

# Distributed Wind Impacts Project Status

---

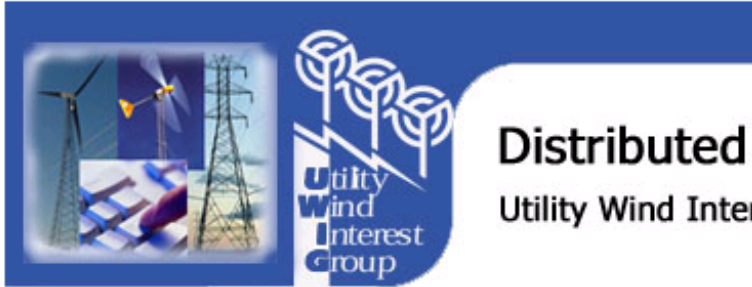
Roger C Dugan  
Electrotek Concepts  
October 23, 2003

UWIG Distributed Wind Impacts Project - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address <http://www.uwig.org/uwigdistwind/>



## Distributed Utility Wind Interest Group

**About the Project Team**

[About the Utility Wind Interest Group](#)  
[About Electrotek](#)

**About the Project**

[Introduction](#)  
[Project Scope and Deliverables](#)

**For More Information**

[Contact Us](#)

**Members Login**

**About This Project**

Recognizing the emerging popularity of wind as a distributed generation application, the Utility Wind Interest Group has organized this effort to assess the impacts of small-scale wind generation on utility distribution networks. Electrotek Concepts®, who provides technical support services to UWIG, is conducting the project

This project's primary goal is the development of a set of tools to aid utility distribution and planning engineers in analyzing wind generation at the distribution system level. The tools consist of technical information resources and a set of engineering software application tools.

Project deliverables include this study web site, the analytical applications, IEEE 1547 Application Guide, Wind-Specific Flicker Application Guide, case studies, and other resources.

## Project Website Intro Page

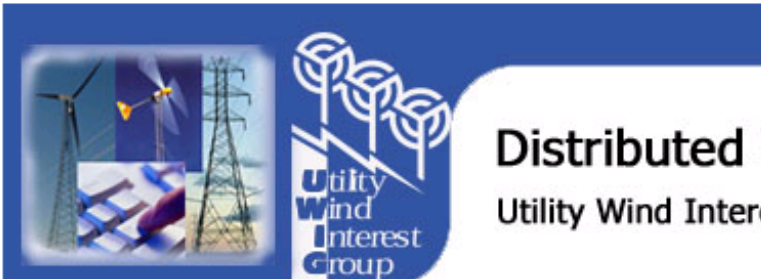
Open to anyone and provides overview of the project and description of deliverables. To access the members only area, click "Members Login".

UWIG Distributed Wind Impacts Project - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address <http://www.uwig.org/uwigdistwind/UWIGDistWindHome.htm>



**Distributed Utility Wind Interest Group**

Log

- Send e-mail to [Karen Lane](#) to request account credentials.

**Project Progress Reports**

- [Feb 2003](#)
- [Nov 2002-Jan 2003](#)

**Project Mailing List**

- [Subscribe to project mailing list.](#)
- [Send email.](#)

area will be added as the development is completed. Note that areas 3 and 4 are not currently in

<p><u><a href="#">I. General Interconnection Application Guide</a></u></p> <ul style="list-style-type: none"> <li>A. IEEE 1547 Application Guide</li> <li>B. Overcurrent Protection Evaluator</li> </ul>	<p><u><a href="#">III. Existing Distributed Wind Case Studies</a></u></p> <ul style="list-style-type: none"> <li>A. Distributed Wind Case Studies</li> <li>B. Distributed Wind Economic Screen</li> </ul>
<p><u><a href="#">II. Detailed Flicker Application Guide</a></u></p> <ul style="list-style-type: none"> <li>A. Flicker Application Guide</li> <li><u><a href="#">B. Voltage Profile Simulator</a></u></li> <li><u><a href="#">C. Wind Turbine Flicker Calculator</a></u></li> </ul>	<p><u><a href="#">IV. Distributed Wind Turbine Monitoring</a></u></p> <ul style="list-style-type: none"> <li>A. Distributed Wind Measurement Dat</li> <li>B. Special Measurement Analysis Rep</li> </ul>

© 2003 Electrotek Concepts, Inc. All Rights Reserved.

Internet

## Members-Only Main Page

Provides access to all project deliverables including software applets. To access the Voltage Regulation applet, click the “Voltage Profile Simulator” link.

## Voltage Profile Simulator Page

Click on feeder one-line components to set parameter values. Click "Voltage Profile" button to run simulation and obtain results for specified circuit and generator output profiles.

The screenshot shows a web browser window titled "Voltage Profile Simulator - Microsoft Internet Explorer". The address bar displays the URL: <http://www.uwig.org/uwigdistwind/Flicker/VoltageProfile>. The page content includes the "Utility Wind Interest Group" logo and the title "Voltage Profile Simulator". Navigation links for "Log Out", "danb", and "Help" are visible. The main area features a single-line circuit diagram with a generator on the left, a transformer, a capacitor, a tap changer, another transformer, another capacitor, and a load on the right. Below the diagram, there are input fields for "Time Step Size" (1 sec) and "Number of Steps" (2400). Two buttons, "Voltage Profile" and "Flicker", are present. At the bottom, there are four output fields: "B Max" (1.0583), "A Max" (1.05), "A Min" (0.975), and "B Min" (0.95). The browser's status bar at the bottom shows the URL <http://www.uwig.org/uwigdistwind/LWIGDistWindHome.htm> and the "Internet" icon.

## Generator Parameter Input Page

Specify parameters for distributed generator by selecting “Generator Type” and “Generator Profile”, as well as specifying other input parameters. Note that similar data input is required for other circuit parameters.

