Ted Orrell

Georgetown Improved System Reliability Case Study

July 9, 2012

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SOUTH CAROLINA

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Utility Technology
Engineers-Consultants

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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

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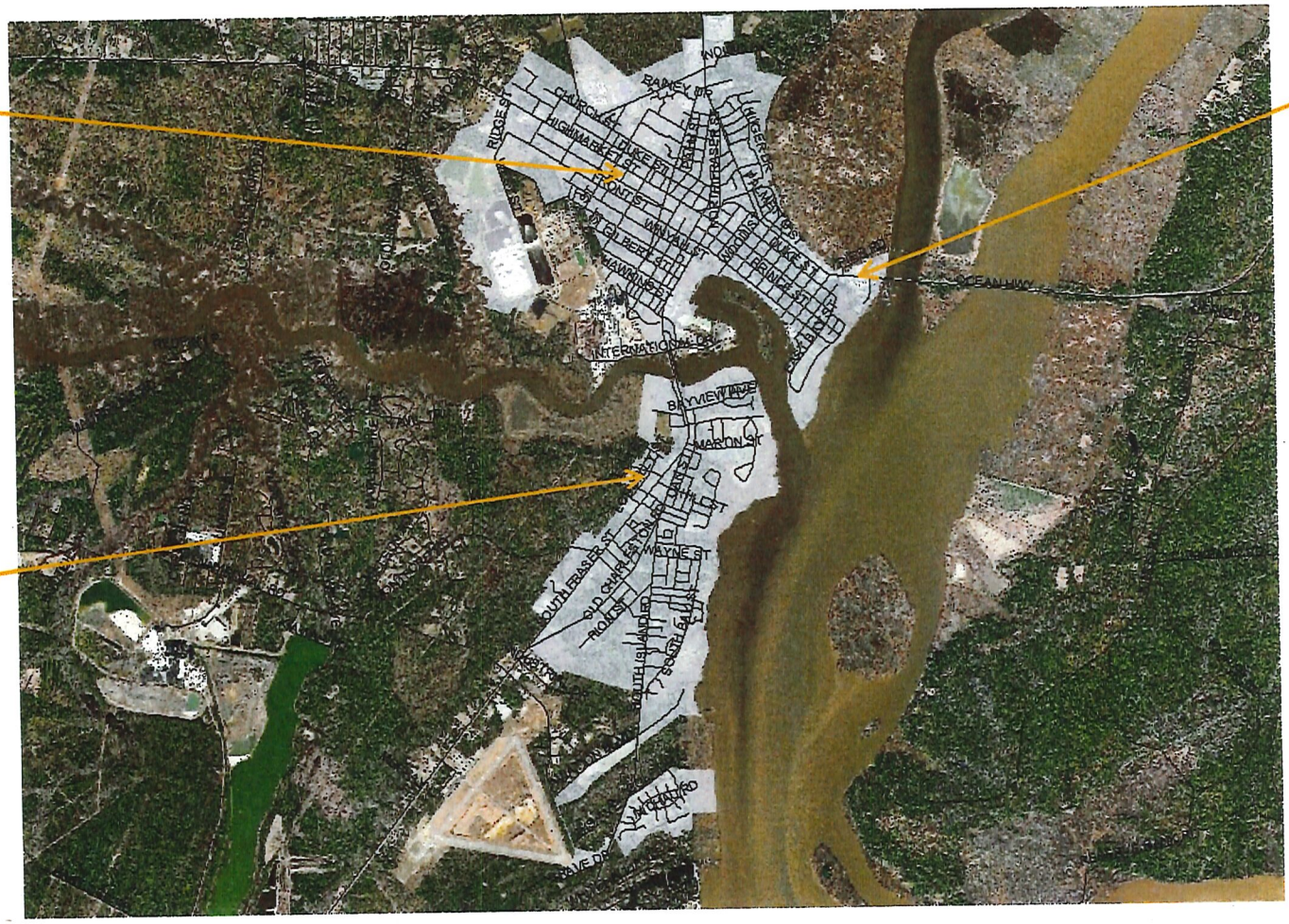
Alan

