

P1547.6 Minutes – Working Group Meeting Aug 4-5, 2005, Arlington VA  
*Draft Recommended Practice For Interconnecting Distributed Resources With Electric  
Power Systems Distribution Secondary Networks*

**Executive Summary.** This was the inaugural meeting of the P1547.6 working group (WG). The P1547.6 project was reviewed, the initial strawman outline and information resources were discussed, initial writing volunteers and assignments were made, and some draft inputs were established. The writing assignments inputs are due to J. Koepfinger and T. Basso by **November 1, 2005** or before, so the information can be posted in advance of the next co-located WG meeting to be held the **week of January 30, 2006** in conjunction with P1547.2, P1547.3, P1547.4, and P1547.6 in Atlanta GA hosted by Georgia Power.

**Introductions and IEEE Introductory Material.**

The first hour and half of this meeting included members from both P1547.2 and P1547.6. After that the two WGs separated to different rooms.

The attendees (**Annex A**) were welcomed by the P1547.6 Chairman J. Koepfinger who requested the attendees introduce themselves and state their interest in developing the recommended practice for DR in networks. Bob Saint of NRECA who sponsored the meeting rooms and refreshments made some welcoming and house keeping remarks. The Chairman presented the agenda (**Annex B**) and P1547.6 Secretary T. Basso showed the information on IEEE P1547.x titles, scopes and purposes, and, IEEE meeting policy, copyright/patent policy and inappropriate topics to discuss at IEEE standards meetings (**Annex C**). That presentation identified what the IEEE standards types are: guide, recommended practice, and standard. There was a question about which document would take precedence, and it was stated that the precedence would be determined by the entity that uses the documents.

The meeting focus was to discuss the P1547.6 project, discuss a strawman outline (**Annex D**), request background/bibliographic materials, and establish volunteer writing assignments. Chairman, Joe Koepfinger challenged the group to consider the target of two years to establish a final draft.

**Discussion of Document and Information Content for The Draft Standard.**

General discussion of areas to be covered by the recommended practice included the following points.

- The material should discuss coordination needed between the DR protection and that of the network protective system in place before the installation of the DR.
- There is a need to have a definition of what is a secondary network and its boundaries.
- Drawings are needed to assist in the understanding of the secondary networks, its boundaries, and elucidation of practices.
- Terminology needs to be clarified, e.g., IEC terms and definitions include networks that are not the same as the USA meaning for network distribution systems.
- Various resource materials were identified and provided to the P1547.6 officers.

The scope and purpose were discussed in more detail. The Chairman explained the scope of the standard project is something that has been approved by the IEEE Standards Association Standards Board and cannot easily be changed. The purpose for the document was reviewed focusing on the connotation that DR interconnection purpose was to enhance quality of service. Discussion led to the motion and vote (15 Yes 5 No 6 Abstain) to remove the sentence in the document purpose “In this standard consideration is given to the needs of the Local EPS to be

able to provide enhanced service to the DR owner loads as well as to other loads served by the network.” Further discussion on bounding the document included setting voltage level constraints, stating/defining types of network configurations not to consider, and, establishing (physically) where DR is sited as a constraint for its consideration in this document. It was generally agreed that DRs should be embedded in the network for consideration in the standard, otherwise, further clarifications such as in the preceding sentence will be drafted and discussed on a case-by-case basis after writing assignments come forth.

#### **Discussion of Strawman Outline (Annex D)**

The Chairman presented a draft outline for consideration and participants volunteered to establish initial text under the respective topics. These assignments are due to Chairman Joe Koepfinger and Tom Basso on or before **November 1, 2005**.

Discussion included why the term “Planning” was used rather than “Impact Studies” and it was agreed that for the time being planning would be used. The initial outline discussion resulted in some editorial changes to the outline as well as the list of volunteer writers listed in the outline (**Annex D**).

#### **Onsite Writing Groups.**

Based on the outline discussions, two breakout groups worked on the following topics: “Planning Considerations” and, “Protection Considerations and Settings” meeting separately on Aug 4 to establish initial text/approaches. The full P1547.6 WG reconvened on August 5, 2005 where we heard reports and reviewed the material established at the breakout group meetings (**Annex E** – Planning Considerations, and **Annex F** – Protection Considerations and Settings). Additionally, we worked as a full P1547.6 WG on reviewing terminology/definitions from existing resources (**Annex G**). And, the **Annex H** to these minutes lists some initial resource materials.

#### **Next Actions and Adjournment**

- P1547.6 web pages and initial materials posted including the P1547.6 contact list (T. Basso)
- Writing volunteers provide inputs Nov 1, 2005 to T. Basso and J. Koepfinger
- Post initial draft outline with inputs Dec 2005 – Jan 2006
- Next meeting Jan 30, 2006.

The Chairman, Joe Koepfinger thanked Bob Saint (NRECA) for sponsoring the meeting and refreshments, and thanked the attendees for their participation. The meeting adjourned at noon. (Participants were invited to stay on and work in adhoc groups.)

Respectfully Submitted, Joe Koepfinger and Tom Basso.

**Annex A - Attendees**  
**P1547.6 Meeting ARLINGTON, VA; 4 AUGUST 2005**

Chairman J. Koepfinger joseph\_1\_koepfinger@msn.com Secretary T. Basso, Thomas\_Basso@nrel.gov

Martin Baier  
Arup Barat  
Tom Basso  
David Beach  
David Bosack  
John Bzura  
Steve Chalmers  
Terry Conrad  
David Costyk  
James Daley  
MurrayDavis  
Francisco DeLaRosa

Paul J. Della  
Mike Doyle  
Joe Galdo  
Andris Garsils  
Larry Gelbien  
Gerald Johnson  
Travis Johnson  
Joe Koepfinger  
Jason Lin  
Paul Mattes  
Sam McAllister  
Jock Moffat

Robert Peterson  
Charles Rogers  
Bob Saint  
Daniel Sammon  
Gene Shlatz  
Herbert Sinnock  
Mohammad Vaziri  
Simon Wall  
Tim Wall  
Jim Watts  
Randy West  
Chuck Whitaker

**Annex B - DRAFT AGENDA FOR INITIAL MEETING**  
**IEEE P1547.6 Recommended Practice for DR in Networks**  
**Arlington VA, NRECA Conference Centre**

Chairman J. Koepfinger joseph\_1\_koepfinger@msn.com Secretary T. Basso, Thomas\_Basso@nrel.gov

**August 4 Thursday 8:10 am - 5pm**

**8:10 am – 8:30 am arrive/register NRECA Conference Center**

**8:30 am – 10:00 am**

- Introductions
- Presentation of IEEE Patent and Copyright Policy
- Presentation of Scope
- Presentation of Purpose and Discussion
- Discussion of Philosophy to be used in the preparation of the Recommended Practice
  1. Contain discussion only of the Pro and Con of DR integration into Secondary Networks and provide recommended solutions?
  2. Contain discussion of methods and example to achieve DR integration into Secondary Networks given examples
  3. Combination of 1 and 2?

