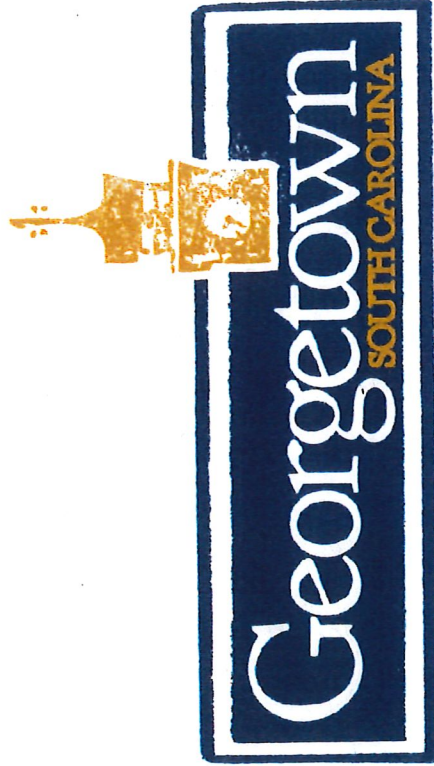


Ted Orr 11

Georgetown Improved System Reliability Case Study

July 9, 2012



Utility Technology
Engineers-Consultants

Introduction

- Ted Orrell – Introductions of Topic and Presenters
- Alan Loveless – Existing System Before Modifications
- Jim Ghrist – New System Operations
- Heather Sudduth – Performance Results
- Ted Orrell – Q & A

