SOUTHERN COMPANY *Transmission*

Recent Experiences with Fault Induced Delayed Voltage Recovery

U.S. Department of Energy Workshop

Dallas, Texas

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Outline

- Southern Balancing Area overview
- FIDVR Definition
- Union City Event
- Assessment and Management of Current and Future Exposure to FIDVR
- Questions / Discussion

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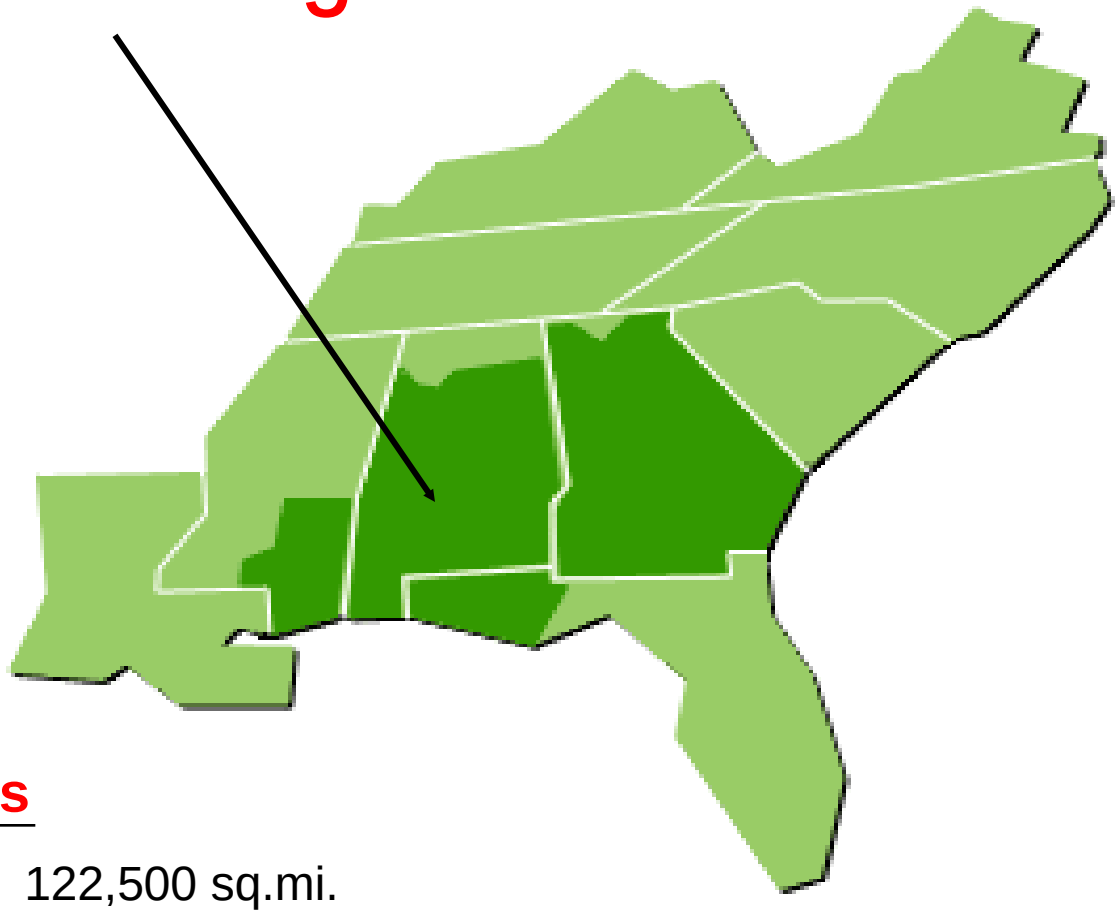
The Southern Balancing Area



Statistics

Service area:	122,500 sq.mi.
2007 Peak Demand:	48,008 MW
2003 Peak Demand:	40,887 MW
1997 Peak Demand:	35,415 MW

Fault Induced Delayed Voltage Recovery (FIDVR)