**10:00 am – 10:15 am Break**

**10:15 am – 12N**

- Continuation of sub items 1,2, and 3
- Opportunity for members to discuss Applications now operating
- Discussion of need to solicit industry (EEI and other sources regarding applications)?

**12N – 1:30 pm Lunch (On own)**

**1:30 – 3:00 pm**

- Preparation of a Draft Outline for the Recommended Practice

**3pm -3:15pm Break**

**3:15 – 5 00 pm**

- Continue preparation of the Draft Outline

**August 5, Friday**

**8:10 am – 8:30 am arrive/register**

**8:30 am – 10:00 am**

- Review outline prepared on Thursday
- Discuss and Draft Boundaries applicable to this document
  1. Spot Type LV Networks only?
  2. Grid Type LV Networks only?
  3. Both Types of LV Networks?
- Other issues to be considered in the preparation of the document  
(For example limitation of tradition network protection)
- Communications Needs (Monitoring, Information and Control - MIC)

**10:00 am - 10:15 am Break**

**10:15 am – 12N**

- Using the previous draft outline make writing assignments and form writing teams
- Identify Liaison needs and make assignments

**12N – 1:30 pm      Lunch**

**1:30 pm – 3 pm**

- Time allocated for writing teams to develop a outline of the material that will be addressed in the respective clauses The effectiveness of this work will be dependent upon members travel arrangements.
- Short review of results of writing group discussion and identifying of problems to be addressed in the preparation of the material
- Review of communication process to be used between face to face meetings
- Time and place of next face to face meeting (week of Jan 30, 2006 Atlanta GA for 1547 series).
- Adjournment

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**Annex C - IEEE Introductory Information: IEEE standards; Std 1547 titles, scopes, and purposes; IEEE patent/copyright and Inappropriate topics for standards meeting discussion; etc.**

4 AUGUST 2005


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IEEE SCC21 1547™ Series Standards Development  
Working Group Meetings Aug 1-5, 2005; Arlington VA  
P1547.6 Aug 4-5, 2005

**P1547.6 Draft Recommended Practice  
For Interconnecting Distributed  
Resources With Electric Power  
Systems Distribution Secondary  
Networks**

Chairperson: Joe Koepfinger  
Secretary: Tom Basso

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**1547 Series of Meetings: Aug 1 – 5, 2005**  
**Draft Timeline - see each work group agenda for exact times**

August 1 Monday 8:10 am - 5pm P1547.3 (Information Exchange)

August 2 Tuesday

- 8:00 am – 1pm P1547.3 (Information Exchange)  
(option 1pm to 5pm) P1547.3 ad-hoc meetings
- 8:10 am - 5pm P1547.4 (DR Island Systems)

August 3 Wednesday 8:10 am - 3pm P1547.4 (DR Island Systems)


August 4 Thursday

- 8:10 am – 5pm P1547.6 (DR/Networks) at CC1
- 10:15 am – 5pm P1547.2 (Guide to 1547) at CC3

August 5 Friday

- 8:10 am – 3pm P1547.2 (Guide to 1547) at CC3
- 8:10 am - 3pm P1547.6 (DR/Networks) at CC1

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IEEE SCC21 P1547 Series of Interconnection Standards Development

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**1547 Series of Meetings: Aug 1 – 5, 2005**  
**Draft Timeline - see each work group agenda for exact times**


August 4 Thursday

- 8:10 am – 5pm P1547.6 (DR/Networks) at CC1
- 10:15 am – 5pm P1547.2 (Guide to 1547) at CC3

August 5 Friday

- 8:10 am – 3pm P1547.2 (Guide to 1547) at CC3
- 8:10 am - 3pm P1547.6 (DR/Networks) at CC1

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IEEE SCC21 P1547 Series of Interconnection Standards Development

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**P1547.6 Project Description**

**Title.** Draft Recommended Practice For Interconnecting Distributed Resources With Electric Power Systems Distribution Secondary Networks


**Scope.** This standard builds upon IEEE Standard 1547 for the interconnection of distributed resources (DR) to distribution secondary network systems. This standard establishes recommended criteria, requirements and tests, and provides guidance for interconnection of distribution secondary network system types of area electric power systems (Area EPS) with distributed resources (DR) providing electric power generation in local electric power systems (Local EPS).

**Purpose.** This standard focuses on the technical issues associated with the interconnection of Area EPS distribution secondary networks with a Local EPS having DR generation. The standard provides recommendations relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. In this standard consideration is given to the needs of the Local EPS to be able to provide enhanced service to the DR owner loads as well as to other loads served by the network. Equally, the standard addresses the technical concerns and issues of the Area EPS. Further, this standard identifies communication and control recommendations and provides guidance on considerations that will have to be addressed for such DR interconnections.

**Chairperson:** Joe Koepfinger      **Secretary:** Tom Basso

**PAR approved** by IEEE June 2005 (project authorization request); ballot to be completed by Jan 2008

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**Agenda P1547.6 Aug 4-5, 2005**

- Welcome and Introductions
- IEEE Standards Development
- 1547 Series of Standards
- P1547.6 Discussion
- Writing Assignments/Next Actions
- Adjourn

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**Welcome and Introductions**

Please sign in on the attendee list

correct and/or add your contact  
information

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## IEEE Standards Development

### **IEEE Instructions - the WG membership shall be advised that:**

- IEEE's Patent Policy is consistent with the ANSI patent policy and is described in Clause 6 of the IEEE SA Standards Board Bylaws;
- Early disclosure of patents which may be essential for the use of standards under development is encouraged -- WG members should identify or disclose patents that you believe may be essential for the use of this standard; responses (specifically the patents and patent applications identified, if any, and by whom) will be recorded in this meeting's minutes.
- Disclosures made of such patents may not be exhaustive of all patents that may be essential for the use of standards under development, and neither the IEEE, the WG nor the WG Chairman ensure the accuracy or completeness of any disclosure or whether any disclosure is of a patent that in fact may be essential for the use of standards under development.



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### IEEE-SA Standards Board Bylaws on Patents in Standards

**6. Patents.** IEEE standards may include the known use of essential patents and patent applications provided the IEEE receives assurance from the patent holder or applicant with respect to patents whose infringement is, or in the case of patent applications, potential future infringement the applicant asserts will be, unavoidable in a compliant implementation of either mandatory or optional portions of the standard [essential patents]. This assurance shall be provided without coercion and prior to approval of the standard (or reaffirmation when a patent or patent application becomes known after initial approval of the standard). This assurance shall be a letter that is in the form of either:

- a) A general disclaimer to the effect that the patentee will not enforce any of its present or future patent(s) whose use would be required to implement either mandatory or optional portions of the proposed IEEE standard against any person or entity complying with the standard; or
- b) A statement that a license for such implementation will be made available without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination.

