

MTC Proposed R&D to Advance DR/Network Interconnections

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Purpose

- To advance the acceptability of DR on network service by encouraging changes in the network protector (NWP) relays and in the DR controls to react instantaneously to required switching conditions utilizing communications between the NWP relays and the DR controls.

Approach

- Held meetings with protector relay manufacturers, DR interface manufacturers, and utilities to determine what developments they feel are feasible and then, prepared a plan for a prototype demonstration project.

Observations

- At present, grid interconnections of .1 to 2MW DR are not meeting widespread acceptance. The most obvious technical fix would require the installation of a grid-wide, protection-speed communication and automatic adaptive control schemes. While conceptually feasible, the implementation cost appears to be well beyond any justification that can be envisioned.

Observations (continued)

- The prospect of developing Recommended Practice for spot network interconnections using presently available technology will *hinge on achieving general acceptability of using NWP time delay tripping for low reverse power.*

Observations (continued)

- Techno-economic issues yet to be discussed are: 1.How to select the low reverse power setting for various types of DR; 2.Guidance on how to select the minimum necessary time delay to avoid false tripping of the NWP's; 3.DR size restrictions; and 4.Cautions on using the time delay technique, e.g., evolving faults and cross town faults.

Observations (continued)

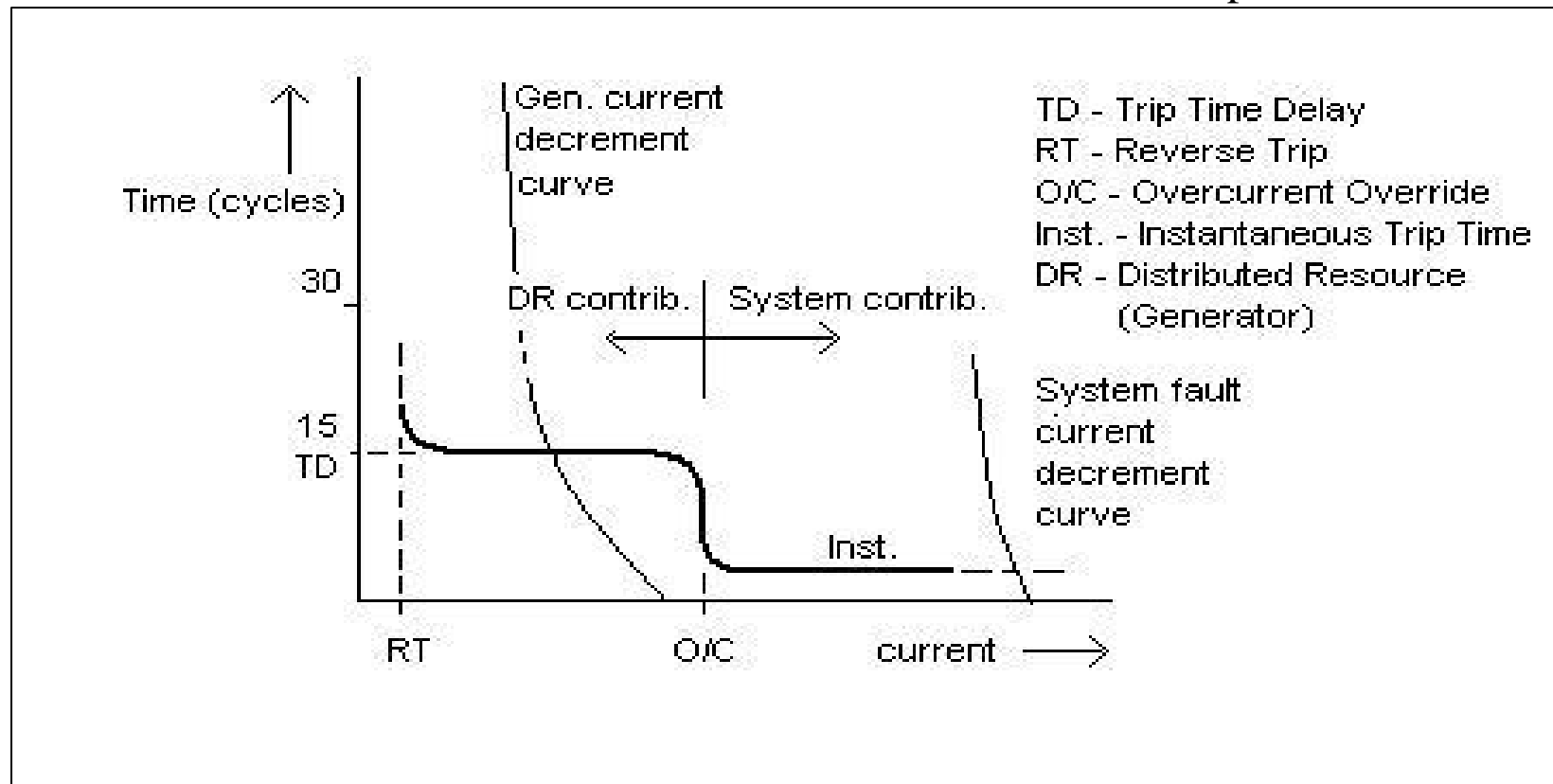
- Techno-legal issues yet to be discussed are:
- De facto giving reverse power tripping control to a non-utility entity when the DR or facilitator owns and maintains the circuits which determine when a network underpower limit has been reached.
- Mitigating this exposure to a non-utility protective function failure by limiting the size of the DR that can be interconnected to less than the minimum spot network load.

