



2012 EERI Annual Meeting & National Earthquake Conference



"A Three Service Utility's System Interdependencies Analysis and Mitigation Efforts "

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25 Years of Risk Assessments and Seismic Mitigation Efforts

- Electric Engineering and Operations reprioritized retrofit actions to the infrastructure based on a 2007 Multi-Hazard Risk Assessment
- Gas Engineering and Operations has played a pivotal role in MLGW's seismic retrofitting efforts when it started a monumental seismic mitigation project to replace of all of our cast iron distribution mains back in 1991.
- Water Engineering and Operations have been at the forefront of MLGW's seismic retrofitting efforts since a 1989 study of the water system.
- Facilities Engineering originally designed life-safety seismic performance into our 1987 build out of our Systems Operations facility prior to code mandates and continue with retrofitting efforts and qualifications on future designs.

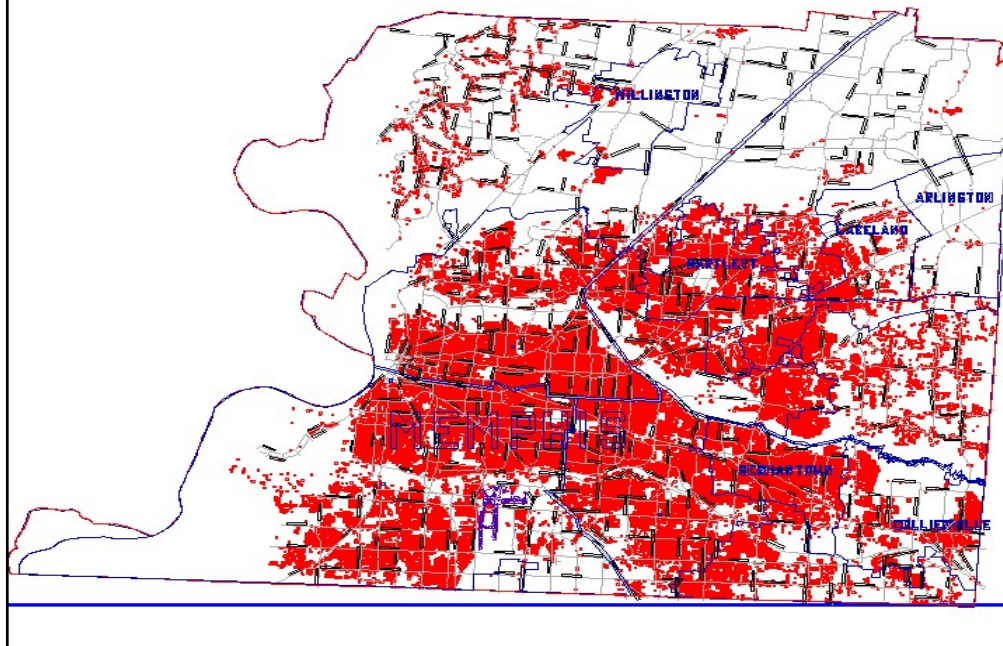
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Tuesday, July 22, 2003

