such as lightning or switching surges, and temporary over-voltages may affect equipment duty. Remedies will depend upon the equipment capability and the type and magnitude of the stress. Requester shall make available to APS all drawings, specifications, test plans, application documents, and equipment settings.

C. Station Grounding

Each interconnecting station must have a ground grid that is solidly connected to all metallic structures and other non-energized metallic equipment. The grid shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment which are in, or immediately adjacent to, the substation under normal and short circuit conditions. Ground grid size and type are dependent upon local soil conditions and available electrical fault current magnitudes, among other factors. In areas where ground grid voltage rises would not be within acceptable and safe limits, grounding rods and grounding wells may be required to reduce the ground grid resistance to acceptable levels. All grounding will follow the guidelines established in IEEE 80-2001 or the more recent guidelines found in the IEEE Guide in AC Substation Grounding. Design review and testing may be required to ensure these guidelines are met.

D. Transformers, Shunt Capacitors, Shunt Reactors, and other Voltage Control Devices

Transformer tap settings, voltage ratings and the set points, sizes of shunt-connected capacitor and/or reactor equipment as well as other voltage control devices shall be coordinated with APS to optimize reactive flows and voltage profiles. Automatic controls may be necessary to maintain these profiles on the interconnected system.

E. Key Reliability and Availability Considerations

The new interconnection shall meet all applicable requirements of the WECC and NERC operating and planning standards. In addition, the following requirements apply to all Projects:

- Tools and spare equipment must be readily available at the Requester's disposal to accomplish foreseeable operations and maintenance tasks.
- Standardized design, planning and operating practices and procedures should be used so that the new connection may be readily incorporated into the existing transmission network.
- For reliable operation, certain telecommunications, control, and protection equipment may need to be provided with redundancy.
- The equipment for the new connection shall have sufficient capabilities for both the initial operation and for the long range operation.



- Operations and maintenance personnel must be properly trained for both normal and emergency conditions.
- Because of increased risks and potential hazards inherent with operating Requester's facilities connected with APS's facilities, overall safety for life, quality of service and property is paramount. APS shall disconnect Requester's facilities anytime Requester's facilities pose a dangerous condition, and such disconnection is appropriate to protect safety of APS's employees, customers, general public, or to maintain integrity of the APS's facilities. Requester agrees to comply with APS Safety and Hold Procedures in operation of its facilities.

F. Power Factor Considerations

APS and Requester shall jointly plan and operate their systems, including reactive devices, so as not to place an undue burden on either Party to supply or absorb reactive power.

As part of APS's Retail Tariff, Service Schedule 1 – Terms and Conditions, customers receiving service at voltage levels below 69 kV shall maintain a power factor of .90 lagging but in no event leading unless agreed to by APS. Customers found to have a power factor of less than .90, or leading, or other detrimental conditions shall be required to remedy the problems, or pay for facilities/equipment that APS must install on its system to correct for problems caused by the customer. This is consistent with the power factor requirements in APS's OATT for Retail Network Integration Transmission Service – Part IV of the OATT. This Part IV of the OATT also sets requirements for loads connected at 69kV or higher to be between .95 lagging and .95 leading.

APS's OATT also provides for the interconnection of generators to maintain a power factor of between .95 leading and .95 lagging, exclusive of wind generators (Section 9.6.1 of the LGIA; and Section 1.8.1 of the SGIA). Load Customers taking network transmission service are also required to maintain a power factor of between .95 leading and .95 lagging. This provision is consistent with the power factor requirements of Part III – Network Integration Transmission Service of the OATT.

G. Metering and Telecommunications

All connections to the APS electrical system at transmission voltage levels will require metering. The following paragraphs discuss typical requirements for metering and telecommunications associated with these connections.

Metering equipment shall be installed whenever possible at the point-of-connection between APS and the customer. If the Metering Point and the Point-of-Connection are not at the same location, APS reserves the right to require transformer losses and/or line losses to be considered. Metering equipment shall include a solid-state meter for each individual load capable of measuring MW demand, MVar demand, MWh, MVarh, and both leading or lagging power factor. If power flow is capable of being bi-directional the metering system shall be designed to capture delivered and received MWh and MVarh in separate registers. These registers may be included in a single meter approved by APS. All metering packages used on the APS system will be required to use revenue-accuracy-metering equipment, including the meter, instrument transformers, and associated devices. Relay-accuracy metering equipment is not acceptable for APS billing metering. Upon request, APS will make metering data available. See Schedule 15 of APS's retail tariff for details on conditions and fees.



SCADA may be required for any interconnection project including projects served entirely or partially from resources outside of the APS control area. An RTU is required to supply the following SCADA information:

- Status and/or control isolating devices
- Load voltage, MW and MVars at the point-of-connection
- Substation transmission line MW and MVars.

