The following article authored by Greg May, President of TSTM appeared in the October 1991 Transmission and Distribution publication and is as relevant today as it was then.

Hazards Of Using Self-Contained Meters As Disconnect Switches

Equipment can be damaged, or someone can be burned or electrocuted.

A widely used watthour meter misapplication poses a threat to public safety. The hazard stems from the common misconception that removing a self-contained meter from its socket breaks all connection of a hot phase to the load side. There are a number of applications where removing the self-contained meter leaves a hot phase present in the consumer's equipment relative to ground. If the maintenance, emergency, electric utility personnel, or the customer uses the meter as a disconnect device, this remaining hot phase can cause damage to equipment, cause an electrical burn, or even electrocution.

It is standard at some electric utilities to remove a self-contained meter from temporarily idled service and plate (cover) the open socket rather than disconnect the source, or cut service entrance wires. Utility records may show the service to be disconnected after meters have been removed. If the consumer, contractor, or emergency personnel were to inquire as to the service status, utility records may show that the service is disconnected because the self-contained meter has been removed. If a hot phase continues past an open socket, the utility may be exposed to liability in the event of personal injury or fire.

Almost all self-contained meters, properly applied, have a current coil in series with every hot phase. The common exception in modern domestic use is the two-stator meter in three-wire,three-phase ungrounded delta applications. As the name implies, ungrounded delta has indeterminant voltages to ground from each phase. Other than ungrounded delta, the first wide-spread use of a self-contained meter in which all hot phases do not contain a current coil is the power meter/light meter combination fed from one four-wire delta source. This two-meter set has a two-or three-wire single-phase meter for lighting loads and a two stator, three-phase meter for three-phase loads. Removing the three-phase meter and the single-phase meter from their respective sockets still leaves one hot phase (usually the 208-V phase to ground wild phase) passing through the three-phase socket uninterrupted to the consumer. This metering scheme has been banned or discontinued in some areas of the United States.

Blondel's Theorem, the theoretical foundation for watthour metering, states that to measure a system of N wires, N-1 stators, properly connected, will measure the power or energy taken. The connection must be such that all potential coils have a common tie to the conductor in which there is no current coil. Several self-contained meter forms do not technically meet the requirements of Blondel's Theorem, but they are commercially acceptable for billing purposes if the source has reasonably good voltage balance. Examples of these are Form 2S, 14S and 15S. All of these examples have a current coil for each hot phase.

A common error in meter applications is to match the meter of the load, not the source. If the load is intended to be only three-phase (thus, three-wire), a ground on the transformer bank secondary may mistakenly not be considered as a wire to be included in the number of wires in the circuit, to be satisfied by the use of Blondel's Theorem. It may be useful to modify Blondel's Theorem to make "N" the number of wires from the source to which the consumer has reasonable access, rather than the number of wires in the source. For example, where four-wire wye is the source for apartment complex metering, each consumer has reasonable access to two hot phases and the neutral. Therefore, a two-stator, Form 12S meter (network meter) is sufficient. If any point of the transformer bank secondary windings is grounded, it must be assumed that the consumer has access to this wire; thus, it must be included as a wire in the source.

Since a corner ground 480-V delta source is particularly disliked, one transformer center tap may instead be selected to be grounded for reasons of safety and to eliminate the 480 V to ground present in the meter socket. Unfortunately, grounding a center tap, even if a separate fourth wire ground is not brought to the load, instantly creates 480/240-V, four-wire delta. A 480-V, Form 15S, four-wire delta meter is needed to properly meter this source.

In the case of a wye-connected secondary on a 480/277-V or 208/120-V bank, the neutral is almost always grounded, creating 480/277-V or 208/120-V, four-wire wye with a grounded neutral. Again, even if a ground wire is not brought to the load from the transformer bank secondary, the source must still be metered as a four-wye with the common for the potential coils being of the same potential as the bank neutral. The proper self-contained meter for this application is either a Form 14S or a Form 16S, four-wire wye meter rated for connection line to neutral.

Using a 480-V, Form 12S, three-wire, three-phase meter to meter either 480/240-V, four wire delta or 480/277-V, four-wire wye with ground neutral will properly record any energy usage between any or all hot phases. Loads connected from a hot phase to ground on the load side of the meter will result in over-registration, proper registration, under-registration, no registration, or negative registration—depending on the phase selected and the load power factor. Far more importantly, removing the Form 12S meter from the socket will result in a hot phase remaining energized in the consumer's equipment.

In the case of a 480/277-V, four-wire wye, grounded-neutral source, the potential of the remaining hot phase to ground is 277 V. With a 480/240-V, four-wire delta source, the remaining hot phase will either be 240 V or 416 V ground—depending on how the socket is wired. Systems of differing voltages will have differing voltages of the remaining hot phase to ground.

Obviously, voltages to ground of 120 V or higher pose a lethal hazard to unsuspecting individuals who may come in contact with the hot element. Correcting this metering error at existing installations may be expensive. In addition to obtaining the correct meter, the socket will also require change-out, and the wiring will need to be modified. If economic constraints prevent an immediate change-out to the correct meter, the following minimum steps should be taken:

1. Notify consumers that the meter is not a disconnect device and should not be used as such. Outline hazards.
2. Inform equipment maintenance companies that operate in your service area of hazards.
3. Instruct all linemen, meter technicians, consumer relations personnel, and any other individuals having even indirect responsibilities for metering that removing meters may not disconnect the entire electric service, especially if a meter is incorrectly applied.
4. Prominently tag each meter location with a caution that the meter should not be used as a disconnect and that removing the meter may not disconnect the service. This permanent tag should be attached to any device or seal securing the meter socket cover or ring.
5. Review policies and procedures for maintaining records of services idled by removing meters. Place responsibility for establishing, with certainty, that a service is disconnected on the individual making the inquiry.

If the known load is only three-phase, a seemingly obvious solution to these application errors might be to modify the service to match the meter, i.e. move the center tap ground to the appropriate corner for a four-wire delta service or move a neutral ground to the appropriate phase on a four-wire wye service. However, this revision could be a serious mistake. Changing the electric service to an existing consumer can be very damaging. Loads may be connected from phase to ground. These phase-to-ground loads may be unknown to the consumer. Changing the ground position on the service may alter voltage on these loads. Damage to equipment or fires could result. In many cases, verifying the hook-up of all consumers' equipment is more time-consuming and expensive than installing the correct metering.

Any new meter installation requiring the self-contained meter should incorporate the correct meter for the application. If extensive maintenance is required on a meter and/or socket involving the incorrect meter, installation of the correct socket and meter should be considered at that time.