This assurance shall apply, at a minimum, from the date of the standard's approval to the date of the standard's withdrawal and is irrevocable during that period.



Approved by IEEE-SA Standards Board – March 2003 (Revised February 2004)


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**Inappropriate Topics for IEEE WG Meetings**

- Don't discuss licensing terms or conditions
- Don't discuss product pricing, territorial restrictions or market share
- Don't discuss ongoing litigation or threatened litigation
- Don't be silent if inappropriate topics are discussed... do formally object.

**If you have questions, contact the IEEE-SA Standards Board Patent Committee Administrator at [patcom@ieee.org](mailto:patcom@ieee.org) or visit <http://standards.ieee.org/board/pat/index.html>**

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 IEEE

Approved by IEEE-SA Standards Board – March 2003 (Revised February 2004)


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**P1547.6 IEEE Web Site**

**P1547.6 public web site (more to add)**  
[http://grouper.ieee.org/groups/scc21/1547.6/1547.6\\_index.html](http://grouper.ieee.org/groups/scc21/1547.6/1547.6_index.html)

- **P1547.6 Archives**  
Will include:
  - Meeting information
  - Registration Information – First time attendees, please return a completed registration form (Excel 24 KB) to David Glickson and Tom Basso, the SCC21 secretary, at least two weeks before the meeting. Ongoing attendees, please RSVP and provide any changes to your contact information.
  - Agenda – for most recent meeting
  - Minutes

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 IEEE

## **P1547.6 Web Site – Work Group Area (being developed)**

- P1547.6 Work Group Area (password protected)  
<http://grouper.ieee.org/groups/scc21/1547.6/private/>  
username p1547.6 password 15for76

Will include:

- Contacts – WG member information (standards development use only).
- Special Topics - background information for the Work Group.
- StdDrafts – Drafts under development
- Listserv – listserv archived emails



## **P1547.6 IEEE ListServ**

ListServ is for IEEE standards development use only.  
IEEE code of ethics identified in Information file sent to each subscriber.

To: [stds-p1547-6@listserv.ieee.org](mailto:stds-p1547-6@listserv.ieee.org)

From: [you@yourISP.com](mailto:you@yourISP.com)

Only subscribers can send to the list. Exchanges between individuals and among your self-established small groups are encouraged.

ListServ emails are immediately sent to all subscribers;

Reply to all – sent to all;

Reply to sender – only sent to sender.

Email to listserv is auto-archived at

P1547.6 Work Group Area (password protected)  
at ListServ (To Be Determined - TBD)

Archived emails can be viewed either under

Subject Thread or Date Thread.




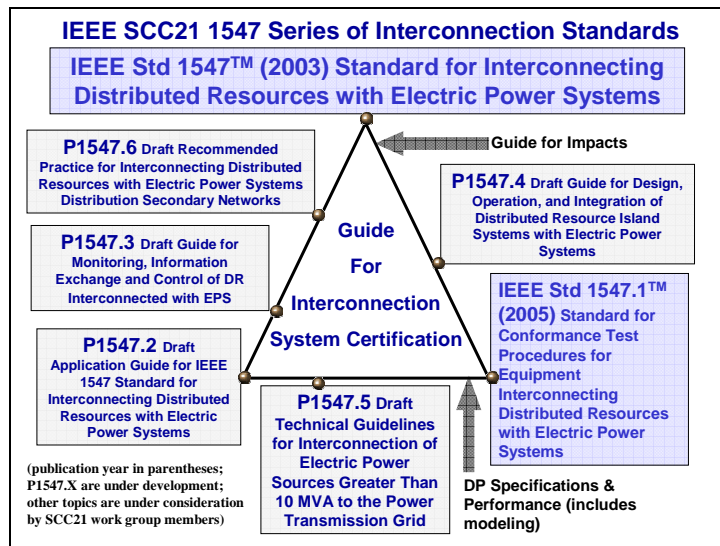
## IEEE Standards Classification

**Standard:** documents with mandatory requirements **(shall)**

**Recommended Practice:** documents in which procedures and positions preferred by the IEEE are presented **(should)**

**Guide:** documents in which alternative approaches to good practice are suggested but no clear-cut recommendations are made **(may)**

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<b>Current SCC21 Interconnection Projects</b>	
<b>Title</b>	<b>Scope &amp; Purpose</b>
IEEE Std 1547™ (2003) <u>Standard</u> for Interconnecting Distributed Resources with Electric Power Systems	<ul style="list-style-type: none"> <li>• This <u>Standard</u> establishes criteria and requirements for interconnection of distributed resources (DR) with electric power systems (EPS).</li> <li>• This document provides a uniform standard for interconnection of distributed resources with electric power systems. It provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.</li> </ul>
IEEE Std 1547.1 (2005) <u>Standard</u> for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems	<ul style="list-style-type: none"> <li>• This <u>Standard</u> specifies the type, production, and commissioning tests that shall be performed to demonstrate that interconnection functions and equipment of a distributed resource (DR) conform to IEEE Std 1547.</li> <li>• Interconnection equipment that connects distributed resources (DR) to an electric power system (EPS) must meet the requirements specified in IEEE Standard 1547. Standardized test procedures are necessary to establish and verify compliance with those requirements. These test procedures must provide both repeatable results, independent of test location, and flexibility to accommodate a variety of DR technologies.</li> </ul>

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<b>Current SCC21 Interconnection Projects</b>	
<b>Title</b>	<b>Scope and Purpose</b>
P1547.2™ Draft Application <u>Guide</u> for IEEE Standard 1547 for Interconnecting Distributed Resources with Electric Power Systems	<ul style="list-style-type: none"> <li>• This <u>Guide</u> provides technical background and application details to support the understanding of IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.</li> <li>• This document facilitates the use of IEEE 1547 by characterizing the various forms of distributed resource technologies and the associated interconnection issues. Additionally, the background and rationale of the technical requirements are discussed in terms of the operation of the distributed resource interconnection with the electric power system. Presented in the document are technical descriptions and schematics, applications guidance and interconnection examples to enhance the use of IEEE 1547.</li> </ul>
P1547.3™ Draft <u>Guide</u> for Monitoring, Information Exchange and Control of Distributed Resources Interconnected with Electric Power Systems	<ul style="list-style-type: none"> <li>• This document provides guidelines for monitoring, information exchange, and control for distributed resources (DR) interconnected with electric power systems (EPS).</li> <li>• This document facilitates the interoperability of one or more distributed resources interconnected with electric power systems. It describes functionality, parameters and methodologies for monitoring, information exchange and control for the interconnected distributed resources with, or associated with, electric power systems. Distributed resources include systems in the areas of fuel cells, photovoltaics, wind turbines, microturbines, other distributed generators, and, distributed energy storage systems.</li> </ul>