Concerns of Many Utilities

- Salient concerns expressed by many utilities are:
- 1. The determination of abnormal system conditions on the utility system that would require network protector action *or non-action absent DR interconnections* should be controlled and maintained by the utility.
- 2. Adding intentional time delay to provide coordination time intervals between independently acting relays (utility's and DR's) may adversely impact the utility system.

Present DR Interconnecting Using a NWP Relay with Low Reverse Power Time Delay

from Baier, Feero, Smith 2003 T&D Conference Paper



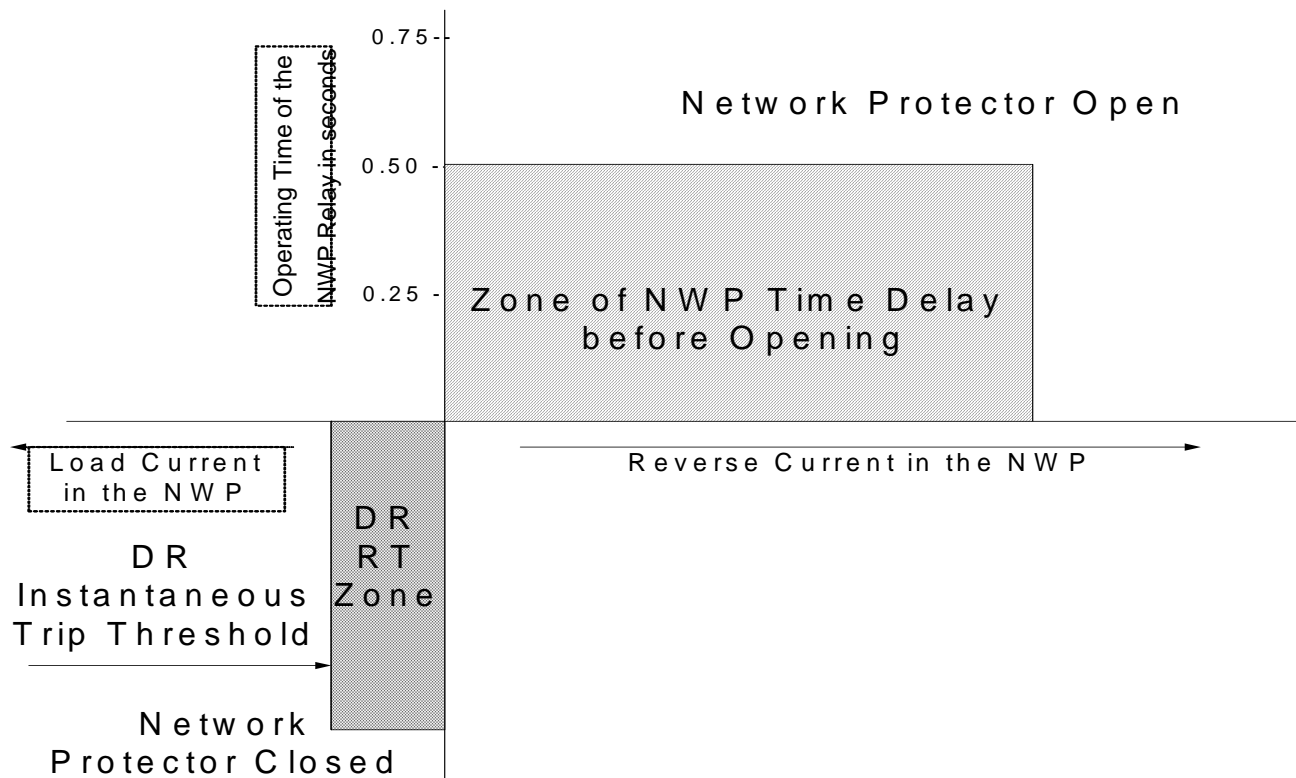
Required Advancements to Mitigate these Concerns