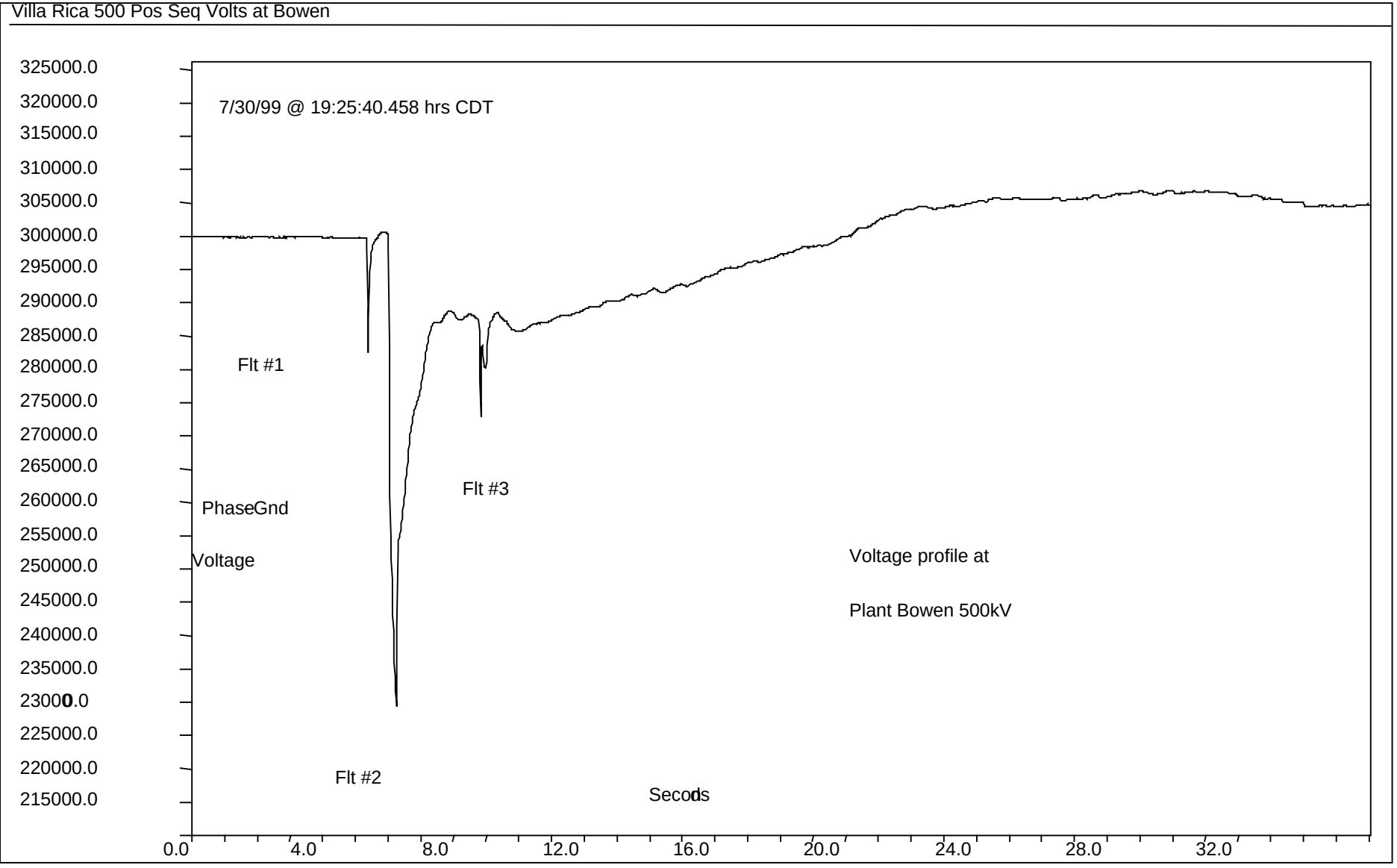
- What is it?
  - After a fault has cleared, the voltage stays at low levels (below 80%) for several seconds
- Results in dropping load / generation or fast voltage collapse
- Key factors driving FIDVR exposure:
    - Fault Duration and Location
    - High load level with high Induction motor load penetration
    - Unfavorable Generation Pattern
      - Lack of well located Dynamic Mvars