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<b>Current SCC21 Interconnection Projects</b>	
<b>Title</b>	<b>Scope and Purpose</b>
P1547.4™ Draft <u>Guide</u> for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems	<ul style="list-style-type: none"> <li>• This document provides alternative approaches and good practices for the design, operation, and integration of distributed resource (DR) island systems with electric power systems (EPS). This includes the ability to separate from and reconnect to part of the area EPS while providing power to the islanded local EPSs. This guide includes the distributed resources, interconnection systems, and participating electric power systems.</li> <li>• This guide is intended to be used by EPS designers, operators, system integrators, and equipment manufacturers. The document is intended to provide an introduction, overview and address engineering concerns of DR island systems. It is relevant to the design, operation, and integration of DR island systems. Implementation of this guide will expand the benefits of using DR by targeting improved electric power system reliability and build upon the interconnection requirements of IEEE 1547.</li> </ul>

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<b>Current SCC21 Interconnection Projects</b>	
<b>Title</b>	<b>Scope and Purpose</b>
P1547.5 Draft <u>Technical Guidelines</u> for Interconnection of Electric Power Sources Greater Than 10 MVA to the Power Transmission Grid	<ul style="list-style-type: none"> <li>• This document provides guidelines regarding the technical requirements, including design, construction, commissioning acceptance testing and maintenance /performance requirements, for interconnecting dispatchable electric power sources with a capacity of more than 10 MVA to a bulk power transmission grid.</li> <li>• The purpose of this project is to provide technical information and guidance to all parties involved in the interconnection of dispatchable electric power sources to a transmission grid about the various considerations needed to be evaluated for establishing acceptable parameters such that the interconnection is technically correct.</li> </ul>
P1547.6 Draft <u>Recommended Practice</u> for Interconnecting Distributed Resources With Electric Power Systems Distribution Secondary Networks	<ul style="list-style-type: none"> <li>• This standard builds upon IEEE Standard 1547 for the interconnection of distributed resources (DR) to distribution secondary network systems. This standard establishes recommended criteria, requirements and tests, and provides guidance for interconnection of distribution secondary network system types of area electric power systems (Area EPS) with distributed resources (DR) providing electric power generation in local electric power systems (Local EPS).</li> <li>• This standard focuses on the technical issues associated with the interconnection of Area EPS distribution secondary networks with a Local EPS having DR generation. The standard provides recommendations relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. In this standard consideration is given to the needs of the Local EPS to be able to provide enhanced service to the DR owner loads as well as to other loads served by the network. Equally, the standard addresses the technical concerns and issues of the Area EPS. Further, this standard identifies communication and control recommendations and provides guidance on considerations that will have to be addressed for such DR interconnections.</li> </ul>

### **Next Actions**

- **P1547.6 WG volunteers draft inputs**  
– due Nov 1, 2005
- **P1547.6 Draft 1 Outline established/posted**  
– due Dec 2005 or Jan 2006
- **P1547.6 Draft 1 outline feedback review prior to next meeting**  
- due Jan 2006
- **Next Meeting – Jan 30, 2006, Atlanta GA**
- **Adjourn: Friday at 3pm**



**Annex D - IEEE P1547.6 INITIAL DRAFT OUTLINE  
4 AUGUST 2005**

**(Edited onsite and volunteers' names added)**

**1. Introduction**

**2. Scope**

This standard builds upon IEEE Standard 1547 for the interconnection of distributed resources (DR) to distribution secondary network systems. This standard establishes recommended criteria, requirements and tests, and provides guidance for interconnection of distribution secondary network system types of area electric power systems (Area EPS) with distributed resources (DR) providing electric power generation in local electric power systems (Local EPS).

**3. Purpose**

This standard focuses on the technical issues associated with the interconnection of Area EPS distribution secondary networks with a Local EPS having DR generation. The standard provides recommendations relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. ~~In this standard consideration is given to the needs of the Local EPS to be able to provide enhanced service to the DR owner loads as well as to other loads served by the network.~~ Equally, the standard addresses the technical concerns and issues of the Area EPS. Further, this standard identifies communication and control recommendations and provides guidance on considerations that will have to be addressed for such DR interconnections.

**4. Limitation**

(To be completed after bulk of the guide has been prepared)

**5. References**

**6. Definitions/Acronyms**

Baier, M. Koepfinger, J.

**7. Types/Characteristics of Network and Control Systems**

Koepfinger, J. Baier, M. Networks: what they are and how they operate

**7.1. Spot**

**7.1.1. Consideration for Integration of DR into Spot Networks**

**7.1.1.1. Map 1547 Requirement to Networks**

Whitaker, C.

(Using 1547 review each requirement to determine its applicability to network operation)

#### **7.1.1.2. Planning Consideration**

Daley, M. Davis, Costyk, D. Peterson, Wall, T. Vaziri, M. Bzura, J.

(Discuss what has to be done to make it possible for a interconnected DR to meet the selected requirements. This discussion should address limitations in the use of DR for this application. Consideration has to be given to modification that may have to be made to control system, local EPS and Area EPS This may include load flows studies, motor starting studies, short circuit studies, voltage regulation studies, maximum and minimum load conditions)

#### **7.1.1.3. Protection Considerations and settings – Impact of DR on**

Gelbien, L. Watts, J. Beach, D.

- Power to Local EPS
- Var Dispatch to Local EPS

#### **7.1.1.4. Communication Considerations**

### **7.2. Grid Networks**

#### **7.2.1. Consideration for Integration of DR into Spot Networks**

##### **7.2.1.1. Map 1547 Requirement to Networks**

Whitaker, C.

(Using 1547 review each requirement to determine its applicability to network operation)

##### **7.2.1.2. Planning Consideration**

Costyk, D. Davis, M. Daley, J. Vaziri, M. Wall, T. Della, P.