Existing Georgetown System



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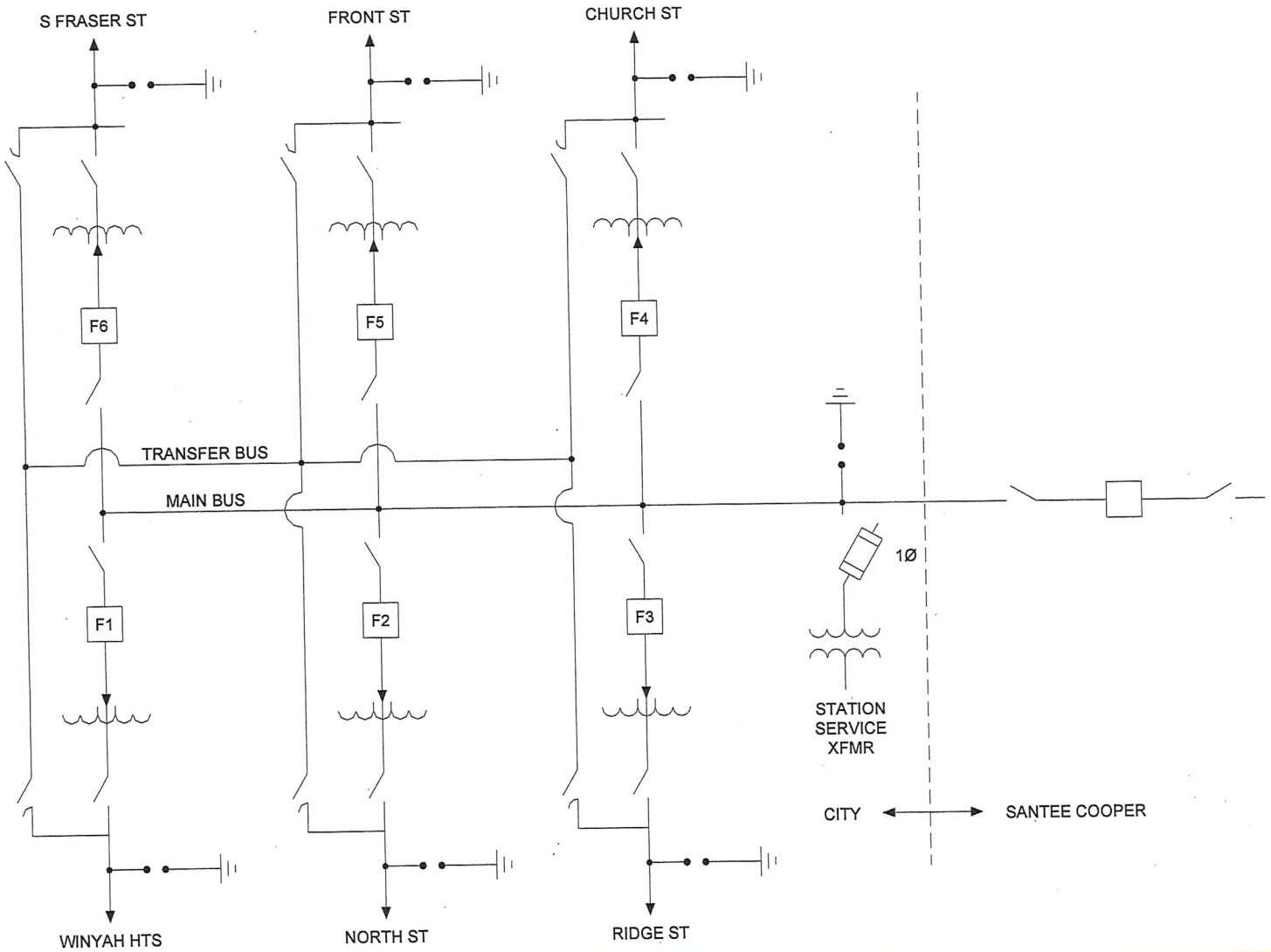
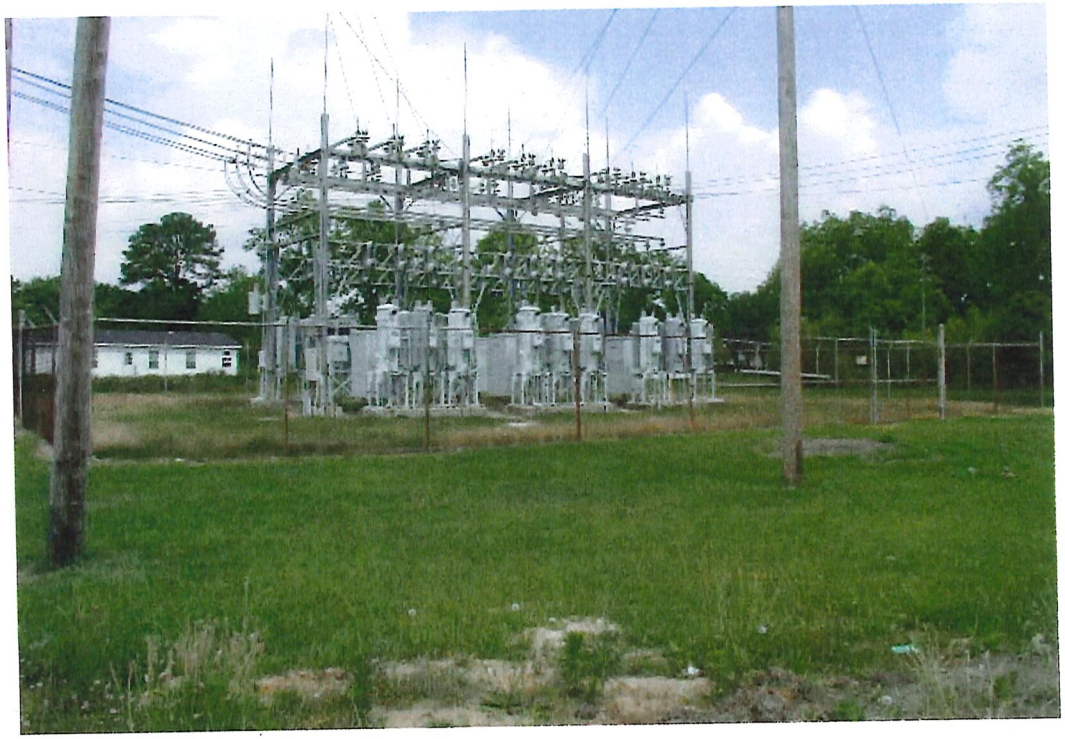
Georgetown Substation



