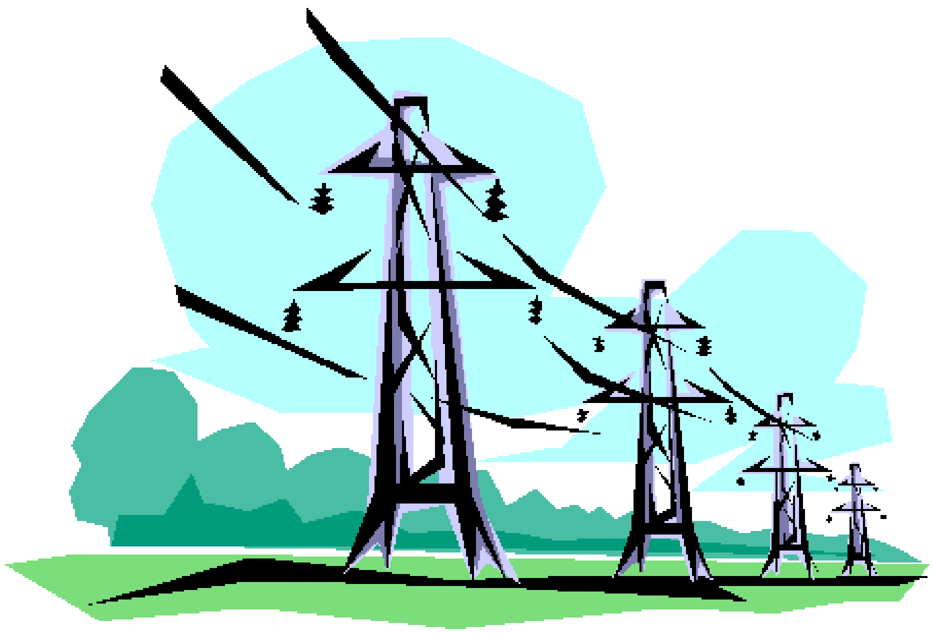
# Michigan Public Service Commission

# Report on August 14th Blackout

**November 2003**




***Public Service Commission***

**J. Peter Lark, Chair**
**Robert B. Nelson, Commissioner**
**Laura Chappelle, Commissioner**

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# MICHIGAN PUBLIC SERVICE COMMISSION

# REPORT

# BLACKOUT OF AUGUST 14, 2003

## *EXECUTIVE SUMMARY*

The August 14, 2003 blackout was a wake-up call concerning reliability of our nation's electric grid. What started out as a typical warm summer day, which looked largely uneventful to most electric reliability coordinators (and others) in the northeastern region of the country took a sharp u-turn at approximately 4:10 p.m., when, in a matter of seconds, 50 million North Americans found themselves without power. North America's largest ever outage stretched from southeastern Michigan through Ontario and northern Ohio, all the way east to New York City. Through this event, North Americans were abruptly reminded how vital electricity is in our everyday lives and how tightly interconnected and vulnerable this country's electric grid has become.

The Public Service Commission did not attempt to determine the root cause of the blackout. However, our investigation did not reveal any evidence that Michigan utilities or transmission operators were responsible for the blackout. All of the transmission line and power plant outages that occurred in the two and one-half hours preceding the power surges that precipitated the blackout involved the facilities of FirstEnergy and American Electric Power in Ohio. These events led to two large power surges as power from southern Ohio attempted to reach load in northern Ohio. The first surge was from southern Ohio, west to Indiana, north to western Michigan, east to the Detroit area, and south to northern Ohio. This surge resulted in the opening of interconnections in central Michigan between the western part of the State and the Detroit area. These interconnection trips occurred as designed to prevent damage to equipment from the power surge. The second power surge involved a giant loop from southern Ohio to Pennsylvania to New York to Ontario to Michigan to northern Ohio. This surge resulted in the blackout around what is generally referred to as the Lake Erie Loop.

Michigan utilities and transmission companies were not notified of the problems being experienced by FirstEnergy and American Electric Power and received no advance warning of the potential blackout. The first indication in Michigan of an impending emergency occurred at 4:09:27 p.m. when an interconnection in central Michigan exceeded its emergency rating as a result of the first power surge coursing through the State. A minute later the power outages began and by 4:15 p.m., the blackout was complete. A total of 2.3 million customers of The Detroit Edison Company, Consumers Energy Company, and the Lansing Board of Water and Light were left without power.

Our investigation leads to the conclusion that electric reliability has been seriously compromised by the fragmented and ineffective regulation of the electric transmission system. The Midwest market is coordinated through two regional transmission organizations (RTO), rather than one. Moreover, the two RTOs are voluntary organizations that do not cover contiguous territories but rather are intermixed in a checkerboard fashion. This "Swiss-cheese" approach to coordination prevents any one entity from comprehending the overall situation. The situation is exacerbated by a lack of enforceable reliability standards. The North American Electric Reliability Council (NERC) is responsible for the development of procedures for reliability coordinators, but lacks the authority to enforce those standards. A NERC investigation of compliance in 2002 found that there were 444 violations of operating measures totaling $9 million in "simulated sanctions". In addition, the Federal Energy Regulatory Commission (FERC), the agency responsible for economic regulation of transmission, indicates that it lacks authority to develop or enforce reliability standards.

In our opinion, the simulated enforcement of reliability standards is inadequate to protect Michigan or the nation's citizens. We recommend that the FERC be authorized to require membership in a single transmission organization for each region and have the jurisdiction to mandate the development of reliability standards and enforce those standards with real rather than simulated sanctions.

With regard to recovery from the blackout, our investigation reveals that Detroit Edison, Consumers Energy, and the Lansing Board of Water and Light performed appropriately. However, we conclude that there were two factors that caused restoration in Michigan to lag behind other States. First, Detroit Edison's computerized dispatch system was inoperable due to the blackout, which required additional time and effort for the restoration. We recommend that the utility conduct a study of potential modifications to the system and report to the Commission on the results. Second, the failure of rupture disks at four of the Detroit Edison generating plants slowed the pace of restoration. Since rupture disks are a feature designed to protect against more serious damage to the units, this does not necessarily indicate a problem. However, we are recommending that Detroit Edison analyze the operation of the rupture disks on its units, including a comparison with the operation of disks on other utility systems affected by the blackout, to determine whether any changes are warranted.

Finally, with respect to emergency planning and response efforts, we conclude that the operations conducted through the State Emergency Operations Center (SEOC) were effective in implementing the emergency response plans. However, we note two important improvements that can be made to better prepare for future contingencies. First, the Commission Staff members who participated at the SEOC were volunteers. We conclude that Staff for the SEOC should be assigned in advance and receive training in the operations required to implement the emergency plans. Second, we note that the existing emergency electrical procedures were adopted in 1979 and have not been reviewed since. Although those particular procedures were not needed in this instance, we conclude that it is time for them to be reviewed and, if necessary, updated.

# INTRODUCTION

The August 14, 2003 electricity blackout stamped an indelible impression on the minds of North Americans. Stretching from as far west as Detroit, the blackout covered much of Ontario, Canada, northern Ohio and extended all the way east to New York City. Almost as quickly as the event struck an avalanche of worldwide media coverage reported that the largest electric blackout in North American history had, in a matter of minutes, suddenly plunged 50 million North Americans into darkness and forced thousands of businesses to abruptly close operations. In its wake a renewed appreciation of the importance of electricity in all aspects of our everyday lives was stirred along with a rekindled understanding of just how intricately interwoven, interdependent, and vulnerable our electrical system has become. A search for answers as to what happened on August 14, and, more importantly, what can be done to strengthen the reliability of our electric system to prevent such an event from recurring in the future was immediately set in motion with a sense of keen urgency. With over six million residents out of power for up to two days and hundreds of businesses shut down, some for several days, Michigan elected to commence an investigation to examine the blackout from our vantage point.

The Michigan Public Service Commission is one of a number of entities commencing an investigation to examine what went wrong on August 14 and, more importantly, to determine how such an event can be prevented from recurring in the future. The recommendations in this report are based upon an analysis of those events in and around the State that resulted in the blackout. The report is organized into five parts. Part I – Facts and Overview – presents a summary of the electric power system, the relevant actors in that system, and the timeline of events on and after August 14. Part II – Electric Transmission – analyzes the operation of the transmission system, including operators and regional oversight organizations. Part III – Utility Operations – analyzes the operation of utility distribution systems and the efforts of utility personnel to recover from the blackout. Part IV – Emergency Planning and Response – discusses the response of the Michigan Public Service Commission and other State government agencies in the recovery operations and discusses the interdependencies among the various infrastructures that were affected by the blackout. Finally, Part V – Conclusions – presents a summary of the recommendations put forth in the report.

This report was prepared by the Michigan Public Service Commission and its Staff. The Commission wishes to thank Gary Kitts, Lisa Molner, Jeff Pillon, and Paul Proudfoot, who were the primary investigators, along with Robin Barfoot, Bill Bokram, Tim Boyd, Angela Butcher, Bill Celio, Mike Fielek, Mick Hiser, John King, Steve Paytash, and Linda Stevens. Information was obtained from various entities involved in the power production and delivery system, including utilities, transmission companies, and regional transmission organizations. Information was also provided by other State government agencies – the Commission wishes to acknowledge the assistance of Bob Tarrent and Celeste Bennett of the Department of Agriculture; James Cleland, Water Division, Department of Environmental Quality; Captain Dan Smith, Michigan State Police; Eileen Phifer, Department of Transportation; Dan Lohrman, Department of Information Technology; and Colonel Mike McDaniel, Homeland Security Advisor to the Governor.

The events of August 14 are reminiscent of a scene from the 1950 movie The Day the Earth Stood Still. Professor Barnhard was talking to his secretary Hilda about the worldwide electric blackout that had been caused by alien visitors to Earth. He asked her, “Does this make you feel insecure?” and she said “Yes.” His response was “I am glad,” because he hoped that the blackout would bring about change. The Commission does not wish to suggest that anyone should be glad about the events of August 14, but we believe that the recommendations in this report will, if implemented, bring about the changes necessary to ensure a more reliable electric system for all.

# PART I

# FACTS AND OVERVIEW

## Section 1.1: Overview of the Electric Power System

We have come to expect it – flip the switch and the light comes on. It is something that almost every child, from the age of two, learns as the natural order of things. However, this everyday commonplace would have seemed like magic to those predating the work of Thomas Alva Edison. Indeed, a large, complex system of organizations and infrastructure is required for the lights to stay on.

Generally, the electric power system is divided into three components: generation, transmission, and distribution.

Generation, or the act of producing electricity, is, for the most part, carried out at large power plants, which convert another energy source to electricity. Although the specific details vary, in general, fossil fuel plants burn coal, oil, or natural gas, use the resulting heat to convert water to steam, and then run the steam (or the heated air from combustion) through turbines to create electricity. Other fuels, such as landfill gas or municipal solid waste, can be substituted in essentially the same process. The generating process in nuclear plants is similar, except that the heat is derived from the fission decay of radioactive elements.

Electricity can also be generated by non-thermal means. Hydroelectric plants generate electricity by directing falling water through turbines. Electricity can also be produced using wind-driven impellers to turn the generating unit. In addition, sunlight can be used to generate electricity in photovoltaic cells. Based on data (through June 2003) published by the Energy Information Administration, the current mix of electric generation in Michigan and nationally is as follows:

| Fuel Type | Michigan | United States |
|---|---|---|
| Coal | 62.6 % | 51.0 % |
| Nuclear | 23.3 % | 20.1 % |
| Natural Gas | 10.2 % | 17.2 % |
| Renewable Power[1] | 2.5 % | 2.1 % |
| Petroleum | 0.8 % | 2.8 % |
| Hydro | 0.6 % | 6.8 % |

The transmission function involves the large-scale movement of power from generating units to the distribution networks, which then deliver that power to the customer. Transmission is distinguished from distribution in that transmission lines are larger, operate at significantly higher voltages, and individually deliver much larger amounts of power. Transmission can be

[1] The Energy Information Administration definition includes: wood, black liquor, municipal solid waste, landfill gas, sludge waste, tires, agricultural byproducts, biomass, geothermal, solar thermal, photovoltaic, and wind.

fairly described as the bulk transport of power primarily at wholesale, while distribution is the delivery to the customer of smaller amounts of power at retail.

In the past (and still to a great extent today), all three functions were performed by a single entity. Investor-owned utilities are usually large private companies that generate their own power and serve customers in designated franchised service territories. In Michigan, there are two large investor-owned utilities (Detroit Edison and Consumers Energy) that between them serve more than 80% of the State and seven smaller ones.[2] Cooperative utilities are member-owned companies that normally serve rural areas. There are 12 cooperative utilities in Michigan. Municipal utilities are publicly-owned organizations that serve the local municipality and may serve some adjacent areas. There are 41 municipal utilities in Michigan. In some cases, cooperative and municipal utilities own generation, but, in others, they enter into joint generation agreements. Both approaches are used in Michigan.

In recent years, three new types of entities have begun to enter the electric utility market. Independent power producers are private companies, not associated with the local utility, that build and operate electric generation plants and sell the power output into the market. In 2002, independent power producers built four new generating plants in Michigan.

Alternative electric suppliers are private companies that sell power at retail in competition with the local electric utilities. Alternative electric suppliers do not own distribution lines or deliver the power – they rely on the local utility to do that for a fee. To date, the Commission has licensed 26 alternate electric suppliers to operate in Michigan.

Independent transmission companies are private companies that own and operate one or more transmission systems. The two largest electric utilities in Michigan have sold their transmission assets to independent companies. Hence, the utilities now own the generation plants and distribution networks, but independent companies own the transmission that connects the two.

There are other organizations that are not directly involved in operations, but can have a significant impact on reliability. Regional transmission organizations (RTO) are composed of transmission companies (both independent and utility) within a given region. RTOs are responsible for coordinating access to and use of the transmission network. RTOs are subject to approval by the Federal Energy Regulatory Commission, which has jurisdiction over wholesale transactions and transmission of electricity in interstate commerce.

## Section 1.2: Key Participants

The following is a list and brief description of electric industry participants relevant to the blackout of August 14:

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[2] All but one of the smaller investor-owned utilities (and the two largest) are subsidiaries of much larger holding companies.

- American Electric Power Company (AEP) – a large public utility holding company that operates in eleven states.[3] Its subsidiary, Indiana Michigan Power Company, operates in the southwest corner of Michigan.

- Consumers Energy Corporation – a large combined gas and electric utility, serving 1.7 million electric customers throughout most of the Lower Peninsula outside of the Detroit metropolitan area. It is a subsidiary of CMS Energy Company.

- The Detroit Edison Company – the largest electric utility in Michigan, serving 2.1 million customers in the Detroit metropolitan area. It is a subsidiary of DTE Energy Company and an affiliate of Michigan Consolidated Gas Company, which is a gas utility serving a similar territory.

- East Central Area Reliability Council (ECAR) – a voluntary organization designed to augment electric reliability through coordinated planning and operation of its members' generation and transmission facilities. The ECAR region includes Indiana, Kentucky, Michigan (Lower Peninsula only), Ohio, West Virgina, and small portions of four other states.

- FirstEnergy Corporation – a public utility holding company with seven electric utilities and a transmission subsidiary operating in New Jersey, Ohio, and Pennsylvania.

- Hydro One Networks, Inc. – one of four subsidiaries of Hydro One, Inc. It owns and operates 97% of the electric transmission lines in Ontario.

- International Transmission Company (ITC) – an independent transmission company that owns and operates the transmission system formerly owned by Detroit Edison. ITC is a subsidiary of the investment firm Kohlberg Kravis Roberts & Co.

- Michigan Electric Transmission Company (METC) – an independent transmission company that owns and operates the transmission system formerly owned by Consumers Energy. METC is a subsidiary of Trans-Elect, Inc.

- Midwest Independent System Operator (MISO) – a regional transmission organization covering all or parts of Indiana, Illinois, Iowa, Kansas, Kentucky, Manitoba, Michigan, Minnesota, Montana, North Dakota, Ohio, Pennsylvania, South Dakota, and Wisconsin. Both ITC and METC are members of MISO.

- North American Electric Reliability Council (NERC) – an umbrella organization formed in 1968 (after the New York blackout) to oversee the functions of ten regional reliability councils, including ECAR.

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[3] In addition to Michigan, these are Arkansas, Indiana, Kentucky, Louisiana, Michigan, Ohio, Oklahoma, Tennessee, Texas, Virginia, and West Virginia.

- Ontario Independent Market Operator – a not-for-profit organization responsible for operating and regulating the wholesale electricity market in Ontario.

- PJM Interconnection – a regional transmission organization covering all or parts of Delaware, Maryland, New Jersey, Ohio, Pennsylvania, Virginia, West Virginia, and the District of Columbia.

**Section 1.3: Key Events from Michigan's Perspective**

This section contains a summary of the key events leading to and following the blackout from Michigan's perspective. It is not intended to include all events that could arguably have affected the blackout. Several organizations (FirstEnergy, ITC, METC, AEP, PJM, MISO, NERC, and the U.S./Canada Power Outage Task Force) have issued sequences of events. All of these sequences are generally consistent. This report draws from all of these in order to set forth what we consider to be the significant events, as viewed from Michigan's perspective.

**Section 1.3.1: Thursday, August 14, 2003**

- 12:05:44 p.m. – AEP Conesville Unit 5, with a rating of 375 megawatts (MW), trips[4] off-line. Most sequences begin with this event and it is included here only for completeness. In our opinion, this was not an event connected to the blackout. Since this unit had been down for two months, it was not expected to be producing electricity that day. The unit, which is located in central Ohio, was out of service for a short period and was back on-line at 3:20 p.m., nearly an hour before the blackout.

- 1:14:04 p.m. – Detroit Edison Greenwood Unit 1, with a rating of 785 MW, goes off-line. Like the previous item, this event is included only for completeness, as it does not appear to be an event connected to the blackout. The unit experienced a boiler fuel trip at 12:45 p.m. The output of the unit was gradually reduced until it went off-line at 1:14 p.m. The unit, which is located north of the Detroit area, was brought back on-line and was producing about half of its rated capacity at the time of the blackout. However, other generators on the Detroit Edison system had been brought on-line to compensate for the capacity loss, so there was no overall reduction in output. The Michigan system was in balance prior to the last significant events before the blackout.

- 1:31:34 p.m. – FirstEnergy Eastlake Unit 5, with a rating of 597 MW, trips off-line. This is arguably the first of many events that cumulatively led to the blackout. The unit, which is located in northern Ohio, along the shore of Lake Erie, was still off-line at the time of the blackout and the output of the unit had not been replaced. According to the testimony of Peter Burg (chairman and CEO of FirstEnergy) before the U.S. House of Representatives Committee on Energy & Commerce, the Eastlake

[4] The term "trip" refers to the automatic removal from service of a unit.

Unit 5 tripped during the process of restoring the voltage regulator from manual to automatic control. According to Mr. Burg, this procedure was undertaken in order to stabilize reactive power output, so that the unit could later resume the requested voltage schedule. An ARS (automatic reserve sharing – a request for assistance to meet load when there is a loss on a utility's system) was initiated for 595 MW from within the ECAR region. Mr. Burg indicated that they planned to supply some of this by cutting a 300 MW sale into PJM.

- 3:05:41 p.m. – FirstEnergy Harding–Chamberlain 345 kilo-Volt (kV) line into northern Ohio trips.

- 3:32:03 p.m. – FirstEnergy Hanna–Juniper 345 kV line in northern Ohio trips. It has been reported that this line disconnected because it sagged into a tree.

- 3:41:33 p.m. – AEP/FirstEnergy Star–South Canton 345 kV line in northern Ohio trips. AEP reports that this line opened due to high load and a phase to ground trip. AEP owns 0.69 miles of this line and FirstEnergy owns 33.42 miles. The U.S./Canada Power Outage Task Force reports that, with this and the prior two transmission lines disconnected, the effectiveness of the transmission path from eastern Ohio into northern Ohio was reduced.

- 3:42 p.m. – Multiple smaller lines begin to trip open in northern Ohio.

- 3:45:33 p.m. – AEP Canton Central–Tidd 345 kV line in northern Ohio trips open and reconnects 58 seconds later. According to AEP, the Canton Central–Colverdale 138 kV circuit experienced six breaker operations in less than 3 minutes. This resulted in the 345/138 kV transformers being disconnected, isolating the 138 kV system from the 345 kV system. AEP owns 0.38 miles of the Canton Central–Cloverdale line and FirstEnergy owns 12.2 miles.

- 4:06:03 p.m. – FirstEnergy Sammis–Star 345 kV line in northern Ohio opens, completely blocking the 345 kV path from eastern Ohio into northern Ohio.

- 4:08:58 p.m. – AEP Galion–Muskingum River – Ohio Central 345 kV line in central Ohio opens due to high loading.

- 4:09:06 p.m. – AEP East Lime–Festoria Central 345 kV line in central Ohio opens due to high loading, blocking transmission paths from southern and western Ohio in northern Ohio.

- 4:09 p.m. – Six 138 kV lines from FirstEnergy Burger Unit substation open.

- 4:09 p.m. – FirstEnergy Burger Units 4 and 5, with ratings of 150 MW and 135 MW, trip.

- 4:09 p.m. – FirstEnergy Burger Unit 3, with a rating of 70 MW, is tripped manually.

- 4:09 p.m. – Power surges occur from southern Ohio, west to Indiana, north to western Michigan, east to the Detroit area, and south to northern Ohio.

- 4:09:27 p.m. – Majestic–Tomkins interconnection between METC and ITC in central Michigan exceeds its emergency rating.

- 4:09:27 p.m. – Bayshore–Monroe interconnection between ITC and FirstEnergy exceeds its emergency rating.

- 4:09:23 to 4:10:27 p.m. – Kinder Morgan plant in central Michigan, with a rating of 500 MW, but loaded to 200 MW, trips.

- 4:10 p.m. – FirstEnergy Harding–Fox 345 kV line in northern Ohio opens.

- 4:10 p.m. – Twenty generating units along Lake Erie in northern Ohio, loaded to a total of 2,174 MW, trip off-line.

- 4:10:36 p.m. – METC Battle Creek–Oneida and Argenta–Tompkins lines trip.

- 4:10:38 p.m. – Pontiac–Hampton and Jewell–Thetford interconnections between METC and ITC trip, isolating the METC system from ITC.

- 4:10:38 Midland Cogeneration Venture, loaded to 1,265 MW, trips.

- 4:10:38 p.m. FirstEnergy Perry–Ashtabula–Erie West 345 kV line trips, isolating northern Ohio from Pennsylavania.

- 4:10:39 p.m. – Power begins flowing in a giant loop from southern Ohio to Pennsylvania to New York to Ontario to Michigan to northern Ohio.

- 4:10:40 p.m. – Lemoyne–Majestic interconnection between ITC and First Energy trips.

- 4:10:40 p.m. – Allen Junction–Majestic–Monroe interconnection trips at Majestic and Monroe, which stops power flow to FirstEnergy's Allen Junction interconnection with ITC.

- 4:10:41 p.m. – AEP Fostoria Central–Galion 345 kV line opens.

- 4:10:41 p.m. – Lansing BWL interconnection with METC at Enterprise opens.

- 4:10:42 p.m. – Consumers Energy Campbell Unit 3, with a rating of 820 MW, trips.

- 4:10:42 to 4:10:43 p.m. – Detroit Edison loses 1,863 MW of generation.

- 4:10:43 p.m. Monroe–Bayshore interconnection trips, isolating ITC from First Energy.

- 4:10:43 p.m. – Consumers Energy Whiting Units 1 and 2 trip.

- 4:10:43 p.m. – Keith–Waterman 230 kV line, which connects Ontario with Michigan, opens.

- 4:10:40 to 4:10:44 p.m. – Four transmission lines disconnect between Pennsylvania and New York.

- 4:10:45 p.m. – Transmission lines disconnect in Ontario and New Jersey.

- 4:10:52 p.m. – Oneida interconnection between Lansing BWL and ITC opens.

- 4:10:46 to 4:10:55 p.m. – Transmission lines between New York and New England (except for Connecticut) disconnect.

- 4:10:50 to 4:11:22 p.m. – Ontario interconnections with New York open.

- 4:10:59 p.m. – Consumers Energy Whiting Unit 3 trips.

- 4:11:05 p.m. – Lansing BWL's Erickson plant trips.

- 4:11:39 p.m. – All major Detroit Edison generation is off-line and most units have no station power.

- 4:11:57 p.m. – Remaining transmission lines between Ontario and Michigan open.

- 4:12:49 to 4:14:22 p.m. – Lansing BWL Eckert Station Units trip, leaving it with no generation on-line and no interconnections.

- 4:15 p.m. – The power outage is essentially complete. A total of 2.3 million customers of Consumers Energy, Lansing BWL, and Detroit Edison are without power. The area affected in Michigan is all of the Detroit Edison service territory, Consumers Energy customers located near the Detroit Edison service territory, and the cities of Lansing and East Lansing and other areas served by the Lansing BWL.

- 4:30 p.m. – Michigan Public Service Commission (PSC) Staff arrive at the State Emergency Operations Center (SEOC) and initiate contacts with officials of Detroit Edison, Consumers Energy, Lansing BWL, and the U.S. Department of Energy (DOE) Emergency Operations Center in Washington, D.C.

- 5:00 p.m. – Michigan State Police (MSP) Emergency Management Division (EMD) activate SEOC.

- 6:00 p.m. – Governor Granholm and her staff arrive at SEOC.

- Evening – PSC Staff develop assessments, estimate recovery timeframes, and brief the SEOC staff, providing information on how to handle a power outage and on the safe use of generators for posting to the State government website.

- 10:00 p.m. – The Governor makes a televised address on WKAR-TV to the State on the power outage (see Appendix A-1).

- 10:00 p.m. – Consumers Energy reports 118,400 customers without power.

### Section 1.3.2: Friday, August 15, 2003

- 12:44 a.m. – Marathon Refinery in Detroit is reported out-of-service.

- 4:21 a.m. – Lansing BWL reports that power has been restored to all 98,000 affected customers.

- 6:00 a.m. – Consumers Energy reports that 70,100 customers remain without power.

- 8:30 a.m. – Detroit Edison reports that 2,000,000 customers remain without power.

- 9:15 a.m. – The Governor issues a Declaration of State of Emergency (see Appendix A-2) for the counties of Macomb, Monroe, Oakland, Washtenaw, and Wayne.

- 9:16 a.m. – Executive Order No. 2003-10 (see Appendix A-3) is issued by the Governor suspending environmental specifications for gasoline required for use in southeastern Michigan.

- 10:00 a.m. – At the request of the PSC Staff, Detroit Edison representatives arrive at the SEOC.

- 10:00 a.m. – Detroit Edison reports 1,750,000 customers remain without power.

- Noon – The Governor holds a press conference on the power outage and recovery efforts with J. Peter Lark, Chair of the PSC.

- Early Afternoon – Consumers Energy reports 17,000 customers remain without power.