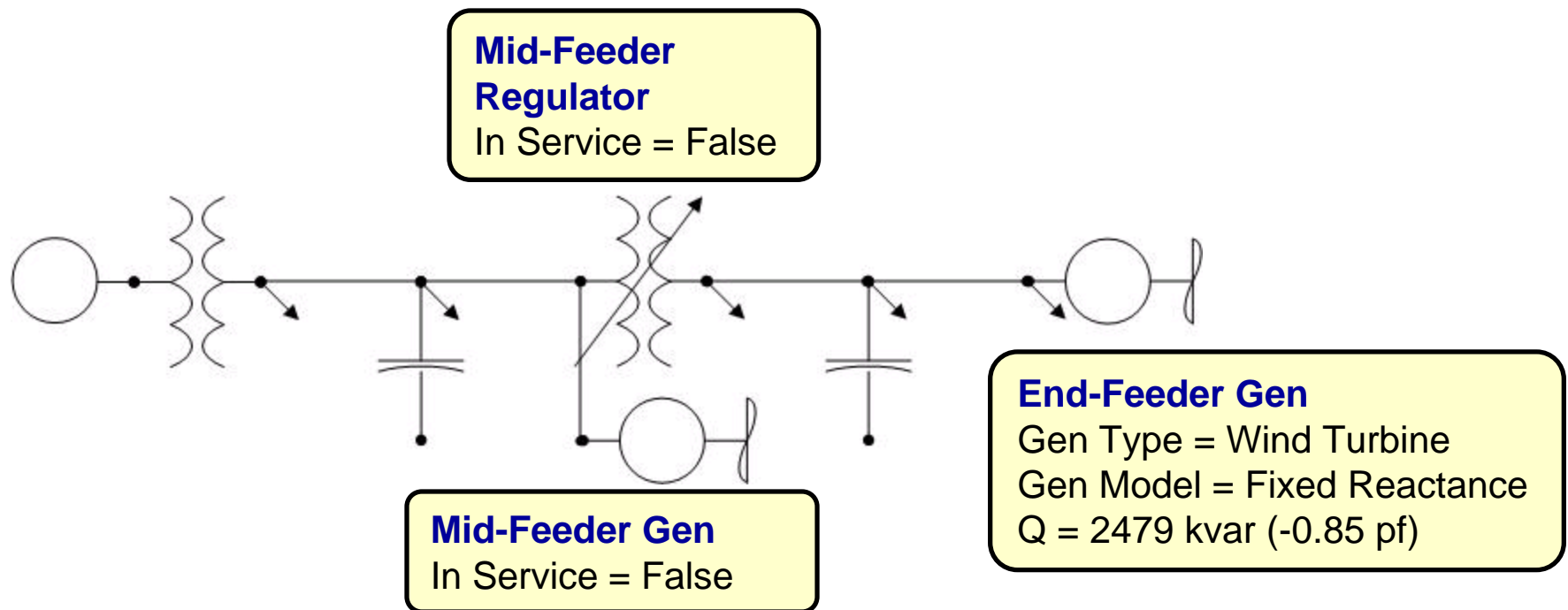
The screenshot shows a web browser window titled "Voltage Profile Simulator - Microsoft Internet Explorer". The address bar displays "http://www.uwig.org/uwigdistwind/Flicker/VoltageProfile". The page header includes the "Utility Wind Interest Group" logo and navigation links for "Log Out" (danb) and "Help". Below the header are "OK" and "Cancel" buttons. The main content area is titled "Generator.WindGen2" and contains the following fields and options:

- Flicker Data** (tab)
- In Service
- Max. Output:  kW
- Power Factor:
- Q:  kvar
- Generator Type:
- Generation Profile:  (dropdown menu is open showing: Wind2400, OneTurbine, FiveTurbines, ElevenTurbines, On-Off-On, Off-On-Off)
- Radio buttons:  Constant PF,  Fixed Q,  Fixed Reactan
- Text: For an induction machine, specify a fixed reactance model and enter a negative value.

The browser's status bar at the bottom shows "Done" and "Internet".

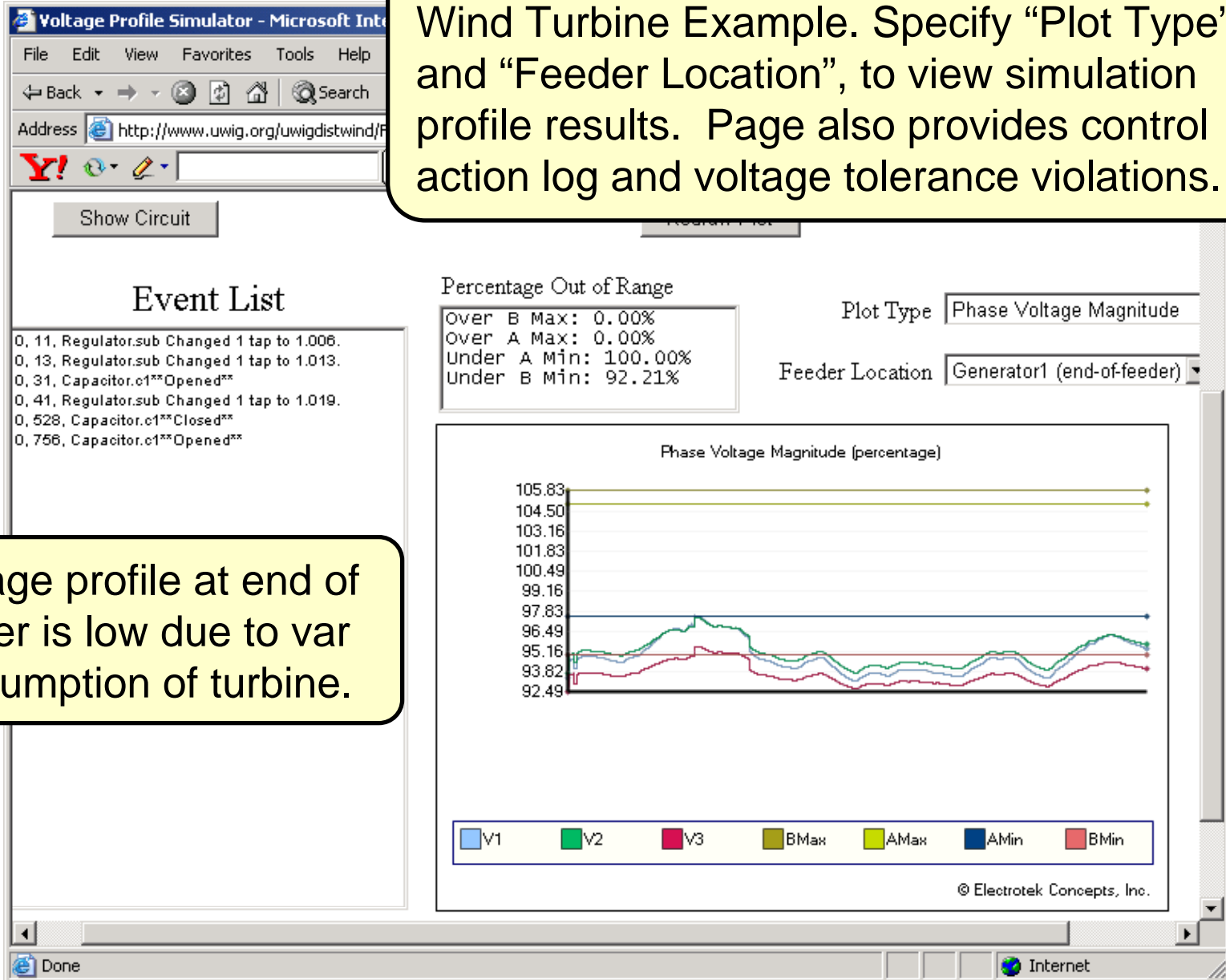
# Wind Compensation Example

Let's alter the circuit model to look at a potential voltage regulation issue associated with compensation of a wind turbine at the end of a 8-mile feeder.