Alan

Georgetown Substation

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



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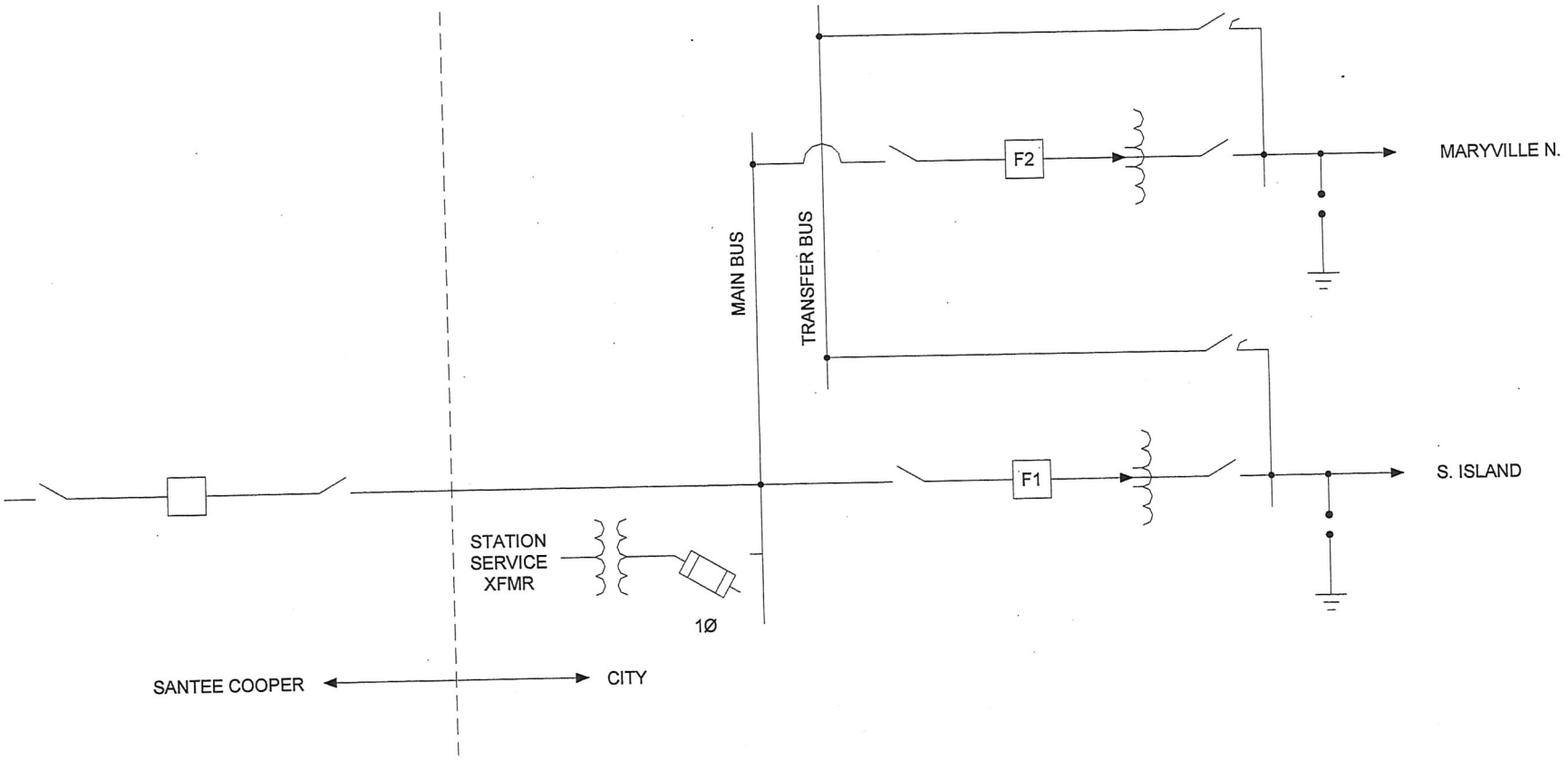
Maryville Substation



Alan

Maryville Substation

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

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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

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Previous Improvements

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

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Equipment

- 1971/74 vintage GE oil blast breakers

- GE electromechanical relays

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Equipment

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

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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

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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

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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

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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