- Afternoon – PSC issues a press release urging Michigan citizens to take all reasonable steps to conserve energy in light of the devastating power outage throughout the northeast (see Appendix A-4).

- Afternoon – At the request of the Michigan Department of Environmental Quality (DEQ), the U.S. Environmental Protection Agency (EPA) provides the State with enforcement discretion on environmental specifications for gasoline required for use in southeastern Michigan until August 22, 2003.

- All day – PSC Staff continues monitoring restoration efforts and return to service of power plants not yet available to the grid.

- Afternoon – Consumers Energy reports power restored to all 100,000 affected customers.

- 10:00 p.m. – Detroit Edison reports that 500,000 customers remain without power.

**Section 1.3.3: Saturday, August 16, 2003**

- 6:30 a.m. – Detroit Edison reports power restored to all 2.1 million affected customers.

- PSC and Detroit Edison continue to monitor power loads and return to service of power plants not yet available to the grid. Customers are asked to reduce power usage, which prevented the need for a rotating blackout.

**Section 1.3.4: Sunday, August 17, 2003**

- The SEOC is deactivated.

**Section 1.3.5: Monday, August 18, 2003**

- The Commission issues an order in Case No. U-13859, directing an investigation into the extent, duration, and cause of the outage relating to Michigan customers.

**Section 1.3.6: Wednesday, August 20, 2003**

- J. Peter Lark, Chair of the Energy Advisory Committee, advises the Governor and the Energy Advisory Committee of an impending energy emergency due to dwindling gasoline supplies as a result of the power outage and damage to the Marathon refinery in Detroit.

- At the request of the DEQ, the EPA provides the State with enforcement discretion on environmental specifications for gasoline required for use in southeastern Michigan until September 3, 2003.

- U.S. Energy Secretary Spencer Abraham and Canadian Minister of Natural Resources Herb Dhaliwal meet in Detroit and agree on an outline to be used by the U.S./Canada Power System Outage Task Force in its investigation. The Task Force will determine cause and effect of the outage. Three working groups addressing the electric system, security, and nuclear issues will be established to support the Task Force.

**Section 1.3.7: Thursday, August 21, 2003**

- 4:00 p.m. – Executive Order No. 2003-11 (see Appendix A-5) is issued by the Governor, which rescinds the Declaration of the State of Emergency and declares an Energy Emergency for the State of Michigan, due to loss of gasoline supplies as a result of the damage to the Marathon refinery and the temporary shutdown of other Midwest refineries supplying the Michigan market.

- 4:02 p.m. – Executive Order No. 2003-12 (see Appendix A-6) is issued by the Governor, which continues in place the suspension of environmental specifications for gasoline required for use in southeastern Michigan.

**Section 1.3.8: Saturday, August 23, 2003**

- The Marathon refinery in Detroit resumes production of petroleum products, including gasoline, that meet the specifications required under air quality rules for southeast Michigan. The refinery, which was shutdown for eight days following the outage, lost nearly 500,000 barrels of petroleum product production, roughly half of which was gasoline (about 11 million gallons). This is equal to about 3 percent of the projected statewide gasoline demand in August. However, the concentration of the lost supply in southeast Michigan made the area's shortfall larger than this figure suggests for that region.

**Section 1.3.9: Wednesday, August 27, 2003**

- Secretary Abraham and Minister Dhaliwal, as Co-Chairs of the U.S./Canada Power System Outage Task Force, announce the membership of the three working groups that will support the Task Force. Participating from Michigan on the Electric Systems and Nuclear Power Working Groups will be J. Peter Lark, PSC Chair. Participating on the Security Working Group will be Colonel Michael C. McDaniel, Assistant Adjutant General for Homeland Security for Michigan.

### Section 1.3.10: Thursday, August 28, 2003

- At the request of DEQ, the EPA provides the State with enforcement discretion on environmental specifications for gasoline required for use in southeastern Michigan until September 15, 2003, at which point the summer environmental specifications are no longer in effect.

### Section 1.3.11: Wednesday, September 3, 2003

- Governor Granholm and PSC Chair Lark testify before the U.S. House of Representatives Committee on Energy and Commerce on the power outage.

### Section 1.3.12: Tuesday, September 30, 2003

- Executive Order No. 2003-16 (see Appendix A-7) is issued by the Governor rescinding the Declaration of Energy Emergency for the State of Michigan.

# PART II

# ELECTRIC TRANSMISSION

## Section 2.1: Scope of the Investigation

Although the electric transmission events that led to the blackout were regional, and perhaps national in scope, the focus of this investigation has been on the impact to Michigan. In the order initiating this inquiry, we concluded “that there should be a Michigan-specific investigation into: (a) the extent, duration, and causes of the outage relating to Michigan customers; (b) the reaction of Michigan electric utilities and transmission grid operators … to the outage and the events preceding it: (c) a comprehensive assessment of the power restoration efforts by Michigan companies; and (d) recommendations designed to prevent future disruptions.”

The central geographic focus of the blackout was on the “Lake Erie Loop.” The Lake Erie Loop is that portion of the eastern interconnection of the electric grid that runs around Lake Erie, most directly impacting the border states of Michigan, Ohio, Pennsylvania, New York, and the Canadian Province of Ontario. However, as evidenced by the blackout, other states were also affected as a result of the extensive interconnectedness of the electric grid running throughout the entire eastern interconnection, which covers much of the eastern portion of the country east of the Rocky Mountains.

Our overall investigative focus has been prospective. Although we examined factors contributing to the cause of the blackout, the principal objective was to identify reliability issues and concerns that were uncovered from the investigation that can provide guidance on ways to strengthen overall grid reliability. Although a comprehensive array of options has been included, our focal point of emphasis was regional grid coordination.

It is important to emphasize that this report does not attempt to establish the “root cause” of the blackout or directly assign blame. That responsibility is best relegated to the U.S./Canada Power System Outage Task Force, which set determination of root cause among its principal objectives. That Task Force is much better positioned to address the root cause question. Clearly, compared to the Commission, it has significantly greater access to information and the substantial resources needed to dig deeply into causal issues. Likewise, the scope of the international investigation is much broader geographically than the Michigan study, which is concentrated primarily in and around Michigan. Finally, as discussed more fully later in this report, we conclude that the events leading up to the blackout occurred in Ohio, which is beyond the purview of this Commission.

In conducting this investigation, the following questions were addressed:

- What happened?
- How was Michigan impacted?
- What are the lessons learned?
- What can be done to prevent a blackout like this from recurring in the future?

## Section 2.2: Study Approach

In conducting the investigation, we utilized a wide variety of information sources. The following are the principal data sources relied upon:

(1) Published information from a wide variety of sources was utilized. In the wake of the blackout, numerous reports, news releases, and articles were published by a variety of sources, both public and private. Among the information sources reviewed were professional reports, analyses from industry and academic experts, testimony from State and Congressional hearings, trade press articles, governmental statements and press releases, and many newspaper and magazine articles. Although often redundant, the flood of information following the blackout proved quite helpful in piecing the events together into a comprehensive picture.

(2) Interviews with key participants charged with grid reliability were a crucial source of information to the investigation. Key to the study investigating regional coordination aspects of the blackout was information obtained from extensive interviews with various individuals with reliability and operational responsibility throughout the region. Included in these interviews were representatives from:

- Michigan's two major transmission companies operating the transmission grid in the lower peninsula – the International Transmission Company and the Michigan Electric Transmission Company.

- The American Electric Power Company transmission reliability coordination and transmission operations personnel.

- The Michigan Electric Coordination System – which oversees the local reliability control areas for ITC and METC covering most of the Lower Peninsula including the service territories of Detroit Edison and Consumers Energy and is the control center where certain reliability functions are jointly managed under the decentralized reliability system within the Midwest Independent System Operator.

- The Midwest Independent System Operator.

- The PJM Interconnection – the regional transmission organization for the Mid Atlantic states and some key Midwestern utilities including AEP.

- The New York Independent System Operator (New York ISO).

- The Ontario Independent Market Operator (Ontario IMO).

- The Federal Energy Regulatory Commission.

(3) Primary data was also very important to the investigation. Review of reliability and operations control room telephone conversations from all the above listed organizations, except the Ontario IMO and the New York ISO, was instrumental to examination of grid management

issues and problems, especially communications coordination among personnel from the various reliability controllers within the region. Although much of the relevant data from these communication links had already been reported through the media, the opportunity to directly examine the actual conversations that took place helped to empirically verify the accuracy of those reports. The additional detail provided by the full text of those conversations also significantly enriched our understanding of what took place in the reliability centers within the region affected by the blackout.

Although many and varied sources of information were carefully evaluated and cross-checked to ensure reliability in the conduct of this investigation, in the final analysis, this report's findings, conclusions and recommendations largely reflect the professional expertise and judgment of the Commissioners and our Staff. Staff assignments to perform the study were made with that in mind, coupled with an appreciation of the importance of the blackout investigation. The expertise and analytical capability of the investigation team encompasses considerable academic training, along with extensive electric industry knowledge and professional experience.

### Section 2.3: Events of August 14, 2003

As previously mentioned, this investigation does not intend to identify the root cause of the blackout. Rather, it identifies the significant events leading up to the blackout as an aid to analyzing what steps are needed to help prevent a reoccurrence.

A list of specific events leading up to the blackout is presented in Section 1.3. A review of this timeline indicates that all of the events in the two and one-half hours preceding the power surges that occurred at 4:09 p.m. involved FirstEnergy or AEP facilities in Ohio. In addition, FirstEnergy's Davis Besse nuclear plant had been out-of-service for some time. It appears that, with the Davis Besse nuclear plant off-line, the tripping of Eastlake Unit #5 was a major event in the northern Ohio region. FirstEnergy was left in a precarious position as far as meeting its load on that day. Power had to come from other sources in order to meet the requirements of the FirstEnergy system. FirstEnergy did initiate a request for automatic reserve sharing and MECS did respond to this request. Nonetheless, lines in Ohio soon began to open. Although information provided by MISO and FirstEnergy indicate that the first lines that opened were not loaded to capacity, it appears that the opening of those lines quickly contributed to the evolving problem. As the number of lines opening in Ohio increased, there were fewer and fewer paths available to serve the demand coming from northern Ohio. According to data from Michigan transmission operators and the MISO, at about 4:09 p.m., over 2,000 MW of power was suddenly pulled from west to east through Michigan and into northern Ohio. Voltage on the Michigan grid became unbalanced. Seconds later, the flow suddenly reversed and over 2,000 MW were pulled into Michigan from the east, again attempting to reach load in northern Ohio. There can be little doubt, based on the sequence of events and magnitude of the power flow reversals, that disturbances in Ohio led to the blackout. Evidence strongly suggests these disturbances led to an internal load balancing collapse of the FirstEnergy system, which ultimately precipitated the blackout.

All of the people interviewed for this investigation agreed that August 14, 2003 was a normal summer day. However, there were some indications that the day was turning out to be hotter and more humid than had been predicted. Early in the day PJM issued a "high load voltage warning." In our interviews with Michigan and other state transmission operators, no specific supply problems were noted and the overall supply situation for the region was very adequate. Transmission operators and reliability coordinators (RCs) had been communicating normally during the day. MISO had been working with Cinergy[5] to relieve congestion in its territory.

In the very last minutes preceding the blackout, Michigan operators saw large flow swings of over 2,000 MW. As a result of the declining voltage, the protective devices on three Michigan power plants tripped. According to ITC records, within seconds it was in full voltage collapse with over 30 transmission lines opening. METC and ITC connections separated as the relays responded to programmed settings. Several more plants in DTE's service area tripped. Most of ITC's system was blacked out, only a few scattered areas still had electricity. METC's system remained largely intact, although there were some scattered outages.

The Greenwood power plant outage on the Detroit Edison system was not a factor contributing to the blackout. The Greenwood plant experienced a fuel trip at approximately 1:14 p.m. and was returned to service in less than 45 minutes at about 1:57 p.m. During the Greenwood outage power from other generation facilities on the Detroit Edison system was brought on-line for replacement of the lost power from the Greenwood generation unit. The facility was fully resynchronized to the system more than two hours before the blackout.

The first event that MISO observed was the opening of the FirstEnergy Hanna–Juniper line at 3:32 p.m.[6] MISO was unaware that the FirstEnergy Harding-Chamberlin line had opened at 3:06 p.m. because MISO only follows "key facilities." At the time of the blackout, the Harding-Chamberlin line had not been identified by FirstEnergy as a key facility.

According to the MISO telephone transcripts, MISO called First Energy at 3:43 p.m. and questioned FirstEnergy about the Hanna-Juniper line. The FirstEnergy operator was not able to respond to MISO's questions and said that he didn't know, that he would have to take a look. MISO requested that FirstEnergy call it back. At 4:04 p.m., FirstEnergy called MISO and stated that they had some problems. The FirstEnergy operator still seemed unsure about exactly what was happening. The operator lists a number of lines that are "off", the Eastlake Plant unit that had gone off-line earlier in the day and the Perry plant that was "having a hard time maintaining voltage". The FirstEnergy operator then asks MISO what it has going on. When MISO responds that FirstEnergy Hanna-Juniper line is open, the FirstEnergy operator questions that. MISO responds that it had discussed this with FirstEnergy earlier. The FirstEnergy operator states that they have "no clue" and the computer is "giving us fits." A FirstEnergy control room operator told a MISO technician minutes before the blackout, "We don't even know the status of some of the stuff around us." The MISO operator states that MISO thought FirstEnergy was trying to

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[5] Cinergy Corporation provides natural gas and electric utility service in Indiana, Kentucky, and Ohio.
[6] FirstEnergy was not a member of MISO on August 14, although MISO was its reliability coordinator. On October 1, 2003, American Transmission Systems, Inc., the transmission subsidiary of FirstEnergy became part of MISO through GridAmerica LLC. GridAmerica, a subsidiary of National Grid USA, manages the transmission system of FirstEnergy, Northern Indiana Public Service Company, and Ameren Corporation.

figure this out. The FirstEnergy operator says they are trying to and then asks if the MISO sees anything else going on around them. The MISO mentions that Cinergy had some lines opening earlier in the day, but the FirstEnergy operator responds that that shouldn't have affected them. The transcript ends in mid-sentence. Based on the MISO telephone transcripts, MISO did not talk to any other control areas about the situation at FirstEnergy. Thus, MISO was unable to communicate effectively with its members, and FirstEnergy was unable to communicate effectively with its reliability coordinator, MISO.

It is important to note that Peter Berg (the CEO of FirstEnergy), in his Congressional testimony, stated that although First Energy was experiencing problems with its energy management computer system, MISO had information about FirstEnergy's system and could have been used as a backup. As is discussed above, MISO did not have access to all of FirstEnergy's information, in that MISO only had information on the key facilities that had been identified by FirstEnergy. However, if FirstEnergy was relying on MISO to provide back up information, then it makes sense that FirstEnergy should have contacted MISO to request that back up. Based on our review of the MISO telephone transcripts, there is no indication that FirstEnergy called MISO to report their dilemma until 4:04 p.m. This was several minutes after MISO had contacted FirstEnergy to discuss the Hanna-Juniper line. During the call that was initiated by MISO, FirstEnergy did not describe any problems. It should be noted that FirstEnergy did not have any problem contacting MISO after the event. The MISO transcripts show a number of calls from FirstEnergy to MISO asking for assistance in the restoration efforts.

AEP and PJM also talked to FirstEnergy and were talking to each other. Based on our review of these calls, FirstEnergy provided less than enlightening information. Both AEP and PJM appear to have gotten the impression, either directly or indirectly, that FirstEnergy was having computer problems. AEP also called PJM when AEP saw that the South Canton–Star line was becoming overloaded. On the telephone transcripts that we reviewed, AEP initially thought that the South Canton–Star line was a FirstEnergy line. After AEP determined that the line was jointly owned, AEP and PJM began discussing the issuance of a Transmission Loading Relief (TLR)[7] procedure. Before the TLR could be issued, the South Canton–Star line opened. As a result of that line opening, PJM called FirstEnergy to discuss the contingency line (Sammis-Star), a line that belonged to First Energy. First Energy was unable to provide any meaningful assistance to PJM and told PJM to talk to AEP.

The two reliability coordinators for the Midwest utilities, MISO and PJM, did call FirstEnergy shortly before the blackout to try and discuss potential problems they were observing on the FirstEnergy system. As described in the detail of the calls discussed above, the response from First Energy was confused, at best. Earlier in the day FirstEnergy had called MISO to report a discrepancy in the outage report on the time that the Eastlake plant went out of service. FirstEnergy indicated during that call, which occurred at 2:24 p.m. (over 50 minutes after Eastlake went out of service), that they did not know why the plant had tripped. Based on the review of telephone transcripts that we reviewed, FirstEnergy did not contact MISO concerning any other problems that FirstEnergy was having that afternoon until 4:04 p.m. – only 5 minutes before the cascading blackout events began.

[7] Transmission Loading Relief is a process that allows reliability coordinators to curtail transmission service.

Immediately after the blackout, grid restoration efforts were commenced. MISO kept a telephone line open so that all parties involved could communicate with each other and assist each other with restoration efforts. The code of conduct, which requires independent functioning of transmission operators and affiliate wholesale marketers except in an emergency, was appropriately suspended to permit communication channels to be fully opened. Overall the grid restoration went relatively smoothly throughout the region.

## Section 2.4: Analysis

### Section 2.4.1: Electric Industry is in Transition

Understanding critical changes shaping the electric industry is important to understanding how the events of August 14 unfolded and what can be done to reduce the likelihood of a recurrence.

The electric industry looks very different today than it did when it first emerged at the turn of the century. Most notably, the nation's electricity delivery system has grown and evolved from a very local, insular, largely self-sufficient network to one that is highly interconnected and regionally interdependent. The August 14$^{th}$ blackout was a clear reminder of just how interdependent the electric grid has become.

It is somewhat ironic that grid interconnections, the mechanism that physically enabled the blackout to spread through such a wide area, were originally established to improve reliability. In the electric industry's infancy the transmission network served exclusively as the mechanism used to move electric power from generating plants to customer load within a local utility company's service territory. However, as the industry matured, companies soon discovered that by linking with neighboring local utility companies they could assist each other in times of emergency and improve overall reliability of service to their customers. Companies were mutually benefited through sharing of supply reserves.

Interconnecting utility transmission facilities over larger geographical areas, while increasing overall reliability, also created dependence among independently operated utility systems. This relationship, as illustrated by the blackout, means connected utility systems are now vulnerable to events occurring on other utility systems linked to the chain. While no credible argument can be made advocating that grid interconnection is not beneficial to overall industry reliability improvements, the tradeoff is that disturbances on one system, if not contained, can cascade throughout the interconnected grid as they did on August 14. Thus, while grid interconnection can be expected to reduce the probability and duration of an outage, it also introduces the possibility of a significant event or a series of smaller events on one system triggering a large outage. The key challenge going forward is to take steps to localize disturbances to prevent them from cascading.

### Section 2.4.2: Electric Industry is Responding to Competitive Pressures

Over the past 20 years real (inflation adjusted) electricity prices paid by consumers have significantly decreased. Since 1990 real electric prices have dropped nearly 12% nationally, almost 18% in the ECAR States, and 21.5% in Michigan (see Figure 2.1). The largest declines are in the Midwest where manufacturing demands for efficiency are most intense. Among the more significant factors driving these recent efficiency gains is the increasingly competitive wholesale electricity market that has emerged during this period.

**FIGURE 2.1**

| Average Retail Prices of Electricity, 1990-2001 (Inflation-Adjusted Cents per Kilowatthour) | | | | | | |
|---|---|---|---|---|---|---|
| | Michigan Total | | Regional Total | | National Total | |
| Year | Real [1] | % Increase | Real [1] | % Increase | Real [1] | % Increase |
| 1990 | 8.8852 | 0.0% | 7.1982 | 0.0% | 8.2197 | 0.0% |
| 1991 | 8.7006 | -2.1% | 7.0457 | -2.1% | 8.1440 | -0.9% |
| 1992 | 8.5273 | -4.0% | 6.8218 | -5.2% | 8.0425 | -2.2% |
| 1993 | 8.2153 | -7.5% | 6.7074 | -6.8% | 7.9704 | -3.0% |
| 1994 | 7.9751 | -10.2% | 6.5380 | -9.2% | 7.7687 | -5.5% |
| 1995 | 7.7656 | -12.6% | 6.3838 | -11.3% | 7.5860 | -7.7% |
| 1996 | 7.6678 | -13.7% | 6.2685 | -12.9% | 7.4102 | -9.8% |
| 1997 | 7.4727 | -15.9% | 6.1365 | -14.7% | 7.2757 | -11.5% |
| 1998 | 7.4391 | -16.3% | 6.1672 | -14.3% | 7.0685 | -14.0% |
| 1999 | 7.3782 | -17.0% | 6.0912 | -15.4% | 6.8949 | -16.1% |
| 2000 | 7.2517 | -18.4% | 5.9813 | -16.9% | 6.9463 | -15.5% |
| 2001 | 6.9788 | -21.5% | 5.9254 | -17.7% | 7.2600 | -11.7% |

1 In inflation-adjusted (2001) dollars, calculated by using Gross Domestic Product deflators. Source is: Budget of the United States Government, Table 10.1 --Gross Domestic Product and Deflators Used in the Historical Tables: 1940-2005, (wk4 or xls).

Prepared by: Competitive Energy Division, Michigan Public Service Commission, September 2003.

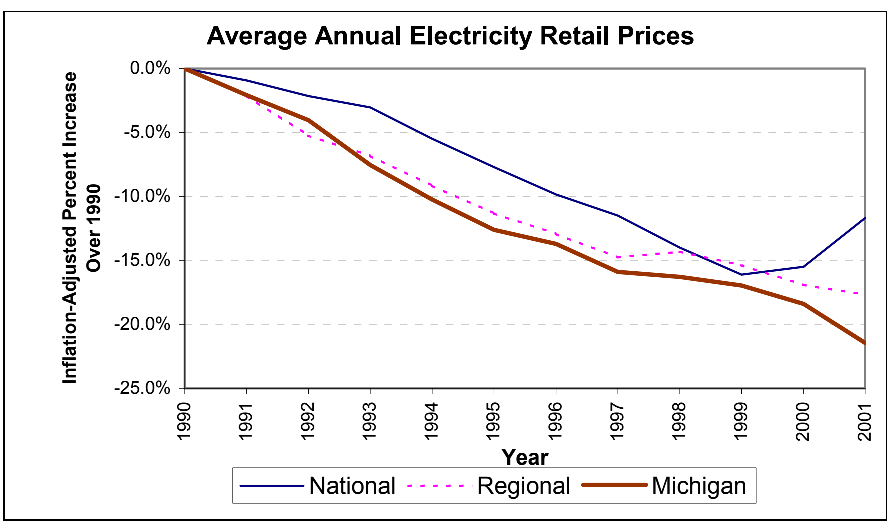
Data Source: Energy Information Administration, U.S. DOE, Electric Power Annual 2001 Table 7.4, Annual Energy Review 2001

Table 8.6, Form EIA-861 Database

http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html

EIA sales_states.xls, evenue_states.xls

http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html



In recent years demands on the electric industry to power our nation's growing economy and satisfy consumer needs has provided the world standard for safety, convenience, and comfort at affordable prices are unprecedented. By and large, the industry has stepped up to the challenge. Since 1990 demand (nationally, regionally and in Michigan) has increased by about 30% (see Figure 2.2). Not only has this significant increase in demand been met, it has been accomplished at lower cost to consumers. Nevertheless, increased demand is a factor stressing the grid's reliability capability. Industry restructuring has also placed stress on grid reliability. Opening the electric industry to competition has introduced new participants (such as independent transmission companies, independent generators, power marketers and energy traders) and expanded the number of power exchange transactions as well as the distances power is transported. Growing pains are also evident as the transmission network struggles to accommodate the sudden and significant increase in power transactions over extended geographic areas. Cost-effective investment is needed to alleviate critical bottlenecks and expand transport capability in some areas. Likewise, significant attention to measures to improve regional grid coordination and management is essential to both electric grid reliability and efficiency improvements.

Competitive electric industry restructuring, while a factor stressing the grid within the Lake Erie loop, is not the cause of the August 14th blackout. Electrons moving through the grid follow the laws of physics, not economics. The grid is indifferent to whether electricity moving through the wires is produced and sold under a market structure that is competitive, regulated or a hybrid of the two. Our investigation of the August 14th blackout found no basis to dispute this conclusion. However, what we did discover is that in the current transition, the "rules of the road" defining the relationship between reliability and efficiency need considerable revision if both reliability and efficiency are to effectively coexist in today's complex restructuring industry. The challenge is to make adjustments to the grid and its management that will continue to make the two critical objectives complementary.

## FIGURE 2.2

***Michigan, ECAR, National Electric Peak Demand***
***(Non-coincident Peak in Megawatts)***

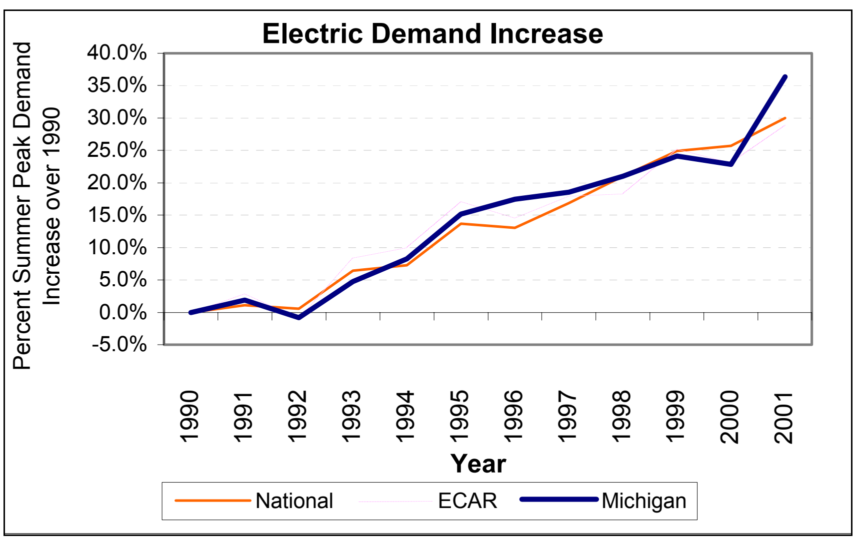
| | Summer Michigan | | | | Summer ECAR | | Summer U.S. | |
|---|---|---|---|---|---|---|---|---|
| **Year** | CE | DTE | Total | **% Increase over 1990** | Total | **% Increase over 1990** | Total | **% Increase over 1990** |
| **1990** | 5,891 | 9,032 | 17,905 | **0.0%** | 79,258 | **0.0%** | 545,537 | **0.0%** |
| **1991** | 6,084 | 8,980 | 18,247 | **1.9%** | 81,539 | **2.9%** | 551,705 | **1.1%** |
| **1992** | 5,939 | 8,704 | 17,759 | **-0.8%** | 78,550 | **-0.9%** | 548,707 | **0.6%** |
| **1993** | 6,226 | 9,362 | 18,758 | **4.8%** | 85,930 | **8.4%** | 580,753 | **6.5%** |
| **1994** | 6,502 | 9,684 | 19,386 | **8.3%** | 87,165 | **10.0%** | 585,320 | **7.3%** |
| **1995** | 7,158 | 10,049 | 20,621 | **15.2%** | 92,819 | **17.1%** | 620,249 | **13.7%** |
| **1996** | 7,167 | 10,377 | 21,032 | **17.5%** | 90,798 | **14.6%** | 616,790 | **13.1%** |
| **1997** | 7,315 | 10,305 | 21,224 | **18.5%** | 93,492 | **18.0%** | 637,677 | **16.9%** |
| **1998** | 7,246 | 10,704 | 21,670 | **21.0%** | 93,784 | **18.3%** | 660,293 | **21.0%** |
| **1999** | 7,460 | 11,018 | 22,223 | **24.1%** | 99,239 | **25.2%** | 681,449 | **24.9%** |
| **2000** | 7,306 | 10,730 | 21,994 | **22.8%** | 97,557 | **23.1%** | 685,816 | **25.7%** |
| **2001** | 8,289 | 11,860 | 24,417 | **36.4%** | 102,161 | **28.9%** | 709,166 | **30.0%** |

Total U.S. noncoincident peak demand is for contigous U.S. without Alaska or Hawaii.

