

# Allowable Uses of the Variable Threshold Neutral Isolator Nuisance Shock at Residences



## Application Note

### Problem:

The Variable Threshold Neutral Isolator (VTNI), hereafter referred to the Neutral Isolator, was designed specifically to minimize a power utility's contribution to the neutral-to-earth voltage on the secondary side of a transformer for farm applications. Large animals, such as dairy cows, have a much lower impedance than humans and are therefore subject to an electric shock at a lower voltage than humans. When subject to electric shock, animal health may be affected. Even where neutral isolation is used in these applications, the use of a Neutral Isolator is often only allowed to be used as a temporary solution, typically for 90 days in the State of Wisconsin, to allow the power utility and the farmer to come up with a permanent solution to the problem. The permanent solution may involve improved grounding on the primary side of the transformer, replacing high impedance neutral splices, improved on-farm wiring, or the installation of equipotential planes so no voltage can exist between contact points. Because a Neutral Isolator is installed on that part of the system that comes under the National Electric Safety Code (NEC) that governs electric power utilities in the U.S., it is only sold to power utilities and only for farm application.

The Neutral Isolator was never intended to be used and is not sold to prevent shocks to humans, such as may occur around swimming pools, hot tubs, etc. While a Neutral Isolator may well address such human shock problems under steady-state conditions, it does not solve the underlying problem. If two contact points on a residential system can support voltage, such that a detectable nuisance shock hazard exists, then the application of the Neutral Isolator by the utility will reduce the steady-state voltage between those contact points. The Neutral Isolator, connected between the utility primary neutral and the customer secondary neutral, will block current flow and minimize the primary neutral-to-earth voltage appearing across the contact points on the secondary side. However, if voltage were ever to be reapplied across those contact points in the future, the same shock hazard would exist. In other words, the risk still exists if voltage were reapplied. The Neutral Isolator will reapply any voltage present during an event that reaches the predefined threshold of about 45V peak (about 32Vrms), and upon reaching that voltage then instantly switches to the shorted

mode, to reconnect the primary and secondary neutrals together for safety. The cause of the event could be an AC system fault or a lightning strike, to name the most typical scenarios. This device operation reapplies any voltage on the utility neutral to the customer contact points, which have been left unaddressed. The customer, who believed that this utility solution would eliminate the nuisance shock hazard, is immediately subject to high levels of voltage – possibly much higher than the steady-state levels.

One may argue in favor of neutral isolation anyway, claiming that Neutral Isolator reconnection of the two systems is no worse than the original condition before isolation, and would eliminate the steady-state nuisance condition. This is accurate, however the device reconnection under AC fault or lightning conditions would be an unexpected surprise for a client that otherwise believed that the utility had solved the problem. In the end, the customer's contact points still can support voltage, if present, which is the point being overlooked by most parties.

For this reason, DEI will not knowingly sell a Neutral Isolator to utilities or others to address shock hazards to humans in residential or non-farm applications.

### Solutions:

Solving the underlying shock problem usually involves both the utility and their customer, as there are actions that can be taken by both parties to reduce or eliminate the problem. Utilities can examine their distribution system as discussed above, to reduce neutral-to-earth voltage, and customers, in conjunction with a qualified electrician, can address contact points that can support voltage at their facility. Proper grounding, bonding, and equipotential grounding mats are possible areas to examine, appropriate for the facility and contact points being considered.

In discussing the above problem and possible solutions, DEI is not offering design guidance on solutions for secondary (customer) facilities. Utilities or their customers should obtain the services of qualified staff, consultants, or electricians, as appropriate, for solutions to contact voltage problems.