Existing Georgetown System



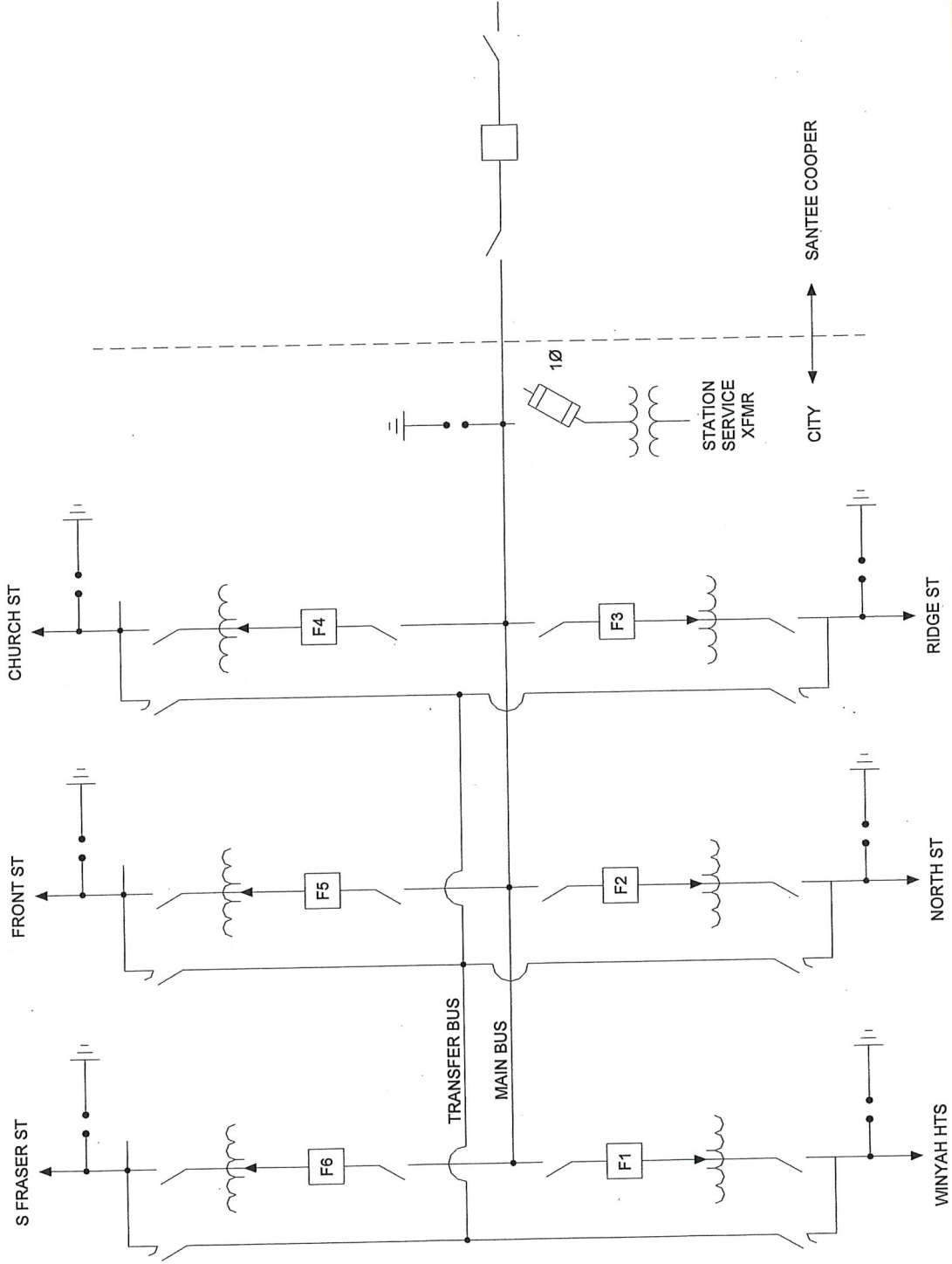
Hwy 17

Georgetown Sub

Maryville Sub



Georgetown Substation



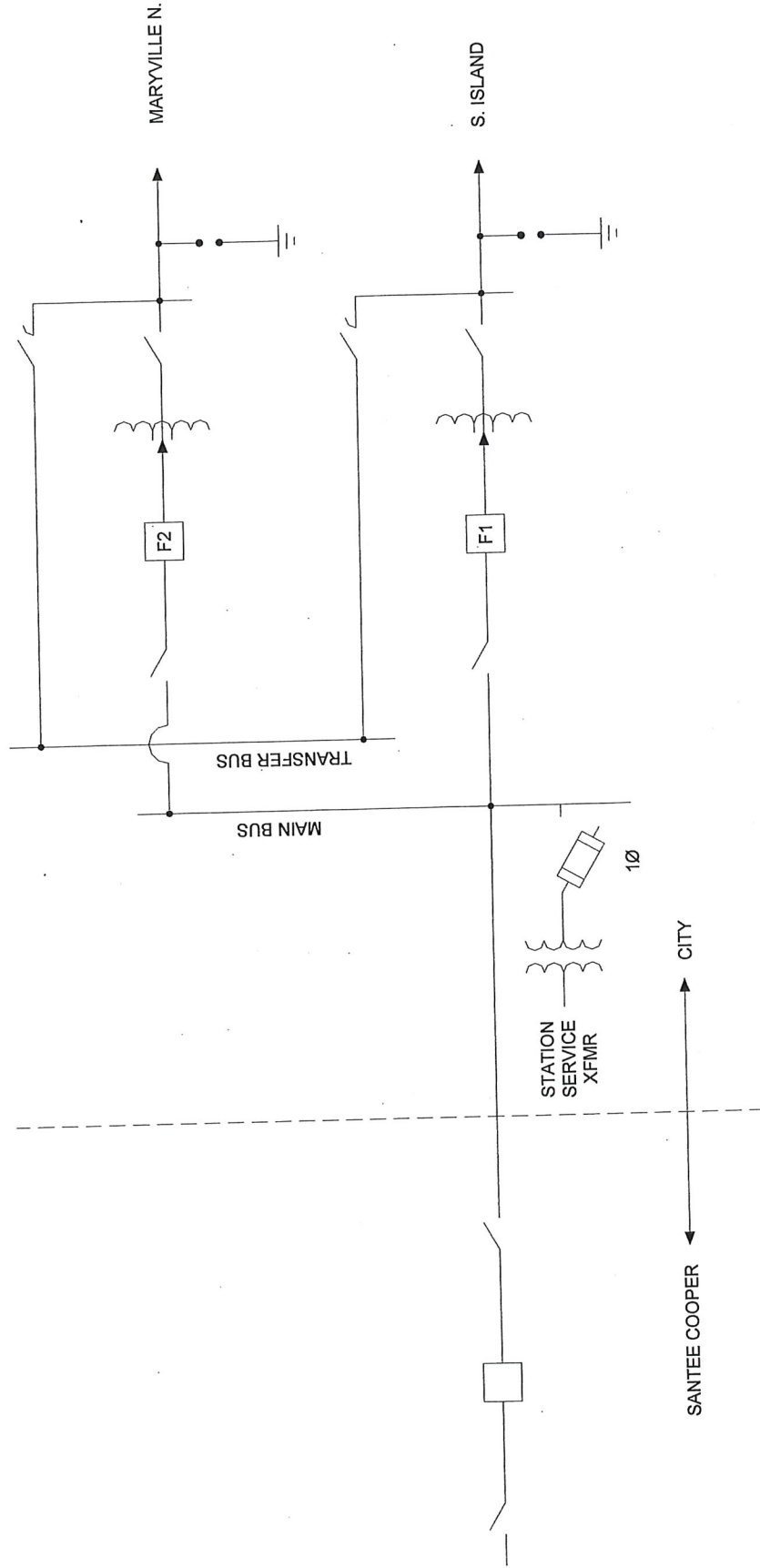
Georgetown Substation

- 12.47 kV Bus
- Transfer Bus
- Transfer Switches
- 6 Circuit Exits
- Breakers/Relays
- Regulators