July 30th 1999 Union City Event

- At 8:25 p.m. EST, a coupling capacitor failed violently at Union City (metro Atlanta)
  - on ccvt for the East Point White 230 kV line
  - phase - to - ground fault normally cleared at both ends
  - about 1/2 second later, Union City reclosed into a phase-phase-ground fault
  - Union City breaker did not open, causing breaker failure scheme to trip all Union City 230 kV Bus #1 breakers

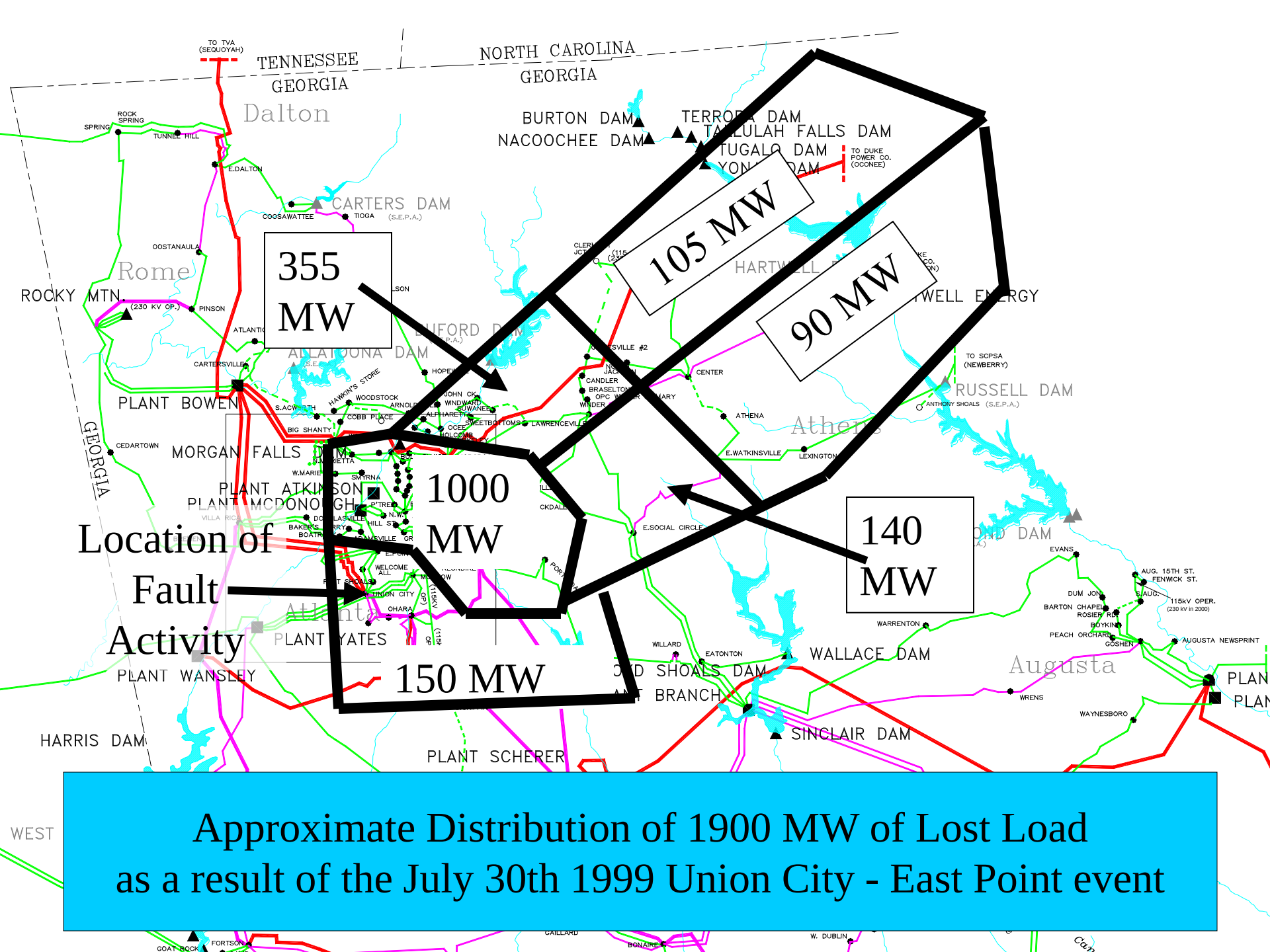
July 30th 1999 Union City Event

- Sequence of Events continued…..
  - Approx. 2 seconds later, debris from the failed capacitor fell into the Union City - East Point 230 kV Black line (located on Union City 230 kV Bus #2) - resulting in yet another phase - to - ground fault
  - Union City end normally cleared for this fault
  - East Point end did not clear quick enough, thus initiating the breaker failure scheme for the East Point #2 230 kV bus


Villa Rica 500 Pos Seq Volts at Bowen
325000.0
320000.0
315000.0
310000.0
305000.0
300000.0
295000.0
290000.0
285000.0
280000.0
275000.0
270000.0
265000.0
260000.0
255000.0
250000.0
245000.0
240000.0
235000.0
230000.0
225000.0
220000.0
215000.0
7/30/99 @ 19:25:40.458 hrs CDT
Flt #1
Flt #2
Flt #3
PhaseGnd
Voltage
Voltage profile at
Plant Bowen 500kV
Seconds
0.0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0

July 30th 1999 Union City Event

- As a result of the event:
  - Approximately 1900 MW of load was dropped
  - Less than 100 MW of load lost was due to utility breaker operations
    - The vast majority of load lost was due to Induction Motor protection
  - Seven units with a total output of approximately 1065 MW tripped during or minutes after the event


355 MW
105 MW
90 MW
1000 MW
140 MW
150 MW
Location of Fault Activity
Approximate Distribution of 1900 MW of Lost Load
as a result of the July 30th 1999 Union City - East Point event

FIDVR Exposure

- Since ‘99 Union City event, load has grown
  - Load growth rate in North Georgia equivalent to the remainder of the Southern Balancing area
  - Metro Atlanta area continues to be a “net importer” of energy and deficient of dynamic Mvar
  - Hence, FIDVR exposure is increasing annually