Prepared by: Michigan Public Service Commission

Sources: May 2003 Michigan Electric Sales Forecast, 1990-01, Energy Information Administration, U.S. DOE, Form EIA-861 Database, ECAR, National data source: EIA Electric Power Annual Table 3.1, EIA Annual Energy Review 2001 Table 8.8, Form EIA-411

see http://www.eia.doe.gov/cneaf/electricity/epa/epat3p1.html
http://www.eia.doe.gov/emeu/aer/elect.html



## Section 2.4.3: Grid Reliability Responsibility

The North American Electric Reliability Council (NERC) has operated since 1968 as a voluntary organization with the goal of ensuring that the electric transmission system is reliable, adequate and secure. NERC does this through two primary tools: planning standards and operating policies. Planning standards are used in the development of new transmission systems. The operating policies are made up of standards, requirements and guides with the intent that no system will impact the integrity of any of its interconnected systems. The primary responsibility for actually carrying out the operating policies is on the control area. A control area, as defined by NERC, is an electric system or systems, bounded by interconnection metering and telemetry, capable of controlling generation to maintain its interchange schedule with other control areas and contributing to frequency regulation of the Interconnection.

Reliability coordinators (RC) act under the auspices of NERC and are responsible for ensuring the operational reliability of the interconnections (the facilities that connect two systems or connect a system to a non-utility generator). The reliability coordinator plans for next day operations, analyzes current day operating conditions and implements the transmission loading relief (TLR) procedure. The TLR procedure is a key component of the reliability coordinator's job since it is intended to relieve overloaded conditions on a transmission system. In a critical situation, the reliability coordinator has the authority to direct control area operators in its reliability area to do whatever is necessary to relieve the situation. The reliability coordinator is also required to advise all control areas in its reliability area and all other reliability coordinators if an emergency exists in its area. This notification can be done through the RCIS (Reliability Coordinator Information System), a computer program that posts information to a central web site that can be accessed by all reliability coordinators and control area operators.

Enforcement of the standards, in practice, has been accomplished through voluntary compliance. Currently, NERC portrays its compliance process as mandatory, but not enforceable. NERC, through its regions, conducts compliance reviews and issues enforcement advisories. The enforcement advisory can be in the form of an award for good performance or a simulated sanction or penalty. NERC uses a simulated sanction or penalty because it does not have the authority to issue an actual penalty. Under the NERC RC Procedures, all Control Areas must comply with a directive from the RC. The 2002 NERC Compliance Enforcement Program Report indicates that there were 444 violations involving operating measures in 2002. These violations resulted in $9 million of simulated sanctions, which could have been actual penalties had penalty provisions been in place and enforced.

FERC is the regulatory agency that oversees the interstate transmission of electricity. The agency regulates the economic aspects of interstate transmission and wholesale sales of electricity. FERC states that it may not have regulatory authority over the construction of transmission or generation facilities, except for hydroelectric facilities.

Regional grid coordination and management must be strengthened through strong and properly configured RTOs. Effective regional grid reliability coordination and management is key to improving reliability on an increasingly interdependent transmission grid. In the Midwest, this should be accomplished by mandatory RTO participation by transmission owners and operators.

Ways to quickly resolve parochial interests and move toward effective regional solutions to regional reliability issues must be forged.

Mandatory RTO participation, where FERC deems it necessary, is essential. RTO development in the Midwest underscores the importance of having a single RTO in the region. Serious configuration and seams problems are stifling RTO development in the Midwest region and threaten the region's ability to effectively manage reliability. Failure to correct these problems could deliver a fatal blow to effective RTO development in the Midwest. The best-designed reliability standards are of little value if they are not uniformly and widely enforced. The system is only as strong as its weakest link. Allowing transmission operators within an interconnected grid to opt out of the RTO or to dictate the terms of RTO participation, as often occurs under the present voluntary system where competing RTOs in the Midwest vie for prospective members, is a recipe for disaster. On August 14$^{th}$, no one chose to be a victim of the blackout. No one should likewise be excused from participation in those efforts necessary to prevent a future occurrence.

### Section 2.4.4: Effect of Competition

Although a factor, electric industry restructuring did not cause the blackout. Primarily an outgrowth of change, the impact of competition on reliability is a factor that can be effectively managed. However, the relationship between reliability and efficiency must be clearly established such that reliability reigns supreme where conflicts surface between reliability and efficiency. This fundamental principle must be clearly established, understood and rigorously enforced.

Reliability enforcement decisions should be placed in the hands of an independent party. Placing authority or any significant control over grid reliability decisions in the hands of companies with a commercial interest at stake must be prevented. Removing the temptation to avoid implementation measures that may be needed to localize or contain a disturbance is a must. There is no question that a reliability coordinator's decision to take action to shed load during a disturbance must take precedence over the commercial impact of the decision. We did not find any evidence to conclude that such a conflict played a role on August 14. However, we note that both companies experiencing disturbances, FirstEnergy and AEP, still play a significant role in the execution of reliability coordination monitoring and decision-making within their respective RTOs. Both AEP and FirstEnergy are vertically integrated utility companies with a financial stake in the commercial operations for energy sales and delivery (transmission and distribution) to their utility customers. This potentially conflicting responsibility is problematic.

### Section 2.4.5: Grid Investment

Strategic grid investment is needed to effectively accommodate industry changes necessary to continue to meet high industry standards for reliability and efficiency. According to the NERC's *Reliability Assessment 2002-2001* issued in October 2002, the number of TLRs requiring curtailment of firm transactions increased from zero in 1998, to 1 in 1999, 7 in 2000, to 16 in 2001, to 18 in the first six months of 2002. This suggests a transmission grid that is under increasing pressure to meet the demands placed upon it. That NERC report indicated that "portions of the transmission systems are reaching their limits as customer demand increases and the systems are subject to new loading patterns resulting from increased electricity transfers."[8]

Customers expect and deserve reliable and competitively priced electricity. With that in mind, grid investment to expand and upgrade the transmission system should be cost-effective so that investment is strategically targeted to cost-effective congestion and growth needs. According to the NERC report, only 155 circuit miles of new transmission is planned for the ECAR region through 2006 out of an existing base of 16,207 miles. Moreover, no new transmission is planned in ECAR during the 2007-2011 time period. This equates to an increase in transmission lines of less than 1% over the next 8 years. For comparison, in the United States as a whole, transmission lines are expected to grow by approximately 6% during the same period. This suggests that consideration should be given to additional transmission lines in this region.

### Section 2.4.6: Grid Reliability

Grid reliability coordination and management must be accomplished on a regional basis. The blackout served as a wake-up call to accelerate regional coordination of all aspects of grid development and operation. Parochial utility and state interests must give way to more effective regional grid planning, operation and management to advance grid reliability objectives. In particular, actions must by expeditiously undertaken to establish strong and effective RTOs throughout the Midwest, Mid–Atlantic, and New England regions, which have become increasingly interdependent and generally supportive of RTO development.

### Section 2.4.6.1: Key Facilities and Other Information

The RCs need to see the big picture, including all key facilities. The MISO is already addressing the use of key facilities. FirstEnergy, for example, has gone from 35 to 90 key facilities that are available to the MISO for detailed on-going review. ITC and METC have indicated that they have made all of their data available to the MISO. Other control areas that are members must also make all of their data available to the MISO. The RCs need to see into the areas that are connected to them. The MISO and PJM had the ability to see some of this but could not see all of the pertinent areas. The RCs should work together to determine what information they need in order to bring the big picture into focus. The interconnections that are common all across the country are making the ability to see a more expansive, comprehensive and timely view of the transmission system increasingly essential to maintaining reliability. System monitoring capability must be state of the art to successfully accomplish this demanding task.

[8] Quotation is from page 20 of the report. Interestingly, that page begins with the statement that: "North American transmission systems are expected to perform reliably in the near future."

### Section 2.4.6.2: Reliability Control Operators

There are indications that more or better-trained reliability control operators may be needed. There should be a sufficient number of well-trained operators in the control room to handle any number of emergencies that might arise. On the MISO transcripts, reliability operators spent considerable time dealing with an emergency on the Cinergy system. While that event did not directly impact the events leading up to the blackout, it did appear that the MISO operators were having some difficulty keeping up with the numerous functions that needed their attention that day. In fact, the MISO's state estimator, which is one of its system monitoring tools, was not operating properly for several hours, and it appears that in the confusion, no one noticed. The control centers must be properly staffed and the operators properly trained, so that in an emergency situation adequate resources are available to respond to the emergency and to the ongoing system operation.

Control room equipment and operations should be thoroughly examined to ensure they are state of the art. The grid is a most complex and interdependent network. Individuals responsible for monitoring the grid and deciding when action is appropriate to prevent outages or isolate systems to prevent outages from cascading face a daunting challenge. Reliability control room operators must be properly trained, equipped, and provided with appropriate protocols to carry out these most important responsibilities.

Good communications are critical. The transmission grid is becoming more and more interconnected. This is not going to change; in fact, the trend is likely to increase. The interconnections provide for increased reliability and assistance during critical times. A communications chain needs to be established and adhered to by all of the entities. In the past, a control area may have only had to call its neighbor, and all of the operators probably knew each other by name. Now, the control area has to determine whom it should call. On the list is the RC (if the RC is different than the control area), the transmission operations centers (generally the utility or independent transmission company that actually operates the controls), and the neighbors (control areas that are connected). On the day of the blackout, there was confusion. AEP was calling FirstEnergy directly, AEP was calling PJM, PJM was calling FirstEnergy, PJM considered calling MISO but did not have time before events started to cascade. Another problem seemed to be that callers did not always know who they were talking to. There were sometimes two or three exchanges on "who is this", "who are you with", "what is your responsibility". A communications chain would also ease this problem, because each link in the chain would know who they are supposed to call and who is calling them.

Another significant part of communications is the communication system itself. The telephone is still being used to a large extent to communicate with others regarding reliability concerns. The whole system should be reviewed and the expanded use of computers should be explored. With e-mail and instant messaging now available, communications could be put in writing, which could provide clarification and consistency. Systems that are already in place, such as the RCIS, should be utilized more extensively. The phone system itself should also be examined to provide better and more reliable phone service. Based on our interviews with transmission operators, the phone service at the Michigan control center was sporadic after the blackout.

Communication protocols should be developed to more effectively address regional reliability coordination needs. Protocols directing appropriate procedures for information exchange among reliability coordinators are much needed. Much confusion was evident in reliability coordination control centers on August 14th regarding communication protocol.

Staffing qualifications, training and levels should be reviewed. Although our investigation did not uncover any specific staffing problems, our review of control room conversations and interviews with industry representatives led to the conclusion that operators may have been stretched to their limits on August 14th. In light of significant industry changes and growing electric grid demands, control room staffing levels and training needs should be carefully examined. We recommend that a comprehensive investigation of reliability control room staffing issues be undertaken by NERC with FERC oversight. Any deficiencies identified from the investigation should be promptly corrected.

**Section 2.4.6.3: Reliability Standards**

Mandatory reliability standards are needed. Many of the industry expert testimonies, articles and reviews of the blackout, along with responses to our interview questions, strongly urged the implementation of mandatory reliability standards. This report concurs with that conclusion. The requirement that standards be applied, with a resultant penalty if they are not, is a critical factor in reliability assurance.

**Section 2.4.6.4: Reactive Power**

Reactive power is that component of total power that is needed to maintain voltage and permit active power to be delivered. It is commonly measured in volt-ampere reactive (VAR) for small units and mega-VARs (MVAR) for large units. The requirement for reactive power to maintain grid integrity has become more important as electricity is transported greater distances because reactive power is consumed locally and cannot be transported long distances. The increased number of independent power producers has also contributed to this concern. On August 14, several entities were requesting reactive power support. The specific details involving reactive power on August 14 are discussed in Section 3.3.[9] In our opinion, RTOs should take the lead on ensuring that there is adequate reactive power support on their systems. This need can be addressed by requiring all power producers to provide reactive power support in sufficient amount and requiring transmission owners to consider adding more capacitors to the system in their planning process.

Reactive power issues are receiving more attention as a result of the blackout. On October 15, 2003, NERC sent a letter to all control areas and reliability coordinators. NERC requests that several near-term actions be taken, including seven involving the management of voltage and reactive power. These actions include: (1) establishing daily voltage/reactive management

[9] Reactive power issues overlap transmission and generation. Reactive power is necessary to maintain voltage on the transmission grid, but it is provided by local generation. This is the reason that the details are discussed in this report under utility operations rather than transmission.

plans, (2) ensuring reactive power supplies are verified and available, (3) having sufficient reactive power reserves, (4) maintaining voltage schedules, (5) reporting low voltage conditions, (6) ensuring generators have automatic voltage regulation, (7) coordinating potential differences of voltage criteria and schedules between systems. We believe that these are appropriate first steps to addressing the reactive power issues highlighted by the blackout.

**Section 2.4.6.5: RTO Authority**

The authority of the RTO should be clear and enforceable. Overall, the RTO should have the authority to enforce directives that are made to preserve grid integrity, especially during a time of emergency. The expansion of the RTOs seems to have led to a situation in the Midwest where the RTOs vie for transmission owners. The agreement that the transmission owner signs with the RTO must be geared toward ensuring the reliability of the system. PJM noted that its contracts with its market participants give it additional ability to oversee the system. As the newer RTOs move toward establishment of a market, they must also make sure that their contracts with market participants have a strong reliability component. One of the advantages that is provided by the RTO process is independence. The RTO must have no direct financial incentive to favor commercial market transactions that operate to the detriment of reliability.

Control over reliability coordination functions should be consolidated within an RTO. The capability to respond to reliability emergencies must be quick and decisive. Decisions to save the grid cannot be subjected to lengthy negotiations among dispersed agents with potentially conflicting interests. Responsibility to act must be clearly established and the authority to carry out those actions firmly vested in the responsible party. As an emergency approaches, command and control must replace coordination as the decision-making modus operandi. The decentralized system now in place within MISO must give way to consolidation. Operating through 35 separate local reliability control areas, MISO's capability to effectively perform its regional reliability responsibility is seriously compromised. Consistency and clarity regarding how reliability responsibilities are shared among the numerous independent control centers is problematic. Consolidation is desperately needed and we recommend centralization with all reliability responsibility placed under the direct control of MISO. While reducing the number of control areas would help, centralization is by far the more desirable option. Many of the other RTOs and ISOs in the Midwest, Northeast and Mid-Atlantic regions (PJM, New York ISO and the Ontario IMO) operate as centralized reliability control systems. Similarly, we recommend that AEP, currently operating as a satellite within the PJM RTO, be fully integrated and placed under the direct control of an RTO.

**Section 2.4.6.6: Transmission Seams**

The current RTO configuration resulting from the RTO choices of utilities in the Midwest presents major transmission seams[10] problems. As utilities make and remake their choices based on a number of factors, RTO seams come and go along with those changes. This constant shuffling and reshuffling must stop. The fact is that utilities are connected. A seamless region

[10] Seams refers to the lines dividing the existing RTOs, where power passes from the control of one RTO to another.

will result in better reliability management, because the region would be overseen by one entity. This entity could then make choices based on the entire region, rather than pieces of it. The first step must be getting all of the Midwest utilities into an RTO. The shifting must stop and commitments must be made to stabilize RTO configuration in the Midwest. After that, the RTOs that cover the Midwest can finalize a meaningful joint agreement so that the Midwest region is operated as a seamless area.

**Section 2.4.7: Demand Response**

Demand response, including distributed generation, must be effectively interwoven into a reliability improvement strategy. Historically, the demand side of the reliability picture has been largely overlooked in favor of the supply side of the equation. Demand response offers great potential to enhance reliability in a cost-effective manner. This opportunity must be aggressively tapped. System load balancing can be accomplished by adjusting either supply or demand. Both must be part of any cost-effective approach. Demand response should include pursuing load control opportunities, such as water heater control and air conditioning cycling equipment, which could greatly improve load-shedding capability. Demand response should also include distributed generation, which offers great value by locating smaller generation in strategic places on the grid that are vulnerable to reliability concerns.

**Section 2.5: Conclusions and Recommendations**

Thorough examination of the blackout event provides significant insight into reliability problems and concerns evident on August 14th that significantly contributed to triggering the event along with actions that may have resulted in failure to localize the outage and prevent it from cascading over such a widespread area. Our findings include the following:

- There is no evidence from our investigation to suggest that Michigan utilities or transmission operators were the cause of the blackout. All of the transmission line and power plant outages in the two and one-half hours before the two power surges beginning at 4:09 p.m. involved the facilities of FirstEnergy and AEP in Ohio. At the time that the power surges began, the electric system in Michigan was in balance.

- MISO, as the regional reliability coordinator, should have informed affected transmission operators of the disturbances that were occurring in northern Ohio.

- Michigan utilities and transmission companies were not notified of the problems being experienced by FirstEnergy and AEP and received no advance warning of the potential blackout. The first indication in Michigan of an impending emergency occurred at 4:09:27 p.m. when an interconnection in central Michigan exceeded its emergency rating as a result of the first power surge coursing through the State.

- Failure to isolate the FirstEnergy system from neighboring systems permitted the blackout to spread. The key to preventing blackouts from cascading is to take quick and decisive action to localize them. The absence of effective support to contain disturbances from regional coordinators responsible for reliability within the Ohio area where the critical grid disturbances occurred is disturbing. Reliability coordinators responsible include MISO on behalf of FirstEnergy and PJM for AEP. Representatives from all four organizations were involved in discussions regarding the disturbances, yet no one entity was able to see the whole picture and put the pieces of the puzzle together. Among the most obvious improvements that need immediate attention is clarification of reliability responsibilities and how they should be executed. Control room communications and statements by industry grid managers and reliability coordinators in our investigation clearly reveal confusion on this most critical function. Enforcement responsibility, authority, and accountability must be clearly defined and strengthened. Structural changes in how MISO executes its coordination duties must be revised.

- FERC should be provided with the authority to develop and enforce reliability standards. Reliability standards enforcement is inadequate and in urgent need of significant revision. The current system to enforce reliability standards lacks accountability and is generally ineffective. The present enforcement structure relies exclusively upon voluntary standards with no governmental agency responsible for oversight. Reliability standards must become the centerpiece of a comprehensive strategy to improve grid reliability. Reliability standards should be: (1) nationally developed and applied, (2) mandatory, (3) strictly enforced by the FERC, and (4) implemented regionally through the RTOs. FERC should have the responsibility to develop and oversee this process and that agency should be held accountable for the results.

- A single RTO should be established for the Midwest region. Regional grid coordination and management through RTOs in the Midwest is not strong enough and seams between RTOs are causing serious problems that must be addressed. Preventing blackouts from recurring requires a strong and effective regional response. In the Midwest, RTO participation must by mandatory. Cascading outages are an unfortunate byproduct of integrated systems; solutions designed to prevent them require a coordinated response. Coordination is not an option if the nation is committed to seriously addressing reliability; it is a must.

- Consideration should be given to building additional transmission in the region. Curtailments of firm transmission have increased each of the last four years.

- The MISO reliability coordination structure is flawed. Reliability coordination within the MISO system is highly decentralized, with 23 independent transmission companies operating as their own control area operators. MISO, under this fragmented structure, in practice, operates as reliability coordination back-up, with front-line responsibility dispersed among the local reliability control operators. This system is fraught with inconsistency and confusion as to delineation of responsibility to monitor the grid and execute reliability control measures. MISO reliability coordination operates like a loose confederation, significantly undermining MISO's ability to act promptly and decisively.

- Electric grid reliability is in need of support on several levels. There is no quick fix to prevent future blackouts. The solution is complex and must be comprehensive. It involves elements that are interdependent and will encompass both short and long-term remedies. Key to a successful response are four interdependent components which must be substantially expanded and strengthened:

    1) Reliability standards;
    2) Regional grid coordination and management;
    3) Strategic grid investment, where necessary, to cost-effectively expand and upgrade the transmission infrastructure; and
    4) Demand response, including distributed generation.

  To become most effective, these grid improvements should be implemented as a comprehensive package. It would be a mistake to pursue a piecemeal approach.

# PART III

# UTILITY OPERATIONS

## Section 3.1: Michigan Electric Utility Systems

### Section 3.1.1: Consumers Energy Company

Consumers Energy Company provides electric service to more than 1.7 million customers and serves 275 cities and villages in 61 counties. Principal cities served are Battle Creek, Bay City, Cadillac, Flint, Grand Rapids, Jackson, Kalamazoo, Midland, Muskegon and Saginaw. The company operates 12 coal-fired and two oil-fired generating plants, 13 hydroelectric plants, a pumped storage generating plant, and several combustion-turbine plants that produce electricity when needed during peak demand periods. The company owns the Palisades nuclear plant. The utility also purchases power from several sources, such as the gas-fired Midland Cogeneration Venture. Major generation facilities include: the J.H. Campbell Generating Complex, J.R. Whiting Plant, the D.E. Karn – J.C. Weadock Generating Complex, the B.C. Cobb Generating Plant, the Palisades Nuclear Plant, Ludington Pumped Storage Plant, and a number of small hydro units.

The J.H. Campbell complex, located on the shore of Lake Michigan between Holland and Grand Haven, is Consumers Energy's largest coal-fired generating complex. Unit 1 began operation in 1962, Unit 2 in 1967 and Unit 3 in 1980. Three turbine-generators produce up to 1,404 megawatts (MW) of electricity.

The Whiting Plant is located on the Lake Erie shoreline of southeastern Michigan. The Whiting Plant produces up to 310 MW of electricity, enough to power a community of 230,000 people. It was built in 1952.

Situated at the mouth of Saginaw Bay, the Karn–Weadock complex generates about one-third of all the electricity produced by Consumers Energy. In 1940 Consumers Energy built the first of what would eventually become eight units on the J.C. Weadock site. Two of those units are still in operation. Between 1959 and 1977, two plants were added: D.E. Karn 1 and 2 and D.E. Karn 3 and 4. The boilers in Weadock and Karn 1 and 2 burn coal; at Karn 3 and 4, they burn natural gas and oil. At peak operation, the plants can produce 2,100 MW of power.

The B.C. Cobb Generating Plant is located on the shores of Muskegon Lake, where its water meets the Muskegon River. The plant's five coal and natural gas units can generate 500 megawatts of electricity.

The Palisades plant, located near South Haven, has been generating electricity since 1971, and represents about 18 percent of Consumers Energy's total electrical capacity. In November 2000, Consumers Energy signed an agreement to become a full partner in Nuclear Management Company (NMC) of Hudson, Wisconsin. As part of the agreement, Consumers Energy transferred responsibility for the operation of Palisades to NMC. Consumers Energy retains ownership of Palisades, the electricity it produces and its spent fuel. The utility also retains the financial obligations for the safe operation, maintenance and decommissioning of the plant.

The Ludington Pumped Storage plant located on Lake Michigan near Ludington can generate 1872 MW of electricity. Customers throughout Michigan use energy generated by the facility. Because its six turbines can begin generating within a few minutes, the Ludington plant can respond quickly to daily, weekly and seasonal changes in energy demands. The Ludington plant operates very simply. At night, when demand is low, the facility's six reversible turbines pump water 363 feet uphill from Lake Michigan. The water is pumped through six large pipes, or "penstocks," to an 842-acre reservoir. During the day, when demand is high, the reservoir releases water to flow downhill through the penstocks. The flowing water turns turbines in the powerhouse to make electricity.

Consumers Energy purchases from small hydroelectric facilities located through out the state that provide 114.9 MW of power. Consumers Energy also owns 345 MW of combustion turbine peakers located throughout the state. The largest group of peakers is at the Thetford facility, which has 192 MW of peakers. There are also 13 MW located at the Campbell facility, 70 MW at Gaylord, 28 MW at Morrow, 16 MW at the Straits, 13 MW at the Weadock facility and 13 MW at the Whiting facility.

Power transmission for Consumers Energy's system is provided by Michigan Electric Transmission Company (METC) – a privately held company. METC acquired Consumers Energy's transmission assets in 2001 and is currently operated out of the Jackson dispatch center. The METC system is interconnected with the American Electric Power system near that utility's Donald C. Cook Nuclear Plant near Bridgman. The transfer capability of this interconnection is rated in 4,000 to 4,500 MW range, depending on the actual configuration of the power system.[11]

### Section 3.1.2: The Detroit Edison Company

The Detroit Edison Company, the largest electric utility in the State, generates and distributes electricity to 2.1 million customers in a 7,600 square-mile service territory in Southeastern Michigan. The utility operates 10 base-load generating plants, all within its service area. The company also is co-owner with Consumers Energy of the Ludington Pumped Storage facility. Detroit Edison's system capacity totals nearly 11,000 MW. Coal is used to generate about 85 percent of its total electrical output, with the remainder produced from nuclear fuel, natural gas and solar energy.

The Fermi 2 nuclear plant is located in Monroe County, south of Detroit on the west end of Lake Erie. Fermi is a boiling water reactor with an in-service date of January 1998 and a summer capability of 1,111 MW.

Placed in service in July of 1979, Greenwood is a conventional steam turbine unit that was designed to burn residual oil. It has been converted to dual fuel burners, with the capability to

[11] These numbers are circuit ratings and may not reflect the actual transfer capability of the interconnection at any given time. Actual transfer capabilities could be less.

also burn natural gas.  Located at the Greenwood energy center in St. Clair County it has a summer rating of 785 MW.

The Monroe Power Plant is a 3,000 MW facility located south of Detroit in Monroe County.  It consists of four coal-fired units, each with a summer capacity rating of 750 MW.  Unit 1 went into service June 1971, followed by unit 4 in March 1973, unit 2 in May 1973, and unit 3 in May 1974.

