
# "Distributed Utility Integration Test"

**Subcontract Number: ZAT-3-32616-03**

Distributed Utilities Associates

**Susan Horgan**
**Bill Erdman**
**Chuck Whitaker**

## Electric Distribution Transformation Program

**2004 Annual Program and Peer Review Meeting,**
**October 28-30, 2003, Coronado (San Diego), California**

# Goal

- **The Goal of the DUIT Project is to advance the state of the art in distributed generation and storage integration practices and strategies**
  - **Accelerate the market growth of DER**
  - **Leading to lower ratepayer cost of service**
  - **Improve energy service, quality and reliability**

# The Objectives of the DUIT project are:

- **To measure the interaction between DER and the distribution system and define metrics to quantify the benefits of the integration of diverse distributed generation and storage technologies in a distribution system**
- **to provide a testing ground for observing and measuring the interactions among the distributed technologies on the distribution system.**
- **to make the results of such credible activities publicly available**

(*Evaluate electrical implications from the high penetration and diversity of distributed resources on the utility distribution system*

- *Examine large numbers of units*
- *Examine diverse technologies*
- *Examine diverse situations)*

## Statement of the Problem

- End-users are expecting traditional and emerging technologies can interconnect to the utility distribution system and all work together seamlessly, to provide the desired mixture of benefits
- Utilities are concerned about the effects of diverse DER and levels of penetration on the distribution system. Some utilities are also seeking evidence that DER can be used to improve system operation and lower the cost of electric service
- Technology developers expect DUIT to provide a vehicle for demonstrating the ability to interconnect and interoperate, and the safety, reliability, and other benefits of their equipment to endusers, utilities and regulators. Confidence by these bodies would potentially remove significant barriers to the wide-scale adoption and implementation of DER technologies
- Regulators require confidence as they consider adopting standardized interconnection procedures and seek evidence that DER can be used to improve distribution system operation and lower the cost of electric service, whether owned or operated by utilities, customers, or third parties

# Approach

- Develop team
- Design and build a facility
- Develop testing regimen
  - Build consensus and prioritize tests
- Collect data
- Analyze data
- Present results

# Collaboration and Leveraging

## (DUIT) Participants

*Capstone Turbine*
Caterpillar
*California Energy Commission*
*Cummins*
*Distributed Utility Associates*
Encorp
*Endecon Engineering*
EPRI
Exelon (PECO)
GE
Magnetek
*NREL/DOE*
Powerlight
*PG&E*
Salt River Project
San Francisco PUC
*SMA*
*SMUD*
Solar Turbines
Southern Company
Texas PUC
United Technologies
*Underwriters Labs*
*Xantrex*

# Progress to Date

- Test Plan 08/2002
- 2003 Based on Cost Shared Activities
- Facility Dedication 08/2003
- Anti-Islanding Testing 09/2003