    - Single and Multiple contingency

FIDVR Exposure

- Management of FIDVR Exposure for single contingencies
  - Risk is currently being managed by avoiding unfavorable generation patterns
  - Management of FIDVR exposure in the Operations arena with current transmission infrastructure will continue until 2008
  - Beginning in summer 2008, capital projects will be required to offset increased exposure to FIDVR due to load growth

FIDVR Exposure

- A plan to manage single contingency exposure has been developed for the entire Planning Horizon (10 years)
- Highlights of 10 year Planning Horizon Plan
  - 260 Mvar SVC
  - Relocation of key units from higher to lower kV interconnection
    - Effectively moves dynamic Mvar source closer to load

FIDVR Exposure

- Highlights of 10 year Planning Horizon Plan continued
  - Conversion of 500 kV line to 230 kV operation
    - Increased line impedance reduces the amount of load seeing depressed voltages for critical fault locations
  - Targeted 2011 RFP resulted in selection of new generation in North Georgia area
- Annual incremental Dynamic Mvar need is currently projected to remain constant
  - Thus, FIDVR exposure and corresponding solutions will continued to be assessed in the future

FIDVR Exposure

- Studies indicate there is exposure to low probability, high consequence multiple event driven voltage collapse in North Georgia (NERC Category D) at high summer load levels
- Three pronged strategy to mitigate exposure to voltage collapse due to multiple event contingencies
  - Faster total breaker failure clearing times
  - Breaker replacements
  - UVLS Scheme
- Implementation of the strategy to manage multiple contingency exposure is ongoing

Conclusions

- The Southern Balancing area experienced its first FIDVR event in 1999 as a result of a multiple contingency event
- Exposure to FIDVR due to single contingency events is managed in the Operations arena by avoiding unfavorable generation patterns
- Plans for capital projects needed to manage exposure to FIDVR due to load growth for both single and multiple contingency events has been developed and is currently being implemented on an appropriate schedule.

DISCUSSION and QUESTIONS