The St. Clair facility, located in county and along the river of the same name, has six active coal-fired units.  St. Clair 7 (placed in service in 1969) is the largest with a summer capability of 451 MW, followed by unit 6 (placed in service 1961) with a summer capacity of 321.  Units 1 (placed in service in 1953) and 4 (placed in service in 1954) are rated at 158 MW each, while unit 3 (placed in service 1954) is rated at 168 MW, and unit 2 (placed in service in 1953) is rated at 162 MW.

The Belle River Power Plant consists of two coal-fired units, each with capability of 635 MW. Unit 1 was placed in service in August 1984 and unit 2 in July 1985. The plant, with a total capability of 1270 MW, is located near the St. Clair facility.

The Trenton Channel facility located in Wayne County on the Detroit River just north of Detroit has 3 active units.  Unit 9, which is coal-fired, is the largest with a summer rating of 535 MW. Units 7 and 8 are each 120 MW coal-fired units.

The River Rouge Facility, located within the city of Detroit, has two active coal-fired units owned by Detroit Edison.  Unit 3, placed in service in 1958, has a summer rating of 276 MW. Unit 2, placed in service in 1957, has a rating of 238 MW.  Unit 1, placed in service in 1956, is rated at 199 MW.  It has been converted to natural gas and transferred to DTE Energy, the parent company of Detroit Edison.

The Harbor Beach plant is located in Huron County near the town of Harbor Beach on Lake Huron.  Placed into operation in 1968, the single 103 MW unit burns coal.

Detroit Edison has a total of 1,371 MW of peaking units[12] with 600 MW located at base load generation facilities and 771 located at various other locations throughout the utility's system. Other significant generation[13] owned by companies other than Detroit Edison in its service territory include: CMS Energy's Dearborn Industrial Generation rated at 330 MW, First Energy's Sumpter–Dayton Station rated at 300 MW and DTE Energy Services Dean Plant rated at 300 MW.

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[12] Base load and peaking units are distinguished by cost and operating characteristics.  Base load units generally are expensive to build but have low operating costs – they are expected to run a high percentage of the time to take advantage of the low variable cost and spread the high fixed cost over a larger volume of output.  Conversely, peaking units are relatively cheap to build but have high operating costs – they are expected to operate only a small percentage of the time (10% or less).

[13] A map of merchant plants in Michigan is available in PDF format from the State Utility Forecasting Group at Purdue University.  See https://engineering.purdue.edu/IIES/SUFG/MAPS/index_html.

International Transmission Company (ITC) owns and operates the transmission lines associated with the Detroit Edison system. It is made up of transmission facilities formerly originally owned by Detroit Edison, which were sold to an independent transmission company in 2002. Detroit Edison currently switches, repairs and maintains the ITC transmission assets under contract. This arrangement will continue for one year. Switching is controlled from Detroit Edison's Systems Operation Center.

Most of the control area operation in Michigan is done by the Michigan Electric Coordinated Systems (MECS) at the old Ann Arbor Power Pool. MECS is comprised of ITC and METC, the two independent companies that operate the Michigan grid.

The Detroit Edison/ITC system has 345 kilo-Volt (kV) interconnection with FirstEnergy at Allen Junction–Majestic–Monroe, Lemoyne–Majestic and Bayshore–Monroe. All of the interconnections are in the southeast corner of Michigan. The Detroit Edison/ITC system is interconnected with Hydro One in Ontario at the 345 kV level through two interconnections at Lambton–St. Clair near Detroit Edison's St. Clair power plant. The total transfer capability with FirstEnergy is 3,380 MW, and 2,400 MW with Hydro One.

The Consumers Energy/METC system has four 345 kV interconnects with the Detroit Edison/ITC system: (1) Majestic–Battle Creek–Onedia, (2) Majestic–Tompkins, (3) Thetford–Jewell, and (4) Pontiac–Hampton. These interconnections have a combined continuous rating of 3,000-3,500 MW depending on the power flow and a short term rating in the 4,000-4,500 MW range.

**Section 3.1.3: American Electric Power**

American Electric Power (AEP) serves customers in the lower western portion of the state. Its major generation facility within Michigan is the Donald C. Cook Nuclear Power Plant, located on the shores of Lake Michigan near Bridgman. The 1,020 MW Unit 1 went into commercial operation in 1975, while the 1,090 MW Unit 2 was completed in 1978. AEP's 765 kV transmission system is interconnected to the Consumers Energy/METC system near the Donald C. Cook plant.

**Section 3.1.4: Lansing Board of Water and Light**

The Lansing Board of Water and Light (BWL) is a municipal utility, owned by the citizens of Lansing. The BWL is the third largest electric utility in the state serving 98,000 customers and the largest municipally-owned utility in Michigan. The BWL has two generating stations: Erickson (located west of Lansing) and Eckert (located near the center of the city). The Erickson Station was completed in 1973 and contains a single coal-fired unit capable of producing 159 MW. It was recently rated one of the most efficient plants of its size in the United States.

Eckert Station Located near downtown Lansing was constructed in the early 1920's and has undergone several rebuilding and expansion projects. The Eckert Station includes six electric generating units ranging from 41 to 77 MW. The six units are capable of generating a total of 351 MW.

Through a membership in the Michigan Public Power Agency (MPPA), the BWL also receives 146 MW of electricity from the Belle River Plant operated by Detroit Edison. The BWL is interconnected with Consumers Energy in two locations.

**Section 3.2: Emergency Procedures**

**Section 3.2.1: Load Management**

Three load management mechanisms are available to interrupt electric load when generation supply, system voltage, or system frequency become deficient: (1) Rotating Load Management (RLM), (2) Remote Load Shed (RLS), and (3) Automatic System Security.

On the Consumers Energy system the RLM approach utilizes rotating blackouts involving Supervisory Control and Data Acquisition (SCADA) control of substation circuit breakers. Detroit Edison uses a manual system to accomplish the same function. RLM is designed to interrupt firm load in the event of a generation shortage or when a widespread transmission system emergency exists. The RLM system is intended to be implemented prior to initiation of Automatic System Security.

For example, on the Consumers Energy system there are fourteen RLM load segments, each with an average load of 89 MW. Twelve of the segments can be implemented via use of SCADA control of substation circuit breakers. Each segment consists of an average 110 MW of load from each of three System Control Center areas – South, West and East. The two remaining segments are manual industrial segments that require operator intervention at the substation/customer site to interrupt load. The Detroit Edison system operates in a similar manner, except the system uses a manual control process.
No interruptions of hospitals with surgical facilities are included in the plan.

Depending upon the electric system requirements, any segment or part of a segment can be interrupted by opening selected 23 kV, 46 kV, and 138 kV circuit breakers via SCADA (on the Consumers Energy system), certain customer substation equipment or customer switchgear equipment. Designated customer substations, sub-transmission and transmission lines will be interrupted for two hours. Customers would be interrupted for two to four hours (or longer if equipment failure or system malfunction occurs). If required, the next RLM segment will be interrupted. Restoration of the prior RLM segment will commence via SCADA on most of Consumers Energy's system and manual intervention Detroit Edison's system.

Consumers Energy and Detroit Edison have the capability to implement RLS to drop load during isolated transmission system problems, which do not require system-wide operating intervention or RLM capabilities. Implementation of RLS is normally the first step after an Emergency Condition has been declared.

On the Consumers Energy system, thirty-three load segments, ranging from 30 to 271 MW, have been identified for RLS purposes via SCADA control of substation circuit breakers. The priority of the RLS segments is based on the nature and location of the transmission system emergency. Depending upon the electric system requirements, any segment can be dropped by opening 23 kV and 46kV circuit breakers via SCADA. Designated sub-transmission lines will be dropped and remain de-energized until the transmission system deficiency has been mitigated.

Both Consumers Energy and Detroit Edison have Automatic System Security under frequency relays installed on selected transmission substation circuit breakers and distribution substation circuit reclosers. These relays will trip and block reclosing of the circuit breakers and reclosers if the system frequency declines below preset values. The intent of this system is to prevent widespread electric system disruption and ultimately system-wide blackout should manual intervention (RLM or RLS) not be implemented quickly enough to stop frequency decay.

On the Detroit Edison system, automatic load shedding did operate as designed at the beginning of the blackout. During the event of August 14, no manual load shedding was implemented due to the absence of advance warning. On August 14, prior to the blackout, both systems were in normal operating condition with all safety devices in service and functional.

### Section 3.2.2: System Protection

The transmission and distribution systems are considered to be stable when voltage, frequency and thermal loading are within normal operating ranges without dramatic variances. In Michigan, the system is designed to withstand the loss of one or more key components.

Key transmission lines and distribution circuits are monitored for excessive current. If an overload condition is detected, the protective relaying or other equipment will interrupt the circuit to prevent damage. The main purpose of this electrical protective equipment is to protect the physical components and maintain electrical integrity of a power system against faults (short circuits).

System frequency is usually maintained at 60 Hertz,[14] but power shortage or oversupply conditions can affect this frequency. For example, if there is an undersupply of power, frequency will drop. This can cause damage to customer or utility equipment. Electric utilities maintain protective relaying systems to monitor for these conditions and to isolate the source.

When reactive power is under or over supplied, voltage will decrease or increase. Either of these conditions can damage critical equipment owned by the utility or the customer. Once again, protective relaying is required to prevent damage.

Protection schemes are designed to rapidly isolate a failed or faulted component or segment of the power system to minimize both its effect on the rest of the power system and damage to the affected component. This allows the remainder of the system to continue to operate normally.

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[14] Hertz is a unit of frequency equal to one cycle per second.

In some cases, lightning strikes for example, faulted line segments are automatically restored to service.

The level of sophistication, redundancy and type of protection equipment used depends on the voltage level of the system on which it is installed. Most protective relays monitor current, voltage, and combinations of these, to determine if an abnormal condition exists. The protection engineer sets the relays to respond to the conditions predicted in system models. Relay schemes are generally divided into phase protection and ground protection. The phase schemes detect when conductors for different phases contact each other. Ground protection schemes detect faults to earth ground, such as lightning. These relays schemes are typically located in the substations and trip the appropriate circuit breakers at line terminations.

On 345 kV transmission systems, most protective schemes are communication based. This means that the protective relays at each end of the line "communicate" with each other via power line carrier, audio tone (phone lines), or fiber optics, in order to determine if a fault exists. This provides complete coverage for high speed clearing of the entire line. METC and ITC systems typically have three levels of redundancy: two primary systems that rely on relay communication and a backup system that operates independently at each end.

On 138 kV transmission systems, some communication-based protection exists where it is required for grid stability or relay coordination. In general, the remaining relay protection is impedance-based, effectively measuring an electrical "distance" down the line. If a fault lowers the impedance to a value that falls within its zone of protection, the relay operates. Most schemes have three zones of protection, operating at different current levels and time delays in order to assure that only the faulted segment is isolated. Zones overlap to provide varying degrees of redundancy.

On the 46 kV high-voltage distribution systems, the relay protection is less sophisticated because less protection is required. Most of the phase fault protection consists of coordinated time-over-current elements that are controlled by impedance-based elements that determine directionality of the fault current. If current flow indicates that a fault could be located downstream, the relay operates. This operation occurs after a specified time delay based on the magnitude of the current flow. The time delay allows the protective devices electrically closest to the faulted equipment to operate first.

The North American Electric Reliability Council (NERC) states that a security coordinator must ensure the integration of reliability practices within an interconnection and market interface practices among regions. The security coordinator is responsible for recognizing alert conditions and providing notification to control areas and transmission providers. Alert conditions include cases where energy requirements cannot be met or resources cannot be scheduled. Transmission Load Relief (TLR) is a mechanism for a security coordinator to curtail or re-dispatch scheduled transactions to keep the use of the grid within its operating limits. The security coordinator for the Consumers Energy/METC system and the Detroit Edison/ITC system is the Midwest Independent System Operator (MISO).

### Section 3.2.3: Individual Generating Units

Individual generators are protected from damage by protective relays. These relay systems sense conditions[15] and isolate the generator from the system if any of the conditions exist or are out of range. Individual relays are on each unit. Also, additional multifunction digital relays are on many units. The multifunction relays have several protective functions incorporated into one device, some of these protective functions duplicate the features of individual relays, but others provide alarms only.

When a generating unit is in the process of being shutdown during a planned outage, steam flow from the boiler to the turbine is decreased through control valves to gradually reduce the electrical load on the unit. This is coordinated with other generation and transmission organizations to ensure system stability. Once the unit's load has been reduced, the main unit breaker is opened. Remaining operating plants increase outputs slightly to satisfy the real and reactive load being served by the unit being shutdown. Numerous procedures are then performed on the off-line unit to prevent damage from residual thermal effects or other physical conditions. This gradual unloading process cannot be followed during an emergency shutdown. In such a case, the main unit breaker trips with the control valves between the boiler and turbine closing. The dramatically increased steam pressure in the turbine and boiler are relieved through equipment and procedures designed to protect personnel and equipment. Returning a plant to service after an emergency shutdown requires time-consuming efforts due to the possibility of damage resulting from the rapid shut down.

Under normal operation, the pressure of the steam generated in boilers in power plants is proportional to the load the plants are serving. When electrical load is suddenly removed from the electrical generator, the steam valves, which feed steam from the boiler to the turbine, close to bring the plant to a rapid but controlled shutdown. During this process, the pressure in the low-pressure turbine may increase suddenly. Rupture discs are designed to relieve this pressure. They are incorporated in power plants in the low-pressure section of the steam turbine to prevent injury to personnel or damage to equipment. If the rupture discs do not perform this function, the turbine generator could be damaged due to an over-speed condition, or the steam turbine housing could rupture. Either of these situations could injure workers and require months or years to repair. Once a rupture disc has operated, it must be replaced before a unit can be returned to service.

When a power plant shuts down, residual thermal effects can distort the Machine Turbine Generator (MTG) shaft or damage its bearings. A sequence of operations must be carefully followed to prevent any of these critical elements of the system from being damaged. Repair of these elements can take months or years. For example, the MTG shaft must continue to turn after steam ceases to enter the turbine – if this motion does not continue, the hot shaft could warp under its own weight.

[15] Examples include: phase differential, loss-of-field, negative sequence, volts per hertz, stator ground over-current, reverse power, under-frequency, inadvertent energization, stator ground over-voltage, phase distance, generator field ground and generator field over-excitation

## Section 3.3: The Blackout

The events leading up to the blackout are discussed in Part I. The initial impact appeared on the Michigan system at 4:09 p.m. on August 14, 2003, as a large load in northern Ohio. This load was initially balanced by power coming into Michigan on the METC system through its interconnection with the AEP system in southwestern Michigan and flowing through the ITC system to FirstEnergy. As described in Section 1.3.1, a rapid series of cascading failures caused violent power surges to flow through Michigan, ultimately causing the interconnects to trip between Consumers Energy, Detroit Edison and surrounding utilities. Some of these interconnections flows are shown in Charts 3.1 and 3.2.

**Chart 3.1**

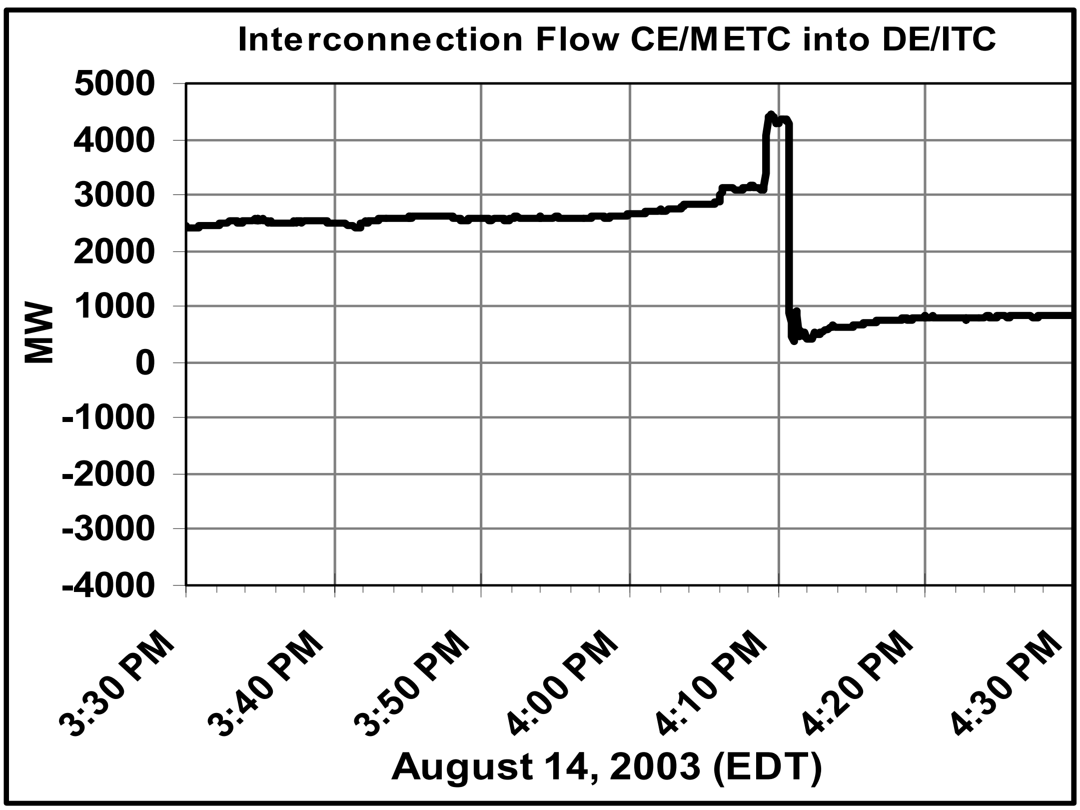
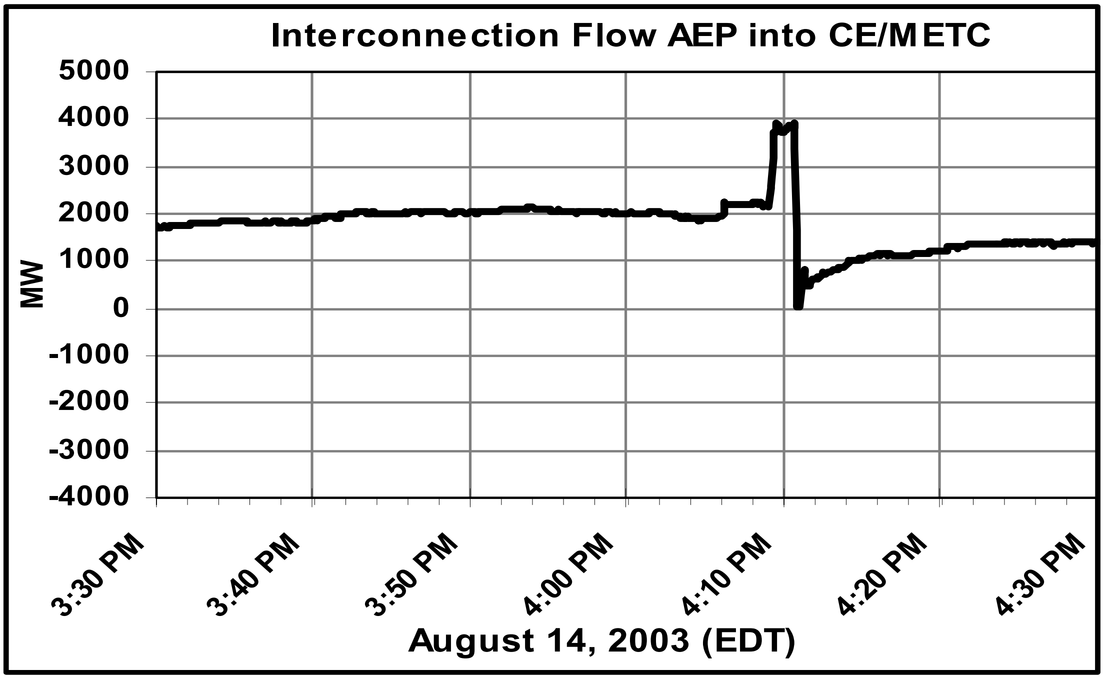


**Chart 3.2**



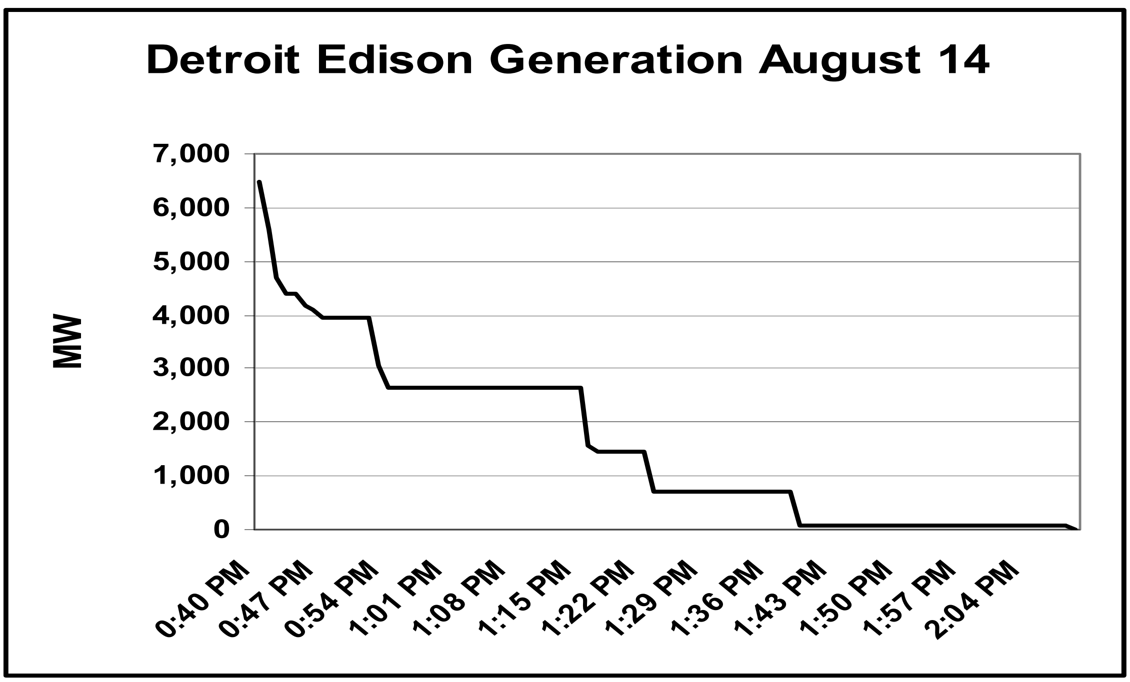

Both Consumers Energy and Detroit Edison report they had no knowledge of the problem developing between FirstEnergy and AEP. In addition, they had no advance knowledge regarding the impending event. The short lead-time (seconds rather minutes) prior to this event on the Michigan system did not allow for human intervention by any entity connected to the system. All actions taken were initiated by automatic switching equipment under the direction of the logic embedded in the systems that control interconnection relays. The protective equipment viewed the increase in load and the general voltage collapse as a fault to ground. Michigan power providers received no advance warning to enable them to protect their customers from the outage.

During the initial seconds of the event, as experienced in Michigan, the Consumers Energy/METC system, which had been transferring about 2,000 MW of power into the Detroit Edison/ITC area prior to the event, separated from the Detroit Edison/ITC system under the additional load placed on it by the FirstEnergy load in Ohio. The load across the east-west interconnections exceeded 4,200 MW on an interconnection with a short term rating of about 4,000-4,500 MW and a 24 hour rating of 3,000-3,500 MW. See Chart 3.1. During this same period the system was experiencing a general collapse in voltage – for example, the voltage at the ITC Bayshore 345 kV interconnection with FirstEnergy dropped to below 305 kV and Detroit Edison 's voltage at its Pontiac Station dropped to 78% of the normal voltage. The protective equipment was designed to interpret such a voltage collapse as a fault to ground.

During the initial phase of the event Consumers Energy's Campbell unit #3, the MCV power facility, the Jackson-based Kinder Morgan facility and most of Detroit Edison's major units were tripped off line by their automatic protection systems. See Charts 3.3, 3.5, and 3.6 for details. In some cases the reactive load requirements placed on generation units exceeded the maximum capabilities by over 300%.

The pre-event loadings coupled with the increased requirements to support FirstEnergy through ITC simply overloaded the Michigan systems and caused the interconnections to open isolating the Detroit Edison system from the Consumers Energy generation and the Ludington Pumped Storage Facility. Consumers Energy was able to continue serving most of its customers through: (1) its own generating units, which, except for Campbell # 3 and the three Whiting Units, stayed on line; (2) AEP power, including power that had been flowing through METC to ITC/Detroit Edison; and (3) Detroit Edison's share of the Ludington Pumped Storage Facility. Some Consumers Energy load was lost in the Flint area during the disconnection of METC from ITC and several southern counties lost power due to the outage of the Whiting Power Plant.

**Chart 3.3**



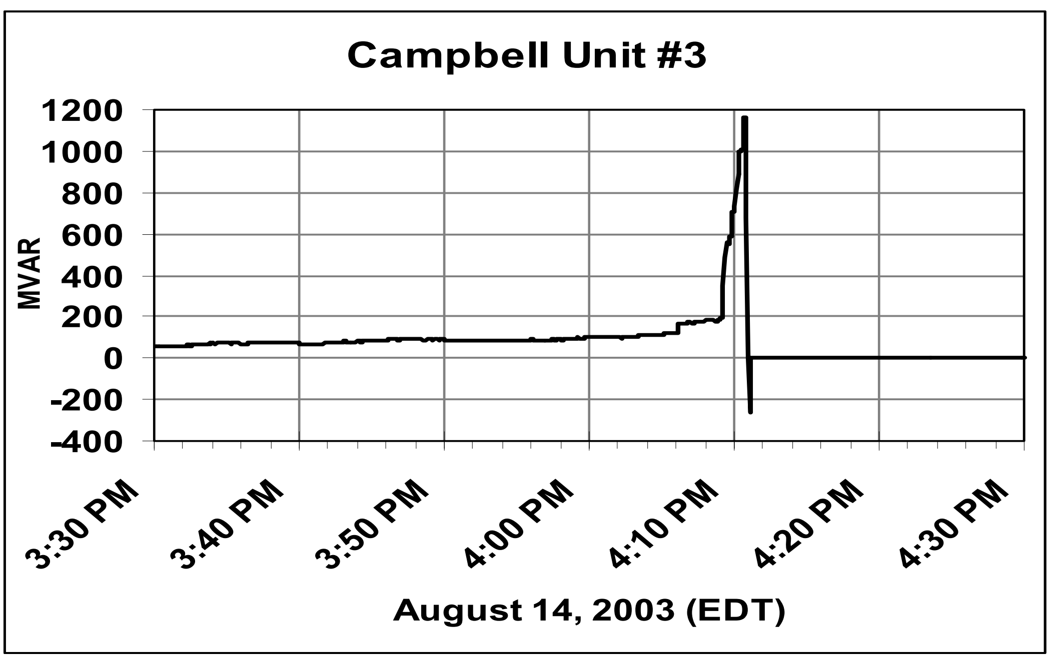

The August 14 event heavily impacted the Michigan electric power systems from a reactive power standpoint. Reactive power must be present at sufficient levels to maintain voltage. Without adequate reactive power support, voltage levels fall and the system becomes unstable. The reactive power component cannot be transported long distances as can the active power component and must be produced fairly close to the actual load either by spinning generators or capacitor banks.