- To alleviate concern #1, a suggested solution is a NWP microprocessor relay capable of providing:
- A means of computing the power import by each protector and sending a trip signal to the DR (or to a vault control unit -later slide) if the imported power dropped below a selectable level such as 6% of the transformer's rating. To prevent cycling of the DR, this relay should also have an over power setting to be exceeded before the DR could be connected online.

Required Trip of the DR

- Presently Required Trip (RT) of the DR is not Initiated by the NWP Relay.
- In some cases the DR Interface Unit attempts to determine the Required Trip at its terminals.
- More generally the Required Trip is determined at a summing point off the network bus in the customer's facility.
- Depending on the location of the summing point, the sensing relay is either a reverse power relay or a under power relay.

The Suggested NWP Relay Conceptual Characteristic

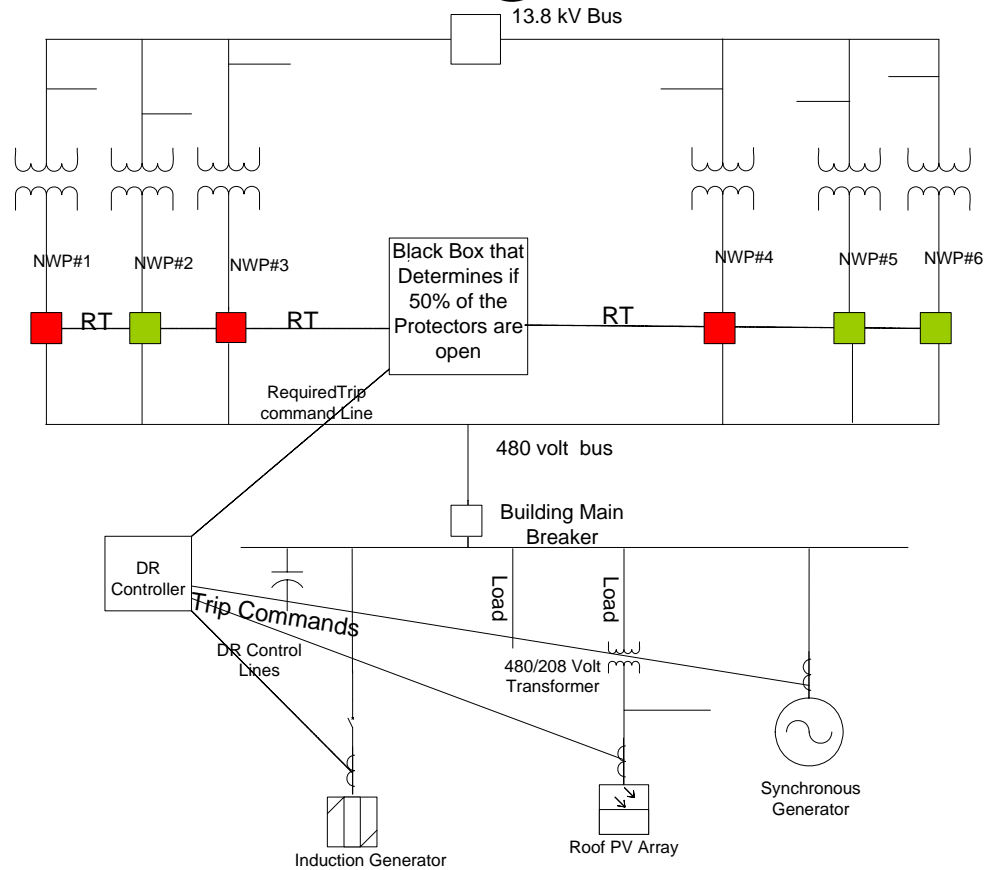


Required Advancements to Mitigate these Concerns – (continued)

Vault Control Unit

For spot networks with more than two transformers, an individual protector relay's call for trip would have to be modified by some form of instantaneous acting AND circuit to only trip the DRs when 50% or more of the protectors required a DR trip