Alan

Maryville Substation



Maryville Substation

- 12.47 kV Bus
- Transfer Bus
- Transfer Switches
- 2 Circuit Exits
- Breakers/Relays
- Regulators

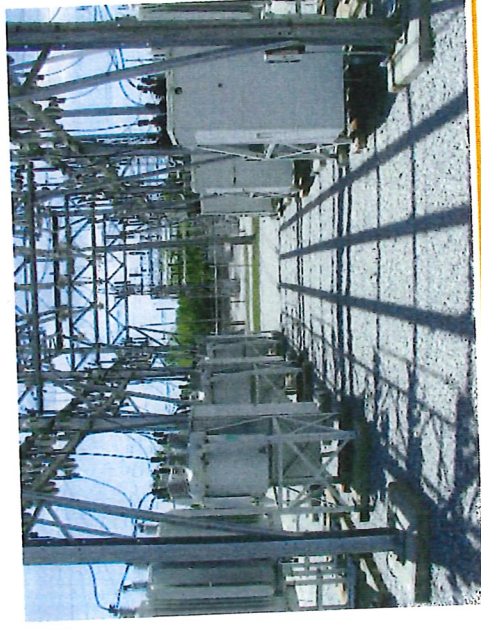


Existing Georgetown System

- Purchase Power from Santee Cooper at 12.47 kV
- Historic Peak – 35 MW
- Currently Serving 3,820 Residential Customers
- Currently Serving 1,178 Commercial Customers

Previous Improvements

- New Ground Grid
- Grading
- Gravel
- Fencing
- Replacement of Transfer Switches

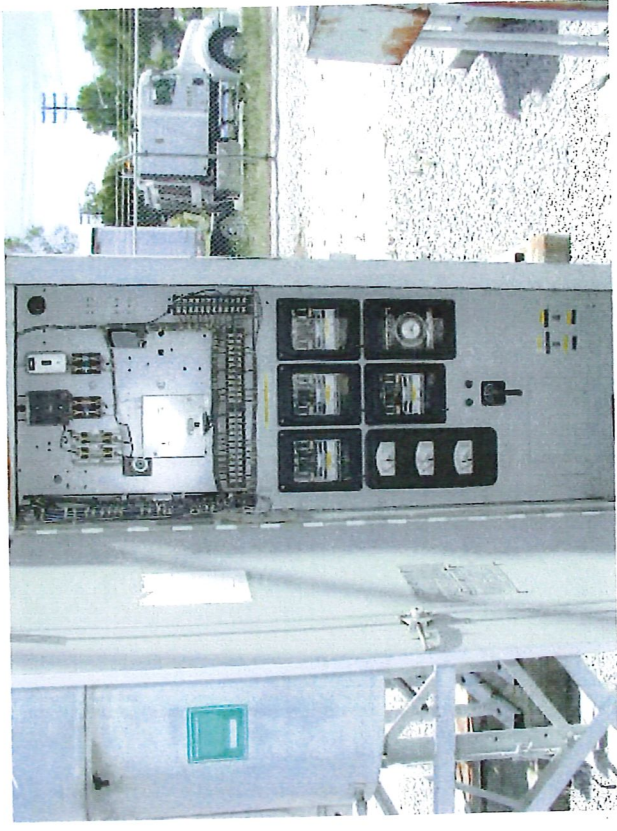


Equipment

- 1971/74 vintage GE oil blast breakers



- GE electromechanical relays



Equipment

- Generally very reliable
- Santee Cooper Provided Assistance and with Maintenance and Repairs
- No Catastrophic Failure
- Recent Mechanical Problems Reduced Confidence Level



Decisions

- Replace/Upgrade?
- With What?
 - Vacuum
 - Recloser vs. Breaker
- Began Discussions with UTEC to Determine Best Possible Choice for Breaker Replacement
 - Primary Considerations
 - Reliability
 - Safety
 - Secondary Considerations
 - Simplicity of Design
 - Ease of Maintenance

Breakers vs. Reclosers

- Both Serve Same Function – Connect and Disconnect Power Circuits with Fault-Interrupting Capability
- Breakers Have Higher Fault Ratings – 20-50 kA vs 12.5 kA
- Built to Different Standards
 - C37.60 – Reclosers, Relays, and Controls are Tested Together
 - C37.06 – Breakers are Tested Independently of Relays and Controls
- Distribution Breakers are Three-Phase Only

Single-Phase Trip vs. Three-Phase Trip

- Traditional
 - Three-Phase Devices for Heavy Loads – Substation Breakers and Large Main-Line or Tap Reclosers
 - Single-Phase Devices for Single-Phase Taps – Reclosers or Fuses
- Reasons for Three-Phase Tripping
 - Unbalanced Load if One Phase Tripped
 - Phase Loss on Three-Phase Motors
 - Single-Phase Devices Not Rated for Heavy Loads
 - Sensitive Ground-Fault Protection Not Available on Single-Phase Devices