At 3:30 p.m. on August 14 (prior to the blackout), the Michigan generation was supplying about 300 megavars (MVAR) to FirstEnergy over the ITC/FirstEnergy interconnection. The MVAR required to support FirstEnergy increased slowly over the 30 minute period preceding the event until it reached just over 400 MVAR at 4:06 p.m. At that time, it jumped to nearly 700 MVAR, where it remained until the METC and the ITC systems separated at 4:10 p.m. After the separation the MVAR flow into FirstEnergy from ITC was near zero.

During this period, the METC system was supplying roughly 200 MVAR into the AEP system in support of the 2,000 MW of power that was being transferred into Michigan over the METC/AEP interconnection. The Consumers Energy/METC system was also supplying about 200 MVAR into the Detroit Edison/ITC system just prior to the event. As the event unfolded, the MVAR transfer into the Detroit Edison/ITC system increased to nearly 300 MVAR at about 4:10 p.m., then reversed and became a 700 MVAR draw from the DE/ITC system just as the event occurred.

Michigan based generating units experienced an extremely large MVAR draw just prior to the event and during the initial phase of the event. Consumers Energy reports that all of the connected generation experienced MVAR requirements beyond their normal capabilities. Generating units are not capable of supporting MVAR requirements at elevated levels for a lengthy time without sustaining serious damage. Chart 3.4 displays the MVAR variation experienced by CE's Campbell unit 3 during the event.

**Chart 3.4**



## Chart 3.5

| Consumers Energy Generation Status Before and After the Event | | | | | | |
|---|---|---|---|---|---|---|
| Plant | Unit | Rating | Load @ 16:00 | Load @ 16:15 | Trip Time | Cause of Trip |
| Allegan Hydro | | 2.5 | 0.87 | 0.34 | 16:15:00 | Undervoltage |
| Campbell | 1 | 260 | 265 | 262 | | |
| Campbell | 2 | 355 | 350 | 347 | | |
| Campbell | 3 | 820 | 812 | 0 | 16:10:42 | Turbine thrust bearing |
| Cobb | 4 | 156 | 152 | 145 | | |
| Cobb | 5 | 156 | 158 | 158 | | |
| Cooke Hydro | | 7.5 | 3 | 3 | | |
| Croton Hydro | | 8.4 | 2 | 2 | | |
| Five Channel Hydro | | 6.4 | 3 | 1 | | |
| Foote Hydro | | 9.9 | 2 | 2 | | |
| Gaylord | 2 | 14 | 13 | 13 | | |
| Gaylord | 4 | 14 | 12 | 12 | | |
| Hardy Hydro | | 32.4 | 10 | 10 | | |
| Hodenpyl Hydro | | 18.4 | 3 | 3 | | |
| Karn | 1 | 255 | 212 | 208 | | |
| Karn | 2 | 256 | 196 | 0 | 16:13:50 | Boiler trip |
| Karn | 3 | 511 | 633 | 632 | | |
| Karn | 4 | 638 | 606 | 605 | | |
| Loud Hydro | | 638 | 2 | 2 | | |
| Ludington | 2 | 312 | 0 | 253 | | |
| Ludington | 3 | 312 | 286 | 303 | | |
| Ludington | 4 | 312 | 325 | 306 | | |
| Ludington | 5 | 312 | 283 | 308 | | |
| Ludington | 6 | 312 | 285 | 290 | | |
| Mio Hydro | | 4.4 | 1 | 1 | | |
| Palisades | | 767 | 762 | 763 | | |
| Rogers Hydro | | 6 | 1 | 1 | | |
| Straits | | 16 | 14 | 14 | | |
| Tippy Hydro | | 21 | 5 | 5 | | |
| Weadock | 7 | 151 | 153 | 146 | | |
| Weadock | 8 | 151 | 154 | 146 | | |
| Whiting | 1 | 102 | 96 | 0 | 16:10:44 | Generator Protective Relaying |
| Whiting | 2 | 102 | 102 | 0 | 16:10:44 | Generator Protective Relaying |
| Whiting | 3 | 122 | 125 | 0 | 16:10:59 | Generator Protective Relaying |

The large MVAR draw on the Michigan system signifies a voltage collapse somewhere on the interconnected system. A further complication of the situation occurs as the MW draw across the Michigan system jumped to over 3,000 MW and subsequently above 4,200 MW. This power transfer across Michigan used up a large portion of the available MVAR support to support the transfer. Unable to maintain the required MVAR support the Michigan systems entered a voltage collapse situation that precipitated the tripping of the generation that Detroit Edison had on-line. With the interconnection with Consumers Energy/METC system open and with almost all of its generation tripped off-line, Detroit Edison was unable to support its internal load.

## Chart 3.6

| Detroit Edison Generation Status Before and After the Event | | | | | | |
|---|---|---|---|---|---|---|
| Plant | Unit | Rating | Load | Load | Trip Time | Cause of Trip |
| | | | @ 16:00 | @ 16:15 | | |
| Greenwood | 1 | 785 | 299 | 0 | 16:10:40 | Generator Protective Relaying |
| St. Clair | 7 | 450 | 144 | 0 | 16:10:41 | Generator Protective Relaying |
| Belle River | 1 | 625 | 609 | 0 | 16:10:41 | Generator Protective Relaying |
| Connors Creek | MTG 15 | 135 | 137 | 0 | 16:10:41 | Generator Protective Relaying |
| Greenwood | 11--1 | 75 | 76 | 0 | 16:10:42 | Generator Protective Relaying |
| Greenwood | 11--2 | 75 | 77 | 0 | 16:10:42 | Generator Protective Relaying |
| Greenwood | 12--1 | 75 | 75 | 0 | 16:10:42 | Generator Protective Relaying |
| Trenton Channel | 7A | 110 | 95 | 0 | 16:10:42 | Generator Protective Relaying |
| Trenton Channel | 8 | 100 | 105 | 0 | 16:10:42 | Generator Protective Relaying |
| Trenton Channel | 9 | 520 | 489 | 0 | 16:10:42 | Generator Protective Relaying |
| St. Clair | 6 | 321 | 285 | 0 | 16:10:43 | Generator Protective Relaying |
| Belle River | 12--1 | 75 | 75 | 0 | 16:10:45 | 345KV Breakers Tripped |
| Belle River | 12--2 | 75 | 74 | 0 | 16:10:45 | 345KV Breakers Tripped |
| Belle River | 13--1 | 75 | 75 | 0 | 16:10:45 | 345KV Breakers Tripped |
| Harbor Beach | 1 | 103 | 83 | 0 | 16:10:46 | Manual Trip by Unit Super. Oper |
| Delray | 11--1 | 70 | 62 | 0 | 16:10:47 | 345KV Breakers Tripped |
| Delray | 12--1 | 70 | 62 | 0 | 16:10:47 | 345KV Breakers Tripped |
| St. Clair | 4 | 158 | 140 | 0 | 16:10:53 | LP Turbine Overspeed |
| Monroe | 4 | 775 | 767 | 0 | 16:10:53 | Generator Protective Relaying |
| River Rouge | 3 | 272 | 270 | 0 | 16:10:54 | Generator Protective Relaying |
| St. Clair | 2 | 162 | 138 | 0 | 16:11:04 | Data Not Available |
| Fermi | 2 | 1111 | 1094 | 0 | 16:11:16 | Generator Protective Relaying |
| Monroe | 2 | 750 | 109 | 0 | 18:01:17 | Generator Protective Relaying |
| Monroe | 3 | 750 | 733 | 0 | 16:11:23 | Generator Protective Relaying |
| Belle River | 2 | 635 | 636 | 0 | 16:11:39 | Generator Protective Relaying |
| Connors Creek | MTG 16 | 80 | 73 | 0 | 16:12:09 | Manual Trip by Unit Super. Oper |
| Belle River | DG 11--1 | 2.75 | 2.25 | 0 | 18:07:35 | N/A |
| Belle River | DG 11--2 | 2.75 | 2.25 | 0 | 18:07:37 | N/A |
| Belle River | DG 11--3 | 2.75 | 2.25 | 0 | 18:07:39 | N/A |
| Belle River | DG 11--4 | 2.75 | 2.25 | 0 | 18:07:41 | N/A |

### Section 3.4: Review and Analysis of Actions Taken

The events that occurred outside of the State that preceded the outage were beyond the view of the power system operators within Michigan. This and the lack of advance warning from MISO, First Energy, AEP, or any other organization, prevented the Michigan electric system operators from taking manual action to protect customers from the impending outage. Even if the Michigan electric system operators had full knowledge of the generation and transmission line outages unfolding between FirstEnergy and AEP, actions open to them might have presented a significant risk to the stability of the Michigan system. Isolating the Michigan system from its interconnections with outside utilities would have been difficult at best and the results uncertain because Detroit Edison was importing about 2,900 MW through the METC/ITC system from the METC interconnect with AEP.

If Michigan operators had full knowledge of the events occurring elsewhere, it appears that approachs other than full isolation may have been available to prevent or at least significantly reduce the pending power surges. In order to prevent the power surge from coming through Michigan, the ITC/FirstEnergy interconnect could have been opened prior to the event. If it is not done before the event, once the interconnect is heavily loaded, opening it would likely have forced Detroit Edison generating units off-line due to turbine over-speed from the sudden loss of load. This could have caused a power outage on the Detroit Edison system. In any case, the lack of information from other systems prevented Michigan operators from exercising or considering this option.

The other course of action that may have prevented the outage in the Detroit Edison service area would have involved unloading the interconnections between the Consumers Energy/METC system and the Detroit Edison/ITC system in advance of the event. An unloaded interconnection may have weathered the coming storm causing the interconnections between ITC and FirstEnergy to open sparing the Detroit Edison system from a full blackout. If Detroit Edison or ITC had received advance notice of the problems experienced elsewhere, they may have been able to increase generation levels within the Detroit Edison territory, thereby unloading the ties with the Consumers Energy/METC system. If Michigan companies had been provided enough advance notice of the events[16] occurring between FirstEnergy and AEP, such action may have reduced or eliminated the impact on Detroit Edison and Consumers Energy customers.

Detroit Edison generation on-line at the time of the blackout had the capability to provide an additional 1,600 MW of power. If Detroit Edison had known of the problems being experienced elsewhere, it could have ramped up its internal generation prior to the event to full power levels in the time period between the FirstEnergy Hanna-Juniper 345 kV trip at 3:32 p.m. (this was the second 345 kV line to trip within the FirstEnergy system, the first was Chamberlain-Harding at 3:06 p.m. EDT) and 4:09 p.m. This would have reduced the transfer across its interconnection with METC by 1,600 MW to approximately 1,300 MW. With the transfer level in this range a Detroit Edison system blackout could probably have been avoided.

Detroit Edison could not exercise this option because the key information regarding the impending system disturbance was not shared beyond FirstEnergy, AEP and MISO. Failure to share key reliability information with Detroit Edison or ITC also prevented ITC from considering the option of opening its interconnections with FirstEnergy, or at least opening two of the three to allow automatic interruption of the remaining connection prior to the opening of the METC/ITC interconnections.

It appears based on the results of this investigation that the protection systems located within Michigan worked as designed. The Detroit Edison/ITC system had too much power flowing into its system to survive a separation from the Consumers Energy/METC system without major generating units tripping off-line. The Consumers Energy/METC system was able to separate a major portion of its system from the problem. The fact that there was no major damage either to transmission and associated equipment or to generating units and their associated equipment demonstrates that the automatic protection equipment worked as designed. If this equipment had

[16] Four organizations, MISO, PJM, FirstEnergy, and AEP, had information about these events. Any of them could have, and should have, provided the information they had to other affected entities.

not worked as designed, there would likely have been major damage to facilities that could have taken weeks or even months to replace or repair.

**Section 3.5: Recovery**

**Section 3.5.1: Consumers Energy**

Restoration efforts were undertaken immediately following the event. Consumers Energy issued an emergency page to notify departments within its Transmission & Distribution organization that a significant system disturbance had taken place and requested that leadership personnel report to the nearest System Control Center. Local headquarters in the affected areas were also instructed to remain open. A conference call was established at 5:15 p.m. to determine initial actions. Subsequent calls were held every two to three hours thereafter. Independent conference calls were also held with METC on a similar schedule.

Personnel in the Merchant Operations Center assessed generation status and established communications with operations centers within Michigan and nearby systems. Management from Fuels & Power Transactions and Nuclear, Fossil and Hydro Operations organizations arrived by 4:30 p.m. to monitor the situation and direct restoration efforts from the supply side. Merchant Operations personnel opened communication with DTE merchant personnel as well as transmission operators to assess the extent of the disruption on supply resources.

On the Consumers Energy/METC system there were significant generator outages, numerous line outages, and two areas were without power. Generation outages included Midland Cogeneration Venture (1,240 MW) in Midland, Karn 2 (260 MW) in Bay City, Campbell 3 (820 MW) in Port Sheldon, and Whiting 1-3 (330 MW) in Monroe. Line outages included two 345 kV ties and two 138 kV ties between METC and the Detroit Edison/ITC system, two 138 kV ties between METC and Lansing BWL, one 138 kV tie between METC and Northern Indiana Public Service Company (NIPSCo), and a multitude of 138 kV and 46 kV lines in the southeastern portion of the state. Additionally, there was one 46 kV line in the Flint area that was out of service and numerous distribution circuits locked out. The two major areas without power were the Lansing BWL and the southeast corner of Consumers Energy's service territory (geographically enclosed predominately by I-94 to the north and M-66 to the west).

Immediately following the event, Consumers Energy started generation in response to the loss of units. Consumers Energy believed at that time it was under-generating, but interconnection frequency continued to be above 60 Hertz, which would generally be an indication of over-generation. In consultation with transmission operators, Consumers Energy maintained its generation level until the status of the system, both in Michigan and in neighboring areas, could be assessed. Between 5:00 p.m. and 7:00 p.m. power output from the Ludington Pumped Storage facility was reduced in order to moderate high frequency levels and manage available stored water for later restoration needs of Detroit Edison. Consumers Energy also obtained additional supplies of electricity from in-state independent power producers and AEP.

Restoration efforts followed black start[17] procedures. Efforts began with an assessment of the 138 kV and 46 kV breakers that were open. The open breakers were plotted on a geographic map of the electric system in order to determine the boundaries of the affected areas. Having defined the affected area, System Control Centers began the process of opening up all breakers contained within the affected area via SCADA and field personnel.

Consumers Energy's Lead System Control established communication with the Electric Sourcing and Trading group to keep apprised of generation status. The Lead System Control also established communication with the Michigan Electric Power Coordination Center, ITC and MISO to keep apprised on issues pertaining to the transmission system and its interconnections with neighboring utilities.

Consumers Energy's merchant group maintained communication with its Detroit Edison counterpart, as well as other control centers. Consumers Energy agreed to fill Ludington Pumped Storage overnight for both itself and for Detroit Edison to prepare for restoration efforts the next day.

The return of generation at the Whiting facility and the restarting of generators at Kinder Morgan power plant were a top priority. These units provide both local power supply and area voltage support. Also, Consumers Energy believed that the automatic relays (which are designed to isolate distribution circuits for sustained periods of under-frequency operation) had tripped and that personnel would need to be dispatched to reset these relays and energize the tripped circuits. Consumers Energy personnel from the western and central portion of Michigan were dispatched to the affected area to aid in resetting the relays.

As of 5:15 p.m., all breakers within the affected area were opened, and the process of restoring the 138 kV system was undertaken. This included service to Whiting Substation, which provided station power for restarting Whiting Generation. The 138 kV system, with the exception of the ties with ITC and NIPSCo, was restored by 7:25 p.m. During restoration of the 138 kV system some 46 kV and 138 kV connected load was also restored. At that time System Control began energizing the remaining 46 kV lines and restoring customers to service. At this point, the system was net generation deficient. Therefore, restoration of customers progressed at a pace relatively equal to the rate at which generation became available.

As generation, particularly the Kinder Morgan power plant, began ramping toward full output, the 46 kV system was restored in the affected area. By 10:05 p.m. on August 14 all 46 kV lines had been energized and all load was returned to service. Automatic relays were checked and it was determined that the relays had not tripped as initially believed. The field personnel dispatched from surrounding areas were returned to their respective headquarters.

The ties between METC and Lansing BWL remained closed from the METC end throughout the event. At 7:45 p.m. on Thursday, August 14, Lansing BWL closed their end of the ties in agreement with METC.

[17] See Section 3.5.2 for an explanation of black start procedures.

According to Consumers Energy's Outage Management System, up to 118,400 customers were out of service during the 4:00 p.m. through 10:00 p.m. timeframe on August 14th.

A restart of Campbell 3 was attempted at 7:44 p.m. but was aborted when the unit experienced water hammer two minutes after turning on steam. This damaged a number of piping hangers in the plant, which required repair, delaying the units return to service. As information on Campbell 3's status and repair time became known, and with the uncertain status of the transmission system, Consumers Energy issued a request that customers continue to conserve electrical use into Friday, August 15.

With the southeastern portion of the Consumers Energy/METC system returned to a normal situation, except for the Whiting Generation and the 138 kV ties to ITC and NIPSCo, seventy-five percent of the power supply to the affected area was coming from the Kinder Morgan power plant and transmitted on the Leoni–Beecher (Jackson to Adrian) and Leoni–Parr Road–Whiting (Jackson to Monroe) 138 kV Lines. The remaining twenty-five percent of the power supply was from the Verona Substation in Battle Creek and was transmitted on the Verona–Batavia 138 kV Line (Battle Creek to Coldwater). These three 138 kV lines, now critical to supply power to the recently restored area, were heavily loaded but within applicable continuous capability limits.

At 10:30 p.m. the Leoni–Beecher 138 kV Line tripped and did not re-close at Beecher due to loss of station power. This resulted in large flows on the remaining two critical 138 kV lines, causing them to open at their source ends. The system within the subject geographic area was then in nearly the same state as it was following the primary 4:09 p.m. outage.[18] Immediately, a similar restoration plan to the primary outage was executed. The 138 kV system was restored by 12:55 a.m. Friday, and the 46 kV system along with all of the connected customers was restored by 1:35 a.m. Friday.

During restoration efforts field personnel were dispatched to patrol the Leoni–Beecher 138 kV Line. Relays protecting this line were remotely interrogated and a suspected fault location was identified. This information was passed on to the field crews as a place to start their patrol. Due to darkness and foggy/hazy conditions, the source of the fault was not located. When that line was returned to service at 11:00 p.m., it was given a derated capability equal to its historically highest sustained power flow in order to avoid further trips or failures.

According to Consumers Energy's Outage Management System, up to 70,100 customers were out of service during the 10:00 p.m. August 14th through 6:00 a.m. August 15th timeframe.

The morning weather forecast for August 15 was reviewed and with the capacity available at that time, Consumers Energy was expected to be short of ECAR operating reserve requirements. Internal company load reductions were ordered, and the public was asked to conserve all day. Specific customers were contacted to request voluntary curtailments and an estimated 400 MW of reduction was obtained. At 12:45 p.m., Detroit Edison gave Consumers Energy permission to use its unused Ludington capacity to meet load. By 4:00 p.m. on August 15, rainstorms occurring across the Consumers Energy service area reduced load, which allowed the widespread general public conservation to be discontinued.

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[18] However the night-time load was considerably less then the afternoon load.

Several reliability concerns were handled by Consumers Energy personnel over the next two days. These included problems in adhering to the derated capability of the Leoni–Beecher line, the clearance status of 138 kV lines located within the affected area, and large power flows between the METC and ITC systems. In addition, continued hot weather, unit outages caused by the event, and uncertain power availability to supplement Consumers Energy's own internal generation led to a forecast of a deficiency in Consumers Energy's operating reserve.

Adhering to the derated capability of the Leoni–Beecher line resulted in Consumers Energy's System Control curtailing load. As loads came up on Friday morning, power flow on the Leoni–Beecher line began to exceed the derated capability established the previous night, risking a line trip again and potentially another outage. Two actions were taken to adhere to the derated capability. All customers in the affected area were asked to curtail power usage and load management procedures were put into place. This resulted in a forced outage of industrial customers in that area and a reduction of approximately 16 MW of load. Additionally the Raisin, Tecumseh Products, La Salle, and Erie 46 kV lines were forced out of service. This resulted in a reduction of approximately 40 MW of load. According to Consumers Energy's Outage Management System, up to 17,500 customers were out of service during the 7:00 a.m. through noon timeframe on August 15th.

With the return of the first Whiting generator at 9:30 a.m. on August 15, the 46 kV lines were restored to service. However, continued restriction of the related large customers was maintained since loading on the Leoni–Beecher line remained at approximately ninety percent of the derated capability. This restriction was imposed until generation at Whiting stabilized on Saturday and all related industrial customer load restrictions were lifted.

All 138 kV lines contained within the affected area, especially the 138 kV lines deemed critical, were patrolled on Friday, August 15 in an effort to avoid a repeat of the Leoni–Beecher line trip. After all items identified as possible concerns were resolved, the remaining ties between Consumers Energy/METC system and Detroit Edison/ITC were closed by 1:05 p.m. on Saturday, August 16.

The final concern was possible separation between the Consumers Energy/METC and Detroit Edison/ITC systems due to any one of three single-contingencies involving tie lines between the two systems on Saturday.[19] With Detroit Edison being generation deficient, it was dependent upon the Consumers Energy/METC system interface for power supply, particularly in the thumb area of Michigan. With power flows between the two systems reaching the 3,000 MW range, analysis indicated a single contingency would load other ties between the Consumers Energy/METC system and the Detroit Edison/ITC system above emergency capabilities. This could start a cascading outage resulting in separation between the METC and ITC systems. A number of items were implemented to prevent this from occurring. On the daily morning conference call with METC these concerns were discussed and patrols were ordered for the METC portion of the tie lines identified by the analysis. MECS and ITC were notified of the

[19] The term "single-contingency" is used in the industry to indicate a situation resulting from the outage of a single unit or transmission line currently in operation. The concept is to plan for operation of the system in a manner that will allow it to continue to function in the event that something unexpected happens.

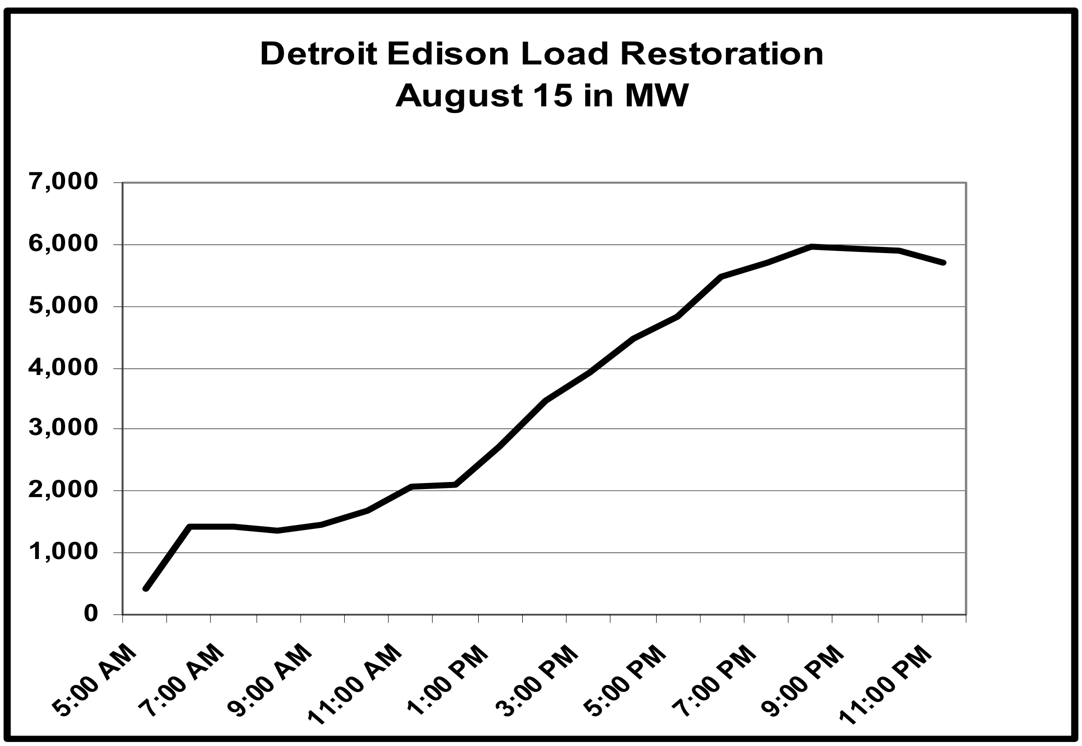
patrol activities.  An additional call to discuss these issues was scheduled with Consumers Energy, Detroit Edison, MECS, METC and ITC for 2:30 pm.  After this call, power flows on these ties decreased within applicable limits as generation within the Detroit Edison/ITC system increased.

Concerns were monitored and discussed via conference calls throughout the weekend as preparations were made for Monday business.

**Section 3.5.2:  Detroit Edison**

The Detroit Edison service territory-wide outage invoked the utility's black start procedures. These procedures were initially developed after the 1965 outage and direct all of the available field operations staff to the proper locations to support the restoration effort.  Given the telecommunication and traffic issues that occurred immediately after the incident, these procedures saved valuable time restoring the system.

**Chart 3.7**




Detroit Edison was faced with the difficult prospect of restarting its entire collection of generation facilities as listed in Chart 3.6 from a near black start position.  This term is referenced in textbooks and technical literature to describe a situation in which a power plant is being brought online with a transmission system that is not energized.  While utilities maintain procedures for this condition, it is not frequently encountered.  A black start condition is particularly challenging because for most generation, power is required to begin the process.

The turbine must begin to turn to start fluid flow, and steam generation, water flow and compressed air are also required during start up. These functions require electrical power, and that power must be made available either through the transmission system or local stand-by generators.