# DUIT Test Plan Protocols

Each protocol represents multiple tests across DR devices

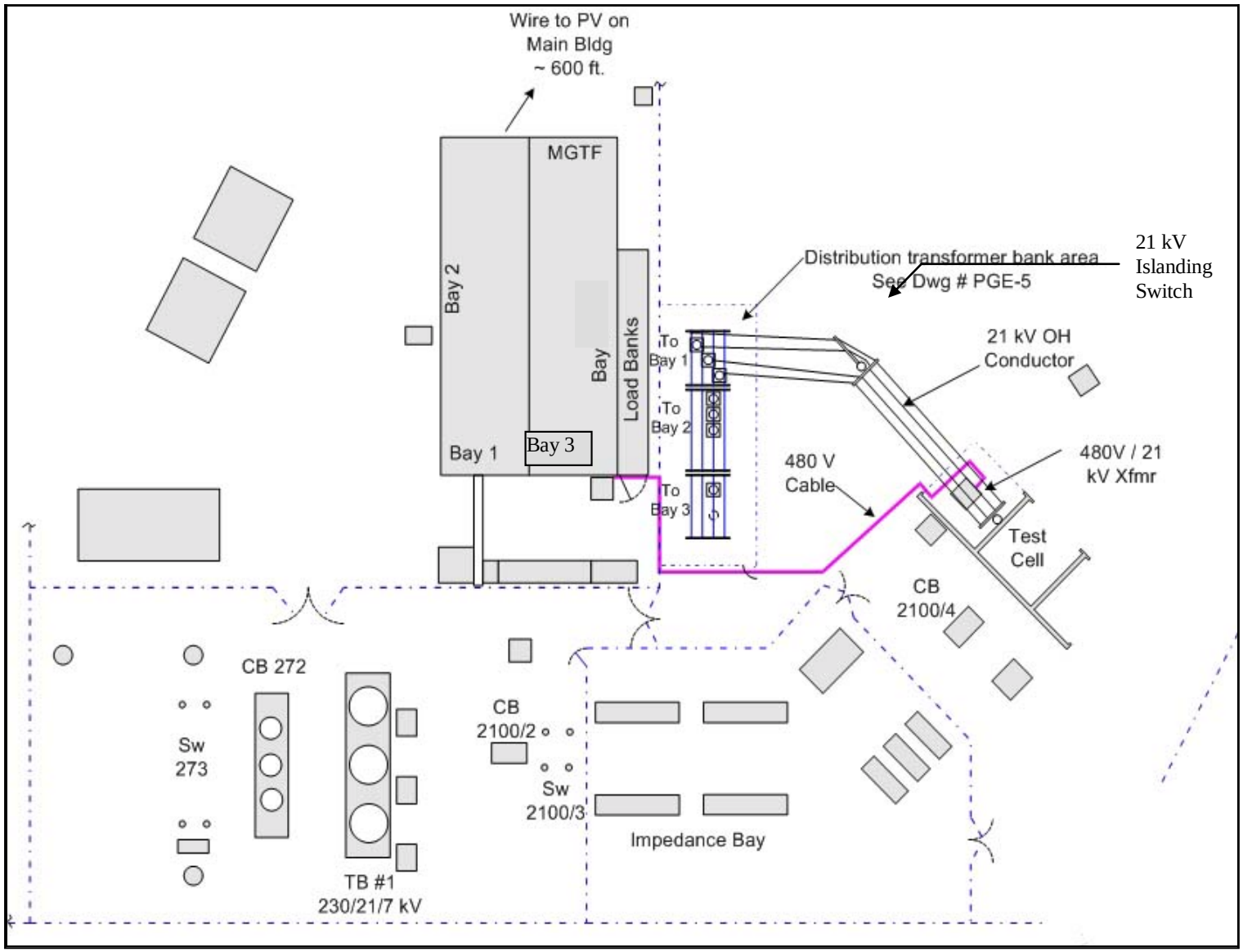
**Abnormal Conditions**
**Adjacent Feeder Faults**
***Anti-islanding***
**Capacitor Switching**
**Cold Load Pick-up**
**Control Strategies**
**Fuse Coordination**
**Network Systems**
**Power Quality**
**Reclosing Coordination**
**Synchronization**
**Short Circuit Current**
***Stability***
**Substation Backfeed**
**Sectionalizer Test**
***Voltage Regulation***