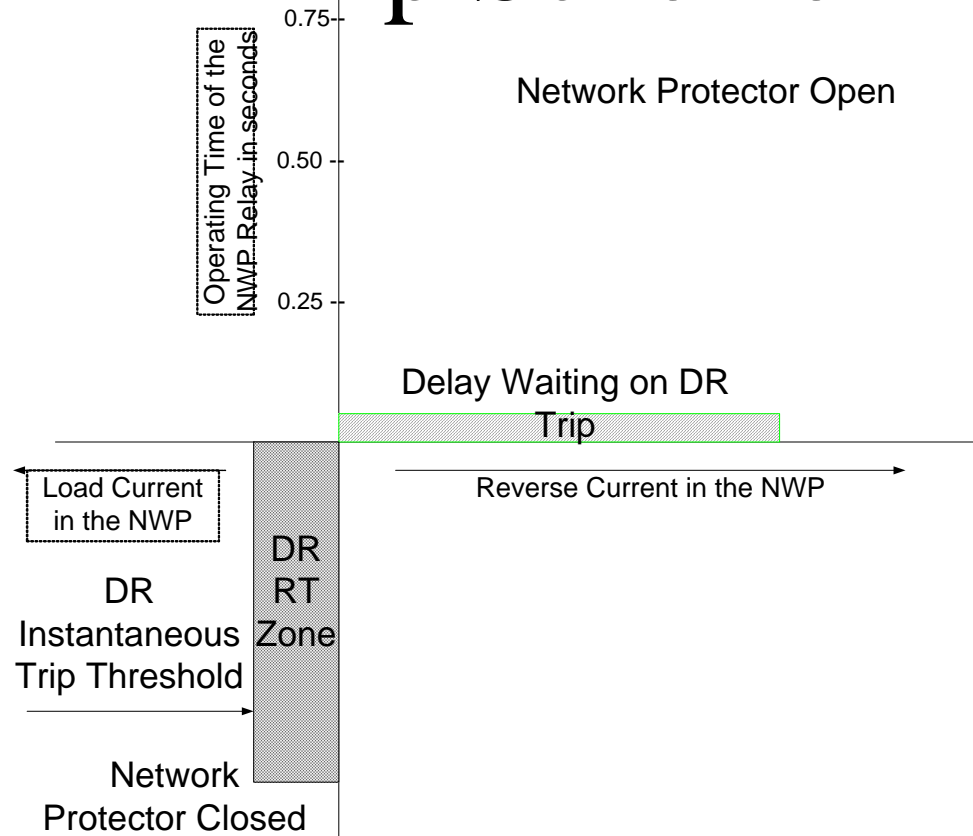
Black Box Conceptual Arrangement



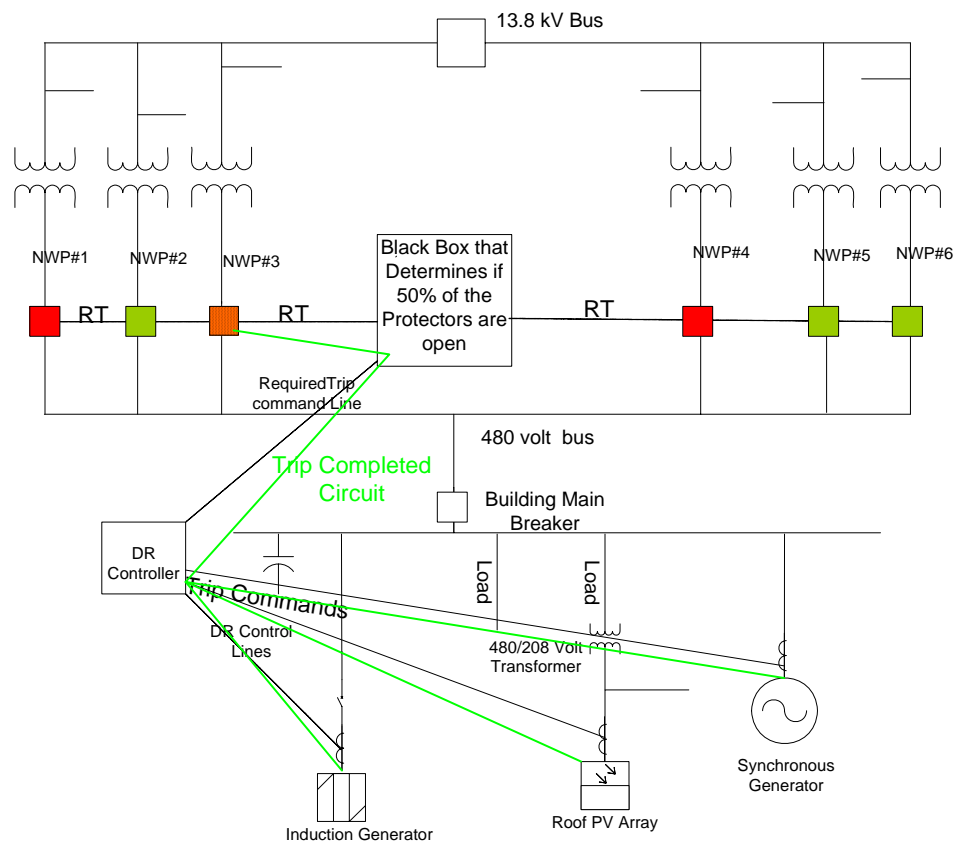
Required Advancements to Mitigate these Concerns – (continued)