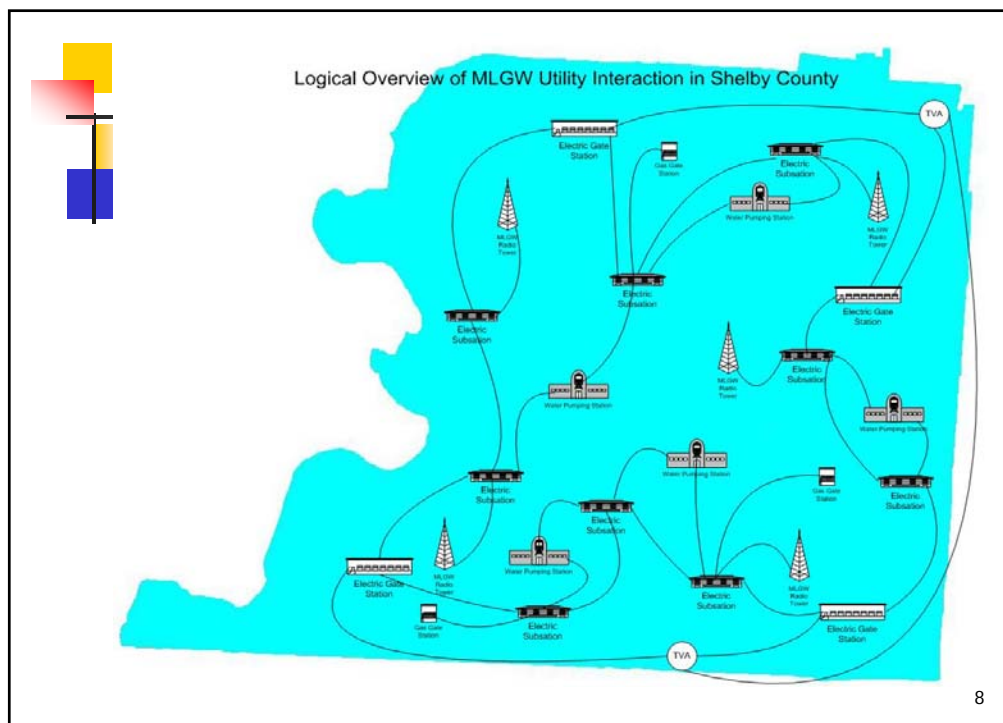
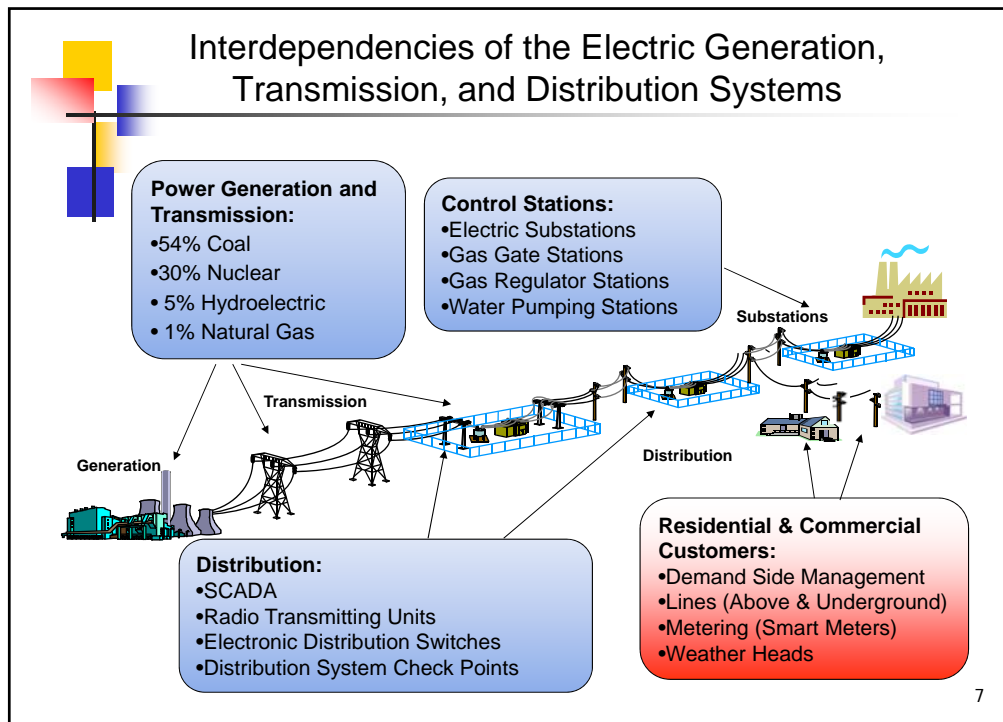
- **279 Distribution circuits affected (>70%)**
 - Approx. **339,000** Electric Customers affected (>80%)
 - Substations themselves remained operational
- **8 Water Pumping Stations affected (80%)**
 - Approx. **200,000** Customers
- Telecommunications failures affecting electric, gas, and water distribution system functionality
- Damage to multiple division facilities
- Storm damage costs in Shelby County exceeded \$525M.