***Anti-islanding tests identified as having highest priority for Phase 1 of the DUIT testing***

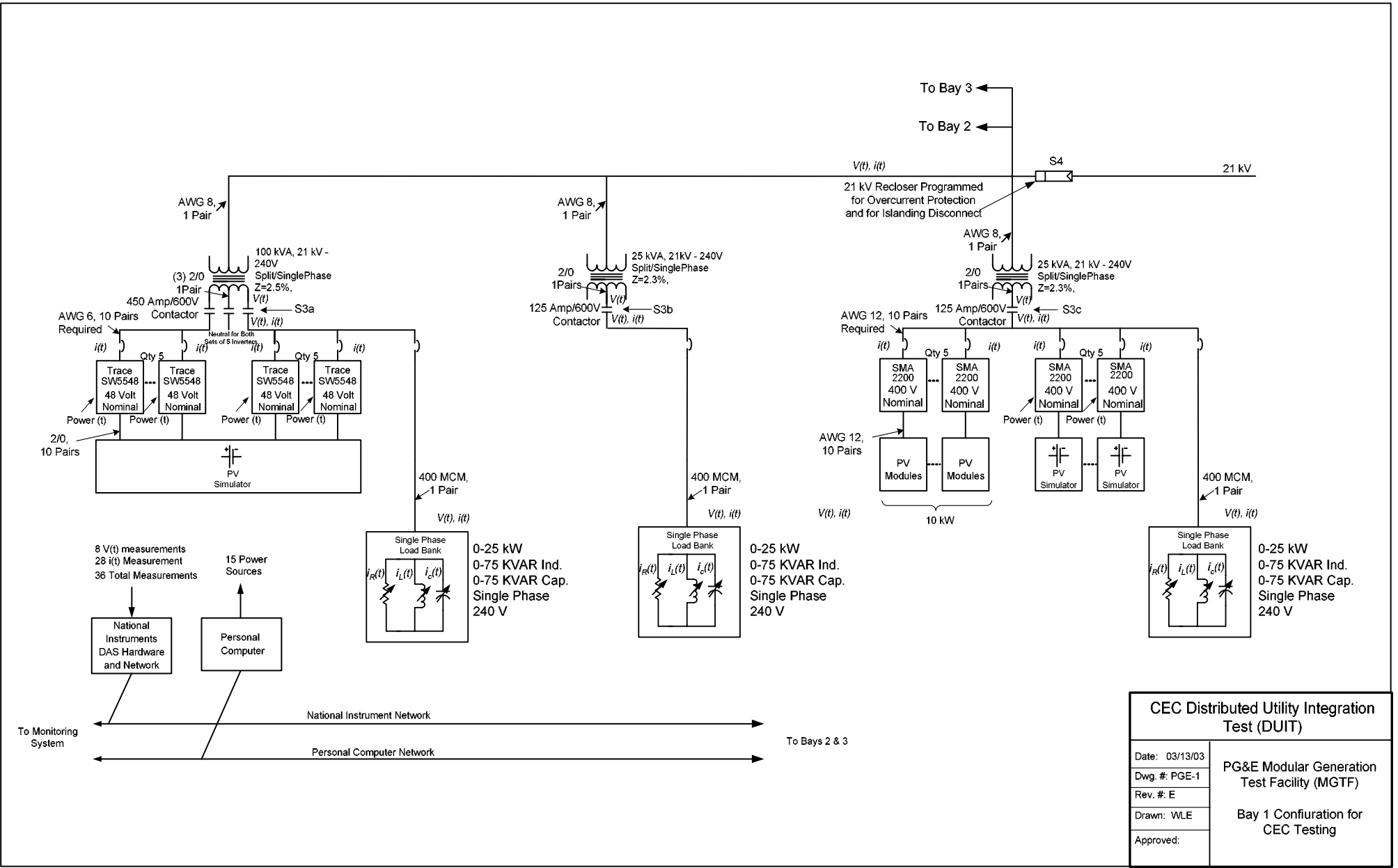
# The MGTF Building

# High Current Yard

# DUIT Test Facility - General Layout



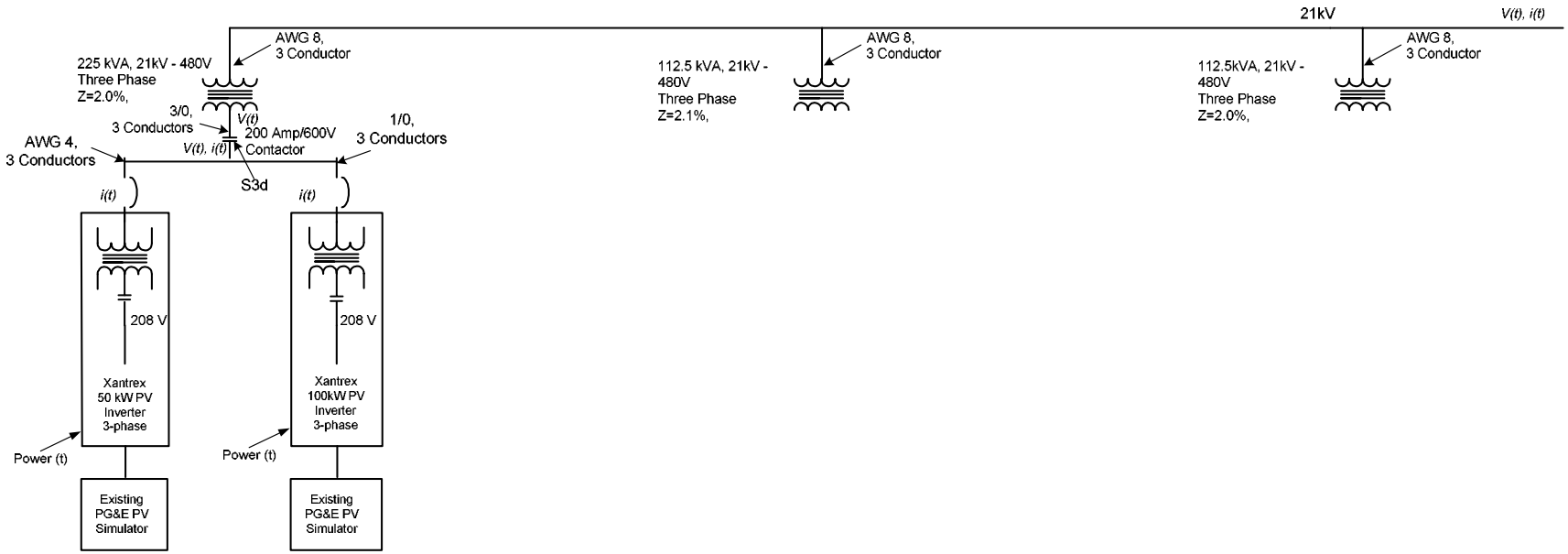