- Concern #2 For utilities who do not wish to set any intentional time delay, a network relay system that could issue a DR trip command and then trip itself, *if required*, after receiving a confirmation signal that the DR had tripped-- a form of permissive tripping. This ability will also require some development by the DR manufacturers.

NWP Relay Utilizing Permissive Trip Scheme



Conceptual Permissive Trip Circuit



Required Advancements to Mitigate these Concerns – (continued)

- A variation might be to block any network protector tripping if all network protector reverse power relays were calling for a trip. The DR trip command would be sent and individual NWPs would be released to trip as soon as at least one unit's power flow moved back into the import (non-trip) direction. This would guard against dumping the network bus for the adjacent feeder fault on the utility system when DRs are interconnected and yet not materially slow tripping for faults on one of the feeders supplying the spot network.

Preliminary Discussions with both NWP Relay and DR Manufacturers

- Discussed the concept of NWP relay centered control and the feasibility of receiving and sending trip communications between the NWP relay system and the DR interface system.
- Reaction has generally been favorable and deemed not to be any significant technological hurdle.

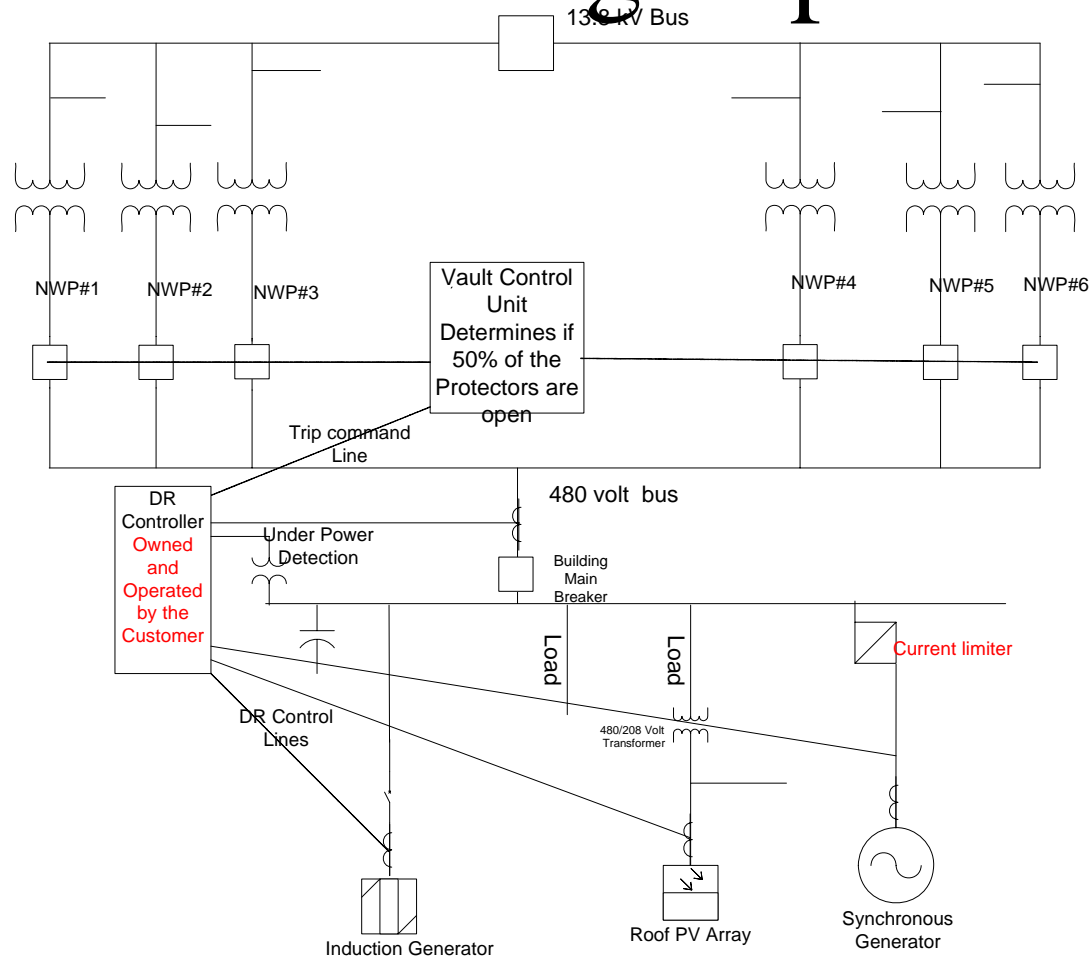
Discussions with Select Utilities*

- Three allow interconnections on Spot Networks by applying low reverse power time-delayed tripping.
- Two do not allow time delay of the protector tripping and therefore have very few and small interconnections.
- *Note some other utilities do allow PV systems small compared to loads on network systems.

Discussions with Select Utilities- (continued)

- Of the three that allow interconnections:
- One would like a better way that would increase reliability and reduce pre-engineering time.
- One has not worried about it lately because of little interconnection activity
- One has a form of Vault Control Unit and sets DR size limits that, with time delay, solves any problems of importance to the utility

Consider a Large Spot Network



One Utility's Approach

- Spot Networks are designed to an N-2 criteria, so for a 10 MVA max load they would install six 2.5 MVA units.
- The minimum network import permitted would be 1 MVA for such a spot or 167 KVA per unit.
- With a 6% minimum criteria, they have reasonable margin even with 20% unbalance.
- Max DR MVA allowed <minimum load MVA-1MVA.

The Tie-line Control Approach

- Requires:
 - Low Reverse Power Time Delay of NWP's which is long enough for tie-line corrections.