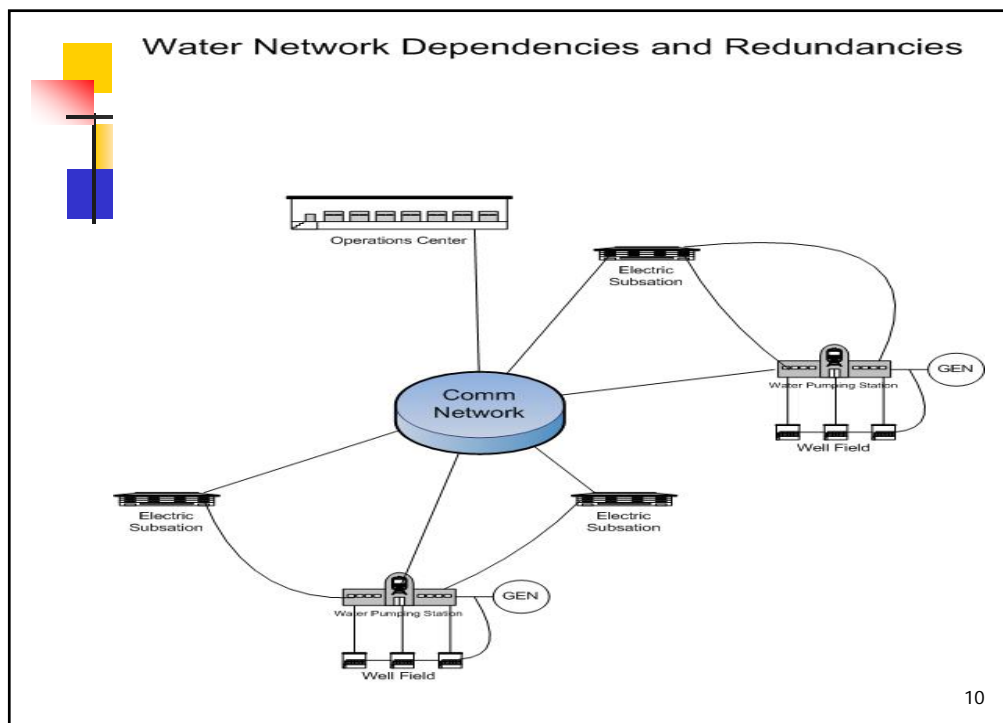
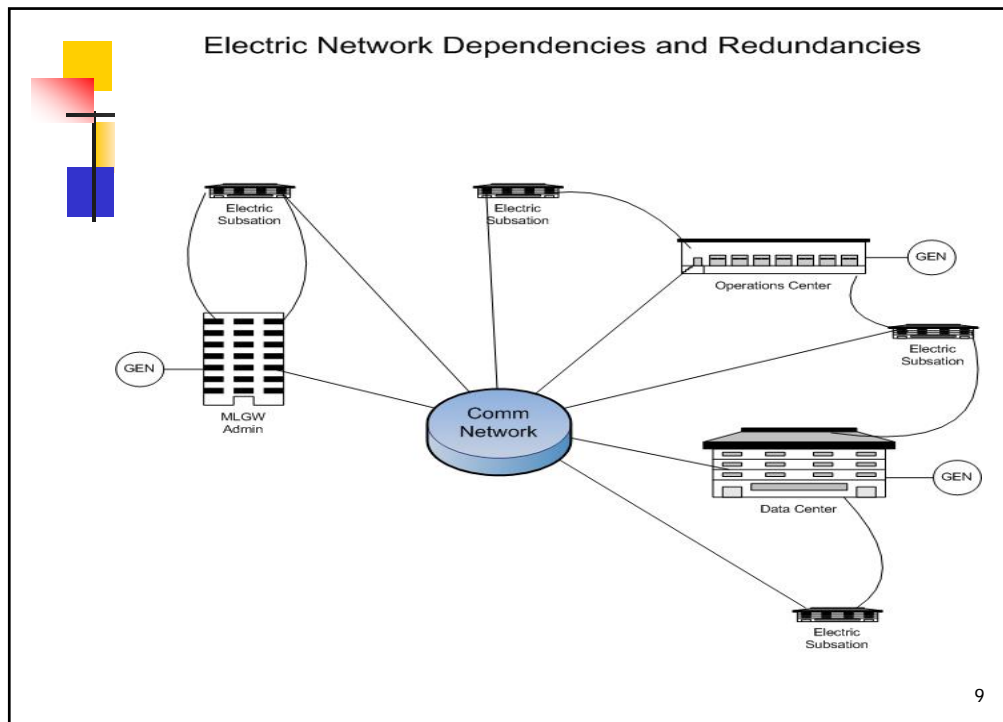
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