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New Substations

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

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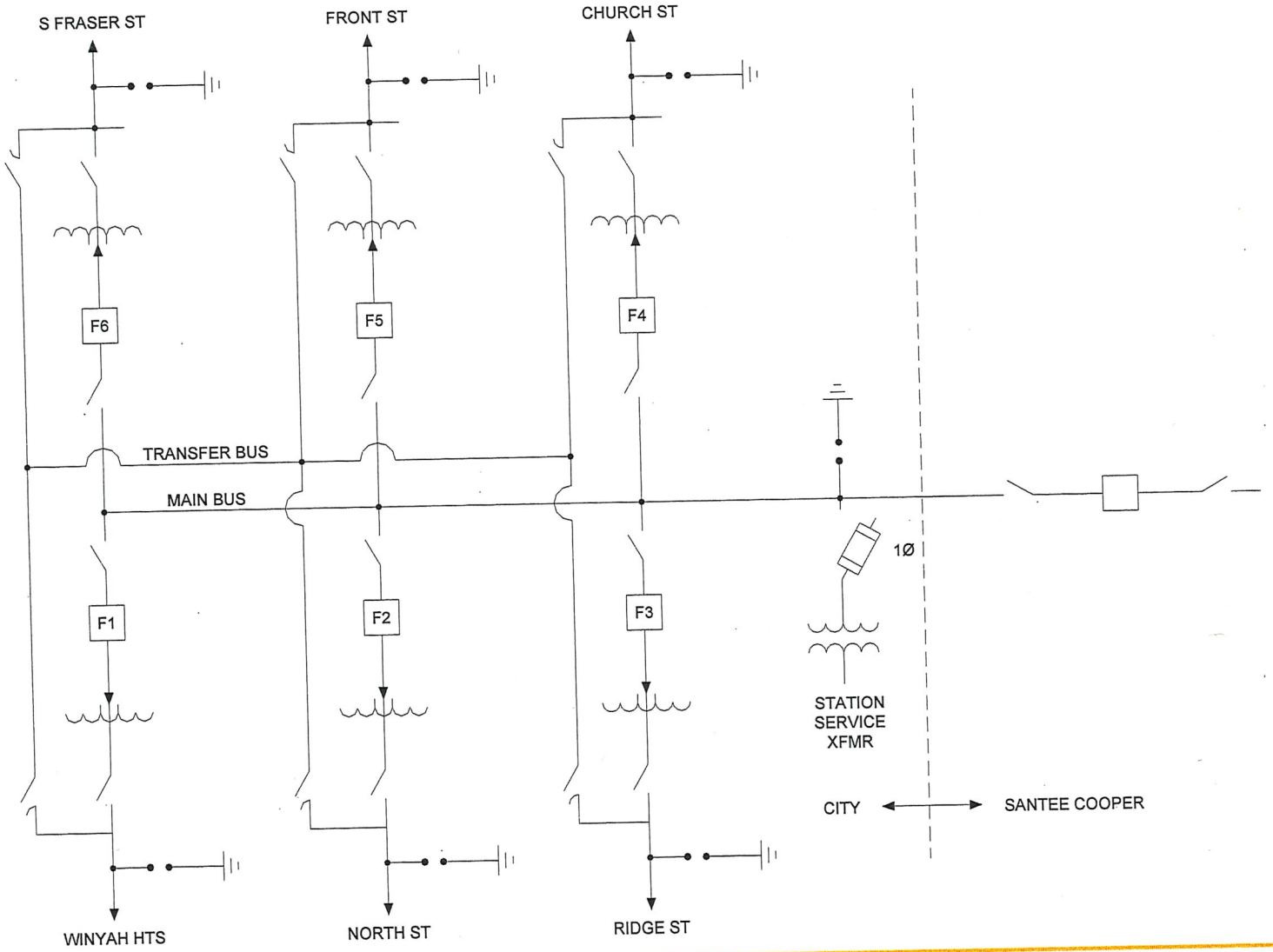
New Substations – Georgetown



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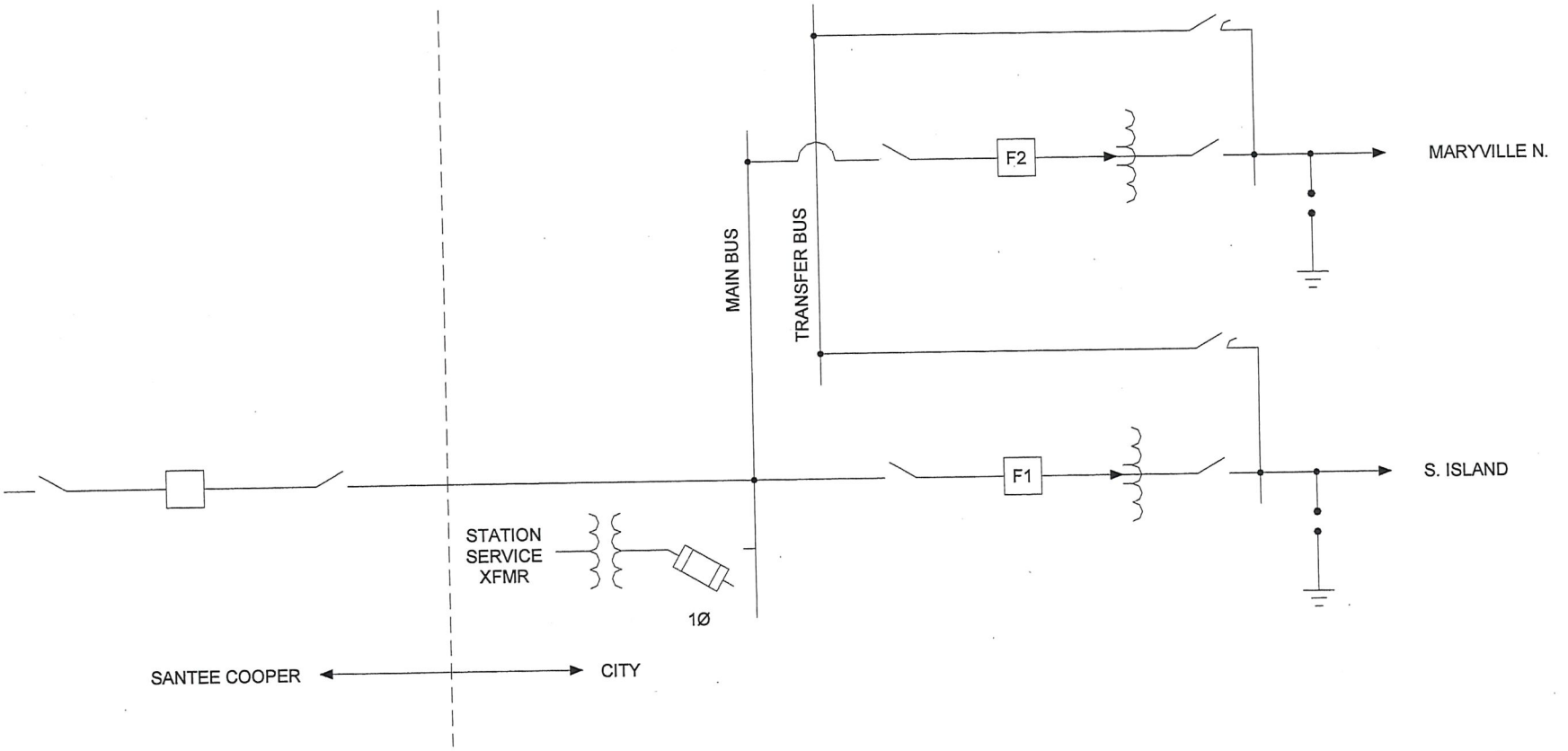
New Substations – Maryville