## Voltage Profile Results Page

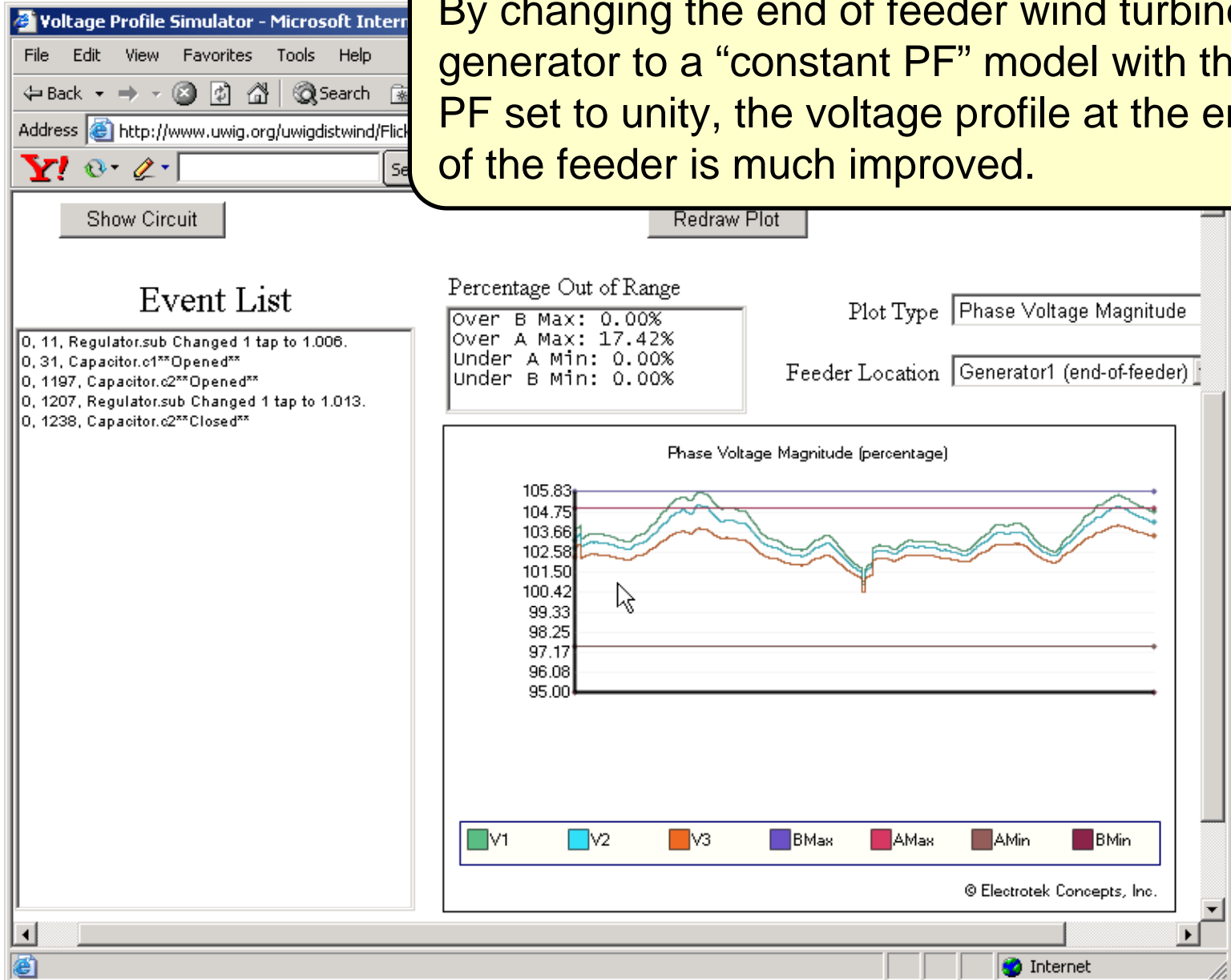
Wind Turbine Example. Specify "Plot Type" and "Feeder Location", to view simulation profile results. Page also provides control action log and voltage tolerance violations.



Voltage profile at end of feeder is low due to var consumption of turbine.

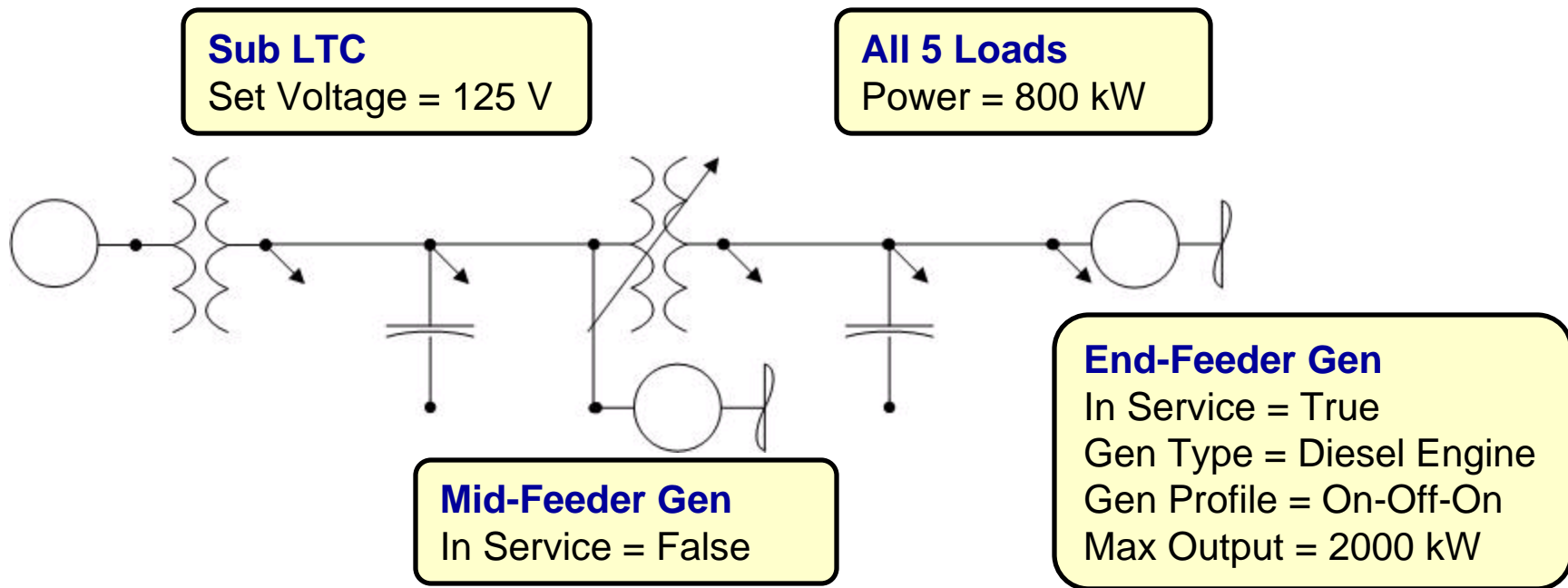
## Wind Turbine Compensation Example

By changing the end of feeder wind turbine generator to a “constant PF” model with the PF set to unity, the voltage profile at the end of the feeder is much improved.



