MEMORANDUM

September 5, 2007

To: Docket UE-060649 – Electric Companies - Interconnection of Electric Generators. WAC Chapter 480-108

From: Dick Byers – Rulemaking Staff Lead

Re: Investigation of proposed WAC 480-108-020(2)(e)

In response to inquiries from four members of the Legislature, staff has reviewed the background, purpose and impact of proposed WAC 480-108-020(2)(e). The legislative inquiries were apparently prompted by an e-mail (included in docket) that alleges that the effect of the proposed rule would be to "negate any future (and current) Net Metering opportunities in the State, thus neutralizing the ground-breaking SB 5101 law (titled "Providing incentives to support renewable energy") that was passed a couple of years ago."

In summary, staff concludes the following from its examination:

1) The provision in question exists in current WAC 480-108-020(2)(e); it is not newly proposed in the current rulemaking.

2) The purpose of network protectors in grid and spot distribution networks (both examples of secondary network distribution systems) is to protect public safety and system reliability by preventing reverse current flow out of a secondary network element when one of the primary circuits serving the network element suffers a fault.

3) The provision in question does not "negate any future (and current) Net Metering opportunities in the State"; it affects only a small proportion of utility distribution systems and therefore only a small proportion of potential net-metering or customer-owned generation facility interconnections.

4) Clarification that the purpose of proposed WAC 480-108-020(2)(e) is to protect public safety and service reliability in these limited circumstances is warranted.

Staff's first conclusion issues from a simple examination of the existing rule. Existing WAC 480-108-020(2)(e) states:

> (e) Applicant must provide evidence that its generation will never result in reverse current flow through the electrical company's network protectors. All instances of interconnection to secondary spot distribution networks shall require review and

written preapproval by electrical company. Interconnection to distribution secondary grid networks is not allowed. Closed transition transfer switches are not allowed in secondary network distribution systems.

The proposed rule amends the first sentence of the existing rule and breaks the subsequent conditions into separate subsections for clarity.[1] The relevant sentence is proposed to be amended as follows:

(e) ((~~Applicant must provide evidence that its generation~~)) The electrical company must verify on the basis of evidence provided by the interconnection customer that the generating facility will never ((~~result in~~)) cause reverse current flow through the electrical company's network protectors.

Staff next examined the reasons this provision is included in the existing rule.

Spot and Grid Network Distribution Systems[2]

Network distribution systems are electrical system designs used by distribution utilities to serve dense, usually urban, load centers with enhanced reliability. The systems accomplish enhanced reliability by serving network elements (i.e., segments of customer load) from multiple primary circuits (i.e., distribution substations). Service reliability is enhanced because in the event of an outage on one primary circuit, the network element can continue to be served by a second, or even a third, primary feeder. This design depends on the principle that the network element can be isolated from any of its multiple primary feeders in the event of a fault on that feeder in order to ensure that one primary fault is not fed by, and does not produce cascading faults on, the other primary feeders. The job of isolating the network elements is performed by the "network protectors." These are essentially one-way circuit breakers that open in the event of a primary circuit fault to prevent reverse current flow into the faulted feeder circuit.

The National Renewable Energy Laboratory (NREL) has published a paper on the subject of interconnection of distributed generation in network distribution systems. The NREL paper includes a detailed description of the characteristics of network distribution systems and, in particular, the ways in which network protectors function to maintain safe

[1] Note that the outright prohibition on interconnection to "secondary grid networks" is also amended. At the recommendation of stakeholders, the proposed rule eliminates this outright prohibition and instead makes such interconnections subject to special study and approval of the utility.

[2] These terms are defined in the proposed rule.

"Grid network distribution system" means electrical service from a distribution system consisting of two or more primary circuits from one or more substations or transmission supply points arranged such that they collectively feed secondary circuits serving more than one location and more than one electrical company customer.