**Chart 3.8**

| Unit | Initial Inspection Results | Synchronizing Time | Full Load | Comments |
|---|---|---|---|---|
| Trenton Channel 7A (110MW) | No issues found during initial inspection | August 15, 2003 0916 hrs | August 15, 2003 1430 hrs | |
| Trenton Channel 8 (100MW) | No issues found during initial inspection | August 15, 2003 0330 hrs<br><br>First attempt on August 14, 2003 at 2340 hrs | August 15, 2003 1430 hrs | |
| Trenton Channel 9 (520MW) | No issues found during initial inspection | August 19, 2003 1405 hrs | August 20, 2003 0550 hrs | 69 SS Transformer available for unit restart at 0400 hrs on August 15.<br><br>Turbine vibration was reduced with a balance shot. Load continues to be limited to 475 MWs due to high vibration. |
| Monroe 1 (770MW) | Unit was in an outage at the time of the event | August 18, 2003 0359 hrs | August 18, 2003 1156 hrs | |
| Monroe 2 (750MW) | Four failed rupture discs were found/replaced, loss of control air on generator seal oil system valves resulted in oil in the generator | August 19, 2003 0114 hrs | August 19, 2003 1700 hrs | |
| Monroe 3 (750MW) | Four failed rupture discs were found/replaced | August 17, 2003 0152 | August 17, 2003 1330 hrs | |
| Monroe 4 (775MW) | No issues found during initial inspection | August 16, 2003 0747 hrs | August 16, 2003 1605 hrs | Initially limited due to auxiliary boiler capacity |
| River Rouge 1 (225MW) | Unit was in an outage at the time of the event | August 15, 2003 1705 hrs | August 15,2003 2100 hrs | |
| River Rouge 2 (247MW) | Unit was in an outage at the time of the event | August 16, 2003 1422 hrs | August 16, 2003 1830 hrs | HP collector repairs were being conducted at the time of the event |
| River Rouge 3 (272MW) | The MTG was placed on turning gear to straighten the shaft. | | | The bearings were found to be damaged during an attempted start. This unit will require several weeks to repair and is not expected to be operational again until late September. |

Another factor affecting return to service of generation units is synchronization. When connecting a power plant to the electrical system, the frequency, voltage and phase of the plant's output must be made to match the rest of the electrical system. If this is not the case, the shaft and equipment on the shaft could be severely damaged and require months to repair.

Large generators and their associated equipment require a ramp-up period before they can be placed under full load conditions. The thermodynamic aspects of operating power plants require operators to maintain the plant at a low output level for a period of time to allow the components to reach thermal stability. Once this point is reached, the plant can be pushed to full load.

**Chart 3.8 (continued)**

| Unit | Initial Inspection Results | Synchronizing Time | Full Load | Comments |
|---|---|---|---|---|
| Belle River 1 (625MW)* | Three failed rupture discs were found/replaced | Attempted synchronization on August 15 at 2100 hrs - Lack of field excitation prevented synchronization | | Inspection revealed a failed exciter. Exciter problems were corrected and the unit was returned to service on August 14, 2003 at 1317 hrs |
| Belle River 2 (635MW)* | Three failed rupture discs were found/replaced | August 16, 2003 1245 hrs | August 17, 2003 0045 hrs | |
| St. Clair 1 (153MW) | No issues found during inspection following the unit trip | August 15, 2003 1924 hrs | August 17, 2003 1000 hrs | Unit remained on the 120 kv system during the initial event - Tripped off line during switching operations on August 14, at 1832 hrs<br>Following restart load was limited due to a ground in the No-Load/Low Load trip switch |
| St. Clair 2 (162MW) | No issues found during initial inspection | August 15, 2003 1223 hrs | August 15, 2003 2000 hrs | |
| St. Clair 3 (171MW) | No issues found during inspection following the trip | August 15, 2003 0541 hrs | August 15, 2003 1300 hrs | Unit remained on the 120 kv system during the initial event - Tripped off line during switching operations on August 14, at 1834 hrs |
| St. Clair 4 (158MW) | No issues found during initial inspection | August 15, 2003 1645 hrs | August 15, 2003 2300 hrs | |
| St. Clair 6 (321MW) | Initial inspection revealed a boiler water circulating pump overheated | August 16, 2003 0948 hrs | August 16, 2003 1500 hrs | Boiler water circulating pump overheated and had to be replaced prior to start-up |
| St. Clair 7 (450MW) | Failed rupture discs found/replaced | August 15, 2003 1901 hrs | August 16, 2003 1300 hrs | Difficulty with turbine turning gear, precipitators and ash handling |

Failure to follow this procedure can substantially damage key equipment on the generating unit and require months or years to correct.

The Harbor Beach power plant (103 MW) tripped off-line during the event on August 14 but was restored to service within a few hours. Greenwood Energy Center (785 MW) was restored to service mid-day on August 15. Unit 15 (150 MW) and unit 16 (65 MW) at Conners Creek power plant were restored to service by mid-day on August 16. Ludington Pumped Storage Facility remained available throughout the restoration effort. Fermi 2 (1130 MW) tripped off-line during the event and was restored to service on August 20, 2003. The time period to start Fermi was longer due to the procedures required for nuclear power plants. A timeline for the remaining major plants is provided in Chart 3.8[20]. In addition to the work described in Chart 3.8, the Dean Power Facility (an independent power producer) was returned to service at 8:15 p.m. August 14 and Detroit Edison personnel resolved issues at various peaking facilities to provide 950 MW of additional capacity on August 15.

In addition to Detroit Edison's generation, purchases from outside the service territory in coordination with independent power producers were crucial to a timely restoration. This was an effective method of restoration, but expensive. Some purchases were $87/MWh or more. A normal summer on-peak purchase cost would be around $50/MWh. Detroit Edison also coordinated filling the Ludington Pumped Storage Facility with Consumers Energy during the night of August 14 to prepare for load restoration on August 15. To prevent rolling blackouts in Consumers Energy's territory, Detroit Edison allowed Consumers Energy to use some of this stored energy on August 15.

Detroit Edison's System Operations Center (SOC) was monitoring the steady state condition of the transmission system at the time of the blackout. There were no indications or notifications of impending problems prior to the blackout, which occurred in a matter of seconds. After the blackout, the first actions taken were to determine the state of the system. Within a few minutes, the system supervisors determined the following:

- System frequency was zero.
- St. Clair Power Plant had two units running in stable condition and serving an island of approximately 89 MW.
- A group of customers were being served in the thumb through an interconnection.
- A group of customers in the Pinckney area were being served by the Majestic interconnection.
- Harbor Beach Power Plant had tripped, but was operational.
- Several interconnections were still energized and available to support the restoration effort.

In addition to the field operations staff, six additional system supervisors, three engineers and several application engineers joined the available SOC staff within an hour to support the restoration effort. Shortly after the incident, numerous members of senior management arrived in SOC to assess the incident and ensure that the proper resources were available. Within 3 hours, additional support was made available from DTE Energy's generation operations and major account services organizations.

The 1965 plan, which had since been updated on numerous occasions, was used as a guideline by SOC. The SOC team broke up into north and south teams. The intent was to begin restoring the 120kV transmission loops around the service territory and provide a source of electricity for power plants to use to start and synchronize. In the early hours of the blackout, the focus was to restore a source of power to the plants and switch load back onto the electrical system in a safe

[20] Chart 3.8, the Generation Restoration Timeline, was prepared by Detroit Edison shortly after the blackout and provides a contemporaneous accounting of the status of each of the company's generating units immediately prior to, during and subsequent to the blackout. We note that the data for the return to service of Belle River 1 is in error. The unit actually returned to service on August 24 at 1:17 p.m. Otherwise we believe that the information is correct.

and orderly manner. The effort was complicated by numerous external factors. Most significantly, releases of hydrocarbons and evacuation around the Marathon Oil refinery blocked several plans the SOC team formulated to reach some of the southern power plants. The team eventually achieved this goal with police support.

The service territory-wide outages include the following counties: Wayne County, Oakland County, Monroe County, Macomb County, 10% of Lapeer County, 25% of St. Clair County and the eastern half of Livingston County – all which had lost power within a 5 minute period. The following counties were not affected because the Atlanta–Karn–Thetford 120 kV and the Hemphill–Hunters Creek 120 kV interconnections to Consumer Energy remained in service: Sanilac county, the northern 90% of Lapeer County, and the northern 75% of St. Clair County. In the southern portion of the system at Majestic station, the 345 kV interconnections with Consumers Energy and the 345 kV interconnections with FirstEnergy remained in service, which allowed the western half of Livingston County to remain in service following the event.

After the blackout, Detroit Edison found it was in the following condition: (1) the St. Clair Units 1 and 3 were available but isolated in an area near the facility; (2) the Atlanta –Karn–Thetford interconnection to Consumers Energy/METC was energized; (3) all 345 KV interconnections to Majestic Station were closed and energized; (4) the Allen Junction–Majestic–Monroe transmission line was energized into the Monroe Power Plant; and (5) the Majestic lines were feeding and carrying Madrid and Genoa Station load. At this point all plants were ordered to initiate black start procedures.

In its restoration process Detroit Edison focused on first energizing a 120 kV path to connect power plants and re-establishing the available inter-connections to neighboring utilities. The first step taken was to restore power to the Harbor Beach plant and Greenwood Energy Center. In the northern part of the system, the Atlanta–Karn–Thetford 120 kV and the Hemphill–Hunters Creek 120 kV interconnections were utilized to provide restoration paths to Harbor Beach and St. Clair power plants. This allowed Harbor Beach generation to start and load was restored in the remaining portions of Lapeer County by 8:00 p.m. Also, a source of power to start the St. Clair plant and Dean generation was established. The St. Clair 120 kV bus[21] was restored at 8:15 p.m. and the St Clair peakers were started.

During the same period on the south side of its service territory, Detroit Edison was able to isolate a path between the Monroe Power Plant, Brownstown Station, Fermi nuclear plant and the Trenton Channel plant. Between 10:00 p.m. and 10:30 p.m., the Allen Junction–Majestic–Monroe interconnection between Detroit Edison and FirstEnergy was used to establish a restoration path from Monroe to Brownstown to Fermi. An additional path was isolated from Brownstown to Navarre Station to Waterman Station. This provided Detroit Edison with the ability to provide station power to these units in preparation of the process of restoring them to service. Just before midnight the lines to Trenton Channel from Brownstown were energized.

Early in the morning of Friday, August 15, Detroit Edison restored the Pontiac–Hampton interconnection, which further strengthened Detroit Edison's interconnection with the Consumers Energy/METC system and allowed a restoration path to be established to the

[21] "Bus" is short for bus bar, a conducting bar that carries heavy currents to supply several electric circuits.

Greenwood power plant, the Belle River power plant, and St. Clair Units 6 and 7. The Essexville-based generation of Consumers Energy could now assist in the restart. The restoration of interconnections with the Consumers Energy/METC also allowed Detroit Edison to use the Ludington Pumped Storage Facility and purchases from AEP to assist in the restoration process. The Belle River Power Plant–Greenwood–Pontiac Station connection was also restored. This connected the Detroit Edison units at Belle River and the Greenwood Energy center to the system. At this point the Greenwood peakers were started.

Around 3:00 a.m., the 120 kV Trenton Channel–Airport line was re-energized to restore power to Metro Airport, which began restoration of critical facilities.

At 3:18 a.m., Remer Station was restored from the St. Clair generation facility to allow Dean Generation to restart. This connected an additional 300 MW of generation to the Detroit Edison system.

At 3:30 a.m., Detroit Edison energized Brownstown–Navarre–Waterman line. The River Rouge Power Plant could not be reached due to Marathon Oil Refinery incident, which required evacuation of the area surrounding the refinery.

Between 3:55 a.m. and 4:43 a.m., the Belle River–St. Clair 345 kV line was restored, along with the Belle River–Jewel interconnection. This action tied the Belle River and St. Clair power plants into the system, so they could begin supporting the restoration activity. By 5:00 a.m., the restoration of the Pontiac–Hampton 345 kV interconnection, and the interconnection to the Greenwood plant, the Belle River power plant, and St. Clair Units 6 and 7 allowed the restoration of approximately 10% of the load in northern Macomb and Oakland Counties and approximately 20% load in St. Clair County.

Restoration of interconnections from St. Clair plant through Stephens station to Northeast station allowed Northeast peakers to feed into the system. This allowed the load to be picked up in the remaining portions of St. Clair County and approximately 70% of Macomb County. Also by 5:00 a.m., additional paths were established which allowed power to be restored to the northern 1/3 portion of Monroe County and Southern 1/3 portion of Wayne County.

Between 7:00 a.m. and 8:00 a.m., a path from Navarre to Waterman was established to provide a source of power to get the Delray peakers started. This path was then extended to provide the River Rouge power plant with a source of power. As these paths were energized a small amount of load in the City of Detroit was restored. Additional lines and substations were energized by noon to pick up additional load in the City of Detroit. Paths were energized between Majestic station and Pontiac station to connect the southwest and northwest portions of the system. Paths were energized between Waterman and Northeast stations to connect the northern and southern portions through the City of Detroit.

The Blackfoot Station–Madrid Station line was re-energized at 8:55 a.m. and at 9:30 a.m. Detroit Edison closed the ring bus at Pontiac. These actions coupled with the restoration of the Bismark–St. Clair line set the stage for restoration of customers in the Pontiac area.

The restoration of distribution load continued with Grayling Station and Malta Station at 9:35 a.m. Further stations were restored between 9:00 a.m. and noon, when lines were energized into Cato Station, St. Antonie Station and Zug Station picking up more load in the City of Detroit as Detroit Edison continued its practice of closing in whole distribution centers without isolating individual circuits

At 10:51 a.m., Stephens–Victor was closed and tied to the St. Clair facility – this action allowed the restoration of distribution load at Victor. At 11:55 a.m., Detroit Edison personnel energized the Lincoln 120 kV buses and transformers. After the evacuation requirements associated with the Marathon Oil Refinery incident were lifted, operators were able to return to the Navarre station and restore all of Navarre between noon and 1:30 p.m.

Just after noon the Caniff 120 kV buses from Northeast and the Sterling 120 kV buses from Jewell were energized. At 12:42 p.m., Detroit Edison energized the Sterling 40 kV buses, the Pont Wixom–Wixom connection and then Malta–Red Run at Malta. The preparation to restore power to Detroit continued with the energizing of Jewell–Stephens at Jewell at 12:50 p.m. and the energizing of Northeast–Stephens at Northeast at 1:02 p.m.

At 1:24 p.m., Detroit Edison closed the 345 kV ring at the St Clair power facility fully connecting the facility to the 345 kV system.

Between 1:30 p.m. and 2:30 p.m., all of the 120 kV system at the River Rouge power facility was restored. The River Rouge facility was now positioned to fully assist in the restoration of the Detroit area.

The Jewell–Thetford interconnection was tied in at 1:38 p.m., which further strengthened the interconnection with Consumers Energy/METC.

At 1:45 p.m., the preparation to restore substantial portions of the City of Detroit load continued as Stephens was tied to the 120 kV system (this tie would be energized at 2:30 p.m.), Caniff–Stephens was energized at Stephens, and the Mack 24 kV buses were energized. The Erin 120 kV system was energized from Stephens via Erin at 1:53 p.m.

For the most part, these actions were preparatory. The restoration of distribution load began in earnest at 2:30 p.m. when the distribution load at Mack was restored. Further activity at the sub-transmission level continued in order to prepare for additional load restoration in the Detroit area with the energizing of the Northeast 24 kV buses and the Lincoln 24 kV buses and transformers. Activity continued at the transmission level as Bismarck–Stephens and St. Clair–Stephens were energized and Caniff–Stephens at Caniff and Mack–Northeast at Mack were closed.

Bloomfield Point at Pontiac (230 kV) was energized at 2:45 p.m. and the Bloomfield 120 kV buses were energized via Bloomfield–Troy at 3:00 p.m. The 345 kV ring at Bismarck was closed during the same time period. The Jewell buses and Spokane 120 kV buses via Jewell–St. Clair were energized at 3:20 p.m. and Bloomfield–Pontiac at Bloomfield was closed at 3:44 p.m.

At 4:00 p.m. the distribution load was restored at the Jewell sub-station. Shortly after that, Detroit Edison energized the Saturn and Frisbie interconnection, the Sloan bus, and Alpha bus from Sterling.

The Mack–Voyager line at Mack was energized at 4:30 p.m., followed by the Chestnut 120 kV buses from Lincoln. The Chestnut–Red Run line was closed at Red Run at 5:10 p.m. and the distribution load at Red Run was restored.

Detroit Edison energized the Essex 24 kV system at 5:30 p.m., which restored distribution load in the City of Detroit. At 5:40 p.m., Detroit Edison energized the Apache 120 KV and the Seneca 120 KV buses, followed by the closure of Essex–Voyager. At approximately 5:30 p.m., the Detroit Water Works was energized.

Paths were energized from Northeast station towards Bloomfield station at the same time paths were energized from Pontiac station to the Bloomfield station. This allowed load to 50% of Oakland County to be restored at 7:00 p.m. During this period of time, paths were also energized from Northeast station to the City of Detroit.

Restoration efforts required coordination between restart of generating units and transmission operations. ITC was in contact with Detroit Energy's SOC and Emergency Headquarters during the restoration effort, but was dependent on Detroit Edison personnel to complete restoration work because the Detroit Edison transmission system was recently sold to ITC and the sales agreement included a maintenance agreement until January 2004. Consequently, Detroit Edison's SOC restored the transmission system, and the utility's System Planning and Engineering organization arranged for visual and thermal inspections of the transmission system.

Because of concerns for the continued reliable operation of the transmission system, the SOC team requested transmission inspections on August 16 at approximately 2:00 a.m. This initial request was delayed until storm conditions abated. On August 16, ITC requested inspections as well. Detroit Edison used visual and thermal inspections performed from the ground and the air. ITC and Detroit Edison jointly prioritized the inspections.

On August 17, Detroit Edison began visual inspections of all interconnections using helicopter patrols and focused on detecting mechanical defects. The patrols were completed with no major mechanical problems identified. Also on August 17, Detroit Edison personnel began thermovision ground patrols. The focus of this effort was to perform close inspections of critical equipment in the 345 kV and 230 kV switching yards, not easily seen from the air. All 120 kV equipment contained in these yards was also inspected. One helicopter team and two ground teams were assigned on August 17.

On August 18, two thermovision-equipped helicopters began patrols, which allows them to look for overheated connections on the interconnection ties. Fifteen inspections were completed by Tuesday, August 19. On Tuesday, August 19, ITC supplied two additional thermovision-equipped helicopters. All four helicopters patrolled the 345 kV corridors between stations looking for overheated connections. Patrols of most of the 345 kV and 230 kV critical equipment and the thumb area north of I-69 were completed on August 19. On Wednesday, August 20, the remaining 345 kV and 230 kV patrols were completed before moving on to the 120 kV stations, as prioritized by ITC based on the size and the complexity of the station. All helicopter thermovision patrols were completed by 4:00 p.m. Thursday, August 21, 2003. Approximately 1,500 miles of transmission line were inspected in five days.

On Wednesday August 20, the ground patrols for the remaining 120kV stations began and were completed by August 30 as requested by ITC. Over 50 stations were inspected from the ground in 14 days.

After the event on August 14, work crews were held to support the restoration effort, but the major portion of the distribution effort began on August 15 as the generation and transmission systems became functional again. Distribution support was critical to ensure that load was properly restored to maintain system stability. The effort was frustrated by the "In Service Application" not being available due to the blackout.[22] The effort was also constrained by the difficulties of maintaining fuel for corporate and employee vehicles and the sporadic availability of the communication systems. The unavailability of the "In Service Application" required work orders to be faxed to regional operations centers. In some cases, the communication issues required work crews to drive back to the service centers to acquire their next set of work orders. The August 16 storm also complicated the restoration effort. Approximately 500 distribution engineers, lineman and other employees were involved in the distribution restoration efforts.

Early in the outage Detroit Edison established a communication link with the Detroit Water and Sewerage Department (Detroit WSD). Without water, sanitation issues became a major problem. In addition, hospital operating rooms could not function nor could they provide adequate care in emergency situations. Detroit Edison worked closely with the Detroit WSD Director to identify the priority pumping stations and worked to restore the four units that would have the most impact on operations. These were restored throughout Friday with the final critical station restored by early Friday evening.

### Section 3.5.3: Lansing Board of Water and Light

At 6:02 p.m., the Lansing BWL began to establish a cranking path to allow the use of Consumers Energy generation to assist in the restoration of station power to its generation facilities. By 6:30 p.m., a cranking path had been established to Eckert Station and the Erickson facility. By 10:07 p.m., the Erickson generation was back on-line and at 10:19 p.m. Lansing BWL restored its first group of customers. Most of the Eckert Station units returned to service just after midnight, with Unit 5 returning at 3:16 a.m. At 4:21 a.m., on August 15, Lansing BWL restored service to the last circuit of customers. The time period from the start of the event to full restoration was just over 12 hours and 10 minutes.

[22] In Service Application is a computerized field force coordination function used by Detroit Edison to prioritize and dispatch its repair crews.

## Section 3.6: Review and Analysis

In our opinion, the restoration after the blackout by The Detroit Edison Company, Consumers Energy Company, and the Lansing Board of Water and Light was fully acceptable.

The restoration effort was made possible by the automatic opening of the interconnections between Consumers Energy/METC and Detroit Edison/ITC, which protected the transmission equipment of both systems from damage. During the initial phase of the restoration process, this was the only electrical connection that Detroit Edison had with other power supplies. This transmission link also connected Detroit Edison with its generation facilities at Ludington, another essential tool in the restoration process. In addition, Consumers Energy provided cranking power to assist the Lansing BWL in restoring service.

Michigan systems had options that could have been exercised and that may have prevented the spread of the blackout into Michigan. Detroit Edison, given adequate warning, could have unloaded the METC and ITC interconnections between itself and Consumers Energy in advance of the event. An unloaded interconnection may have weathered the power surge and spared the Detroit Edison system from the blackout.

In the heavily interconnected power system of today, almost every major action taken by an entity connected to the grid is capable of impacting the electric system within Michigan. The events that precipitated the blackout occurred beyond the view of the system operators in Michigan. With no advance warning, the operators were unable to take any action to protect customers from the impending outage. As discussed more completely in Part II, adequate reliability standards and an effective enforcement organization are required to ensure the reliability of Michigan systems.

Additionally, it appears likely that two factors hampered the restoration efforts. First, the computerized "In Service Application" system used to dispatch and coordinate personnel was inoperable. This system was clearly not designed for a blackout of this magnitude, which required the first use in Michigan of widespread black start procedures. The lack of emergency power for this system required additional time and effort for restoration. The "In Service Application" process has performed satisfactorily during other, smaller outages. In our opinion, Detroit Edison should conduct an analysis of the "In Service Application" process to determine what modifications are warranted in light of the experience gained in this restoration effort. Detroit Edison should report to the Public Service Commission on the results of its analysis.

The second factor was the failure of rupture disks at four of the Detroit Edison generating units. The failed rupture disks slowed the pace of restoration. Six of the 13 plants without failed rupture disks were returned to full load on August 15 and three more on August 16. Conversely, none of the plants with failed rupture disks were returned on August 15 and only one on August 16.

However, the presence of failed rupture disks does not, in itself, indicate a problem that needs to be corrected. Rupture disks are a design feature – they are intended to fail under certain conditions, thereby avoiding more serious damage to equipment. Thus, there is a trade-off involving the avoidance of major damage and the potentially more frequent occurrence of outages due to failed rupture disks. An analysis of the operation of rupture disks and the trade-offs involved requires specialized engineering expertise, which the PSC Staff does not possess. Accordingly, we recommend that Detroit Edison analyze the operation of the rupture disks on its units, including a comparison with the operation in other utility systems affected by the blackout, to determine whether any changes are warranted. Detroit Edison should report the result of its analysis to the Commission.

**Section 3.7: Recommendations**

We make the following recommendations:

1. That Detroit Edison conduct an analysis of the "In Service Application" system to consider modifications or alternatives that would function more effectively in the event of a similar blackout and report the results of its analysis to the Commission.

2. That Detroit Edison conduct an engineering analysis of the operation of the rupture disks to determine if any modifications are warranted and report the results of its analysis to the Commission.

# PART IV

# EMERGENCY PLANNING AND RESPONSE

## Section 4.1: Introduction

This part of the report addresses specific response measures initiated in Michigan as a result of the blackout of August 14, 2003. It further makes recommendations on specific actions that should be considered as a means to improve the response to a power outage of this type in the future. It should be remembered that there has never before been a blackout of this nature in Michigan. As we look for solutions to prevent a reoccurrence, the focus should be on reducing risks and vulnerability to all hazards. While some problems did develop, to a considerable degree the response went as planned and worked well, and more serious problems were largely averted.

The sections of this report present a description of the roles and responsibilities of the PSC and various other State and federal agencies (Section 4.2); a discussion of the response by PSC, its Staff, and the State of Michigan Emergency Management Team (Section 4.3); and lessons learned and recommendations for improving future State responses (Section 4.4).

**Michigan State Emergency Operation Center**
**August 14, 2003**

**Press Conference August 15, 2003**

**Section 4.2: Roles and Responsibilities**

To understand the sequence of events and actions taken, it is important to understand the roles and responsibilities of the PSC and its Staff for energy emergency preparedness and response. The PSC is charged with assuring that sufficient energy resources are available to Michigan's citizens and businesses at competitive prices.[23] As part of this charge, the Commission has two separate but related responsibilities. The first is energy emergency preparedness. If a supply problem develops with natural gas or electricity, the Commission has adopted through rules and orders the procedures that a utility will use to respond, which include provisions for reporting on its actions to the Commission. If an energy emergency requires mandatory State action, the Governor, upon recommendation of an interdepartmental Energy Advisory Committee or at her own initiative, may declare a State of Energy Emergency under 1982 PA 191, as amended (MCL 10.81). The Governor may order mandatory actions following such a declaration.

Second, if the situation worsens, or another event such as a tornado, flood, or terrorist attack occurs, the Governor can declare a State of Disaster. In this case, the primary responsibility of response efforts shifts to the Emergency Management Division (EMD) of the Michigan State Police (MSP), through which the PSC Staff would provide a support function. In addition, each department of state government has designated an Emergency Management Coordinator (EMC)

[23] MCL 460.901

who represents the department and coordinates departmental resources that may be needed to respond to any given event. PSC Staff have been assigned to serve this function in the Department of Consumer & Industry Services (CIS, but soon to become the Department of Licensing and Economic Development), in addition to the Commission's responsibility for energy-related matters.

**Section 4.2.1: Energy Emergency Act**

The Energy Emergency Act grants the Governor broad powers in the event of a Declaration of an Energy Emergency. These include the following, as described in the Act:

"10.84 Powers of governor during energy emergency.

Sec. 4. During an energy emergency, the governor may do all of the following:

1. Order specific restrictions on the use and sale of energy resources. Restrictions imposed by the governor under this subdivision may include:
    a. Restrictions on the interior temperature of public, commercial, industrial, and school buildings.
    b. Restrictions on the hours and days during which public, commercial, industrial, and school buildings may be open.
    c. Restrictions on the conditions under which energy resources may be sold to consumers.
    d. Restrictions on lighting levels in public, commercial, industrial, and school buildings.
    e. Restrictions on the use of display and decorative lighting.
    f. Restrictions on the use of privately owned vehicles or a reduction in speed limits.
    g. Restrictions on the use of public transportation, including directions to close a public transportation facility.
    h. Restrictions on the use of pupil transportation programs operated by public schools.

2. Direct an energy resource supplier to provide an energy resource to a health facility; school; public utility; public transit authority; fire or police station or vehicle; newspaper or television or radio station for the purpose of relaying emergency instructions or other emergency message; food producer, processor, retailer, or wholesaler; and to any other person or facility which provides essential services for the health, safety, and welfare of the residents of this state.