Single-Phase Trip vs. Three-Phase Trip

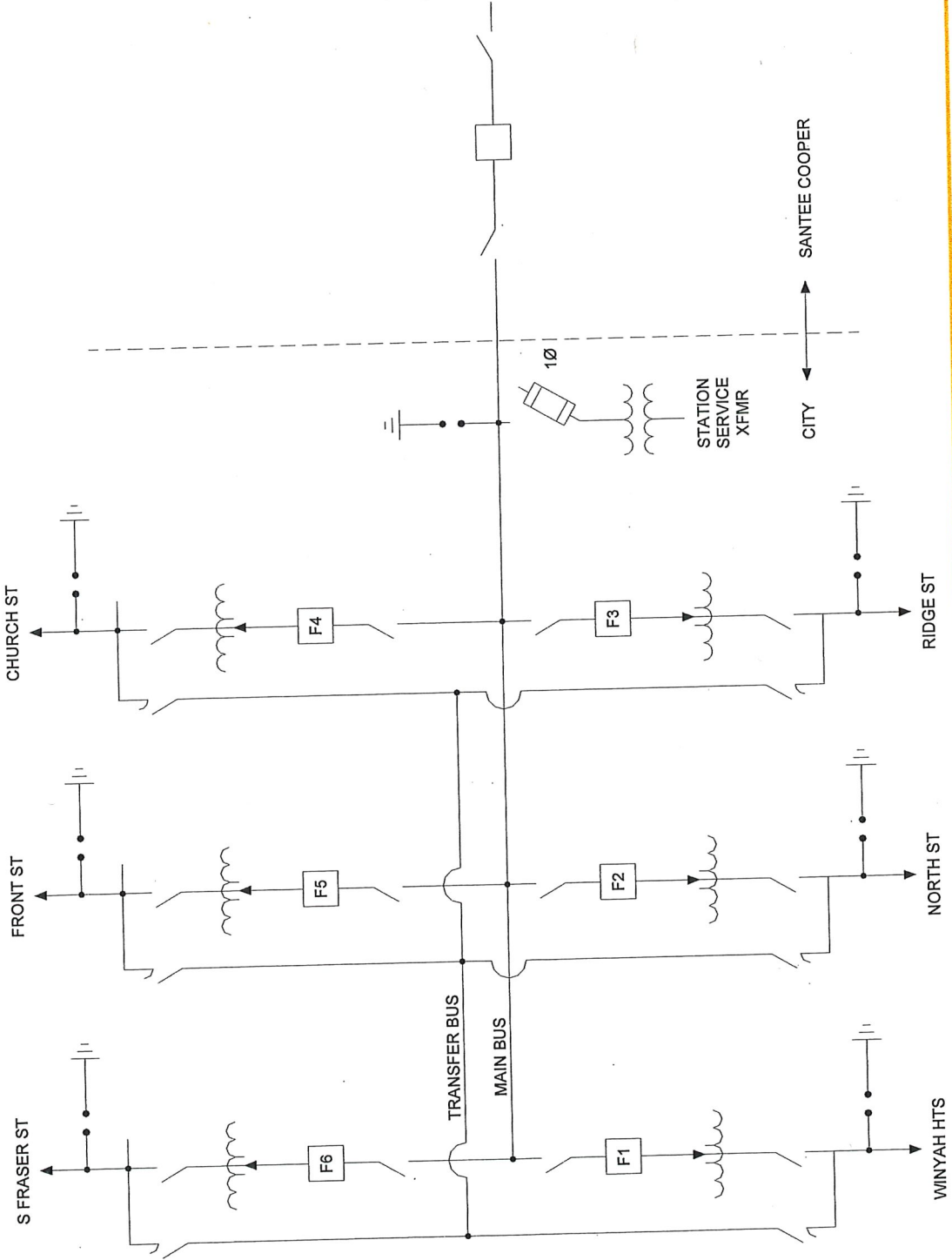
- Reasons for Single-Phase Tripping
 - Single-Phase Ground Faults are Most Common
 - Tripping Only Faulted Phase Leaves 2/3 of Customers in Service
- Overcoming Single-Phase Tripping Problems
 - Tripping Single-Phase Only on First Trip with Fast Reclose
 - Unbalanced Load Current for Short Duration
 - Intact Phases of Three-Phase Motors Hold Voltage on Open Phase – Prevents Contactor Drop-Out
 - Three-Phase Lockout
 - Three-Phase Reclosers Now Available with Single-Phase Tripping

New Substations

- Update Equipment
- Improve Reliability – Distribution and Substation
- Substation Configurations Unchanged