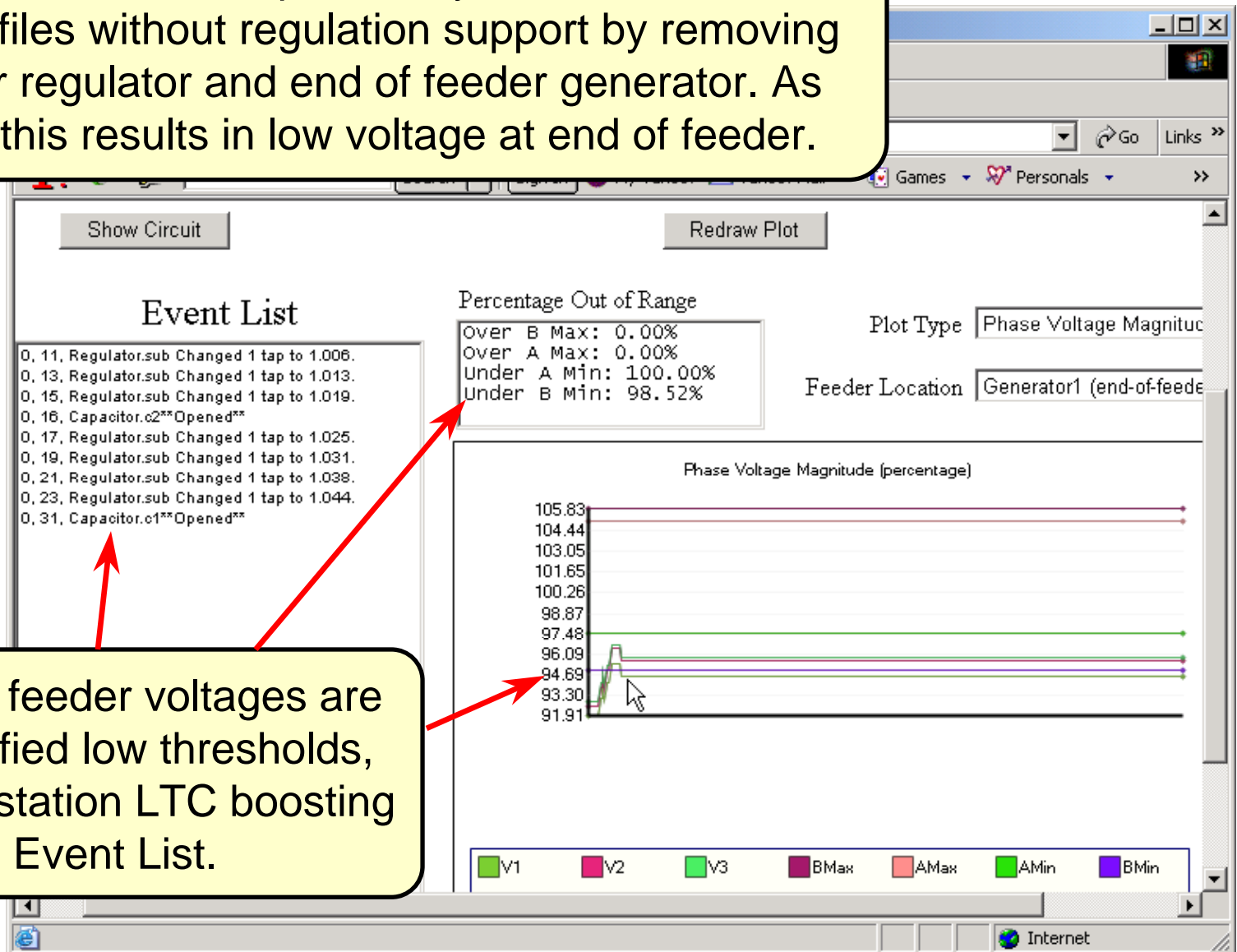
# Diesel On-Off-On Example

Let's alter the circuit model to look at a potential voltage regulation issue associated with a diesel engine at the end of a 8-mile feeder.



## Baseline Circuit Profiles

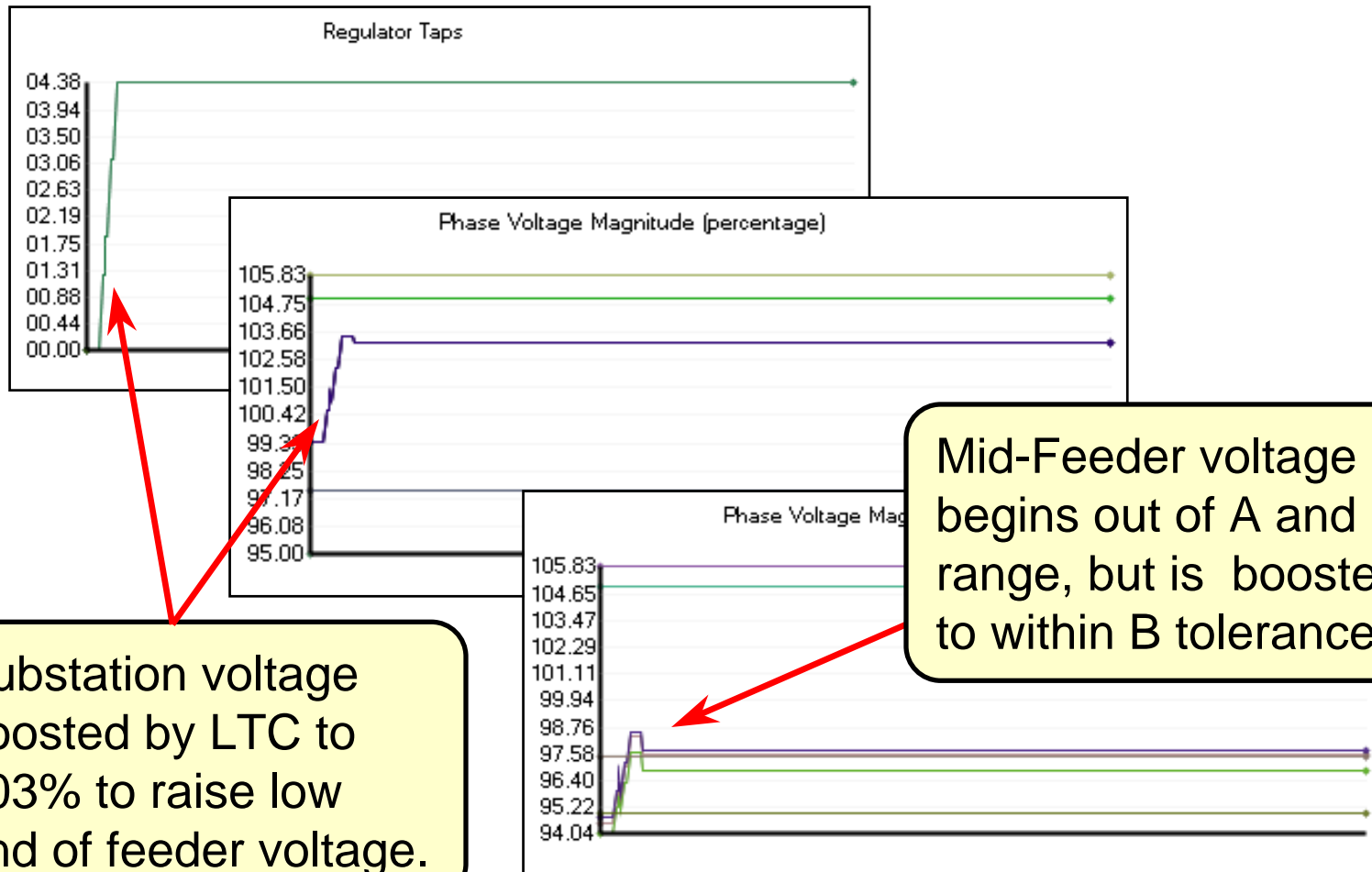
For the circuit described previously, we can look at feeder profiles without regulation support by removing mid-feeder regulator and end of feeder generator. As expected, this results in low voltage at end of feeder.