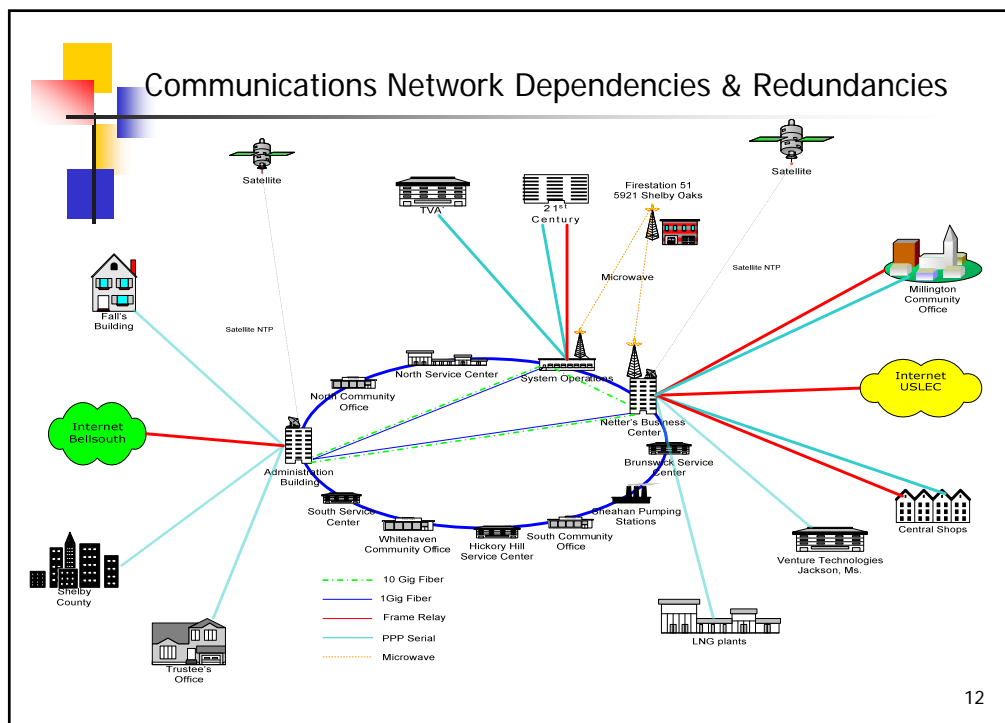
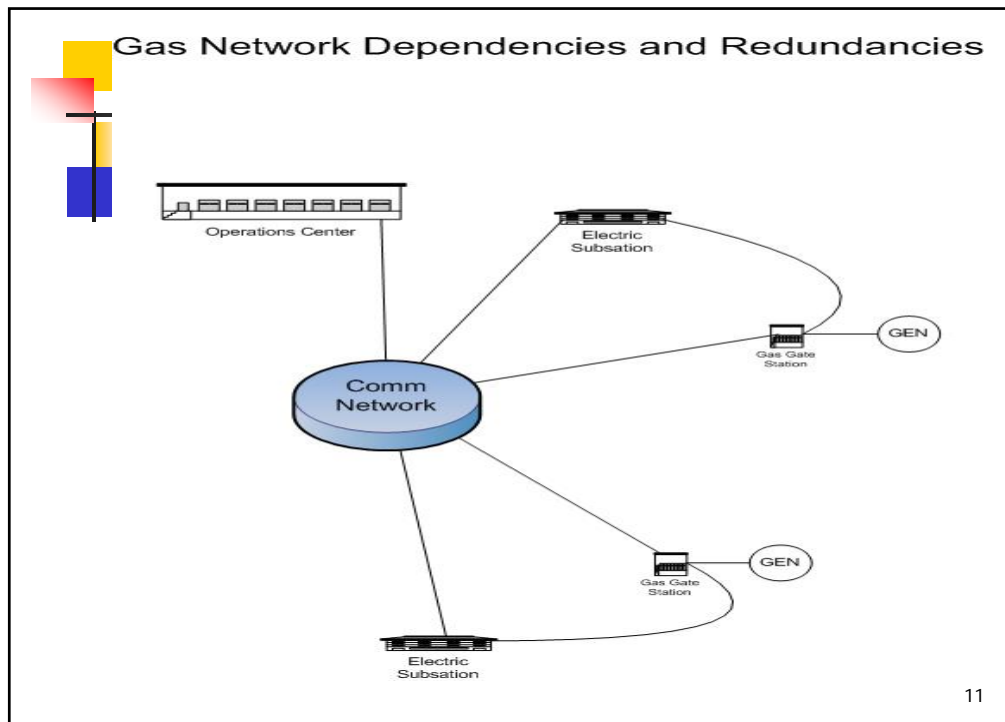