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New Substations

Georgetown Substation

Maryville Substation

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New Substations

Reclosers

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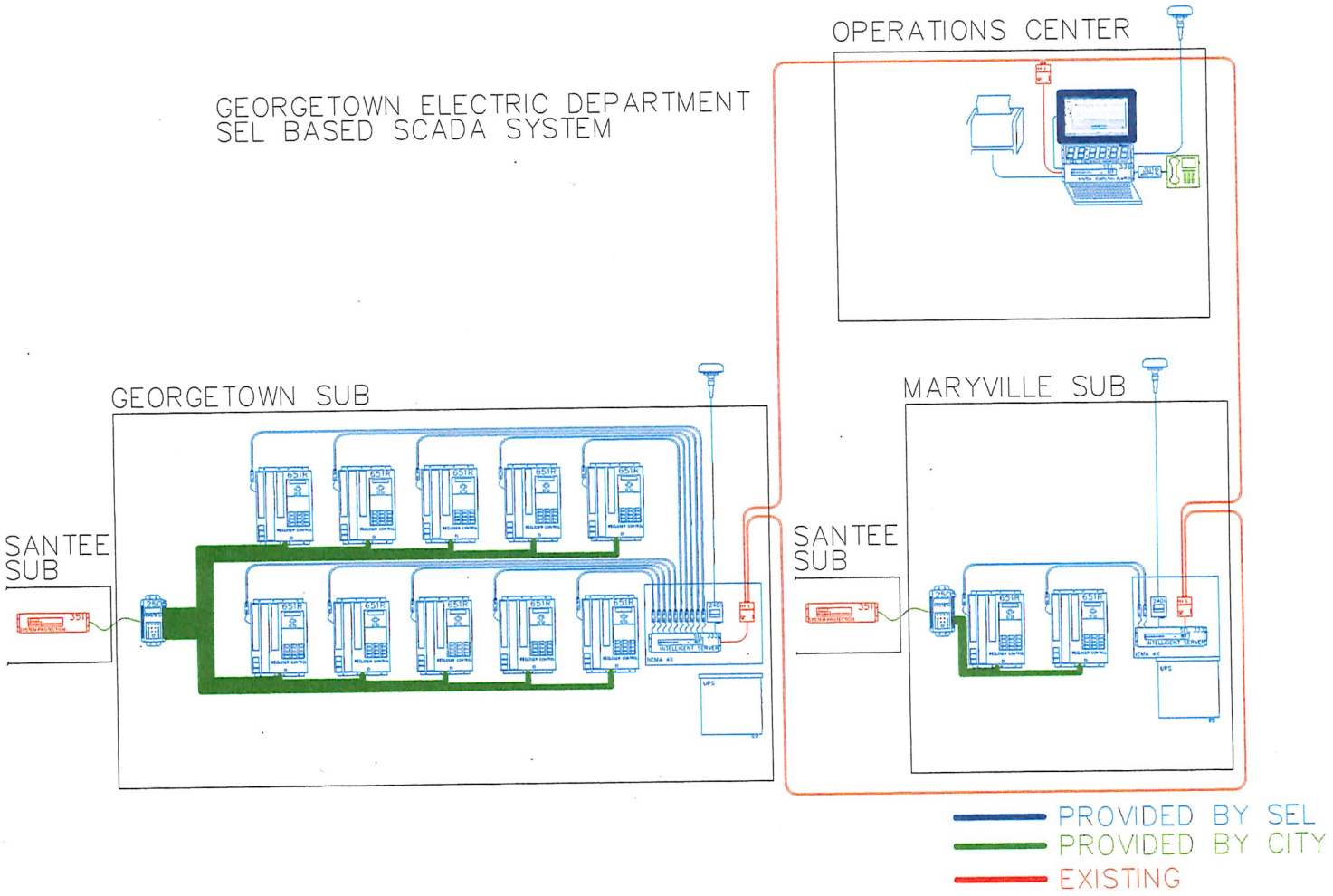
New Substations – SCADA