Note end of feeder voltages are below specified low thresholds, despite substation LTC boosting as shown in Event List.

## Baseline Circuit Profiles, (cont.)

Voltage profiles across the remainder of the feeder and the substation LTC tap changes.

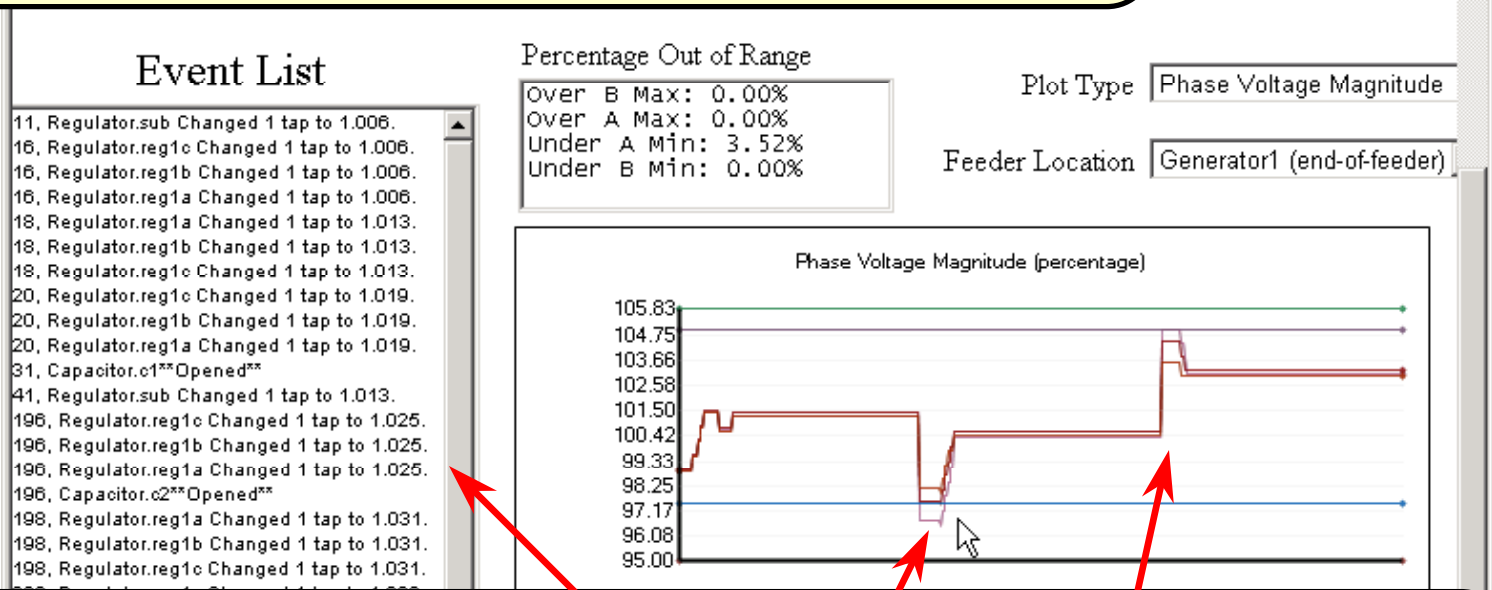


Substation voltage boosted by LTC to 103% to raise low end of feeder voltage.

Mid-Feeder voltage begins out of A and B range, but is boosted up to within B tolerance.

## Baseline Circuit Profiles

Once we add the mid-feeder regulator and end of feeder generator, the substation LTC can be backed down to 122 V. When the end of feeder generator trips out, there are some voltage variations, but not overly extreme.



With generator at rated output, mid-feeder regulator still boosts to get voltage to approx 100%. When generator drops, voltage drops below A limit on one phase until regulator boosts further. When Gen comes back online, voltage jumps to A limit until Regulator bucks.

# Overcurrent Protection Applet

---

- ◆ Prototype Windows Applet has been developed
- ◆ Not yet available on the Internet site
- ◆ For screening the impact on DG on typical radial system overcurrent protection
- ◆ Examples of capabilities from prototype ...

# Main Screen

**Electrotek Wind Farm Interaction Simulation Program**

File Edit View

*ELECTROTEK WIND GENERATOR - OVERCURRENT COORDINATION PROGRAM*

Circuit Plots

Time Step: 0.0833 sec

No. Steps: 100

Fault: B3, 0.0001

**GO** Solve

**STOP** QUIT

**Source**

Transmission: 115 kV, 1.05 pu, 20000 MVA

Substation: D/Y, 115/12.47, 20000 kVA, 7%

**Generator**

Tg: Y/Y, 12.47/0.48, 1500 kVA, 5%

Multi-Function Relay (MFR):

Gen: 1200 kW, 1.000 PF, 1500.000 kVA, Induction

**Lines**

L1: 336matrix, 10  
 L2: 336matrix, 10  
 L3: 336matrix, 10  
 L4: 336matrix, 10  
 L5: 336matrix, 3  
 L6: 336matrix, 10  
 L7: 336matrix, 10

**Reclosers**

Rec1: 1a3d, 280 A  
 Rec2: 1a3d, 200 A

**Breakers**

CB1: 800A phs, 800A grd.  
 CB2: 800A phs, 800A grd.

**Capacitors**

C1: 600 kvar, 12.47 kV  
 C2: 600 kvar, 12.47 kV  
 Cg: 600 kvar, 0.48 kV

**Fuses**

F1: 65 A, klink  
 F2: 65 A, Tlink

Electrotek Wind Farm Interaction Simulation

File Edit View

ELECTROTEK WIND GENERATOR OVERCURRENT COORDINATION PROGRAM

Circuit Plots

Time Step: 100

No. Steps: 100

Fault: B3, 0.0001

GO Solve

STOP QUIT

Reclosers:  
Rec1: 1a3d, 280 A  
Rec2: 1a3d, 200 A

Breakers:  
CB1: 800A phs, 800A grd.  
CB2: 800A phs, 800A grd.