(Discuss what has to be done to make it possible for a interconnected DR to meet the selected requirements. This discussion should address limitations in the use of DR for this application. Consideration has to be given to modification that may have to be made to control system, local EPS and Area EPS This may include load flows studies, motor starting studies, short circuit studies, voltage regulation studies, maximum and minimum load conditions)

##### **7.2.1.3. Protection Consideration – Impact of DR on**

- Power Dispatch to Area EPS
- Power to Local EPS
- Var Dispatch to Area EPS
- Var Dispatch to Local EPS

#### **7.2.1.4. Communication Considerations**

## **8. ESENTIAL ISSUE TO BE ADDESED FOR INTERCONNECTION OF DR ON NETWORKS**

### **8.1. SPOT NETWORK**

### **8.2. GRID NETWORK**

### **Annex - BIBLIOGRAPHY**

Members to supply Chairman and Secretary with references and reference material, e.g.,

- IEEE C37.108-2002

- IEEE C57.12.44-2000 (provide guidance on the capabilities of network systems to accept distributed resources.
  - Westinghouse book (MBaier)
  - NREL report 38079 (T. Basso)
- 
- **Other Draft Standard Document Annexes as Needed.**

## Annex E – Planning Considerations

Breakout group Report to P1547.6 WG Members Aug 5, 2005 – presented by John Bzura

### Planning Considerations:

Participants:

Mohammad Vaziri	PG&E	<a href="mailto:myv1@pge.com">myv1@pge.com</a>	510-874-2470
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Thomas Yeh	Connected Energy	<a href="mailto:Thomas.yeh@connectedenergy.com">Thomas.yeh@connectedenergy.com</a>	585-697-3809
Murray Davis	Detroit Edison	<a href="mailto:davism@dteenergy.com">davism@dteenergy.com</a>	586-770-6221
Tim Wall	Alabama Power	<a href="mailto:ctwall@southernco.com">ctwall@southernco.com</a>	205-257-4293
Jim Daley	Asco Power Technology (Consultant)	<a href="mailto:jmdaley@optiointernet.net">jmdaley@optiointernet.net</a> <a href="mailto:jdaley@asco.com">jdaley@asco.com</a>	973-361-6349
Dave Costyk	Detroit Edison	<a href="mailto:costykd@dteenergy.com">costykd@dteenergy.com</a>	313-235-5323
Sam McAllister	TXU	<a href="mailto:smcalli1@txued.com">smcalli1@txued.com</a>	817-215-6064
Joe Koepfinger 264-6148	Consultant	<a href="mailto:joseph.l.koepfinger@msn.com">joseph.l.koepfinger@msn.com</a>	412-

Moffat to provide trip times, etc.

Spot Networks:

Jim Daley,

ComEd allows synchronous machines to connect to networks. Hospitals and critical loads. Connect and soft-load to the generators then separate and on return from an outage to avoid and outage.

IEEE paper available on connection to the networks.

IAS Paper December 2002

Application of Emergency and Standby Generation for Distributed Generation Part 1 and Part 2 James Daley, PE S.M. and Robert L. Siciliano

DTE uses a dual set-point on network protector relays with time delay tripping for back-feed up to 125% of the transformer capacity at which time it goes instantaneously.

Murray Davis:

Some utilities allow generation up to 30% of the minimum network center load on a low voltage grid.

Tim Wall:

Alabama Power has a large synchronous generator on spot network. It has paralleled for testing and outages.

M. Vaziri:

300 or so KW generator installed on the network without any approval. It was less than 30% of the spot network load. PG&E has allowed other synchronous generators since then. They do not have a specific size based on minimum load.

Dan Daley:

They have used an underpower relay to determine what kind of load can be installed on the network. (M. Vazin has also used under-power relays)

John Bzura:

National Grid will allow up to 1/15<sup>th</sup> of the minimum line load. Will send a copy of the tariff.

Adopt a Tips, Techniques and Rules of Thumb.

Planning Settings & Concerns Spot Network (No Export Allowed):

1. DG Capacity Vs. Facility Load
2. DG Capacity Vs. Network Capacity
3. Operating Constraints (Network, facility, and transformer)
  - a. Minimum Loads
  - b. Time of Day
4. Generator Technology (Inverter, Synchronous, Induction)
5. Equipment Constraints (Interrupting, Fault Duty)
6. Protector Interrupting
  - a. Total Clearing Time of NP.
    - i. Sensing Time
    - ii. Breaker Operating time
      1. Direct Acting Trip (Instantaneous)
      2. Relyed Trip
  - b. Old Versus New Protectors (Age and Vintage of equipment)
7. Type, magnitude, and profile of the load on the network
  - a. Influence on opening
  - b. Influence on closing
8. Network Protector Settings Criteria
  - a. Capability on Network Protector Relaying
9. Revision to operating practices (necessary?)
10. Novel Fault Current Limiting Technologies
  - a. Typical Synchronous Generator Fault Current
    - i. Subtransient reactance = 6-10 times PU rated current
    - ii. Transient =
11. Power directional / Level Monitoring Device

12. Need to Monitor Network Status
13. Trip the Synchronous Generator at full rated current of generator (current relay set to nameplate of the generator and trip the generator if this current is reached.) move this to settings: more precisely 51V per Baier)
14. Network Protector closing Strategy (Ability to handle out of phase closing)
  - a. Other close concerns
15. Operate DG when the network is down (island generation). Possible subject for IEEE1547.4? How will the load re-sync to the system? This is a potential item to consider for planning.
16. DG Saturation on a Network Feeder.

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Planning issues from “7.1.1.3 working group” original issues list.

- A. Reverse power method of protection employed by network protectors prevents power export. Exporting power into the utilities’ primary system is not practical because of the reverse-power method of protection used on the network to prevent backfeeding from one transformer through another. If the DG output exceeds the total on-site load at any time, power will flow toward the primary feeders and the network relays will open each of the network protectors, thereby isolating the secondary network. Current DG protection systems cannot coordinate with network protectors that open in 3-6 cycles. The requirement of a minimum site load to prevent reverse power flow may limit the size and/or operating hours of the DG. Additionally, in the case of the loss of a sudden large customer load there could be reverse power flow through the network units causing them to trip.
- K. Export into the secondary network. 1) For spot networks, export into the secondary network is the same as export into the primary system. This export would cause network protectors to open. 2) Area networks are more complicated. Exports into the secondary network would have to be studied with regards to power flow. Exports into the utility primary distribution system will isolate the secondary network with attendant loss of load.
- L. Safe parallel generator interconnection. DG interconnection facilities must be designed to nationally recognized guidelines that conform to specific and relevant standards formulated by industry committees and organizations like IEEE. This approach ensures the design is based on prudent utility practices and consistent with regulatory requirements in order to ensure a safe parallel generator interconnection and operation.
- M. Physical limitations of new installations. Network protector relays are part of an integrated assembly frequently in a submersible enclosure with tight access. This constraint is particularly frequent for secondary area networks. Network protector relays are not as easily modified as a typical relay control schemes. Modifications may be difficult due to physical barriers and space constraints.

- N. 14. Relying on customers' generator protection. Utilities do not rely on customers to protect other customers, equipment and utility personnel. Interconnection arrangements must comply with and fully address the utility's safety, operational and maintenance criteria and concerns.
  