"Spot network distribution system" means electrical service from a distribution system consisting of two or more primary circuits from one or more substations or transmission supply points arranged such that they collectively feed a secondary circuit serving a single location (e.g., a large facility or campus) containing one or more electrical company customers.

and reliable operation of network feeders in the event of faults and restoration. Noting that interconnection of distributed generation in networks is more complex than interconnections made to a traditional radial distribution system, the paper identifies a variety of interconnection issues that are unique and important in the context of network safety. The NREL paper is included in the docket.

IEEE Standard 1547 entitled IEEE Standard for Interconnecting Distribute Resources with Electric Power Systems also addresses network distribution systems. With regard to secondary grid networks, Standard 1547 does not include any interconnection standards for distributed resources and instead reserves this issue for future revisions. With regard to secondary spot networks, Standard 1547 allows for interconnection of distributed resources, but only if requirements regarding interaction with network protectors are met. The conditions are set out in section 4.1.4.2 of Standard 1547 which also specifies that special studies may be appropriate if the aggregate distributed resource capacity exceeds 5 percent of the spot network's maximum load. Standard 1547 states unequivocally that the distributed resource shall not energize a utility's power system when that system is otherwise de-energized. Standard 1547 is included in the docket.

The Electric Power Research Institute (EPRI) published a paper entitled National Standards Emergent – Distributed Energy Interconnection in 2005 which discusses the issue of relays and other approaches to ensuring that interconnection of distributed resources does not degrade system safety. While the topic of system protection in the context of network distribution designs is not specifically addressed, the paper describes at pages 46 and 47 the importance of preventing reverse flow and unintended "islanding"[3] in the event of feeder line faults or outages.

The California Energy Commission (CEC) published an interconnection guidebook that specifically addresses network service in the context of California's Electric Rule 21.[4] The following lengthy quotations are a good description of both the purpose of secondary networks and the complications they present for interconnection. The CEC guidebook is included in the docket.

> In very high-density load areas, typically major metropolitan areas such as Los Angeles and San Francisco, a Network Secondary Distribution System may be used. Here, multiple paths and multiple sources increase reliability and reduce outages in the event of a fault on the system, either on one of the supplying feeders, or within the Network itself (figure omitted). Within a Network system, bidirectional power flow is anticipated and is, in fact, a key reason for its improved reliability. However, power flow out of the Network back to the radial feeder(s) is expressly prohibited, a function provided by the Network Protector. Network systems are characterized as either Grid Networks, which may supply

[3] A situation where a distributed generation facility energizes a portion of the utility's distribution that the utility thought was de-energized.

[4] California Interconnection Guidebook: A Guide to Interconnecting Customer-owned Electric Generation Equipment to the Electric Utility Distribution System Using California's Rule 21. P500-03-083. California Energy Commission. September 2003.

> several city blocks of high-rise office buildings, as suggested in Figure 1-3 (figure omitted), or Spot Networks, which supply only one or two buildings. Thus Networks present more complications to the interconnection of customer generation than do Radial systems. The criteria and requirements for interconnecting customer Generators within Network systems are still being debated within the technical community.

Id. Page 6.

> Because of the design and operational aspects of network protectors, the utility must give special consideration to Generators on networked secondary Distribution Systems. . . Since radial systems do not contain network protectors, radial Distribution Systems do not have the concerns that network protectors present. . . [N]etworked secondary systems are typically located in densely populated load areas. (figures omitted) Protecting each of the connection points to this secondary Distribution System are network protectors—relays that allow current to flow into the network, but not out of it. If current tries to flow back through the protector, the relay opens, isolating that input to the network system.[5] Network protectors are not designed for frequent operation and the cause of any operation (e.g. a fault on one of the feeders) must be determined and corrected before the network protector can be reset.
>
> The boundary of a network system—where the network ends and radial distribution begins—is a function of the density of the load and a number of other factors. . . There is limited experience with the operation of Generators within secondary networks throughout the United States. Siting a Generator within a secondary network may require some special considerations. Rather than go into great detail in Rule 21 on how to address these issues, it was decided that siting a Generator within a secondary network would necessitate supplemental review.

Id. Page 39.