Fuses:  
F1: 65 A, klink  
F2: 65 A, Tlink

Source:  
Transmission: 115 kV, 1.05 pu, 2  
Substation: D/Y, 115/12.47, 200

Generator:  
Tg: Y/Y, 12.47/0.48, 1500 kVA  
Multi-Function Relay (MFR):  
Gen: 1200 kW, 1.000 PF, 1500.000 kVA, 1500.000 kVA, 1500.000 kVA

Cq: 600 kvar, 0.48 kV

**Apply a temporary SLG Fault at B7**

**Recloser 1 has Fast Trip**

**Fault Dialog**

Fault Location (bus): B3

Fault Resistance: B1 B2 B3 B4 B5 B6 B7 Bg

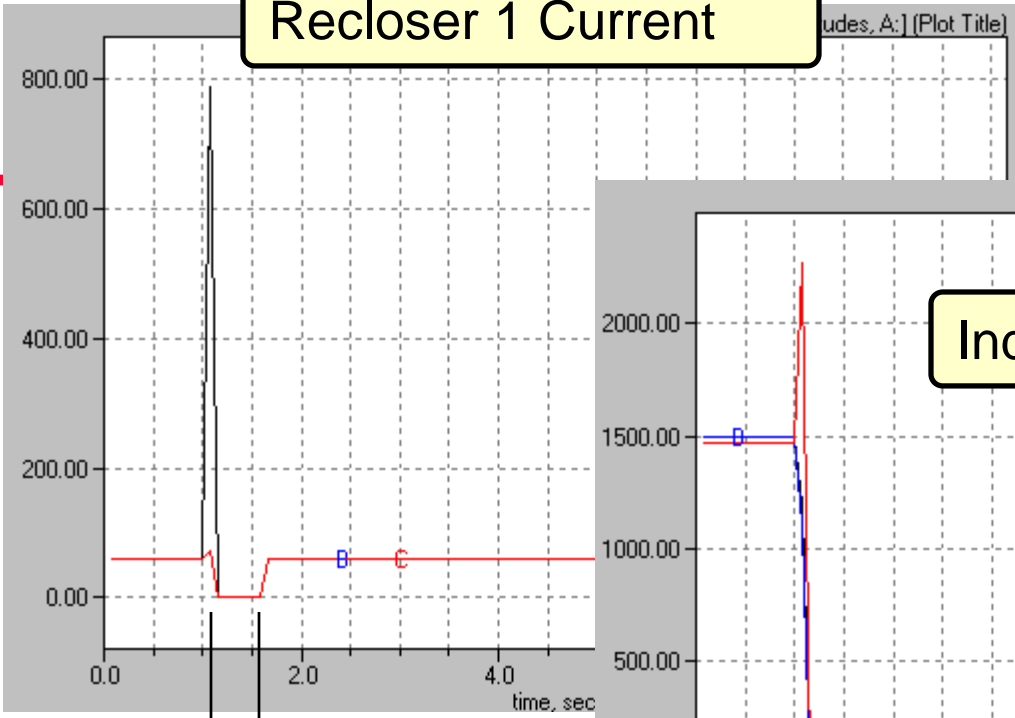
Fault Initiation time: hms sec

Fault Clearing:  
 Temporary  
 Permanent

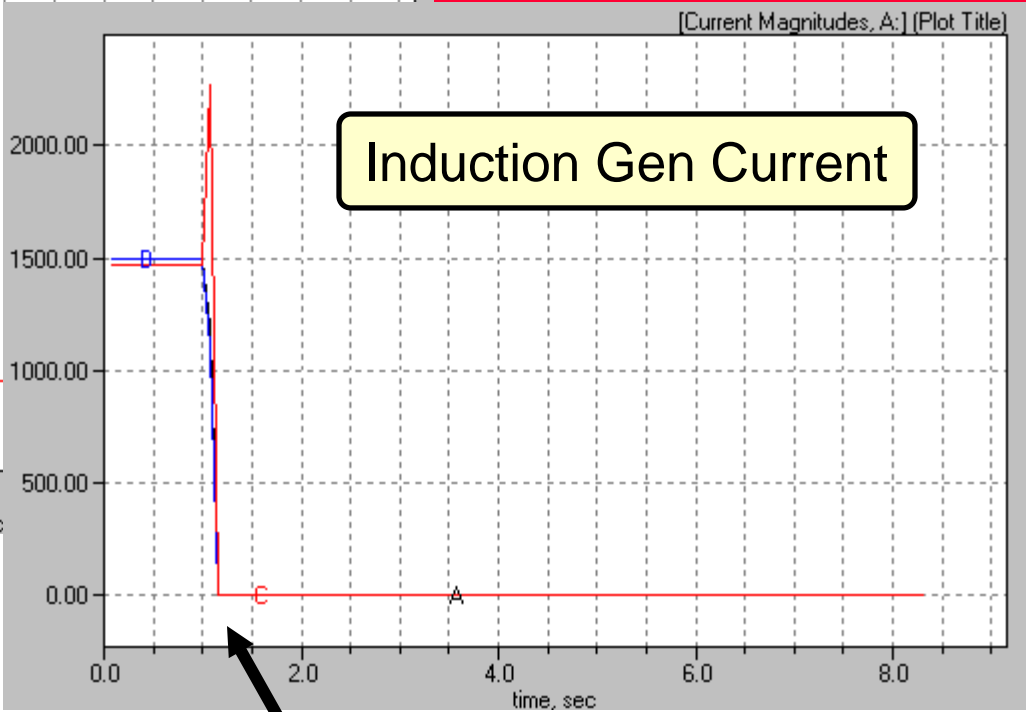
LL  
 LLG  
 3 Phase

OK Cancel

Recloser 1 Current



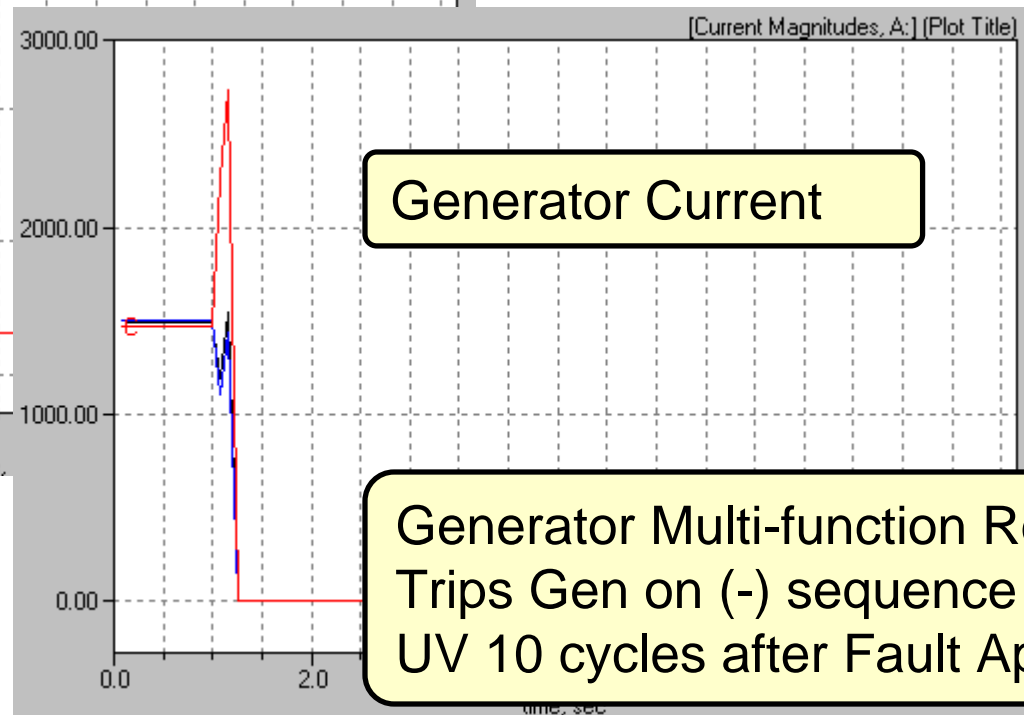
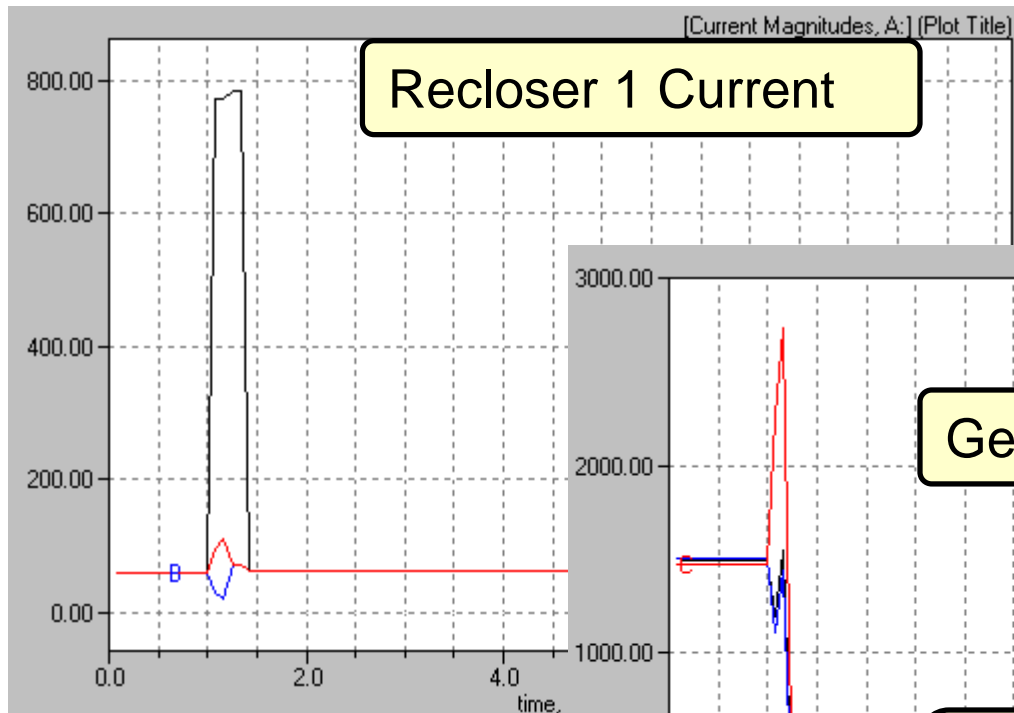
Induction Gen Current