# Bay 1

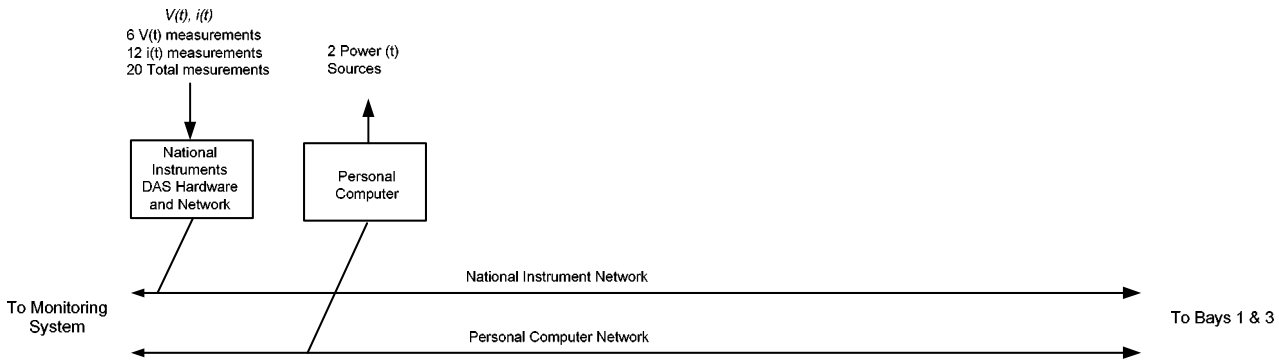



| CEC Distributed Utility Integration Test (DUIT) | |
|---|---|
| Date: 03/13/03 | PG&E Modular Generation Test Facility (MGTF) |
| Dwg. #: PGE-1 | |
| Rev. #: E | |
| Drawn: WLE | Bay 1 Confiuration for CEC Testing |
| Approved: | |