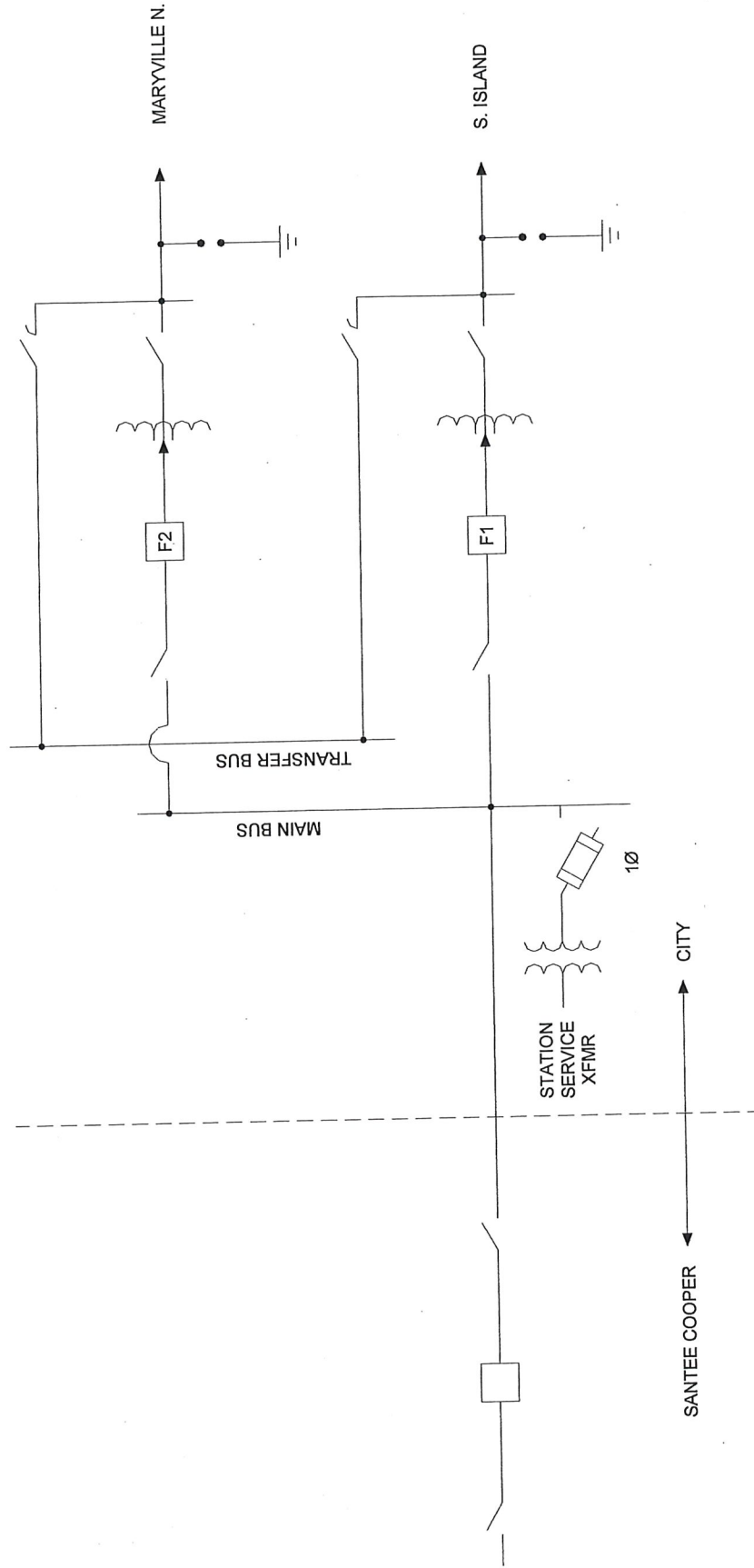
Jim

New Substations - Georgetown



Jim

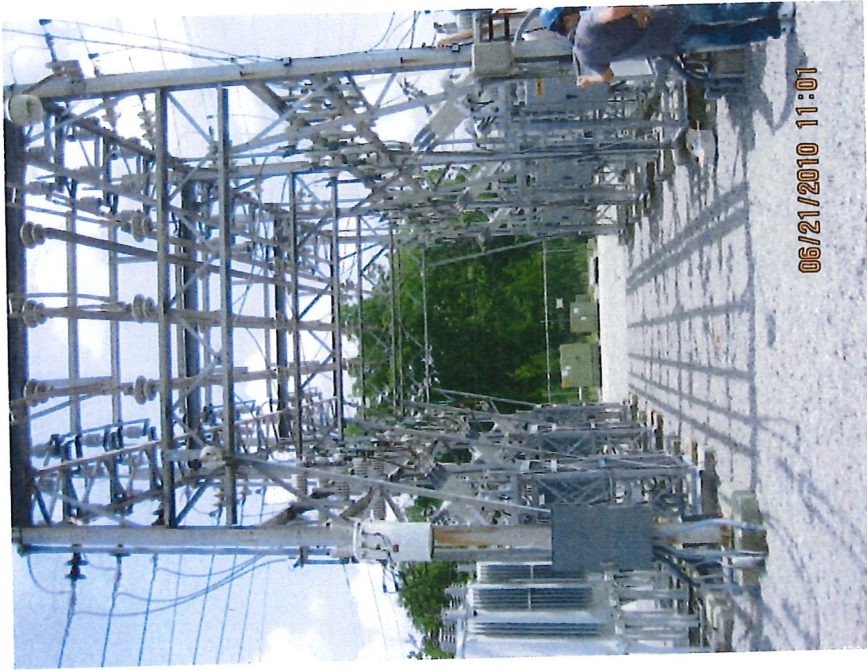
New Substations – Maryville



New Substations



Maryville Substation



Georgetown Substation

Jim

New Substations



Reclosers

Jim

New Substations – SCADA



New Substations – SCADA

- Relay Based – Uses Recloser Control for Status, Control, and Measured Values
- Data Concentrator in Each Substation
- Ethernet
- Existing Fiber-Optic Communications
- Master Station
 - One-Line Diagram for Status and Control
 - Recloser Control Details
 - Alarms

Jim

New Substations - SCADA

6/10/2010 1:53:02 PM SEL

CITY OF GEORGETOWN SUBSTATION - OVERVIEW

Logged On: SEL
 Select Overview | Select Onlines | Select Targets | Select Comms | Alarms | Tools

S. FRASER ST | FRONT ST | CHURCH ST | Santee Cooper (SSGT) | WINYAH HTS | NORTH ST | RIDGE ST

Date	Time	Equipment Group	Description	Alarm State	Tag Name	Priority	LC