3. By executive order, suspend a statute or an order or rule of a state agency or a specific provision of a statute, rule, or order, if strict compliance with the statute, rule, or order or a specific provision of the statute, rule, or order will prevent, hinder, or delay necessary action in coping with the energy emergency. The governor may not suspend a criminal process or procedure or a statute or rule governing the operation of the legislature. At the time of the suspension of a statute, rule, or order or a specific provision of a statute, rule, or order, the governor shall state the extent of the energy

shortage and shall specify the provisions of a statute, rule, or order which are suspended, the length of time for which the provisions are suspended, and the degree to which the provisions are suspended. A suspended statute, rule, or order shall be directly related to an energy emergency."

**Section 4.2.2: Energy Advisory Committee**

Section 10.82 of the Energy Emergency Act provides for an Energy Advisory Committee (EAC), which is responsible for notifying the Governor of an impending energy emergency. When the EAC determines that an energy emergency is imminent based on information from the PSC and other sources, the Governor is informed and may respond by declaring a State of Energy Emergency. The monitoring activity to forewarn of the potential for an energy emergency is provided by the Michigan Energy Appraisal[24], which is issued twice a year in the spring and fall by the PSC. In recent years, the Commission has also directed Consumers Energy, Detroit Edison and American Electric Power to report on how they plan to meet peak summer needs, and PSC Staff has held weekly conference calls with the utilities over the summer months to monitor supply and demand conditions. The Governor may also declare an energy emergency on her own initiative. The EAC is comprised of the Directors of the Departments of CIS, Agriculture, Community Health, Transportation, and MSP. It is chaired by the Chair of the PSC, as provided for in Executive Order 1986-17 (MCL 460.901).

Previous to the August power outage, the EAC had met twice – in the spring of 1979 to respond to shortages arising out of the oil distribution caused by the Iranian Revolution, and in June 2000 in response to the potential gasoline shortage from the Wolverine Pipeline break in Jackson.

**Section 4.2.3: Energy Emergency Management Team**

In the case of an energy emergency or in anticipation of such an emergency, the Chair of the MPSC may convene an Energy Emergency Management Team (EEMT). The EEMT will monitor developments, prepare assessments, and develop responses. The EEMT consists of senior PSC Staff, including representatives from the Commission Operations and Energy Operations Divisions. The PSC Chair is responsible for convening the EEMT, assigning tasks to its members, and providing information developed by the EEMT to the Governor and EAC. In general, the EEMT responsibilities include monitoring developments, preparing assessments, and implementing responses on a day-to-day basis. Each member of the EEMT will appoint appropriate staff to support EAC work on a priority project assignment basis.

**Section 4.2.4: Michigan Emergency Management Plan**

Michigan Emergency Management Plan (MEMP) is the State's overall disaster response and recovery plan. There is a basic plan as well as specific plans that address specific types of

[24] http://www.cis.state.mi.us/mpsc/reports/energy/current/

disasters, including: nuclear accidents, enemy attacks, natural disasters, and technological disasters. The August 14 power outage fell under the technological disasters category. In each of these areas, each department's roles, responsibilities and authorities are identified. In addition to this plan, each department and agency has one or more planning documents which supports in further detail the departmental or agency response. This plan is currently undergoing updates and revisions.

It should be noted that, in addition to the PSC responsibilities for coordinating energy emergencies, the manager of the Energy Data & Security Section is also the Emergency Management Coordinator (EMC) for CIS. The EMC plays a critical role in ensuring that the department is capable of implementing the tasks assigned to it in the MEMP before, during, and after a disaster or emergency. To that end, each EMC must be concerned with the following responsibilities within their department:

- Developing procedures for carrying out responsibilities assigned by the MSP;
- Conducting departmental reviews of procedures developed and making revisions where appropriate (subject to the approval of department director);
- Developing necessary support documents (standard operation procedures, resource lists, telephone notification lists, etc.);
- Ensuring staff are aware of and trained for assigned responsibilities;
- Revising procedures as conditions change (i.e., in organizational structure, departmental mission, resource base) in conjunction with EMD/MSP;
- Conducting a training needs assessment on an annual basis to identify personnel who, by virtue of their position or area of responsibility, need to receive emergency management training;
- Getting important emergency management information into the hands of all appropriate department personnel; and
- Developing contacts with federal agencies and private sector organizations within the department's sphere of responsibility that could be called upon to assist in disaster response and recovery operations; and, representing the department in the SEOC to coordinate department response and recovery activities, and to establish communications with department field personnel.

There are two PSC divisions with primary responsibilities in energy emergency planning and response activities – the Commission Operations Division (COD) and the Energy Operations Division (EOD). The energy emergency responsibilities of these divisions fall into four broad categories:

- Monitor Michigan's energy supply system for the purpose of detecting unusual imbalances that may indicate the potential for an energy emergency and advising the appropriate state officials in such events;
- Develop, administer, and/or coordinate energy emergency contingency plans;
- Act as the communication focal point for federal, state, and local activities related to energy emergency planning and management; and
- Maintain ongoing contact with the petroleum, natural gas, and electric industries concerning Michigan's energy situation.

During the power outage, a number of PSC Staff provided support at the SEOC. In particular, the manager of the Energy Data & Security Section in COD and the safety manager in EOD spent considerable time in the SEOC working with the MSP and other state officials monitoring the situation and providing consultation for the Governor and the EAC on what Michigan's rules and regulations regarding energy emergencies entailed.

**Section 4.3: Response by the PSC and the State's Emergency Management Team**

This section addresses PSC, Staff, and State government involvement in responding to the outage and its secondary effects. At the onset of the power outage, PSC Staff went immediately to the SEOC to manage power outage responsibilities from that site. The SEOC has a backup generator and lighting, computer access, and phones were available throughout the emergency. Other PSC Staff remained at the PSC offices at Mercantile Way in Lansing for a number of hours until it became impractical to continue due to sunset. These Staff members used cell phones for communication.

The PSC provided staffing at the SEOC from 4:30 p.m. on Thursday, August 14, 2003, until 2:30 a.m. on Friday, August 15, returned by 6:45 a.m. that Friday and remained until midnight. Staffing on Saturday, August 16, was provided from 7:00 a.m. to 5:30 p.m. During this time, there were always at least two PSC Staff members at the SEOC and sometimes three. In addition, PSC Chair Lark was on-site for a briefing on each of these days. Although power had been restored to all customers by Saturday morning, the concern remained that continued voluntary conservation measures were required to reduce demand, while a number of Detroit Edison power plants returned to operation. If electric demand exceeded Detroit Edison's available generation, it could have been necessary to implement rotating power blackouts. Therefore, PSC Staff's focus on Saturday, August 16, was to monitor Detroit Edison's ability to balance load.

During and following the power outage a number of issues arose that required response. These issues clearly demonstrated the critical interdependencies that exist that support our citizens and businesses. The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets[25], issued in February 2003, describes the interdependencies as follows: "The facilities, systems and functions that comprise our critical infrastructures are highly sophisticated and complex. They consist of human capital and physical and cyber systems that work together in processes that are highly interdependent. They each encompass a series of key nodes that are, in turn, essential to the operation of critical infrastructures in which they function. To complicate matters further, our most critical infrastructures typically interconnect and, therefore, depend on the continued availability and operation of other dynamic systems."

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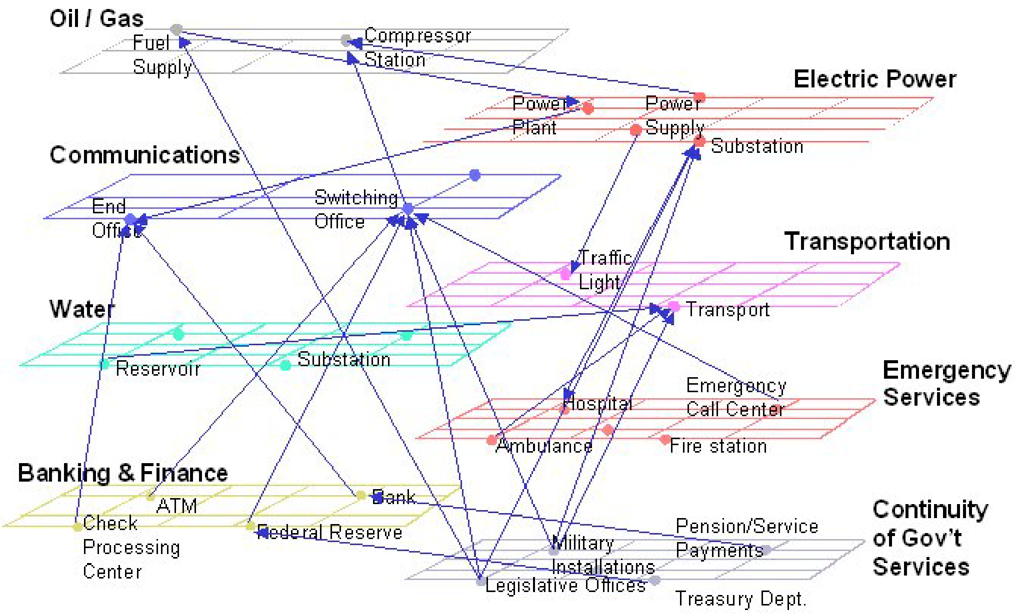
[25] National Strategy for the Physical Protection of Critical Infrastructures and Key Assets, February 2003. See: http://www.whitehouse.gov/pcipb/physical_strategy.pdf

# Interdependencies[26]

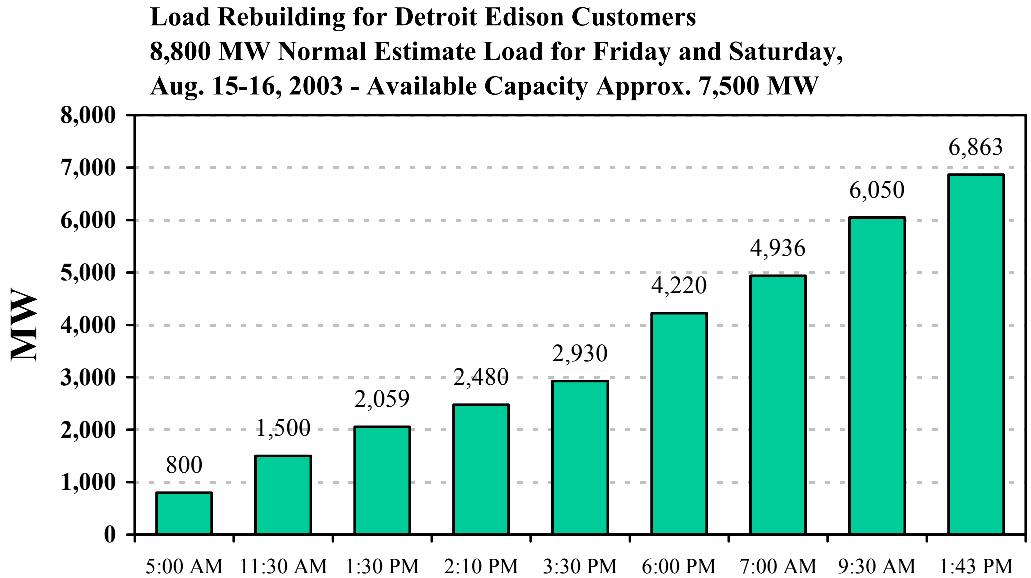



Following are some of the key issues and actions taken at the SEOC to respond to the outage in which many of the critical interdependencies were clearly demonstrated.

### Section 4.3.1: Power Outage Status Assessment, Analysis and Reporting

This was one of the primary functions of the PSC Staff, with the assistance of Detroit Edison personnel who arrived at the SEOC on Friday morning. The SEOC held periodic briefings with each of the departmental agencies, providing a summary of events, issues, and problems in their area of responsibility. The computer systems normally used by Detroit Edison were not available to the company due to the power outage and, therefore, the number of customers that were without power could not be provided. Typically, this information is available in situations such as storm outages and provides the basis for assessing the severity of the problem and rate of restoration. Absent this information, the recovery of the system and restoration of power was monitored in three ways. First, Detroit Edison personnel in the control center provided information on the load being served. This was a measure (albeit indirect) of the rate at which customers were being restored, and the trend by early Friday afternoon was encouraging. The following graph was prepared and circulated at the SEOC as an indicator of the restoration rate.

[26] Figure provided by the U.S. Department of Energy, Office of Energy Assurance.




Second, reports from city and county emergency operation centers provided further information as areas were restored. Third, one of the early indications of the extent of the outage was a map that showed the state's 800 MHz radio system towers that were operating on emergency backup generators.

### Section 4.3.2: Collecting Information

As soon as the PSC Staff arrived at the SEOC, they began a systematic inquiry directed to the operations centers and emergency personnel at the affected utilities to ascertain the extent of the power outage and the status of a return to power. The U.S. Department of Homeland Security informed us that the blackout was not an act of terrorism. We also communicated with DOE and regional energy officials. After ruling out a terrorist act, the question quickly turned to the source and extent of the blackout. First reports on the early evening of Thursday, August 14, suggested a power plant was on fire in New York City, and then it was a transformer. Next, reports came in that lightning had hit a power plant operated by the Niagara Mohawk utility in western New York, problems in Canada were then suggested, and at one point ABC News reported that the problem originated in Michigan. None of these reports proved to be accurate, but each was checked to determine if the information could be verified. Later reports began to focus on transmission lines in northern Ohio that tripped off the system. Web site searches on news sites was one means used to track the reports that were coming in, sometimes second and third hand, and suffering the distortion that occurs as information is removed further and further from its source.

NERC, located in Princeton, New Jersey, was an important source of information. A conference call held by NERC on Friday, August 15, provided a helpful update and a preliminary report of events posted to the NERC web site was provided to the Governor on Saturday morning, August 16.

### Section 4.3.3: Public Information Needs

One of the most important crisis management actions state government takes during an emergency is to provide information to the public. Timely, accurate information about an emergency can help prevent confusion and uncertainty, as well as enlist the support and cooperation of the public. It is also important that the public understand what caused the emergency and what needs to be done to ease and eventually resolve it. The Michigan Energy Emergency Operations Manual provides a useful guide on how a public information program should be used and operated in an energy emergency. Following these guidelines, the PSC provided information to the Governor and the public regarding the status of the power outage, what steps were being taken to resolve the situation, and how the public could help.

The PSC public information efforts started at the onset of the power outage. Early in the evening of August 14, two PSC Consumer Alerts were faxed to the Governor's office from the SEOC. The alerts were entitled "Tips For Buying And Using A Portable Generator" and "Surviving Electrical Power Outages – What You Can Do If You Lose Your Electric Service." This information was then modified to reflect the current outage conditions and posted to the Michigan.gov web site (see Appendices A-8 and A-9).

Also on the first night of the power outage, we provided information to the Governor and her staff on the affected utilities' power restoration efforts in preparation for her WKAR television broadcast appearance at 10:00 p.m. the night of August 14.

In the days following the power outage, PSC Staff continued to provide information as needed on utility restoration efforts, reports on preliminary causes of the power outage, and other outage-related information to the Governor and the public. The Governor and the PSC Chair utilized this information during the press conference that was held at noon on August 15. Also on August 15, the PSC issued a press release asking Michigan citizens throughout the State to conserve electricity to reduce demand and help stabilize the system in light of the fact that a number of power plants were off line, both in and out of the affected area.

At the request of the Governor's press office, during and following the outage, the PSC responded to media inquiries from the trade press; national press (New York Times, Boston Globe, Washington Post, Reuters, Associated Press, Dow Jones, Wall Street Journal); and Michigan media (WJR, WWJ, WDET, Michigan Public Radio, Detroit News, Detroit Free Press, Oakland Press, Jackson Citizen Patriot, Booth newspapers; and Bay City Times). A number of these entities wanted specifics on the geographic areas affected by the power outage. In these cases, we directed them to the PSC web site where maps of the affected service territory areas could be found.[27]

[27] http://www.cis.state.mi.us/mpsc/electric/map.htm

After the power had been restored, the PSC continued providing information on the power outage. On September 3, 2003, the PSC Chair testified before the U. S. House Committee on Energy and Commerce on the power outage.

**Section 4.3.4: Declaration of Emergency**

On the morning of Augsut 15, Governor Granholm declared a State of Emergency under the provisions of both the State's Disaster Act and the Energy Emergency Act.

With this declaration, two things needed for coping with the power outage and a possible gasoline shortage occurred: 1) the declaration allowed petroleum suppliers to import gasoline to make up for the dislocation of supply, and 2) a driver hour waiver provision automatically went into effect under contingencies established by the Federal Motor Carrier Safety Administration (FMCSA) that would allow the drivers of trucks carrying gasoline and other needed supplies into the Detroit area to drive for extended hours.

The initial declaration was followed up on August 22 by a Declaration of Energy Emergency caused by the fact that the power outage had adversely affected eight refineries in the U.S. and Canada, including the Marathon refinery in Detroit. The loss of production at the damaged refineries posed the potential for a gasoline shortage for the Detroit Metro area, creating the potential for an energy emergency. A second Executive Order, also issued on August 22, 2003, continued the suspension of rules for gasoline vapor pressure because strict compliance with the rule could "...prevent, hinder, or delay necessary action..." to cope with a gasoline shortage.

The basic authority for the Governor's ability to issue the Executive Orders discussed above comes from two pieces of legislation. First, the State's emergency management legislation (1976 PA 390) was enacted in December 1976 and amended in April 1990. This act replaced Michigan's Civil Defense Act and broadened the scope of emergency management. Act 390 also brought the State into compliance with provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288, as amended), which provides federal assistance in declared (by the President) emergencies or major disaster situations.

The Governor also acted under Section 10.82 of the Michigan Compiled Laws (MCL), 1982 PA 191, as amended. The purpose of this act is to allow for the declaration of a state of energy emergency, to provide for procedures to be followed after a declaration of a state of energy emergency, to create an energy advisory committee (EAC) to the governor and prescribe its powers and duties, to prescribe the powers and duties of the governor, to prescribe penalties, and to repeal certain acts and parts of acts. The EAC is chaired by the Chair of the MPSC, as provided for in Executive Order 1986-17. Under the provisions of Act 191, the Governor can declare an energy emergency on her own initiative or at the advice of the EAC. During the power outage and subsequent events involving the damaged refineries, the EAC Chair provided information to the Governor advising that an energy emergency was potentially imminent. The Governor subsequently declared an energy emergency.

### Section 4.3.5: Contacts

There were considerable contacts between the State and other agencies, both local and federal, DOE and the Department of Homeland Security (DHS), and other states. Staff members at the SEOC were in communication with both federal agencies and other states. Generally, communication worked, although there is always room for improvement. The evolving relationships and emergent roles of DOE and DHS are in need of clarification. The information from federal agencies in Washington was somewhat fragmented, and available information was not always made readily available. The DOE has been working with state officials to prepare a protocol that would enhance information exchanges and coordination between states and the federal government in an energy disruption, such as the power outage. This will require a better delineation of energy emergency responsibilities between DOE and DHS. Several DOE functions, including an office that had oversight of critical energy infrastructure, were transferred to DHS.

The DOE Office of Energy Assurance (OEA) is working on a procedure for communication that can be used in any kind of energy disruption. This should allow for a more systematic sharing of information between the states and federal government to assure that information is rapidly distributed to key participants and to avoid misinterpretation of information. OEA played a major role in DOE's response to the blackout, assisting state and local authorities and industry, and advising Energy Secretary Abraham.

### Section 4.3.6: Telephone System Operation

In the early evening hours of August 14, it became apparent that there was an issue concerning fuel required for standby generators used by the local phone system. In addition, a number of government offices and private entities were operating generators in order to maintain power at their own sites and were competing for limited fuel supply. Although all had arrangements with fuel suppliers, some suppliers and distributors did not have the capability to pump the fuel from underground storage tanks without power or their own generators.

Another problem that came up Friday night involved a critical site, which handles all 911 calls in Oakland County, which was running on standby generators. Because the generators were not fully capable of meeting cooling needs due to the hot weather at this site, additional generators were moved to this location when power was restored Friday evening. The generator at this site was relocated to other critical needs. There is now a plan to add additional generation at this location.

The local phone system, which is operated by SBC, requested assistance from the SEOC in locating supplemental supplies of gasoline, kerosene, or #1 diesel fuel to assure the continued operation of the local telephone system. This fuel was needed for both standby generators and company vehicles to allow travel to remote locations to assure continued operation of equipment. During the power outage, more than 3 million customer lines in the central offices and 380,000 customer lines serviced by remote terminals could have been impacted by the loss of commercial power. However, because of SBC's emergency backup procedures, only 50,000 customers were impacted for a little over an hour. And this was despite the fact that the blackout generated an increase of 149 percent in the volume of calls placed on the SBC network.

Initially, 120 central offices and 2,300 remote terminals lost commercial power throughout Lansing and southeast Michigan. However, by using backup generators and batteries, SBC was able to maintain service in the offices and to the remote terminals even though they were without power for an average of 28 hours. Only the Mt. Clemens north central office was impacted, and those customers could not call outside of their local area for 68 minutes during the early morning on Friday, August 15.

As indicated, SBC called the SEOC for assistance and the PSC Staff at the SEOC identified a number of suppliers that had fuel available and could supply SBC's needs. Ultimately, SBC spent almost $650,000 purchasing 320,000 gallons of fuel. Some of that fuel was purchased from suppliers identified by the SEOC and some of it from existing suppliers.

SBC owns two large trailer-mounted generators and a number of smaller portable generators; in addition, SBC borrowed two larger generators from a local manufacturer and moved these generators around to meet their needs. Each of the 2,300 remote terminals needed to have their batteries periodically recharged. SBC accomplished this by having its technicians move portable generators to a terminal, powering up the generator until the terminal batteries were fully charged, and then moving the generator to another terminal and repeating the process. This was an additional challenge because a number of terminals are in rural locations and not easily identifiable, particularly at night.

No long distance companies reported any problems, in part, because their services are dependent on the operation of the local phone system. In addition, because many had developed business continuity plans; they were able to continue operations. Some cell phone companies did lose service for a time, and as the duration of the outage became more extended, they were also at the point of needing additional supplies of fuel for generators; however, the power was restored before this became a problem.

### Section 4.3.7: Communications[28]

There was full and robust communication between the appropriate federal and State agencies, although further improvements can be made. DHS and the Federal Emergency Management Agency (FEMA) in DHS were in regular, consistent contact with the SEOC. DEQ, MPSC, and the National Guard were communicating with the EPA, DOE, and the National Guard Bureau, respectively.

Two suggestions for improvement can be made, however. First, the reports given to both DHS and FEMA Region V were redundant. While the pace of the emergency response was such that this was not a serous problem, this redundancy should be eliminated as the reorganization of federal agencies within DHS is completed. Some material was sent over phone lines by

[28] Some of this information is taken from the Congressional Testimony of Col. McDaniel, Homeland Security Advisor to the Governor, to House Select Committee on Homeland Security, September 17, 2003.

facsimile, but e-mail with text-based documents would have been a better alternative, since the information can more readily be shared and incorporated within E-Team. Second, all communication was by telephone and, given the intermittent outages of commercial telephone service elsewhere in the State, a backup system needs to be instituted that is not reliant on commercial lines. There is a wireless system between FEMA Region V and the SEOC, and this capability could be expanded.

The DOE Office of Energy Assurance (OEA) is working to enhance and expand the Energy Emergency Information Coordinators (EEIC) Program[29] with the assistance of the National Association of State Energy Officials and the National Association of Regulatory Utility Commissioners. This program provides a point of contact in each state for information on energy supply, availability, and potential distribution problems. This set of contacts will be expanded to include contacts in public utility commissions on matters related to electric and gas supplies. While the vehicle for communication is principally based on non-secure e-mail at present, other communication technologies will be examined as part of this effort. It is intended to provide for an additional communication channel between the states and federal government to provide for the exchange of information between and among states. These contacts provided for some of the communication that occurred during the power outage. To be successful, this system will need broad-based participation by the states, and information to be shared must be reliable, timely and useful.

Internal communications, both within a State agency and between employees of the State and local agencies, worked very well. Over the last 12 years, the State of Michigan has spent in excess of $220 million to create a statewide 800 MHz digital trunk radio system. This system provides full interoperability for all organizations using it. Currently, 374 different public agencies use the Michigan Public Safety Communications System as their primary radio communication, and another 90 agencies use the system for emergency management purposes only. The member agencies include all state agencies, as well as counties, townships, tribes, and federal agencies (the FBI, U.S. Customs, Bureau of ATF, and Forest Service). There are currently more than 11,000 radios on the system.

There were no interruptions to the system anywhere during the blackout because the control center and all antennae have independent generators. Four of the five affected counties, as well as many municipalities within those counties in the declared emergency area, are now considering joining the Michigan Public Safety Communications System.

### Section 4.3.8: Cyber Systems

Cyber systems were shut down in areas affected by the power outage unless they had backup batteries or generation. Many computers and nearly all servers supporting large-scale systems operate with Uninterrupted Power Supply (UPS) units. The UPS provides power conditioning (controls fluctuations in current and voltage which can damage circuitry), and when power is lost automatically shifts over to battery backup and then directs the server to a controlled shutdown

[29] http://www.naseo.org/eeic/default.htm

to avoid errors in software operations. When power is resumed, the servers then reboot, as normal, bringing operation systems back on line. In not all instances will this execute properly and some servers will require a technician to bring the system back on line. In some cases the age of equipment may have been a factor in returning the system to operations.

Computer operations, which run multiple servers, also require cooling in the server room. Since the outage occurred on a hot summer day, it was necessary to get air conditioning systems back into operation, allowing the server room to be cooled to normal operating temperatures before the servers could be returned to service if back up generation was not available.

A significant challenge faced by computer system operators was that the outage occurred in the middle of an effort against the "MSBLASTER" worm virus attack and the "SoBig" virus. The system attacks as a result of these two viruses had already caused some disruptions to computer systems and the power outage compounded the problems and the response.

Many of the State of Michigan's computer operations were affected. Most Lansing and southeast Michigan computer hardware encountered a hard shutdown, with the exception of most voice systems. The Department of Information Technology (DIT) Command Center was without power in the Hannah Building in downtown Lansing.

Actions taken by DIT included a quick response to assure most servers in data centers were powered down prior to exhaustion of UPS battery power to eliminate problems when power was restored. The DIT Emergency Management Coordinator went to SEOC at 7:15 p.m. on Thursday, August 14, and a DIT secondary command center was activated at the State Secondary Complex, which still had power. Additional fuel to power these generators was not available when planned due to the heavy demand on fuel suppliers, and these server operations were cut over to power from the grid at about the time fuel supplies for the generator were exhausted.