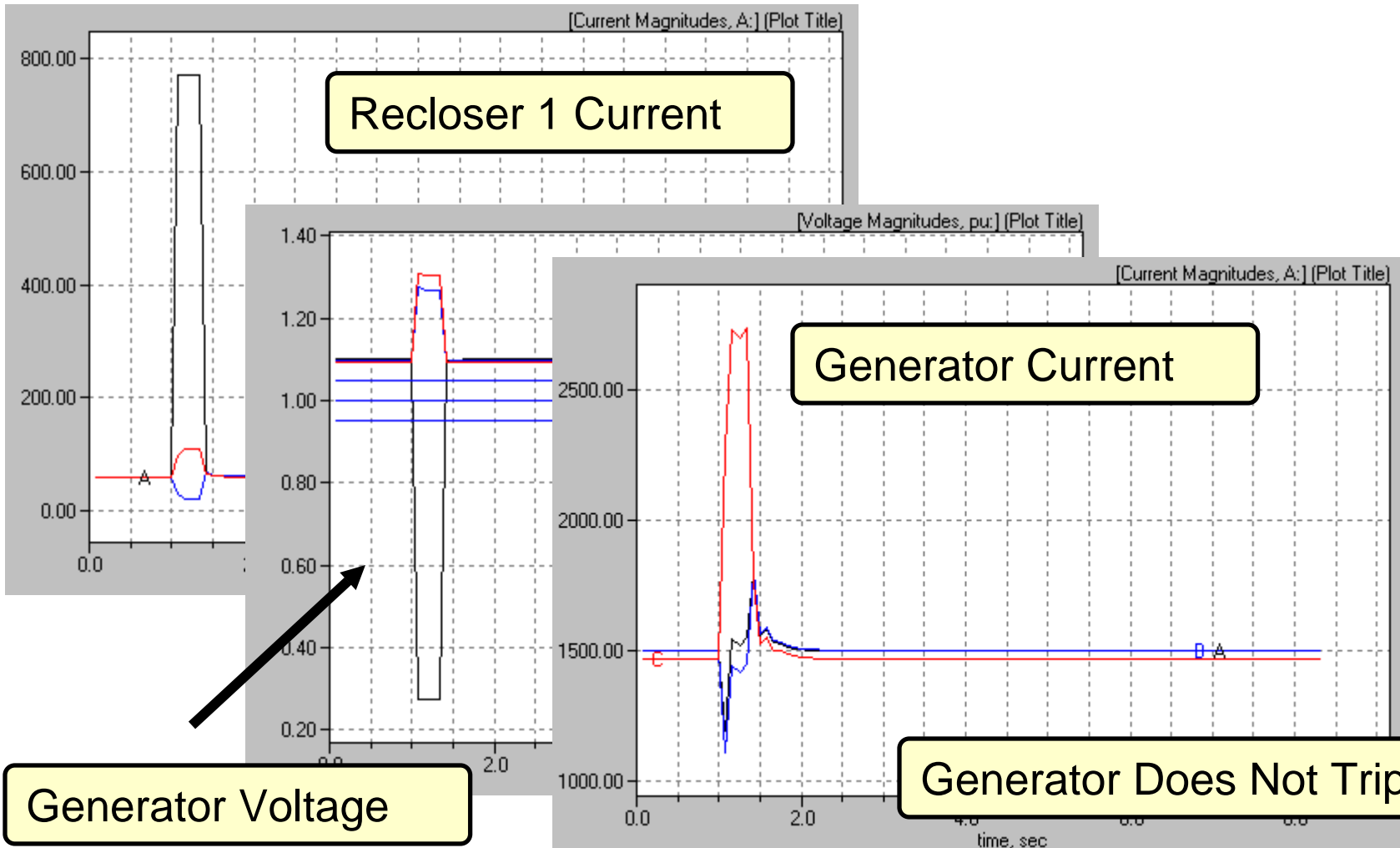
Reclose Interval

Generator Multi-function Relay  
Trips Gen on UV After Recloser  
Opens

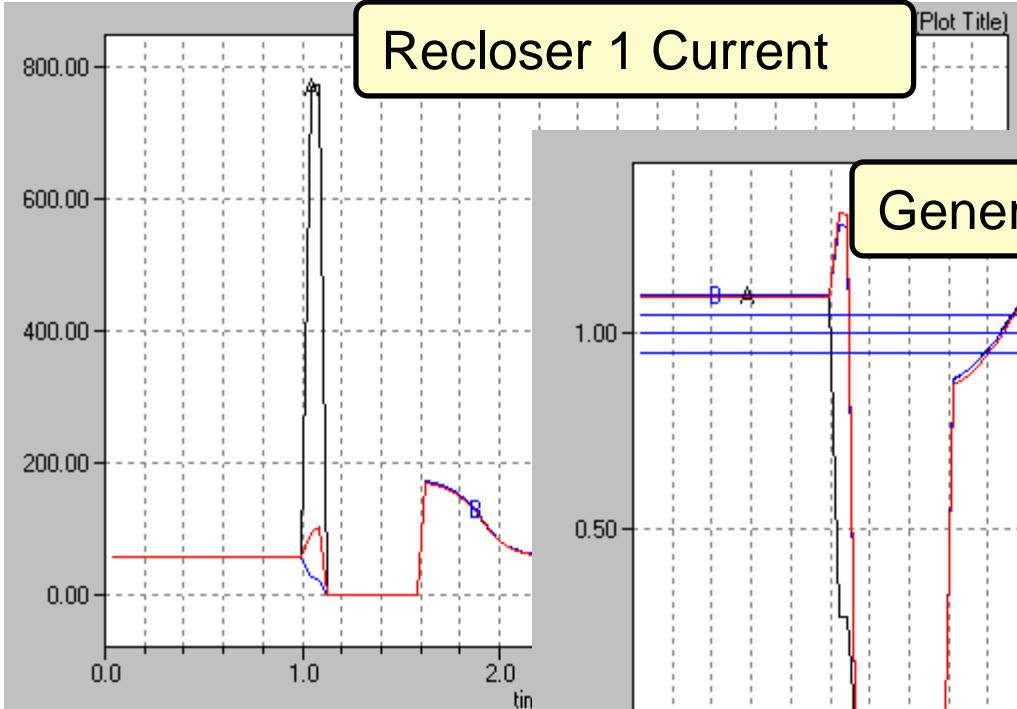
## Remove Fast Trip on Recloser 1 ...



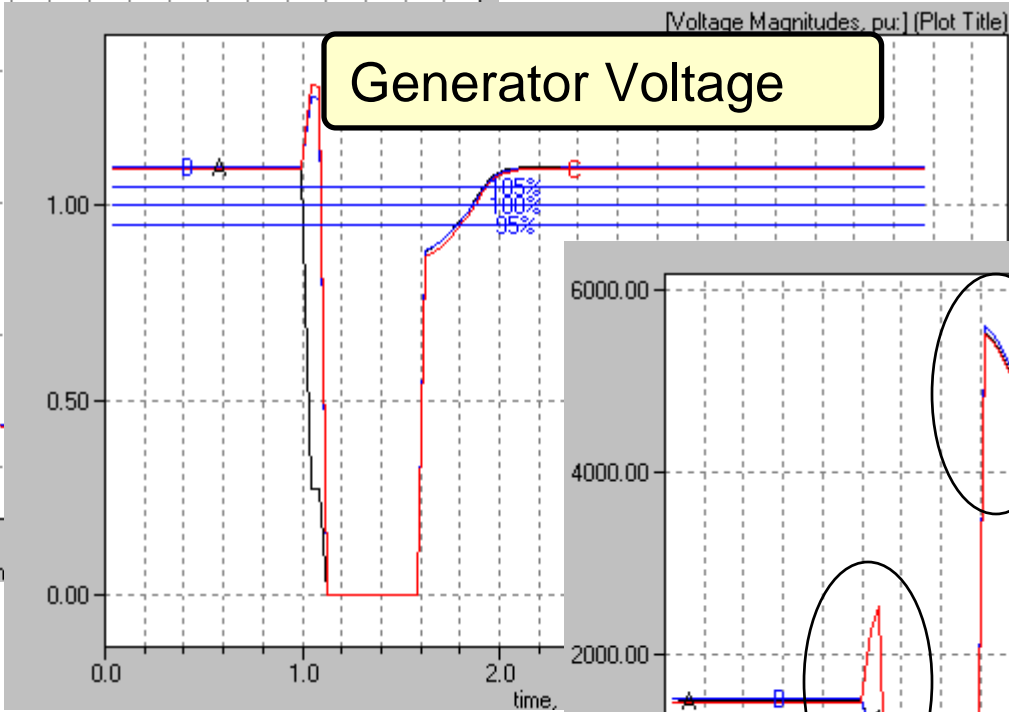