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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

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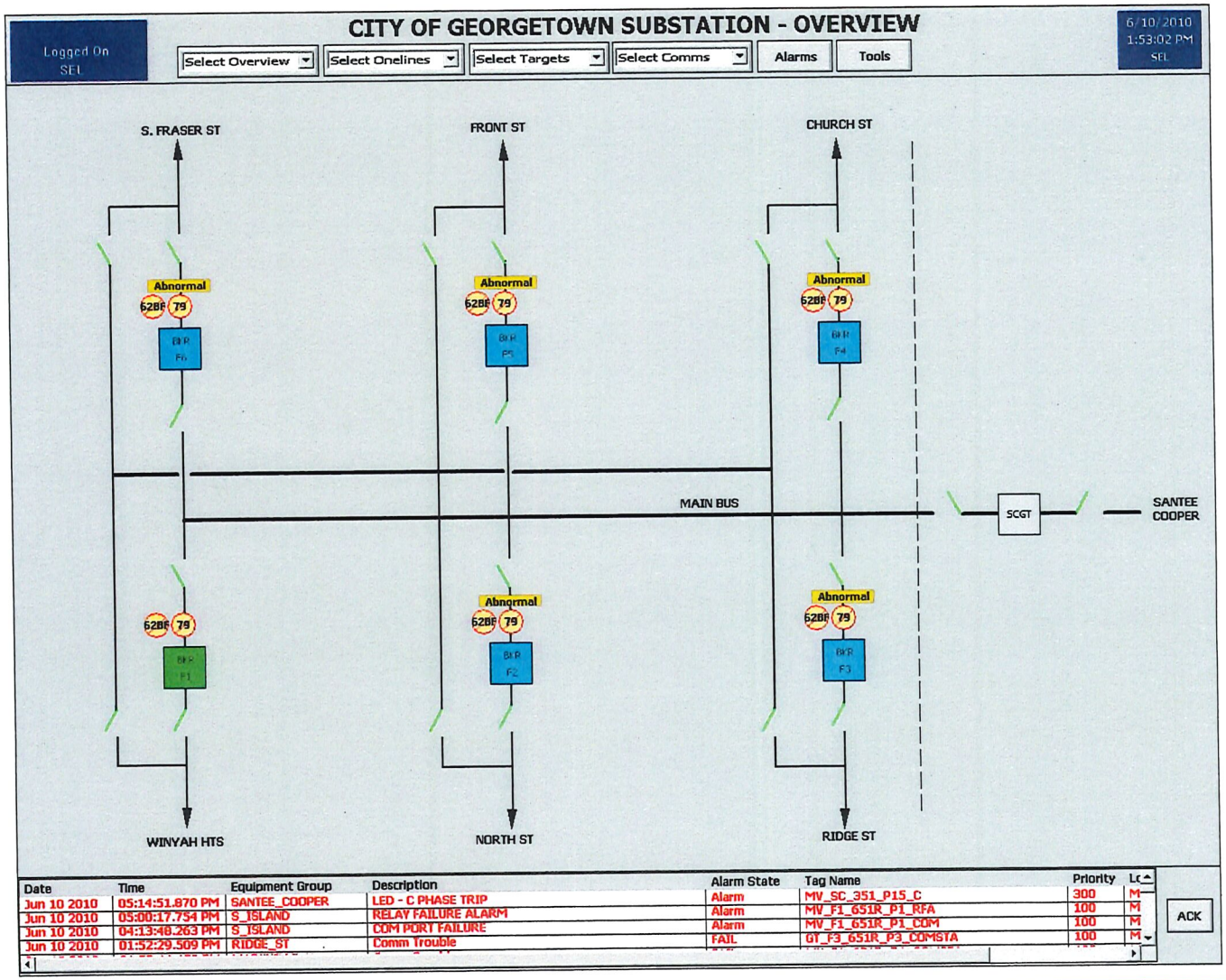
New Substations – SCADA