# View of Bay 1

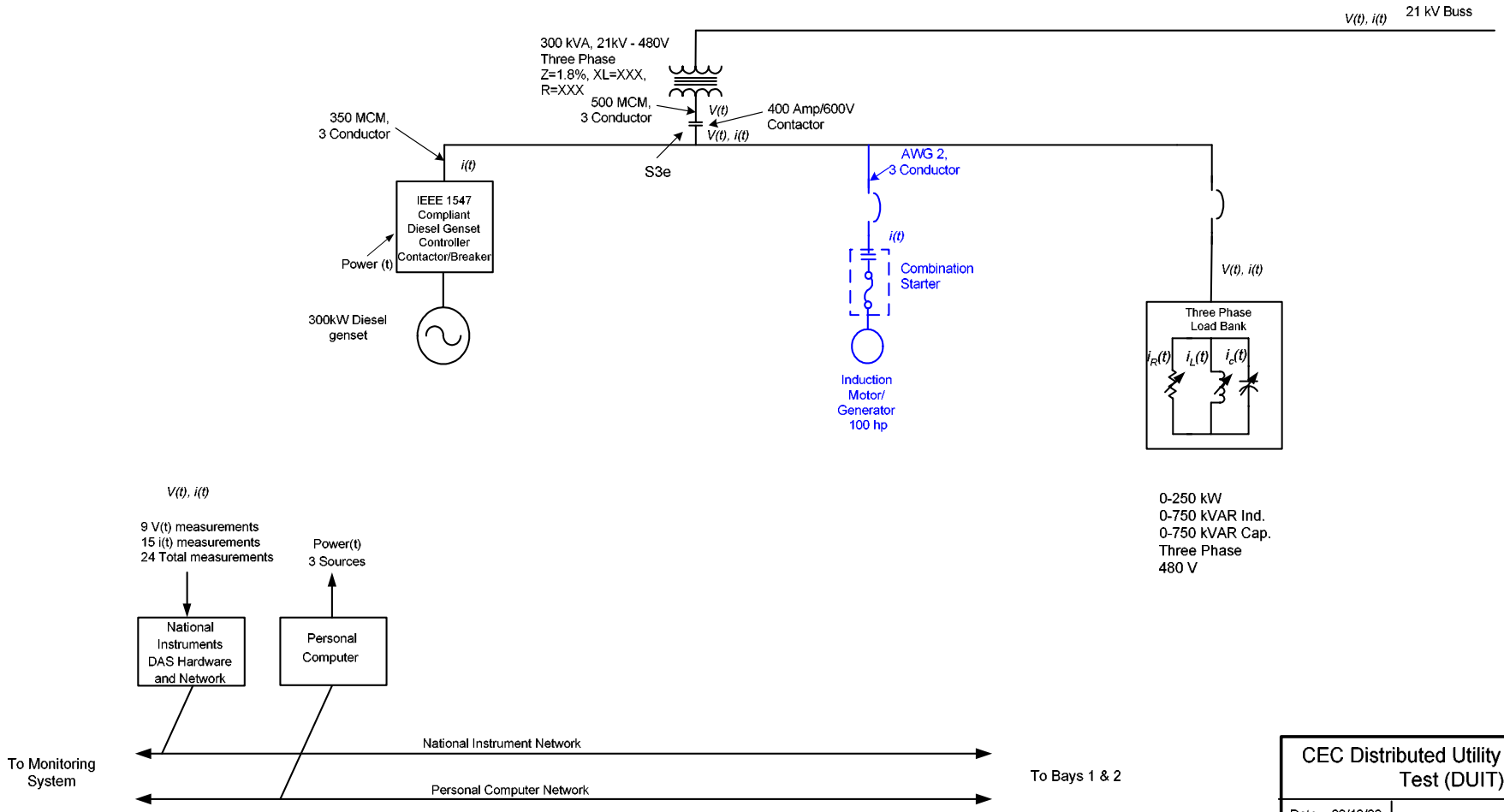
# Bay 2




| CEC Distributed Utility Integration Test (DUIT) | |
|---|---|
| Date: 03/13/03 | PG&E Modular Generation Test Facility (MGTF) |
| Dwg. #: PGE-2 | |
| Rev. #: E | |
| Drawn: WLE | Bay 2 Configuration for CEC Testing |
| Approved: | |