- O. 15. Location of protection and control equipment. Non-utility personnel inadvertently adjusting or modifying protective relay settings, control systems and related equipment when the equipment is located outside of utility locked vaults and facilities is not acceptable. DG owners' operations and maintenance staff must be prevented from inadvertently adjusting or disabling control or protection settings.

## **Annex F – Protection Considerations and Settings**

Breakout group Report to P1547.6 WG Members Aug 5, 2005 – presented by Jim Watts

### **7.1.1.3 Protection Considerations and settings – Impact of DR on**

Secretary's note. Highlighted text needs to be considered here and in planning.

Issues list:

- B. Network protectors built in accordance with ANSI/IEEE Standard C57.12.44-2000 are not designed to withstand 180 degree out-of-phase voltages. When DG is disconnected from the distribution company's power system the DG phase angle will drift out-of-phase with the utility-side. Network protectors and relays are not designed with the intention of opening and reclosing two out-of-phase electricity sources. Additionally, network protectors are not designed to interrupt fault current with higher reactance to resistance (X/R) ratios than those usually encountered in low-voltage network systems. New design standards and enhanced interrupting capabilities for network protectors are necessary to prevent failure due to out-of-phase closing. This condition is relevant only if the DG unit remains in operation when the Company electric power system is de-energized. DG units must incorporate anti islanding features.
- C. Reverse power method of protection employed by network protectors prevents power export. Exporting power into the utilities' primary system is not practical because of the reverse-power method of protection used on the network to prevent backfeeding from one transformer through another. If the DG output exceeds the total on-site load at any time, power will flow toward the primary feeders and the network relays will open each of the network protectors, thereby isolating the secondary network. Current DG protection systems cannot coordinate with network protectors that open in 3-6 cycles. The requirement of a minimum site load to prevent reverse power flow may limit the size and/or operating hours of the DG. Additionally, in the case of the loss of a sudden large customer load there could be reverse power flow through the network units causing them to trip.
- D. Potential for network protector cycling. If a bus tie breaker is open or if feeders from a second substation are used to supply the network, there is a possibility that protector cycling could occur under light load conditions while DG is operating. Even with the tie breaker closed, a small imbalance in transformer impedances could cause network protector cycling with the DG operating under certain light load conditions. This issue limits the amount of DG output under light load conditions. In addition, grid reliability or power quality can be adversely affected if there is network protector cycling.

- E. Potential for network protector pumping. If a network protector opens, thereby isolating the secondary network and DG from the utility primary source, the network relay may repeatedly attempt to reclose the protector. The result of network protector pumping could lead to the destruction of the network protectors, transformer(s) and ancillary equipment.
- F. Inadvertent opening of network protectors under fault conditions. Fault current supplied by the DG could cause all network protectors to open for faults on the primary side of a network transformer. This opening would isolate the entire secondary network with a complete loss of supply to all customers served by the secondary network.
- G. DG contribution to fault current may exceed equipment ratings. The additional fault current contribution from DG could cause the total fault current to exceed equipment ratings. Fault current levels on network systems are typically higher than radial systems. This contribution could cause equipment failures and interruptions to other customers served by the network.
- H. Fault current contribution of the DG to external faults. Fault current contribution of the DG for close-in external line and substation bus faults could cause some or all network protectors to open, thereby isolating network load. To avoid inadvertently opening network protectors within the network system, the control scheme for the DG and network protector at the point of common coupling must be coordinated. This may involve delaying when the network protector opens<sup>23</sup> or use of other alternatives to enable the DG to disconnect before tripping network protectors.
- I. Relying on time delays on network protectors to clear primary cable faults. The increased fault clearing time associated with the time delay feature causes the fault to remain on the primary cable for a longer period of time. The preferred method of protection is to clear faults as quickly as possible in order to prevent additional damage and provide further protection to the public. Instituting an additional time delay in the protective function of network protectors will allow faults to exist for longer periods before they are cleared. A consideration of types of faults might be appropriate. This problem is more significant for single line to ground faults on wye-wye connected network systems.
- J. DG's protection is unable to detect distribution line ground faults. The generator's protective relay system must be able to detect the fault and open prior to the network protector relay for a primary line ground fault. It may not be possible to detect all high side phase to ground short circuit by the generator protection. This problem is more significant for single line to ground faults on wye-wye connected network systems.
- K. Network protector relay with time delay. Network protector relays with time delay could decrease building supply power quality. A 50% drop in voltage needs

to be cleared within 4-5 cycles for sensitive customer-owned equipment and processes. Distribution companies strive to achieve Computer Business Manufacturers Association (CBEMA) or other criteria to avoid adverse impacts to customer-owned equipment.

- L. Export into the secondary network. 1) For spot networks, export into the secondary network is the same as export into the primary system. This export would cause network protectors to open. 2) Area networks are more complicated. Exports into the secondary network would have to be studied with regards to power flow. Exports into the utility primary distribution system will isolate the secondary network with attendant loss of load.
- M. Safe parallel generator interconnection. DG interconnection facilities must be designed to nationally recognized guidelines that conform to specific and relevant standards formulated by industry committees and organizations like IEEE. This approach ensures the design is based on prudent utility practices and consistent with regulatory requirements in order to ensure a safe parallel generator interconnection and operation.
- N. Physical limitations of new installations. Network protector relays are part of an integrated assembly frequently in a submersible enclosure with tight access. This constraint is particularly frequent for secondary area networks. Network protector relays are not as easily modified as a typical relay control schemes. Modifications may be difficult due to physical barriers and space constraints.
- O. 14. Relying on customers' generator protection. Utilities do not rely on customers to protect other customers, equipment and utility personnel. Interconnection arrangements must comply with and fully address the utility's safety, operational and maintenance criteria and concerns.
- P. 15. Location of protection and control equipment. Non-utility personnel inadvertently adjusting or modifying protective relay settings, control systems and related equipment when the equipment is located outside of utility locked vaults and facilities is not acceptable. DG owners' operations and maintenance staff must be prevented from inadvertently adjusting or disabling control or protection settings.
- Q. Coordination of network protector and generator breaker opening times to detect arcing faults by heat detection system. A thermal detection system that opens all protective devices on a secondary (480 V) spot network upon detection of a fire, arcing fault or other abnormal event that generates heat above a prescribed threshold is necessary. Opening of the generator breaker prior to the network protectors within an acceptable margin must be ensured.