Restoration Priorities

- Hospitals
- Water Pumping Facilities
- Public Sewage
- Airports (MIA and NAS)
- Facilities Essential for Restoration; EMA Requests, Major Media, MLGW
- Primary Trunk Circuits
- Primary Tap Circuits
 - Life support issues
 - Police
 - Fire
 - Nursing Homes (by number of beds)
 - Schools (School in/out dependent)
- Other Broadcasting (Stations above 100 KW and only if their emergency generation is inoperable.)
- Community Convenience e.g.. Major grocery stores, gas stations etc
- Secondary (including transformers)
- Individual Services









Electric Infrastructure

2007 Multi-Hazard Risk Assessment Prioritized Recommended Retrofit Actions

- **Seismic anchorage of unanchored 161 kV substation transformers**
- **Seismic anchorage of rail-mounted 115 kV & 23 kV substation transformers**
- Seismic anchorage of unanchored network system transformers
- Non-structural anchorage, bracing or restraints for nonstructural control and metering equipment in substation control and oil buildings and in the electric operations/SCADA building.
- Seismic anchorage of selected highly vulnerable substation yard equipment other than transformers and selective mitigation of components such as surge arrestors whose failure poses an impact risk to critical transformers.
- Structural retrofits for seismically deficient substation control and pump buildings
- Seismic anchorage of unanchored distribution system transformers, including pad-mounted and vault-mounted transformers, gravity hung transformers on pole cross arms and unrestrained platform mounted transformers, and seismic anchorage of unanchored distribution system switchgear cabinets.

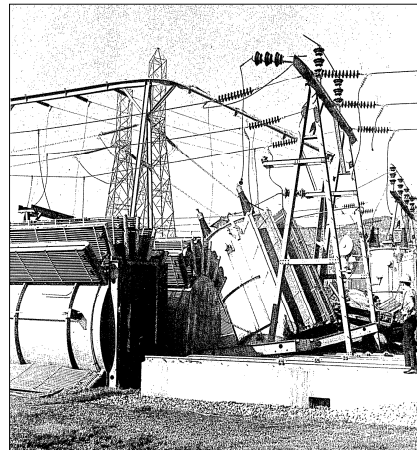
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Electric Infrastructure Cont'



MLGW Substation #3



Substation after the 1971
San Fernando Earthquake

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Electric Infrastructure Cont'

Seismic Retrofit of Substation Transformers



Transverse Seismic Restraint



Longitudinal Seismic Restraint

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Gas Infrastructure



- Gas Engineering/Operations has also played a pivotal role in MLGW's seismic retrofitting efforts. The decision of the Tennessee Regulatory Authority to require MLGW to plan the replacement all of its cast iron distribution mains back in 1991, was actually the beginning of a monumental seismic mitigation project for the Division.
- The combination of rigid pipe material, mechanical pipe connections at the joints, and an extremely low operating pressure makes the cast iron gas distribution system very vulnerable to numerous gas leak problems in the event of an earthquake.
- The new, polyethylene replacement piping is flexible, which means it can stand deflection and ground movement without as much risk of failure. Also, with a higher operating pressure, gas leaks can be identified earlier at failure points.
- MLGW started with 330 miles of cast iron gas mains.