Finally, the rulemaking record for existing WAC 480-108-020(2)(e) in Docket UE-051106 includes a specific comment from Seattle City Light supporting the prohibition of interconnection to grid distribution networks and the requirement for special studies and approval of the utility for interconnection to spot distribution networks.[6] Seattle commented (emphasis in original).

> First, it is important to understand that all types of secondary distribution networks have protection relays on the points where they are fed from primaries. These relays, called network protectors, are specifically designed to open on reverse current flow. This is a requirement of the network design concept, to avoid faults on any primary being fed from other primaries that are connected

[5] Typically reverse power flow is the result of a fault on one of the supplying feeders, which the utility does not want to feed from one of the other feeders supplying the network system.
[6] Docket UE-051106. Comments of David Van Holde filed December 9, 2005.

through the network to the fault. This impacts distributed generation installed in networks by necessitating that no reverse power flow can occur through the network protectors. So, in any case, no power can be exported from a network.

For any number of reasons, generation interconnection in an *area, or grid* network is extremely problematic. Among the reasons are that, unlike a spot network:

> Multiple customers are directly connected to an area network, so that, since their loads are changing at all times, the power flow directions in the network are constantly changing. This makes it difficult or impossible to accurately characterize power flow in an area network on a dynamic basis, and so assess generation impact.
>
> Any fault or problem requiring a breaker operation in it is also likely to impact many customers at once.
>
> Finally, the fault current potential in an area network may be very high, as many customers are attached to it.

One result of these realities is that IEEE 1547-2003 does set some terms for DG interconnection to *spot* networks, *but not grid, or area, networks*.

Our review of the preceding sources demonstrates that the purpose of network distribution system configurations is to enhance service reliability and that objective can only be achieved safely through use of network protection devices that prohibit reverse current flow out of network elements. Staff concludes that the protection against reverse current flow out of network distribution systems is necessary and appropriate to protect public safety and convenience.

<u>The Extent and Consequence of Network Distribution Configurations in Washington for Net Metering</u>

Staff also investigated the degree to which the protection against reverse current flow out of network distribution systems might limit net metering and other customer-generator interconnections in Washington.

In the instance where a network distribution system element serves multiple customers or loads, the prohibition on current flow out of the network element would not necessarily prevent net metering or other injection of customer-owned generation if such generation is less-than or equal to customer loads within the network element. How much customer generation can be accommodated within the network element and under what conditions is recognized by IEEE Standard 1547 as a matter necessitating specific study by the utility. The proposed rule provides for this flexibility at WAC 480-108-020(f-g).

Staff asked the three investor-owned utilities to determine the proportion of their service territories served by network distribution system configurations. Puget Sound Energy reports that it serves one large facility (Southcenter Mall) with a spot distribution network and has no grid distribution networks on its system. Avista reports that it serves roughly 20 facilities including large office buildings and a shopping center in downtown Spokane with spot network distribution systems and it has no grid network systems. PacifiCorp reports that it has no spot and no grid network systems in Washington. Avista's territory contains the largest concentration of network systems, but even these serve only large customers accounting for only about three percent of its Washington customer load and less than one percent of its Washington service territory.

Staff concludes from its examination that:

1) Prohibition on reverse current flow out of the elements of a network distribution system does not necessarily preclude net metering or interconnection of other customer generation. The proposed rule specifically allows the flexibility for such interconnections subject to special study and approval of the electric company.

2) Even if net metering and other customer generation interconnections are precluded for reasons of protecting safety and reliability on network distribution systems, these systems constitute only a very small part of the IOU's distribution systems and are unlikely to affect more than a few potential interconnection customers, if any.

Recommended Text to Clarify Proposed WAC 480-108-020(2)(e)

To make clear that the purpose of the rule is to protect safe and reliable service, staff recommends that the proposed text be clarified to read as follows.

> The electrical company must verify on the basis of evidence provided by the interconnection customer that a generating facility interconnected to a grid network distribution system or a spot network distribution system will not impair public safety or quality of service to the electrical company's other customers as a result of reverse current flow through the electrical company's network protectors.