# Appendix M: Service Entrance Conductor Taps for Utility-Interactive Inverter Systems

Section 690.64 of the *National Electrical Code (NEC)* establishes how and where a utility-interactive PV system may be connected to the utility system. The point of connection may be either on the load side of the service disconnect or the utility (supply) side of the service disconnect. In many cases, the complex requirements for load-side connections established by 690.64(B)(2) make such a connection impractical and dictate that the utility-interactive inverter be connected on the supply side of the service disconnect. Here are some, but not all, of the major code sections that address the requirements for such a connection.

Section 690.64(A) allows a supply (utility) side connection as permitted in 230.82(6).

Section 230.82(6) lists solar photovoltaic equipment as permitted to be connected to the supply side of the service disconnect.

It is evident that the connection of a utility-interactive inverter to the supply side of a service disconnect is essentially connecting a second service entrance disconnect to the existing service and many, if not all, of the rules for service entrance equipment must be followed.

Section 240.21(D) allows the service conductors to be tapped and refers to 230.91.

Section 230.91 requires that the service overcurrent device be co-located with the service disconnect. A circuit breaker or a fused disconnect would meet these requirements. A utility-accessible, visible break, lockable (open) fused disconnect (aka safety switch) may also meet utility requirements for an external PV ac disconnect.

Section 230.71 specifies that the service disconnecting means for each set of service entrance conductors shall be a combination of no more than six switches and sets of circuit breakers mounted in a single enclosure or in a group of enclosures. The addition of the photovoltaic equipment disconnect would be one of the six.

Section 230.70(A) establishes the location requirements for the service disconnect. Section 705.10 requires that a directory be placed showing the location of all power sources for a building. Locating the PV service disconnect adjacent to or near the existing service disconnect may facilitate the installation, inspection, and operation of the system.

Section 230.79(D) requires that the disconnect have a *minimum* rating of 60 amps. This would apply to a service-entrance rated circuit breaker or fused disconnect.

Section 230.42 requires that the service entrance conductors be sized at 125% of the continuous loads (all currents in a PV system are worst-case continuous). The actual rating should be based on 125% of the rated output current for the utility-interactive PV inverter as required by 690.8.

The disconnect must have a 60-amp minimum rating. Larger conductors may be required after temperature and conduit fill factors have been applied.

For a small PV system, say a 2500-watt, 240-Volt inverter requiring a 15-amp circuit and overcurrent protection, these requirements would appear to require a minimum 60-amp rated disconnect, but 15-amp fuses could be used; fuse adapters would be required. While 15-amp conductors could be used between the inverter and the 15-amp fuses in the disconnect, Section 230.42(B) requires that the conductors between the service tap and the disconnect be rated not less than the rating of the disconnect; in this case 60 amps.

Dealing with the 60-amp disconnect, 15-amp over current requirements using circuit breakers is not as straightforward. A circuit breaker rated at 60-amps could serve as a disconnect and it could be connected in series with a 15-amp circuit breaker to meet the inverter overcurrent device requirements. In this case the requirements of 690.64(B)(2) should be applied for the series connection.

Section 110.9 requires that the interrupt capability of the equipment be equal to the available fault current. The interrupt rating of the new disconnect/overcurrent device should at least equal the interrupt rating of the existing service equipment. The utility service should be investigated to ensure that the available fault currents have not been increased above the rating of the existing equipment. Fused disconnects with RK-5 fuses are available with interrupt ratings up to 200,000 amps.

Section 230.43 allows a number of different service entrance wiring systems. However, considering that the tap conductors are unprotected from faults, it is suggested that the conductors be as short as possible with the new PV service/disconnect mounted adjacent to the tap point. Conductors installed in rigid metal conduit would provide the highest level of fault protection.

All equipment must be properly grounded per Article 250 requirements. See 250.24(B) for bonding requirements. Neutral-to-ground bonding is generally required at each service disconnect.

The actual location of the tap will depend on the configuration and location of the existing service entrance equipment. The following connection locations have been used on various systems throughout the country. On the smaller residential and commercial systems, there is sometimes room in the main load center to tap the service conductors just before they are connected to the existing service disconnect. In other installations, the meter socket has lugs that are listed for two conductors per lug. Combined meter/service disconnects/load centers frequently have significant amounts of interior space where the tap can be made between the meter socket and the service disconnect. Of course, adding a new pull box between the meter socket and the service disconnect is always an option. In the larger commercial installations, the main service entrance equipment will frequently have bus bars that have provisions for tap conductors. In the larger commercial installations, the main service equipment may have bus bars that are marked for and provided with provisions for tap conductors.

In all cases, safe working practices dictate that the utility service be de-energized before any tap connections are made.

Additional service entrance disconnect requirements in Article 230 and other articles of the *NEC* will apply to this connection.