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Gas Infrastructure Cont'



- Another seismic mitigation project by the gas division is the de-commissioning of the Arlington LNG plant. The 2007 Hazards Mitigation Study identified that the amount of money required to safely utilize the LNG storage tank was simply not worth the investment for MLGW.

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Water Infrastructure



- Six main areas of seismic retrofitting can be categorized for water production:
 - 1) Building seismic retrofits at four pumping stations to include aerator, filter, and pump buildings.
 - 2) Installation of reservoir-mounted high service pumps at three pumping stations to negate the effect of building collapse hazards on transmission or pumping capabilities.
 - 3) Upgrades have been performed to provide dedicated electrical circuits to well fields feeding five water pumping stations.
 - 4) Work has been completed to install emergency generators at water pumping stations and in some cases a second backup generator was provided.
 - 5) Seismic retrofitting of select wells in each well field feeding all of the eight major water pumping stations.
 - 6) Installation of SCADA-remote capable header valves at all eight of the major water pumping stations.

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Facilities Infrastructure

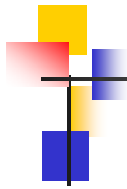


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Facilities Infrastructure Cont'

- Building Seismic Mitigation
 - Netters Business Building 2003
 - Critical areas relocated from Administration Building to Netters for Business Continuity (CCC, IT, Dispatch, CRC)
 - \$600,000 spent towards foundation and superstructure seismic upgrades
 - Electric/Systems Operations
 - Originally designed for life-safety seismic performance level prior to code mandates
 - All other facilities do not have seismic structural design (except water retrofitted pumping stations)
 - Truck Canopies at Brunswick, Hickory Hill, and South Service Center have been seismically retrofitted. This was recommended to prevent damage to parked crew trucks under the concrete canopies at these service centers.

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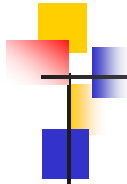


Structural Mitigation



- Foundation Strengthening

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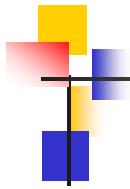


Structural Mitigation



- Vertical Truss Retrofitting

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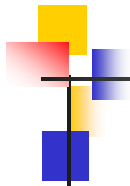


Structural Mitigation



- Horizontal Truss Retrofitting

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Structural Mitigation



- Wall Panel Connections Retrofitting

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Facilities Infrastructure Cont'

- Non Structural Seismic Mitigation

- Seismic anchorage of pad mounted Power Transformers at Netters, ESO, and planned/budgeted for other facilities.
- Light fixture anchors added at Administration Building
- All newly installed HVAC duct work and equipment are seismically anchored.
- Seismic gas shut-off valves installed at 16 locations including all of NSC and all of the water pumping stations.
- Damage to Non-Structural Systems and Components Typically:
 - Results in the majority of earthquake financial loss
 - Losses can typically exceed 50% of the total value even though the structure sustains little or no damage
 - Best cost to benefit ratio!

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Facilities Infrastructure Cont'

- ATC Post Earthquake Inspections

- About 35 in-house engineers and technical professionals are trained and certified to perform post-earthquake inspections of MLGW facilities.
- A total of approximately \$1.3M has been spent since 1992 on these facilities-related seismic improvements.
- Future Planning
 - Future building purchases to be restricted to buildings constructed post-1991.
 - Continue budgeting for non-structural upgrades to Power Transformers, HVAC, Lighting, architectural building elements, etc.

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Emergency Operations Center

- Inside the room are five LCD televisions to monitor local as well as national news and weather.
- There are more than 36 dedicated phone lines as well as laptops and Internet connections.
- There are good old fashioned paper maps of utility grids in case GIS mapping is unavailable.
- Crisis teams are in one room and have the capability of looking on the network, on their own laptop, bringing up their own information and talking amongst themselves in this room in a coordinated effort.
- Reinforced windows
- Back up generators
- 30 mobile radios are stored in case other communications go down.

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New Crisis Teams Assembly: MLGW Gary Emergency Center



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