# Bay 3




| CEC Distributed Utility Integration Test (DUIT) | |
|---|---|
| Date: 03/13/03 | PG&E Modular Generation Test Facility (MGTF) |
| Dwg. #: PGE-3 | |
| Rev. #: E | |
| Drawn: WLE | Bay 3 Configuration for CEC Testing |
| Approved: | |

# Challenges Encountered

- Funding and timing of funding
  - Financial positions of partners
- Building consensus
  - Takes time to bridge divergent views
  - Repetitive
- Coordination of testing methods
- Coordinating modeling and testing to reduce testing time

# Current Phase 2002-2003 Budget and Funding Sources

| | | |
|---|---|---|
| CA Energy Commission | $2,050,000 | |
| PG&E | $ 285,000 + | $100,000 |
| DR Vendors | $ 200,000 | |
| NREL | $ 500,000 | +$1,000,000 (FY:05-06) |
| SFPUC | $ 50,000 | |
| DUA/Endecon | $ 16,000 | |
| Total | $3,201,000 | |

***Total DUIT Budget requires $10million over 7- 9 years***

## NREL BUDGET SUMMARY

| Cost Element | FY04 ($K) | FY05 ($K) | FY06 ($K) |
|---|---|---|---|
| Labor | $170,000 | $220,000 | $200,000 |
| Travel | $15,000 | 15,000 | 15,000 |
| Subcontracts | $270,000 | $262,000 | 281,000 |
| Other Costs | 5,000 | 2,500 | 2,500 |
| TOTAL | $500,000 | $500,000 | 500,000 |

# FY03 Progress and Accomplishments -Publications

- Systems Characterization, Distribution Impacts, and Operational Field Testing
  - *"DUIT: Distributed Utility Integration Test"*, NREL/SR-560-34389, August 2003

# Planned Activities for FY04

- **Conduct Network Workshop in San Francisco**
- **Develop network testing protocols**
- **Upgrade facility to 7MVA**
- **Upgrade DAS and control system**
- **Complete Anti-Islanding testing 6.1-6.7***
- **Modeling to complement testing**

| Anti-Islanding Test Plan | Test Description and Sequence |
|---|---|
| *6.1* | *Basic Islanding Test*<br>Individual unit testing |
| *6.2* | *Islanding with Multiple DRs*<br>Homogeneous Groups<br>Small Groups<br>Progressions |
| *6.3* | *Non-Linear Loads, Anti-islanding Tests*<br>Individual Units |
| *6.4* | *Islanding with Dynamic Load:Generation Ratios*<br>Individual Units |
| *6.5* | *Anti-islanding with Rotating Loads*<br>Individual Units |
| *6.6* | *Harmonic Content due to Anti-islanding Schemes*<br>Individual Units |
| *6.7* | *Voltage/Frequency Trip Settings*<br>Individual Units<br>Homogeneous Groups<br>Small Groups<br>Progressions |

# Summary of Outyear Activities

- **Radial system testing beyond anti-islanding**
  - **Testing high penetrations on the 7MVA feeder**
- **Test control system strategies**

- **Develop test plan for spot and secondary network testing**
  - **Build a network**

## Impacts and Benefits on electricity affordability/reliability and infrastructure security/resilience, from implementation of project advancement

- End-users can interconnect to the utility distribution system seamlessly, to provide the desired mixture of benefits
- Utilities understand the effects of diverse DER and levels of penetration on the distribution system
- DER can be used to improve system operation and lower the cost of electric service
- Technology developers demonstrate the ability to interconnect and interoperate, and the safety, reliability, and other benefits of their equipment to customers, utilities and regulators
- Regulators are confident about adopting standardized interconnection procedures and DER can be used to improve distribution system operation and lower the cost of electric service, whether owned or operated by utilities, customers, or third parties

# Contact Information:

Susan Horgan
Distributed Utility Associates
925-447-0625
Susan@dua1.com

Bill Erdman
Distributed Utility Associates
925-447-0627
Bill@dua1.com