# Desensitize Gen relay ...



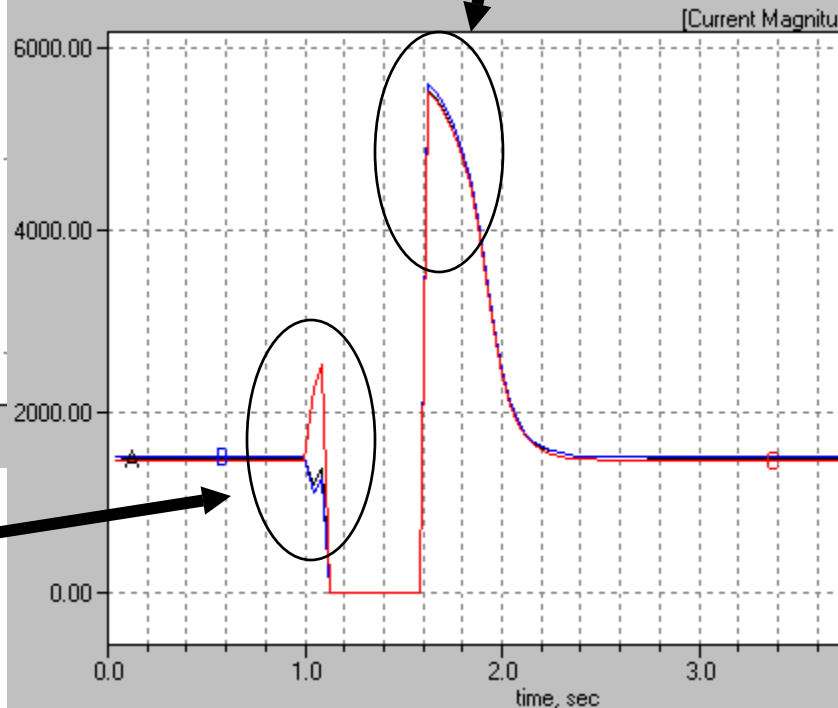
# Induction Gen Fails to Disconnect Through Reclose ...



Recloser 1 Current



Generator Voltage



Generator Fault Contribution

Generator Inrush after Reclose