Possible solutions list:

1. Simplified interconnection process to spot networks for systems that have inverters that pass UL 1741, are <10kW, and have aggregate generating facility capacity less than 1/15 of customer's minimum load. Inadvertent operation of network protectors under normal (non-fault) conditions is highly unlikely for small, inverter-based DG. Hence, the Phase I Collaborative agreed to establish simplified interconnection procedures for DG applicants meeting these requirements.
2. Modify/Upgrade Network and Generator Protection Control Systems. Time coordinate the network protector using microprocessor type relays to ensure protectors will not operate due to power flow contributions from the Generator. A possible option is the use of time delays on the protector that will cause Generator relays to operate prior to the protector for low level faults or power flows. This option is designed to prevent network protectors from inadvertently tripping due to DG fault contribution. A related option is to time coordinate power flows on the network protector and isolate or reduce output from the DG whenever flows across the protector drop below a specified level. A similar option is to install a load totalizer on critical load buses and isolate the DG whenever reverse power flows occur on that bus. In all cases, the size of the Generator may need to be limited in order to maintain power quality. The preferred method of protection is to clear faults as quickly as possible in order to prevent additional damage and provide further protection to the public. Instituting an additional time delay in the protective function of network protectors will allow faults to exist for longer periods before they are cleared. A consideration of types of faults might be appropriate.
3. Network Upgrades and/or Expansion. Upgrade key network system components such as protectors or relays with modern devices designed to withstand the currents and voltages that may be produced by Generators. Upgrading the secondary network lines and equipment may prevent overloads. It may be possible to reconfigure or expand a grid network to obviate the need for dedicated facilities or mitigate the possibility of unintended reverse power flows on network protectors.
4. Secondary Network Fault Duty Current Assessment and Mitigation. The amount of potential short circuit current contribution from a DG installation must be viewed in context with the spot network to which it interconnects. In many cases, the short circuit current available from the utility system through network feeders may dwarf the potential contribution from the DG. For example, consider a spot network with three feeders (and network protectors) connected to a common bus. In the event of a fault on the primary side of the transformers, the network protector on that feeder would see the potential fault current available from the utility system through the remaining two feeders. The potential fault current from the DG would not be seen at the other two network protectors. The short circuit contribution of the DG may be significant for faults on or in the vicinity of the network bus. There are a number of solutions that may mitigate short circuit

current from exceeding the breaker fault duty and the ratings of the network protectors. For example, it may be possible to apply standard current limiting fuses to disconnect a customer's generation in less than 1 cycle as a means of mitigating breaker duty stress on the low-voltage breakers. Such an application would likely require negative sequence protection of the generator. For relatively small units (<500 kW), contactors can be substituted for breakers and can be opened in less than 2 cycles.

5. Mitigating Excessive Fault Duty on the Utility Substation Bus. In some systems the utility substation equipment may already be near its maximum fault duty capability. In such cases, even a modest addition of generation on the network grid may cause aggregate fault current to exceed breaker or other device ratings. Because the network protector tripping must be delayed to give time for the generator breaker(s) to clear, the substation breaker responsible for clearing the fault will see the DG fault contribution during its clearing time. Such conditions might be resolved by the addition of current limiting reactors to the feeders supplying the network with generation. However, the impact on power quality at the network bus would have to be reassessed.

## Annex G – Definitions and Terms

Participants reviewed the following definitions using IEEE Std C57.12.44 (2000) as a basis.

- The “OK” identifies definitions agreed upon by attendees as a starting point for use in P1547.6 document.
- The double underline identifies additional wording to C57.12.44 text agreed upon by P1547.6 attendees.
- It was later agreed that the NREL Report 38079 definitions would be further reviewed against the C57.12.44 definitions since the group having developed the NREL report have already used C57.12.44 definitions as well as other documents as a basis.

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### **3. Definitions** C57.12.44 (2000)

An asterisk (\*) following a definition indicates that the definition is identical to that which appears in IEEE Std 100 (1996), *IEEE Standard Dictionary of Electrical and Electronics Terms*.

#### **3.1 arcing contacts: OK**

The contacts of a switching device on which the arc is drawn after the main (and intermediate, where used) contacts have parted.\*

#### **3.2 desensitizing relay:**

A relay (or function) that prevents tripping of a network protector on transient power reversals, which neither exceed a predetermined value nor persist for a predetermined time.

#### **3.3 intermediate contacts: OK**

Contacts in the main circuit that part after the main contacts and before the arcing contacts have parted.\*

#### **3.4 main contacts: OK**

Contacts that carry all or most of the main current.\*

#### **3.5 network limiter: (cable limiter) OK**

An enclosed fuse for disconnecting a faulted cable from a low-voltage network distribution system and for protecting the unfaulted portions of that cable against serious thermal damage.\*

#### **3.6 network master relay: (revisit)**

A relay that functions as a protective relay by opening a network protector when power is backed into the supply system and as a programming relay by closing the protector in conjunction with the network phasing relay when polyphase voltage phasors are within prescribed limits.\*  
Network master relay (from NREL report for comparison to above): A poly-phase relay with two functions: (1) opening the network protector when power flow is from the low-voltage side to the high-voltage side of the network transformer and (2) closing the protector in conjunction with the network-phasing relay when transformer voltage is higher than network voltage and leads the network in phase angle. In most installations, the master relay is electromechanical, although microprocessor-based master relays are available for retrofit and new construction.

### **3.7 network phasing relay:**

A monitoring relay or function that has as its function to limit the operation of a network master relay so that the network protector may close only when the voltages on the two sides of the protector are in a predetermined phasor relationship.\*

Note. Not a synchronizing relay (see synchronizing relay).

### **3.8 network protector<sup>1</sup>:**

An assembly comprising a circuit breaker<sup>2</sup> and its complete control equipment for automatically disconnecting a transformer from a secondary network in response to predetermined electrical conditions on the primary feeder or transformer, and for connecting a transformer to a secondary network either through manual control or automatic control responsive to predetermined electrical conditions on the feeder and the secondary network.

NOTES —

1. The network protector is usually arranged to connect automatically its associated transformer to the network when conditions are such that the transformer, when connected, will supply power to the network and to automatically disconnect the transformer from the network when power flows from the network to the transformer.

2. Circuit breaker used in a network protector may or may not have fault closing capability.

### **3.9 network protector fuse: (revisit)**

A back-up device for the network protector.

#### 3.9 network protector fuse: (revisit)

A back-up device to clear faults on the source side of the network protector.

### **3.10 network secondary distribution system: (revisit)**

A system of alternating-current distribution in which the secondaries of the distribution transformers are connected to a common network for supplying light and power directly to consumers' services.

NOTE- This system may or may not include network protectors.

### **3.11 phasing voltage:OK**

The voltage across the open contacts of a selected phase.

NOTE—This voltage is equal to the phasor difference between the transformer voltage and the corresponding network voltage.\*

### **3.12 pumping: OK**

The unintentional cyclical tripping and closing of a network protector.

3.13 – deleted C57.12.44 definition for “removable breaker.

### **3.13 removable network protector:**

It consists of the circuit breaker, disconnecting provisions, network relays, auxiliary panels, current transformers, control devices, other attachments, and all interconnecting wiring, which can be rolled out of the network protector enclosure on rails for maintenance or removal.