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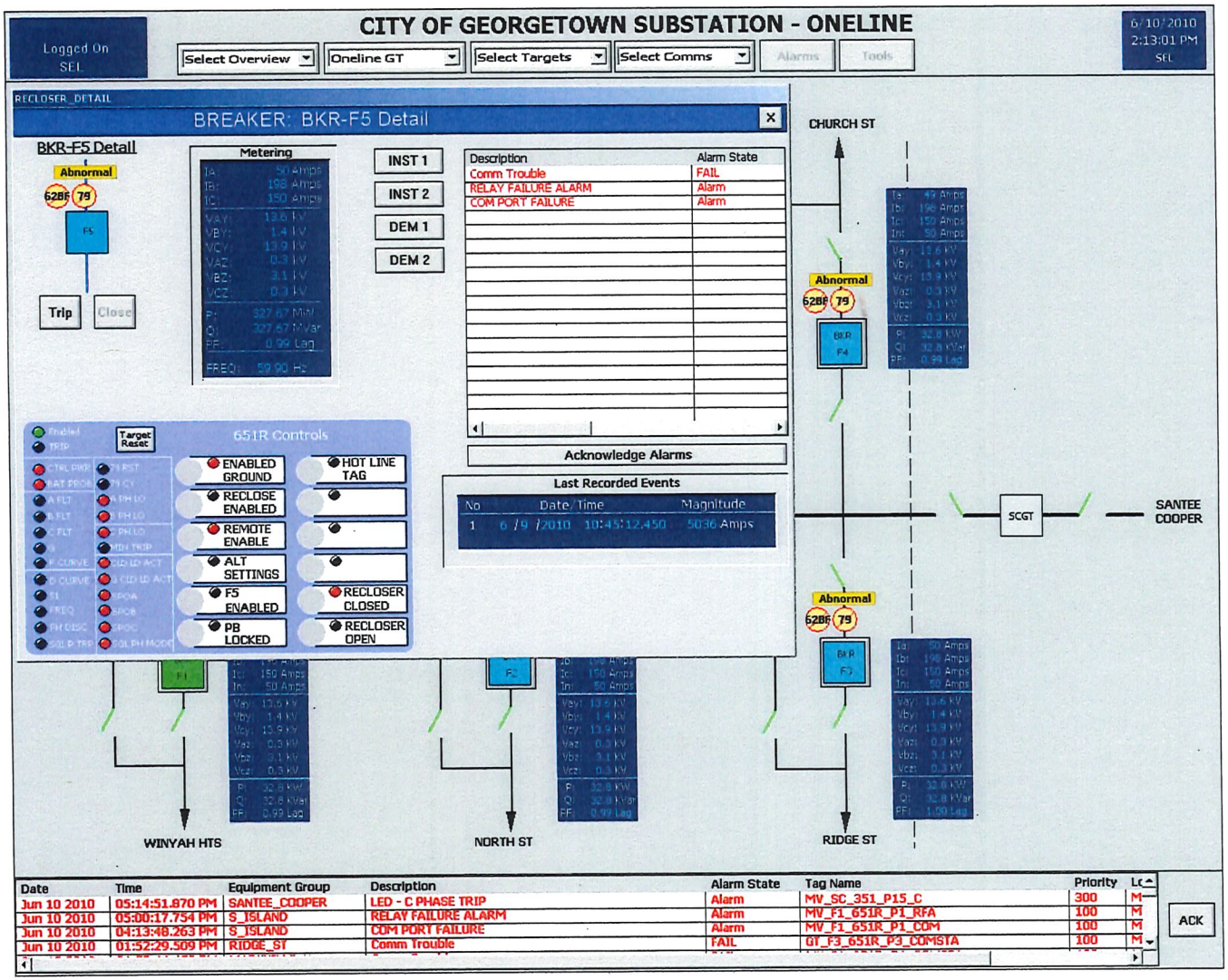
New Substations – SCADA



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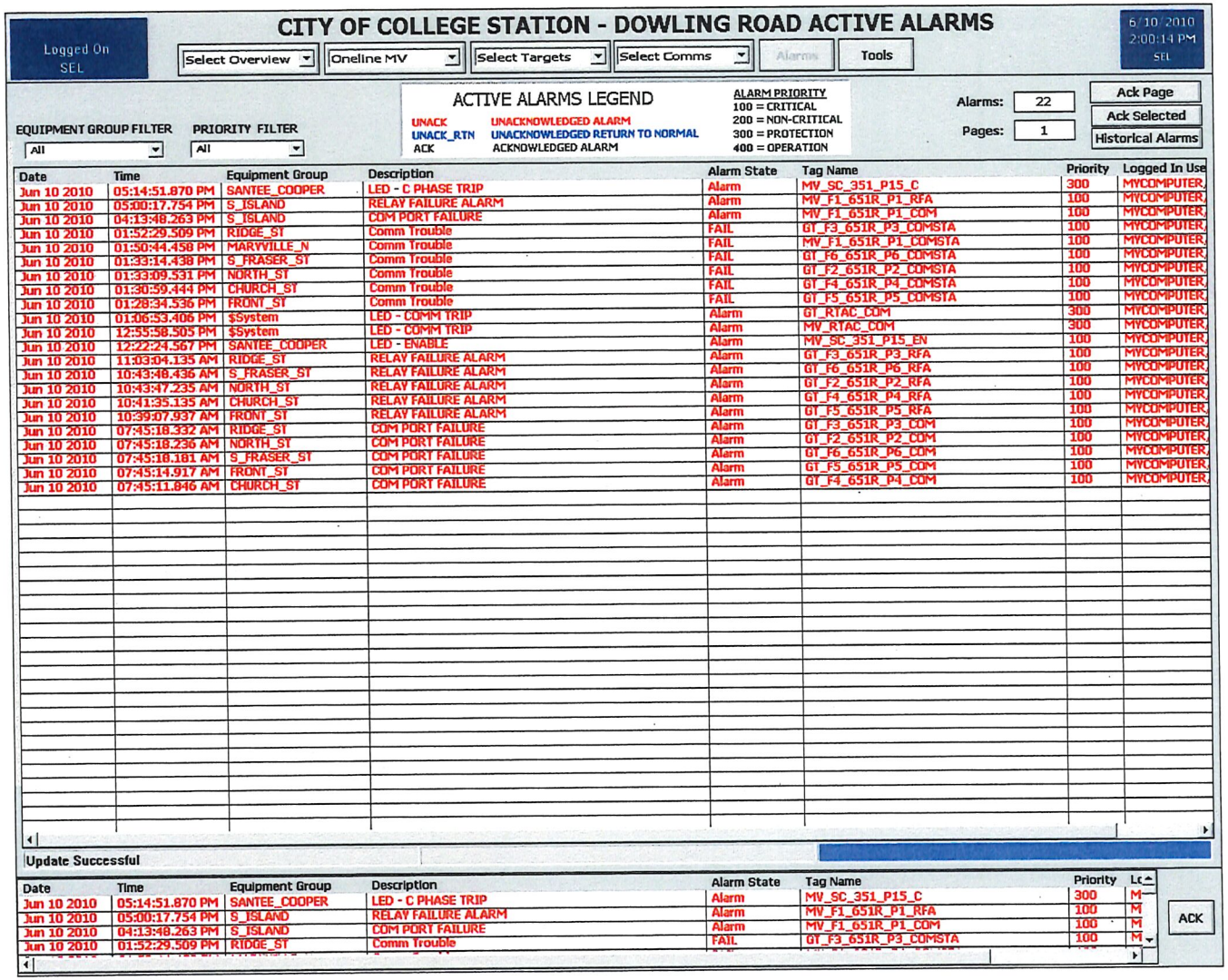
New Substations – SCADA