Maintenance requirements will be determined on a case-by-case basis.

Voice communication and communication requirements for protection purposes will be determined on a case-by-case basis. If required, a compatible and reliable communication media shall be provided for voice, SCADA and remote access to metering data. New communications facilities are designed to conform to company and system requirements. Communications facilities installed for the express purpose of supporting Power Operations conform to the applicable sections of the following:

- WECC Guidelines for the Design of Critical Communications Circuits (Telecommunications Work Group)
- WECC Communications Systems Performance Guide for Protective Relaying Applications (Telecommunications and Relay Work Groups)

Communications facilities are planned, engineered, constructed and tested per internal APS I/S Procedures.

H. Equipment Ratings

1. Transmission Line Ratings

For transmission lines interconnecting into APS's facilities transmission line ratings shall meet the requirements of APS's transmission line design standards, including MVA, operating voltage, ampacity, insulation critical flashover, insulation clearances, shielding, tower grounding, and short circuit withstand requirements. In all cases, NESC and OSHA requirements shall be satisfied. Requester shall make available to APS all drawings and specifications, terminations plans, and line ratings.

2. Substation Facility Ratings

Substation facility ratings shall meet the requirements of APS's substation design and construction standards and must be designed to the applicable requirements of NESC, NEC, ANSI, and IEEE Standards. Electrical equipment in the substation must be sized to carry the full continuous and short time current ratings of the intercepted transmission path. All interrupting devices, such as circuit breakers shall have interrupting capability sufficient to satisfactorily interrupt the maximum short circuit currents that may occur at the location of the interconnection including margin for circuit breaker duty and DC offset. Where the substation becomes a facility within the intercepted transmission path, APS shall become the engineer of the facility, shall procure all required equipment, and shall construct the facility.



I. Inspection, Testing, Calibration and Maintenance

All transmission elements (i.e. lines, line rights-of-way, circuit breakers, control and protection equipment, metering, and telecommunications) shall be inspected and maintained in conformance with regional standards. APS may request an annual certification that the Requester has documented and implemented an adequate transmission maintenance and inspection plan for its interconnecting facilities.

1. Pre-Energization Testing and Inspection

Pre-energization testing and inspection is the responsibility of the Requester in accordance with a documented Inspection and Test Plan. Requester shall make available to APS all drawings, specifications, equipment settings, and test records of the interconnecting facilities.

2. Ongoing Maintenance and Inspection Planning

Ongoing maintenance and inspection planning of Requester's facilities shall be conducted by the Requester, and the Requester shall include in its inspection plans the specific scheduled maintenance and inspection intervals and/or conditions that trigger maintenance and inspection. Such plans shall also describe the maintenance methods and the criteria to be used to assess the condition of facility components.

3. Maintenance Coordination

Each Party shall provide the other with reasonable notification for routine maintenance, operational tests, inspection activities and meter testing. For such activities that do not require major equipment or system outages, the Party performing the same shall provide the other Party notice at least twenty-four hours before scheduled outage. For such activities that will require major equipment or system outages, the Party performing the same activities shall provide the other Party notice at least seventy-two hours before scheduled outage.

J. Power Quality

Interconnection Requester's will be required to meet APS and industry standards regarding voltage flicker and harmonic distortion and interference.

K. Communications

Complete, precise, and timely communication is required for maintaining the reliability and security of a power system. Under normal operating conditions, the major link of communication with various interconnectors shall be by telephone lines. APS and its customers shall maintain communication which shall include, but not be limited to, system paralleling or separation, scheduled or unscheduled shutdowns, equipment clearances, periodic load reports, maintenance schedules, tagging of interconnection interrupting devices, meter tests, relay tests, billing, and other routine communication. In case of emergency or abnormal operating conditions, various communication channels may be used. Emergency telephone numbers should be agreed upon by both Parties prior to the actual interconnection date.



Version Table:

Version	Effective Date	Change Tracking	Reviewed By	Approved By	Standard No.
1	2007	Reviewed for Audit	Don Davis	Bob Bean	FAC-001
2	08/01/2012	Corrected the document to reflect the current address and added the version date	Don Davis	Bob Bean	FAC-001
3	7/17/2015	Update the contact information under Section II – Requesting an Interconnection of New Facilities	Jonathan Pagnussat	Joe Wilhelm	FAC-001
4	11/2/2015	Update the version of the standard to FAC-001-1	Jonathan Pagnussat	Joe Wilhelm	FAC-001
5	1/21/2016	Update the version of the standard to FAC 001-2	Jonathan Pagnussat	Joe Wilhelm	FAC-001