### **3.14 short-time current: OK**

The current carried by a device, an assembly, or a bus for a specified short time interval.\*

### **3.15 shunt release (shunt trip): revisit**

A release energized by a source of voltage. NOTE—The voltage may be derived either from the main circuit or from an independent source.\*

**3.16 solid-state or microprocessor network relay:**

A relay with few or no mechanical parts, using solid-state components, that performs the combined functions of the master and phasing relays, and that may include a time delay function.

**3.17 spot network: revisit**

A ~~small~~ network, usually at one location, consisting of two or more primary feeders, with network units and one or more load service connections.

**3.18 trip-free: (revisit)**

The capability of a switching device to have the moving contacts return to and remain in the opening position when the opening operation is initiated after the initiation of the closing operation, even if the closing force and command are maintained.\*

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**The following are the definitions from NREL Report 38079 (for future consideration in relation to preceding definitions).**

**Cable limiter:** An enclosed fuse for disconnecting a faulted cable from a low-voltage network distribution system and protecting the unfaulted portion of that cable from serious thermal damage.

**(following is from C57.12.44 definition - to compare to Cable limiter above:**

**3.5 network limiter:** An enclosed fuse for disconnecting a faulted cable from a low-voltage network distribution system and for protecting the unfaulted portions of that cable against serious thermal damage.\* )

**Cycling:** Undesirable cyclical tripping and closing of a network protector because of external (load) conditions.

**Grid network:** A secondary network system with geographically separated network units and the network-side terminals of the network protectors interconnected by low-voltage cables that span the distance between sites. The low-voltage cable circuits of the grid networks are typically highly meshed and supplied by numerous network units. Also referred to as area network or street network.

**Isolated network:** A network served by primary feeders that do not have alternative sources. Also used to describe a type of spot network that does not have a tie to the adjacent distributed network rated equal to the capacity of one of the network units.

**Network master relay:** A poly-phase relay with two functions: (1) opening the network protector when power flow is from the low-voltage side to the high-voltage side of the network transformer and (2) closing the protector in conjunction with the network-phasing relay when transformer voltage is higher than network voltage and leads the network in phase angle. In most installations, the master relay is electromechanical, although microprocessor-based master relays are available for retrofit and new construction.

**Network protector fuse:** A backup protective device for the network protector.

**Network protector:** An assembly composed of a circuit breaker and its complete control equipment for automatically disconnecting a transformer from a secondary network in response to predetermined electrical conditions on the primary feeder or transformer and for connecting a transformer to a secondary network through manual or automatic control responsive to predetermined electrical conditions on the feeder and the secondary network. The network protector is usually arranged to automatically connect its associated transformer to the network when conditions are such that the transformer, when connected, will supply power to the network and to automatically disconnect the transformer from the network when power flows from the network to the transformer (from IEEE C57.12.44-2000).

**Network system:** A collection of spot networks, secondary grid networks, or combinations of such networks and the primary feeders that supply them.

**Network transformer:** A transformer designed for use in a vault to feed a variable capacity system of interconnected secondaries. A network transformer may be submersible or vault. It usually, but not always, has a provision for attaching a network protector (from IEEE C57.12.80-1978). Dry transformers are also used for spot network applications.

**Network unit:** A network unit consists of a primary disconnect and grounding switch, a network transformer, and a network protector.

**Primary network feeder:** A feeder that supplies energy to a network system or the combination of a network system and other radial loads.

Dedicated primary network feeders are feeders that supply only network transformers for the grid network, the spot network, or both. Non-dedicated primary network feeders, sometimes called combination feeders, are feeders that supply both network transformers and non-network load.

**Pumping:** The rapid, uncontrolled, unintentional, and intolerable repetitive tripping and closing cycle of a network protector, normally because of a failure in the network protector control circuitry.

**Secondary network:** The low-voltage circuits supplied by the network units (the network transformer and its associated network protector). Unless specifically excepted, in this document, any reference to “the network” means the secondary network.

**Secondary network system:** An AC power distribution system in which customers are served from three-phase, four-wire low-voltage circuits supplied by two or more network transformers whose low-voltage terminals are connected to the low-voltage circuits through network protectors. The secondary network system has two or more high-voltage

primary feeders, with each primary feeder typically supplying 1–30 network transformers, depending on network size and design. The system includes automatic protective devices intended to isolate faulted primary feeders, network transformers, or low-voltage cable sections while maintaining service to the customers served from the low-voltage circuits.

**Spot network:** A secondary network system consisting of two or more network units at a single site. The low-voltage network side terminals of these network units are connected together with bus or cable. The resulting interconnection structure is commonly referred to as the paralleling bus or collector bus. In spot networks, the paralleling bus does not have low-voltage ties to adjacent or nearby secondary network systems. Such spot networks are sometimes called isolated spot networks to emphasize that there are no low-voltage connections to network units at other sites.

**Spot network with reach:** A spot network with low-voltage cables that reach to connect to one or more similar spot networks or with low-voltage cables that connect to a nearby grid network.

**Underground connectors:** Underground connectors in manholes and transformer vaults that provide for multiple connections at a single junction point.

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## Annex H – Information Resources

The following information resources are available via the contacts listed below.

- IEEE 100, The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition, New York, Institute of Electrical and Electronics Engineers, Inc.
- IEEE Std C37.108-1989 (R2002), IEEE Guide for the Protection of Network Transformers.
- IEEE Std C57.12.44-2000, IEEE Standard Requirements for Secondary Network Protectors.
- "Network Distribution Systems Background and Issues Related to the Interconnection of Distributed Resources" NREL/TP-560-38079  
Available electronically at <http://www.osti.gov/bridge>  
Scope and Purpose.
  - This document addresses the technical considerations associated with the interconnection of Distributed Energy Resources (DER) to network distribution systems. It provides an overview of the characteristics of various distribution systems and interconnection requirements, and identifies unique issues that are specific to network interconnections.
  - The purpose of this document is to identify the network specific interconnection issues for which test protocols should be developed, and to assist in the design of the test facility and development of test plans. Finally, recommend criteria and requirements for interconnection of DER with network distribution systems is presented.
- Massachusetts Electric Company and Nantucket Electric Company -- interconnection compliance tariff  
Contact: John Bzura.
  - Massachusetts interconnection reports and activities: Contact: Jim Watts  
E.g., "Generation Monitoring at the GSA Williams Building And Modeling of Feeder Fault Cases Recorded For Massachusetts Technology Collaborative" By William E. Feero, W. E. Feero, PE, 110 Barrville Mtn Rd, Reedsville, PA 17084
  - PG&E Bulletin: Contact M. Vaziri. "(Draft) Secondary Spot Network System Requirements For Distributed Generation Interconnection"