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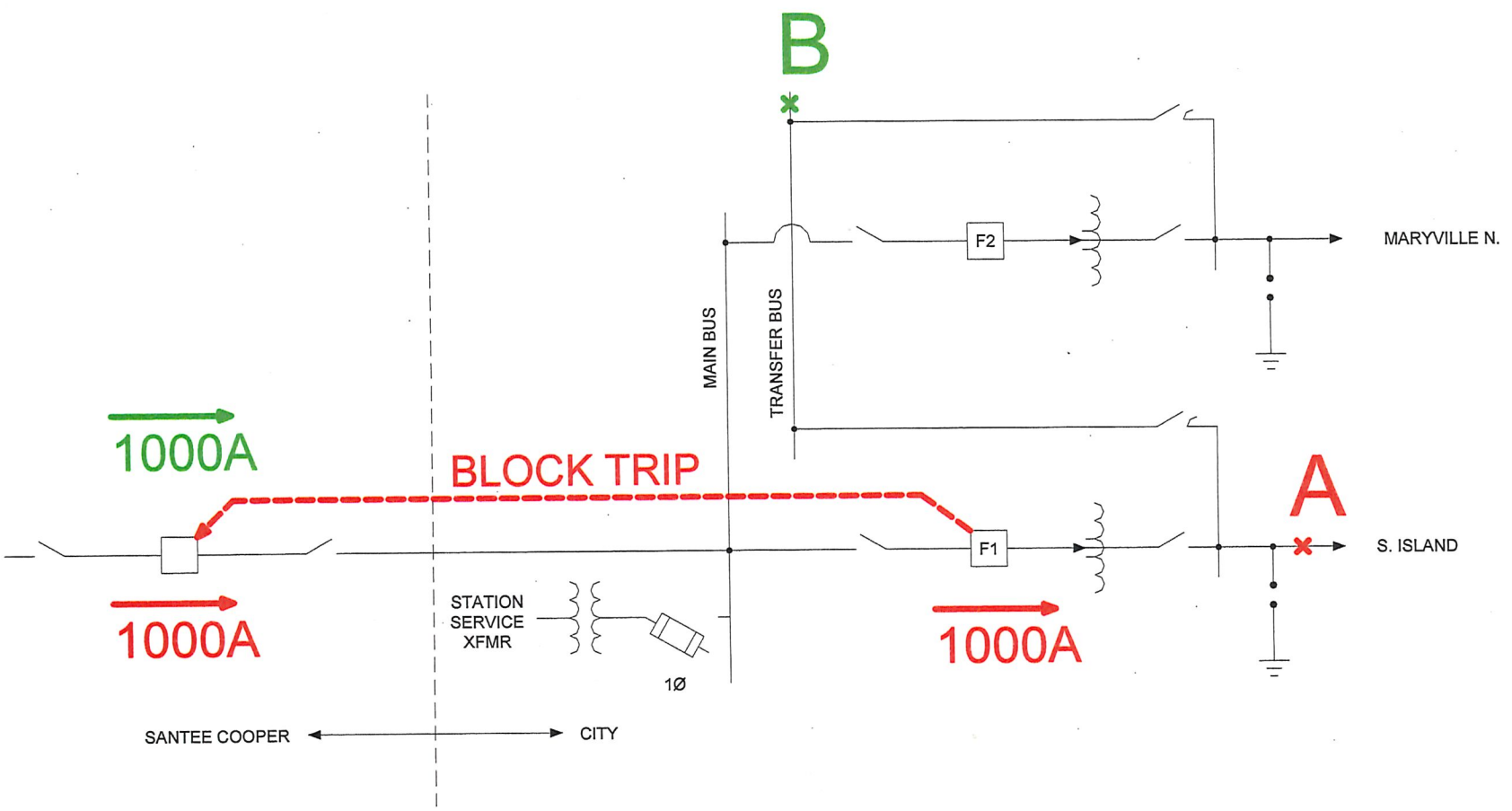
New Substations – Fast Bus Trip



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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.

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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%

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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 1st Reclose	104	76.5%	40	85.1%	144	78.7%
Cleared by 2nd Reclose	22	16.2%	2	4.3%	24	13.1%
Cleared by 3rd 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%

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Questions

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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

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