 - A Vault Control Unit to determine when 50% of the protectors are open.
 - DR size limited to less than *minimum load or customer maintenance of a tie-line control which meets or exceeds local utility quality and maintenance practice.*

Tie-line Control Works, BUT

- The use of time delay increases the utility's exposure to additional fault damage, at the point of fault or cross town, i.e., other phase remote.
- It relies on good maintenance by the customer or
 - DR rated output restrictions at initial installation, *and*,
 - Future awareness of any drop in minimum load.
 - In the event of a reduced minimum load, network reliability is only as good as the tie-line control's reliability.

Next Steps

- The Massachusetts Technology Collaborative, MTC, has developed and posted on its web site an RFP for these suggested NWP relay developments that might be possible by the responding team(s). A team would likely consist of a relay manufacturer, a utility, and at least one DR manufacturer.
- www.masstech.org/dg/collab.reports.htm
- Attachment F: Relaying and Control Technology Development for Spot Networks.

GOALS OF MTC's RFP

- To advance the acceptability of DG on network service by encouraging changes in the network protector (NWP) relays and in the DG controls to react instantaneously to required switching conditions utilizing communications between the NWP relays and the DG controls.

GOALS OF MTC's RFP (continued)

- Encourage protector relay manufacturers, DG interface manufacturers, and utilities to determine what developments they feel are feasible, develop a prototype relaying and control system, and prepare a plan for a prototype demonstration project on a spot network test bed.

GOALS OF MTC's RFP (continued)

- Increase the acceptability of DG interconnection with network service by utilities by assuring that all conditions that can cause protector operations are controlled by utility owned and maintained relays and controls.
- Decrease the complexity and site-specific variability for DG suppliers in designing network interconnection systems.

GOALS OF MTC's RFP (continued)

- Advance communication and control exchanges between network protectors and DG to achieve high levels of security while increasing operating range flexibility.

Conclusions

- The relay advancements that are suggested in this presentation are an attempt to offer tools to utilities who don't permit time delays and won't accept customer controls that can impact their network's reliability.
- The functions that could be performed in the suggested relay development and the ability to deal with two-way communications will also be a key step in resolving the grid interconnection issue.