Jun 10 2010	05:14:51.870 PM	Santee Cooper	LED - C PHASE TRIP	Alarm	PMV_SC_351_P15_C	300	M
Jun 10 2010	05:00:17.754 PM	S ISLAND	RELAY FAILURE ALARM	Alarm	PMV_F1_651IC_P1_RFA	100	M
Jun 10 2010	04:13:48.263 PM	S ISLAND	COM PORT FAILURE	Alarm	PMV_F1_651IC_P1_COPM	100	M
Jun 10 2010	01:32:29.509 PM	RIDGE_ST	Comm Trouble	FAIL	GT_F3_651IC_P3_COPMSTA	100	M

ACK



Jim

New Substations - SCADA

6/10/2010
2:00:14 PM
SEL

Logged On
SEL

CITY OF COLLEGE STATION - DOWLING ROAD ACTIVE ALARMS

Select Overview

Online MV

Select Targets

Select Comms

Alarm

Tools

Alarm

Tools

ACTIVE ALARMS LEGEND

UNACK UNACKNOWLEDGED ALARM

UNACK_RTN UNACKNOWLEDGED RETURN TO NORMAL

ACK ACKNOWLEDGED ALARM

EQUIPMENT GROUP FILTER: PRIORITY FILTER:

Alarm State

100 = CRITICAL

200 = NON-CRITICAL

300 = PROTECTION

400 = OPERATION

Alarm State

100 = CRITICAL

200 = NON-CRITICAL

300 = PROTECTION

400 = OPERATION

Alarms: Pages:

Ack Page

Ack Selected

Historical Alarms

Ack Page

Ack Selected

Historical Alarms

Date	Time	Equipment Group	Description	Alarm State	Tag Name	Priority	Logged In Use
Jun 10 2010	05:14:51.870 PM	SANTEE COOPER	LED - C PHASE TRIP	Alarm	MV_SC_351_P15_C	300	MVCOMPUTER
Jun 10 2010	05:00:17.754 PM	S_ISLAND	RELAY FAILURE ALARM	Alarm	MV_FL_651R_P1_RFA	100	MVCOMPUTER
Jun 10 2010	04:13:48.263 PM	S_ISLAND	COM PORT FAILURE	Alarm	MV_FL_651R_P1_CDM	100	MVCOMPUTER
Jun 10 2010	01:52:29.509 PM	RIDGE_ST	Comm Trouble	FAIL	GT_F3_651R_P3_CDMSTA	100	MVCOMPUTER
Jun 10 2010	01:50:44.458 PM	MARYVILLE_N	Comm Trouble	FAIL	MV_FL_651R_P1_CDMSTA	100	MVCOMPUTER
Jun 10 2010	01:33:14.438 PM	S_JRASER_ST	Comm Trouble	FAIL	GT_F6_651R_P6_CDMSTA	100	MVCOMPUTER
Jun 10 2010	01:30:09.531 PM	NORTH_ST	Comm Trouble	FAIL	GT_F2_651R_P2_CDMSTA	100	MVCOMPUTER
Jun 10 2010	01:30:09.444 PM	CHURCH_ST	Comm Trouble	FAIL	GT_F4_651R_P4_CDMSTA	100	MVCOMPUTER
Jun 10 2010	01:28:34.536 PM	FRONT_ST	Comm Trouble	FAIL	GT_F5_651R_P5_CDMSTA	100	MVCOMPUTER
Jun 10 2010	01:06:53.406 PM	System	LED - COM1 TRIP	Alarm	GT_RTAC_CDM	300	MVCOMPUTER
Jun 10 2010	12:22:24.567 PM	System	LED - ENABLE	Alarm	MV_SC_351_P15_C	300	MVCOMPUTER
Jun 10 2010	11:03:04.135 AM	RIDGE_ST	RELAY FAILURE ALARM	Alarm	GT_F3_651R_P3_RFA	100	MVCOMPUTER
Jun 10 2010	10:43:48.436 AM	S_JRASER_ST	RELAY FAILURE ALARM	Alarm	GT_F6_651R_P6_RFA	100	MVCOMPUTER
Jun 10 2010	10:43:17.235 AM	NORTH_ST	RELAY FAILURE ALARM	Alarm	GT_F2_651R_P2_RFA	100	MVCOMPUTER
Jun 10 2010	10:41:35.135 AM	CHURCH_ST	RELAY FAILURE ALARM	Alarm	GT_F4_651R_P4_RFA	100	MVCOMPUTER
Jun 10 2010	10:39:07.937 AM	FRONT_ST	RELAY FAILURE ALARM	Alarm	GT_F5_651R_P5_RFA	100	MVCOMPUTER
Jun 10 2010	07:45:18.332 AM	RIDGE_ST	COM PORT FAILURE	Alarm	GT_F3_651R_P3_CDM	100	MVCOMPUTER
Jun 10 2010	07:45:18.236 AM	NORTH_ST	COM PORT FAILURE	Alarm	GT_F2_651R_P2_CDM	100	MVCOMPUTER
Jun 10 2010	07:45:18.181 AM	S_JRASER_ST	COM PORT FAILURE	Alarm	GT_F6_651R_P6_CDM	100	MVCOMPUTER
Jun 10 2010	07:45:14.917 AM	FRONT_ST	COM PORT FAILURE	Alarm	GT_F5_651R_P5_CDM	100	MVCOMPUTER
Jun 10 2010	07:45:11.046 AM	CHURCH_ST	COM PORT FAILURE	Alarm	GT_F4_651R_P4_CDM	100	MVCOMPUTER

Update Successful

Alarm State

100 = CRITICAL

200 = NON-CRITICAL

300 = PROTECTION

400 = OPERATION

Alarm State

100 = CRITICAL

200 = NON-CRITICAL

300 = PROTECTION

400 = OPERATION

Alarms: Pages:

Ack Page

Ack Selected

Historical Alarms

Ack Page

Ack Selected

Historical Alarms

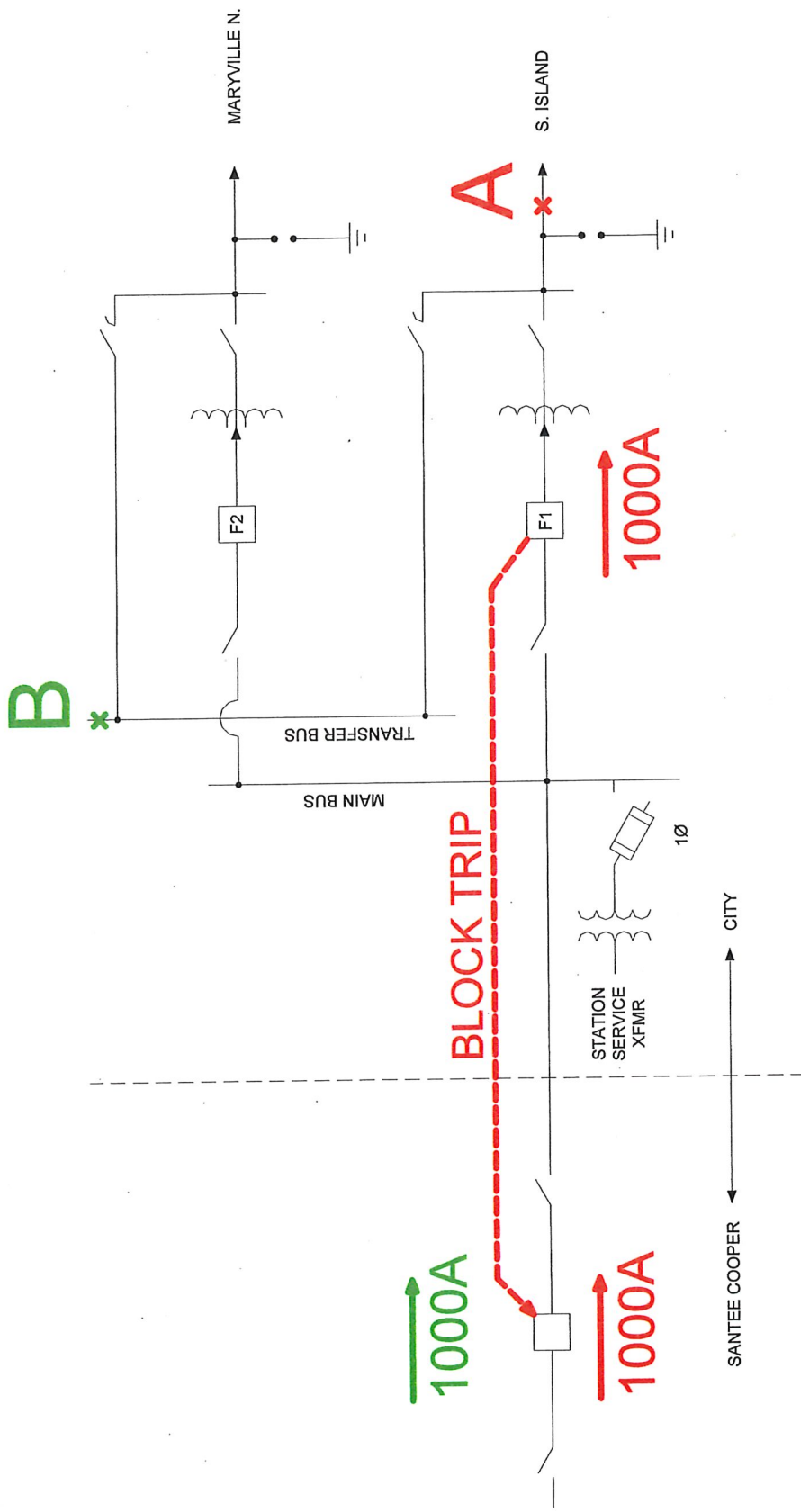
Date	Time	Equipment Group	Description	Alarm State	Tag Name	Priority	Lc
Jun 10 2010	05:14:51.870 PM	SANTEE COOPER	LED - C PHASE TRIP	Alarm	MV_SC_351_P15_C	300	M
Jun 10 2010	05:00:17.754 PM	S_ISLAND	RELAY FAILURE ALARM	Alarm	MV_FL_651R_P1_RFA	100	M
Jun 10 2010	04:13:48.263 PM	S_ISLAND	COM PORT FAILURE	Alarm	MV_FL_651R_P1_CDM	100	M
Jun 10 2010	01:52:29.509 PM	RIDGE_ST	Comm Trouble	FAIL	GT_F3_651R_P3_CDMSTA	100	M

ACK



Jim

New Substations – Fast Bus Trip



Jim

Upgrade Costs

- Cost of Purchasing Reclosers/Controls \$135,200
- Cost of Installing Reclosers/Controls \$107,000
- Cost of SCADA System (purchase/install) \$114,272

Above figures do not include engineering costs.



Outage Analysis

Outage Type	Georgetown Sub		Maryville Sub		City Total	
	No. of Outages	% of Total	No. of Outages	% of Total	No. of Outages	% of Total
1Ø Momentary	79	58.1%	34	74.3%	113	61.8%
2Ø Momentary	19	14.0%	6	12.8%	25	13.7%
3Ø Momentary	32	23.5%	3	23.5%	35	19.1%
3Ø Lockout	6	4.4%	4	8.5%	10	5.5%
Total	136	100%	47	100%	183	100%

Outage Analysis

Fault Types	Georgetown Sub		Maryville Sub		City Total	
	No. of Outages	% of Total	No. of Outages	% of Total	No. of Outages	% of Total
Temporary						
Cleared by 1 st Reclose	104	76.5%	40	85.1%	144	78.7%
Cleared by 2 nd Reclose	22	16.2%	2	4.3%	24	13.1%
Cleared by 3 rd Reclose	4	2.9%	1	2.1%	5	2.7%
Permanent						
3Ø Lockout	6	4.4%	4	8.5%	10	5.5%
Total	136	100%	47	100%	183	100%

Ted

Questions



Outage Analysis

- Momentary Average Interruption Frequency Index (MAIFI)
- $MAIFI = \frac{\text{total no. of mom. customer interruptions}}{\text{total no. of customers served}}$

	Total Number of Customers	1Ø Recloser Tripping		3Ø Tripping	
		Yearly Avg. No. of Cust. Interrupt.	MAIFI	Yearly Avg. No. of Cust. Interrupt.	MAIFI
Georgetown Sub	3663	24490	6.69	45611	12.45
Maryville Sub	1334	7391	5.54	17445	13.08
Overall City	4998	31881	6.38	63055	12.62