Additionally, the following actions were taken:

- Established an ongoing DIT conference call for problem resolution and status updates.
- Identified all critical customers facing processes, i.e., Food Stamps, UA checks, CSES batch, Medicaid provider batch run, etc.
- Performed modification so Governor could update Michigan.gov Web site.
- Identified status of existing second and third shift staff and established a plan of action for scheduling critical work.
- Worked with Department of Management and Budget (DMB) to restore failed air conditioning units.
- When power returned, waited until data centers had cooled and followed start up procedures in all buildings.
- Resolved network and hardware issues caused by failed components on Friday, August 15, in Lansing area and through Monday in Detroit.

One of the lessons learned in the computer system operations was that any disaster recovery planning that had been done previously proved very helpful in the recovery of systems. For many, the procedures that came out of the preparation for the rollover to the year 2000 (Y2K) helped immensely and exercises held since then were also very useful. The use of toll free conference calls proved to be an invaluable communication tool, as cell phones could not always be relied on. It was also clear that contact lists need to delve deeper into the organization and need to be listed on paper.

### Section 4.3.9: Water and Wastewater Systems[30]

Detroit operates the largest water and wastewater utility in Michigan and the third largest in the U.S. It serves 4.3 million people in 126 communities in nine counties in southeast Michigan. Highly trained and certified professionals operate well-maintained water and wastewater treatment facilities. The drinking water facilities consist of five water treatment plants, 22 booster-pumping stations, and over 13,000 miles of water transmission and distribution mains. The system also consists of telemetry and automated SCADA equipment. The drinking water produced at the water treatment plants and pumped throughout the distribution system is monitored in accordance with Michigan DEQ requirements for chemical, microbiological and radiological contaminants.

Detroit lost power to all pumping stations at the five water treatment plants, as well as system control telemetry. Of these five plants, Springwells, Southwest and Lake Huron used backup generators to restart within hours. Several communities called the system's control center to complain of low or no pressure; however, many communities were able to maintain reduced pressure due to location and storage capacity. One Detroit Edison power feed was restored to the Lake Huron water treatment plant at approximately 7:30 p.m. on August 14. The three plants combined supplied approximately 430 million gallons per day (mgd) of drinking water to the distribution system during the blackout. Six (of 22) booster-pumping stations have backup generators, but only four stations were functional during the blackout. The annual average water demand for the Detroit Water and Sewerage Department (Detroit WSD) system is approximately 600 mgd. With prompt implementation of water restrictions during the blackout, 430 mgd of water should have been sufficient to maintain pressure in the distribution system.

A "boil water" advisory was issued for the entire Detroit WSD service area at 7:15 p.m. on August 14 and rescinded at 3 p.m. on August 18. The boil water advisory was necessary because of a system-wide pressure loss that resulted from the blackout. The large number of residents and communities affected by the water emergency, the high level of involvement by state and local officials, and the potential health implications made this a serious matter of concern.

Rule R 325.11206 of the Michigan Safe Drinking Water Act (PA 399 of 1976 and Administrative Rules) reads, "For a type I public water supply, a means shall be provided to continuously supply finished water to the entire distribution system during periods when the normal power service is interrupted." This rule was implemented by requiring each water treatment plant to have a minimum of two electrical feeds from two separate substations, backup

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[30] Much of the information in this section is taken from *A Report on the Detroit Water and Sewerage Department System during the Blackout of 2003, August 2003,* prepared by the Michigan Department of Environmental Quality, Water Division, Field Operations Section, Southeast Michigan District Office.

generators, or sufficient gravity storage. The Detroit system exceeded this requirement at all water treatment plants and six booster stations. Each of the Detroit water treatment plants and booster-pumping stations has two electrical feeds from two separate substations, with the exception of Waterworks Park and Northeast, which has three separate feeds from three separate substations. Springwells, Lake Huron, and Southwest water treatment plants have backup generators able to deliver approximately 430 mgd total (near average day) to the distribution system. Six booster-pumping stations have backup generators as well.

The separate electrical feeds provide for a contingency more frequently seen with storm outages where some localized areas are affected and others are not. This outage was highly unusual in that the entire electrical system failed and the power companies were required to initiate black start procedures. Under these procedures the process begins at the power plant and restores the power moving from the plant outwards. Restoration of service to water treatment plants is an important priority in the overall electrical power restoration effort.

During the August 14 power outage, wastewater utility professionals attempted to minimize negative impact from the sanitary sewer system. All wastewater systems are unique, and it is up to the licensed wastewater professionals to handle emergencies to affect the least damage and best outcome based on the capabilities of their systems.

In addition to some wastewater systems having emergency backup electrical generators, some wastewater systems without backup power were able to store sanitary sewage in the gravity collection system. However, after filling the space in the limited storage of the sanitary sewers, utility personnel were faced with options of either allowing raw sewage to back up into residential basements, with significant public health issues, or overflowing at some point in the system to the receiving waters – a lake or a river. Overflows are typically managed to allow for partial treatment followed by disinfection as much as practicable.

### Section 4.3.10: Driver Hour Waivers

The limits on the number of hours truck drivers can normally be on the road were suspended to assist with the recovery and re-supply following the power outage. The Federal Motor Carrier Safety Regulations (FMCSR) (390.23) provide relief from compliance with most safety regulations when an emergency is declared. This means a carrier would have to comply with Controlled Drug and Alcohol Testing (382) and with CDL Requirements (383), but not the provisions dealing with the Driver Qualifications (391), Hours of Service (395) and Maintenance of Vehicles (396). For example, a carrier would be granted relief from complying while providing assistance to the emergency. According to 49 CFR 390.5, an "Emergency means any…storm (e.g., thunderstorm, snowstorm, ice storm…) earthquake…explosion, power outage, or other occurrence, natural or man made, that interrupts the delivery of essential services…or supplies (such as food and fuel) or otherwise immediately threatens human life or public welfare…." Under such situations, the FMCSA Field Administrator may declare emergencies if there is a regional crisis, which justifies such regulatory relief or when an emergency has been declared by the President of the United States, the governor of a state, or their authorized representatives having authority to declare emergencies.

Under a declaration of emergency under CFR Part 390, governors have broad authority to respond to disastrous situations. This authority in nearly all cases would automatically give effect to driver hour waivers upon an emergency declaration by a governor. FMCSA recognized a governor's authority as the basis for granting interstate waivers for drivers supplying the affected areas in a state in relation to disaster situations. Therefore, once Governor Granholm issued the emergency declaration at 9:15 a.m. on August 15, 2003, the waivers automatically went into effect. This waiver helped assure the delivery of needed supplies to southeast Michigan, including water and later gasoline, and remained in effect until the emergency declaration was rescinded. Notification was sent out over the State Police Law Enforcement Network and e-mails were sent to the energy and transportation trade associations informing them of this action. While these waivers should not be employed any longer than needed by companies, they technically remain in effect during the period under which the emergency declaration is in effect. The energy emergency declaration following the power outage was rescinded on September 30, 2003.

### Section 4.3.10: Detroit Marathon Refinery[31]

Late on August 14, 2003, reports to the SEOC incorrectly indicated that there was a fire at the Marathon refinery located in southeast Detroit and storage tanks were a concern. What in fact occurred was that when the power went out, the refinery went into emergency shutdown procedures. These procedures provided in part for petroleum products being processed under pressure to be dumped to safety flares. The flares, a safety valve for the refinery, burned off petroleum products in process, producing a flame that was reported to be anywhere from 30 to 75 feet high. Over a darkened city, this was very prominent. In addition, one of the units, a carbon monoxide boiler, did not shut down properly, causing an explosion, resulting in the release of a mixture of hydrocarbons and steam. The reduction in water pressure also was a compounding problem in the shut down of the refinery.

The release of the hydrocarbons and steam created concerns as to whether or not these emissions were toxic. Testing done at the refinery suggested that it was not an immediate hazard and the presence of benzene or hydrogen sulfide was ruled out. However, as a precautionary measure, the immediate surrounding residential communities located in southeast Detroit and Melvindale were evacuated. Additionally, I-75, which runs immediately adjacent to the refinery, was temporarily shut down to facilitate with the evacuation. The hydrocarbon release was contained at the Marathon refinery by about 8:00 a.m. the morning of August 15, and I-75 was opened back up to traffic. However, people that had been evacuated to shelters were not allowed to return to their homes until later in the day on August 15, following additional testing by the EPA, which had come into the area to monitor the air quality effects. Once it was determined that those effects were not harmful, residents were allowed to return to their homes.

The Marathon refinery can process 74,000 barrels of crude oil per day into a variety of petroleum products. Approximately half of the production from the refinery is gasoline. The gasoline being produced at the Marathon refinery at the time of the power outage was of a specification

[31] Celeste Bennett, Michigan Department of Agriculture, provided some of the information in this section.

designed to meet air quality requirements in southeast Michigan. The Motor Fuels Quality Act, P.A. 44 of 1984, as amended, requires that Wayne, Oakland, Macomb, Washtenaw, Livingston, Monroe, and St. Clair Counties use lower evaporating gasoline (7.8 pounds per square inch (psi) Reid Vapor Pressure[32] (RVP) or less) from June 1 to September 15 of each year.[33] This particular specification is intended to reduce evaporative emissions of volatile organic compounds (VOC) from gasoline during the summer months. This program is part of the State Implementation Plan (SIP) submitted to the EPA in 1996 in response to the clean air act mandates. The balance of the state uses RVP 9 psi gasoline throughout the summer and the same RVP limits are in effect statewide for the remainder of the year. The State's failure to enforce the 7.8 psi gasoline requirements could result in federal sanctions of highway dollars or implementation of federal enforcement measures.

Due to the damage at the refinery, it did not go back into full production until August 23, eight days after the onset of the outage. This meant that during that time, the refinery did not produce approximately 500,000 barrels of petroleum products, of which about half was gasoline with the 7.8 psi specification required for southeast Michigan

Marathon alone supplies an estimated 38 percent of the 7.8 psi gasoline used in that area by utilizing full refinery capacity all summer long and bringing in additional 7.8 psi product to meet demand. And, although the Toledo and Sarnia, Ontario refineries were only offline for a day or two, the lost production from these production facilities also contributed to a shortfall in supply of the 7.8 psi gasoline. According to the Energy Information Administration, the Marathon refinery and the two refineries in Toledo typically supply about 6-7 percent of distillate fuel oil (heating oil and diesel) and about 7-8 percent of gasoline demand in the Midwest and are even more important to the upper regions of the Midwest, where they are the major suppliers to Michigan and parts of Ohio. Each day these refineries are down, they do not produce 8 million gallons of gasoline, which is about two-thirds of what the entire State of Michigan uses in one day.

**Section 4.3.11: Gasoline Distribution Problems**

As a result of the disruption to refinery production both in Detroit and Toledo Ohio, the available supplies of 7.8 psi gasoline were quickly depleted. Only about 9 percent of the stations in the Detroit area were operational during the power outage and they reported customers were lined up in the street filling every canister they could. Stations were not able to replenish their supply of 7.8 psi gasoline because all but one Detroit terminal with 7.8 psi gasoline were without power. The one terminal with power was supplying petroleum products, but would not send their own tanker trucks out because of unsafe road conditions due to the lack of operating traffic signals. Some stations with available gasoline shut down because they were unable to handle consumers' behavior and had concerns for employee safety. Police were dispatched for crowd and traffic

[32] "Reid vapor pressure" means the absolute vapor pressure of volatile crude oil and volatile non-viscous petroleum liquids, except liquefied petroleum gases, as determined by A.S.T.M. D-323-72.
[33] After September 15, gasoline RVP requirements for the Detroit area are as follows: September 16 to October 31 – 13.5 psi; November 1 to March 31 – 15 psi; April 1 to April 31 – 13.5 psi. Ethanol blended fuels are 1 psi higher.

control at numerous stations in and out of the Detroit area as lines of cars backed up for as much as two hours.

Consumers began to migrate west and north in search of available gasoline and operational stations in Pickney, Manchester, and Chelsea reported a run on gasoline. Stations in outlying areas began reporting that they were out or running out of gasoline from the deluge of customers "stocking up." Reports were received of consumers filling as many as 10 portable gas cans at a single purchase. There were reports that at some gas stations tanker trucks could not maneuver through the heavy traffic to get in to restock the stations, even with 9.0 psi gasoline, so some stations were forced to shut down until consumer demand coming out of Detroit had slowed down.

Recognizing the potential supply shortfall of 7.8 psi gasoline in southeastern Michigan, the Governor declared a State of Emergency and a State of Energy Emergency on Friday morning, August 15. At approximately 9:15 a.m., Executive Order No. 2003-10 was issued by the Governor to suspend the environmental specifications for gasoline used in southeast Michigan counties to ensure that the area stations could receive any available gasoline. The DEQ requested that the EPA exercise enforcement discretion in regards to the SIP 7.8 psi requirements in southeast Michigan. The request was granted and was in effect until midnight on Friday, August 22. Notification of the suspension of the 7.8 psi requirements was sent out to all Michigan gasoline trade associations. Notice was also sent to Oil Price Information Service, which is utilized heavily by the petroleum industry for up-to-date news.

The following Wednesday, August 24, EAC Chair Lark advised the Governor of an impending energy emergency due to dwindling gasoline supplies as a result of the continued shut down of the Marathon refinery in Detroit. At the request of the DEQ, the EPA extended the state's enforcement discretion for southeast Michigan until September 3. On Thursday, August 21, Executive Order No. 2003-11 was issued by the Governor, which rescinded the State of Emergency and which also declared that an energy emergency existed for the state of Michigan due to the loss of gasoline supplies. That same day, Executive Order No. 2003-12 was issued by the Governor, which continued the suspension of environmental specifications for gasoline required for use in southeastern Michigan.

Inspectors from the Michigan Department of Agriculture, Motor Fuel Quality and Weights and Measures Division, who enforce the specification requirements for the State Implementation Plan under the air quality requirements, determined that a number of stations in southeastern Michigan had taken advantage of the waiver of the requirements and had blended a 9 psi gasoline into 7.8 psi gasoline already in tanks in retail gas locations in the Detroit and southeast metropolitan area. Based upon this information, it became apparent that it would be impractical to drain the tanks of this blended gasoline so that 7.8 psi could be put in place. A complete change over of gasoline stocks from 9.0 psi to 7.8 psi normally requires about a one-month lead time. Once the 9.0 psi product was in the distribution chain, it would continue to impact upon gasoline supplies for several weeks.

By Saturday, August 16, power was restored to much of southeastern Michigan and consumers' gasoline buying habits returned to normal by that evening. Power was restored to the Marathon and Toledo refinery operations, but production could not be resumed until after a total systems check and damage assessments were completed. Sunoco's Toledo refinery was back on line August 17, but Marathon was unable to return to full production until August 23. Other major marketers to southeastern Michigan indicated they had sufficient 7.8 psi gasoline to meet their normal market share, but did not have surplus product to make up for the refinery's shortfalls.

To resolve the shortfall of the availability of the 7.8 psi gas, the DEQ had originally requested that EPA permit the State enforcement discretion until September 5 to allow sufficient gasoline supplies for the holiday weekend. The EPA granted the state enforcement discretion until September 3, at which time a re-evaluation would be done. However, on August 28, because of the commingling tank contamination and the continued potential for problems with obtaining sufficient quantities of 7.8 psi gas, the DEQ requested that the EPA extend the environmental waivers until September 15, at which point the summer specifications would no longer be in effect. The EPA granted this discretion for distribution, transportation and sales until September 15, provided regulated parties took all reasonable steps to produce and supply 7.8 psi gasoline to southeast Michigan.

During this same time, beginning on August 15, a surge in demand for gasoline took place as people in the areas affected by the power outage drove to locations outside the affected area to fill up their vehicles. This resulted in a substantial drain of gasoline supplies around the periphery of the power outage area. In the week that followed the power outage, gasoline prices in both Michigan and the Nation rose at record rates. The average price in the Detroit area prior to the outage was $1.59 per gallon[34] on August 11, 2003. By August 25, the price had increased to an average of $1.77, and just prior to the Labor Day weekend peaked at nearly $1.88 per gallon at many stations. These price increases were not unique to Michigan and, in fact, these increases were seen nationwide.

The reason for the increase in prices seemed to be the result of a combination of events, which included rising crude oil prices through the month of August and a significant increase in gasoline demand that was evidenced by sharp draw downs in gasoline inventories. Even though the loss of refinery production was relatively minor, it nevertheless contributed to a tightening of supply, which further accelerated the price increases. As a comparison, problems with a gasoline pipeline near Phoenix, AZ had caused gasoline prices to go to $4.00 a gallon at some locations for a temporary period of time. Another one of the reasons for the accelerated demand for gasoline was the cooler than normal weather during the months of June and July, which tended to defer travel until August, at which point improved weather patterns caused people to take to the roads in notable numbers. Gasoline prices typically show an increase leading up to the Labor Day weekend and a seasonal decline following Labor Day weekend. This trend has taken place as gasoline prices have now settled back down along with the decline in crude oil prices.

[34] http://www.autoclubgroup.com/michigan/autos/fuel_gauge.asp

## Section 4.3.12: Food Supply[35]

The most significant events impacting the food supply were the loss of electricity to power refrigeration and the boiled water advisory that resulted from the loss of municipal water pressure due to the loss of electricity to pumping stations. Large grocery retail chains have contingency plans in place to provide auxiliary refrigeration to impacted stores. Smaller grocery retail establishments and restaurants faced significant challenges to prevent their perishables from becoming compromised.

The Michigan Department of Agriculture's response included directing extensive food safety inspection resources into the area to inspect grocery retail establishments, guidance to local health departments regarding restaurants, and extensive public outreach.

The food and agriculture infrastructure experienced the same difficulties in communications as other sectors. The dependence on cellular and cordless telephones, as well as the computer assisted switching in both the private sector and government made communications difficult.

The lack of the availability of commercial sources of gasoline posed an impediment to responders being sent into the impacted area. Allowing Michigan Department of Agriculture inspectors to fuel at State Police Posts solved this problem.

Resources that would be available in many situations to transport potable water, bulk milk haulers, were busy transporting milk from areas impacted by the loss of electrical power.

The amount of food being discarded by grocery stores posed a public health hazard as an enticement to poor people and an attraction to rodents. Initially, licensed waste haulers were not willing to deviate from their pre-existing contract obligations and landfills were not readily available on the weekend. The loss of electricity created a situation where public health was potentially impacted by the availability of a landfill on a Sunday.

## Section 4.3.13: Transportation[36]

The transportation system was also affected by the power outage in the following ways:

- Traffic signals were not functioning which meant, in some cases at busier intersections, police personnel had to be deployed in directing traffic when their services could perhaps have been needed elsewhere.
- Pumps used to keep depressed highways from flooding had to be powered with portable generators. This required crews to work 24 hours a day until power was restored. Some areas received so much rain that the crews could not keep up and some highways (I-94 in St. Clair Shores, M-39 in Detroit) were temporarily flooded.

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[35] Prepared by Robert Tarrent, Emergency Management Coordinator, Michigan Department of Agriculture.
[36] Information in this section was provided by Eileen Phifer, Michigan Department of Transportation, and, in part, was taken from Congressional Testimony of Col. McDaniel, Homeland Security Advisor to the Governor.

- Systems at the Michigan Intelligent Transportation System Center were without power. Video cameras, changeable message boards, and the Center's Web site all went offline. Communications with freeway courtesy patrols, outside media, and Michigan Department of Transportation was nearly impossible until the power was restored.
- The Detroit Windsor Tunnel was shut down due to the inability to operate ventilation, but the Ambassador Bridge continued to operate.
- The Ambassador Bridge in Detroit, the busiest commercial land port in the U.S., with 16,000 tractor-trailers crossing daily, was also affected. Interestingly, both the bridge and U.S. Customs had their computers interrupted only momentarily until their backup systems activated. Canadian Customs, however, lost their computer data link, and thus their ability to verify trucking manifests electronically. As a result they were forced to visually and manually inspect the manifests and, if warranted, the freight itself. This resulted in an approximately four-mile back up of traffic for almost 24 hours on the U.S. side.
- Metropolitan Detroit Airport was closed and all flights canceled until midnight on August 14. Flooding of the approach roads to the McNamara Terminal caused by a storm on August 15 cut off vehicle access to the terminal temporarily.

## Section 4.4: Lessons Learned and Recommendations

Even though the State as a whole was well prepared for the events following the August blackout, events such as this serve as a reminder that we can be better prepared. Most of the following items are in areas where work has been done that greatly contributed to the ability to respond to problems caused by the outage, but some gaps in planning and preparedness were evident and should be addressed. In general, improvement efforts need to focus on planning, assessment, communication, and training.

1. Examine the current Emergency Electrical Procedures adopted in Commission Case No. U-4128 to determine if they remain valid. These procedures were last updated in 1979 and the electric utility industry has changed dramatically since then.

2. Update Emergency Gas Procedures manual. Natural gas curtailment procedures have been adopted by the PSC for each jurisdictional gas utility in the State. However, many of these procedures may no longer be effective because large volume customers no longer buy directly from the local distribution utility.

3. Update the PSC Energy Emergency Operations manual. This manual was last revised in May 1992.

4. Update the Department's Emergency Management Coordinator responsibilities as contained in the State Emergency Management Plan currently undergoing revision.

5. Update contact lists and emergency procedures. While the contact lists in existence at the time of the power outage proved invaluable, some deficiencies in the lists were revealed. It is important for PSC Staff to maintain a professional working relationship with the key emergency contacts. Both the emergency contact lists and the communications procedures

have been updated since August 14, 2003. However, in the future, contact lists of emergency numbers – work, home and cell/pager – and e-mail addresses need to be kept up to date. This should be done on a regular schedule, preferably annually, and should include the following groups:

A. State agencies
B. Industry/private sector and non-profits
C. Federal agencies

6. Provide for additional PSC Staff training. PSC Staff that worked at the SEOC during the outage included individuals that were selected due to their availability, not necessarily their expertise in energy emergency procedures. A total of six individuals provided support at the SEOC. Additionally, a number of PSC individuals from public information, Energy Operations Division, and Energy Data & Security Section provided support to those at the SEOC from the Commission offices on Friday, August 15, 2003. While Staff at both the SEOC and the Commission offices provided invaluable help and support, previous training in the workings of the SEOC and energy emergency procedures would have been helpful. It is suggested that PSC Staff should be pre-designated to serve this function in case of future energy emergencies. Staff should be trained in the procedures of both the SECO and energy emergency procedures and should participate in annual emergency preparedness exercises conducted at the SEOC and elsewhere. The SEOC training should include training in the use of E-Team,[37] crises management software, and maintaining a duty log.

7. Training for the Department's Emergency Management Coordinator and alternates should also be provided on the use of E-Team and SEOC procedures. The list of emergency contacts in each bureau should be kept up to date and these bureau contact individuals should meet annually to review and discuss the Department's emergency response procedures.

8. Events should be more fully documented. Staff assigned to the SEOC should be trained in the use of E-Team, and events should be documented as they occur in E-Team. This will mean becoming more proficient in the use of the E-Team software and having better rules as to how this system should be used. Additionally, it is important that both a duty log and a phone contact log be maintained at the SEOC and by PSC backup support from the Commission offices. The PSC Staff assigned to do this support should be familiar with these procedures and trained to keep these records. This information is valuable both for keeping track of the event at the time and for assessing the emergency after it has been resolved.

9. Evaluate interdependencies. Staff working on energy emergencies should be versed in the potential interdependencies involved in such an emergency. For instance, in this power outage, it quickly became apparent that the loss of electrical power seriously affected the water systems of many of the affected communities. This loss had the

[37] E-Team is an incident management software package recently implemented at the SEOC. It includes a data base that provides for tracking of events, allocation of resources, and information sharing.

potential to cause very serious problems had the power outage lasted longer than it did. These problems could have included lack of clean drinking water for public consumption, lack of adequate wastewater treatment abilities, and lack of water for firefighting purposes.

Another interdependency that manifested itself as the power outage progressed was the need for fuel for the generators many entities were running to maintain services (hospitals, telecommunication systems, etc.). While some institutions and businesses had the foresight to have generators in place, they had neglected to contract for fuel deliveries to continue running the generators for an extended period. In some instances, generators fueled by natural gas should be considered.

Staff needs to be familiar with at least the concept of interdependencies and some of the more likely problems to spring from a power outage and related systems. Staff should be versed in potential solutions to some of these problems. For instance, in the case of generators running short of fuel, Staff made calls to area terminals and fuel supply depots in an effort to locate a supply. And, while the solution to interdependency may not lie with MPSC Staff (e.g., with the power outage, traffic signals were not working and police had to be dispatched to busier intersections to direct traffic), they should at least be aware of potential problems so as to advise the appropriate agency.

10. The roles and responsibilities of state and federal agencies and associations need to be clearly delineated, including the U.S. Department of Energy Office of Energy Assurance, U.S. Department of Homeland Security, the PSC, National Association of Utility Regulatory Commissioners, and National Association of State Energy Officials.

11. Good up-to-date reference information should be provided. There is a need to have reference materials available on systems and infrastructure that may be involved or affected by an energy emergency. While PSC Staff had a great deal of this information available when it was needed (Emergency Operations Manual, State rules and regulations governing energy emergencies, contact lists, and statistics readily available regarding the Marathon refinery), some of this information was not readily available because it was contained in an electronic database on computers at the PSC offices. Since the PSC offices were without power, this information was not available. It is important that detailed information on all critical energy infrastructure and any other reference material deemed to be useful be developed and maintained in both electronic and hard copy formats, which will ensure that it is available when needed.

**Section 4.5: Conclusion**

In conclusion, the efforts of the PSC, its Staff, and other State and federal agency personnel made a significant contribution to avoiding much more serious consequences that might have occurred absent emergency management intervention. Statewide coordination of what turned out to be a widespread regional problem was essential to the maintenance of order and the restoration of public services. Finally, the tireless endeavors of utility personnel and management as well as local first responders were critical in restoring essential services and maintaining public safety throughout the duration of the blackout of 2003. Nonetheless, this report reveals that a number of lessons were learned from this review, and a number of steps should be taken to improve the response to future emergencies.

# PART V

# CONCLUSIONS AND RECOMMENDATIONS

This part summarizes the most important conclusions and recommendations of this report. It is intended only as a convenient summary of items discussed more fully in the text. The most significant conclusions and recommendations in each sector are included:

**Section 5.1: Transmission**

- Michigan utilities and transmission companies were not the cause of the blackout. All of the events in the two and one-half hours preceding the power surges that occurred at 4:09 p.m. involved the facilities of FirstEnergy or American Electric Power in Ohio. No Michigan utilities or transmission companies were involved in these events. Information involving these events was not shared with Michigan companies prior to the blackout.

- Congress must provide the FERC with the authority and responsibility to ensure (1) that mandatory reliability standards are in place, (2) that they are enforceable, and (3) that they include penalties for noncompliance.

- FERC should permit but one regional transmission organization to operate in the Midwest market; but if it chooses to permit the existence of more than one organization, at an absolute minimum, there must be mandatory, enforceable rules that address issues that arise at the seams between the organizations.

**Section 5.2: Electric Utilities**

- Detroit Edison should conduct an analysis of the "In Service Application" system to consider modifications or alternatives that would function more effectively in the event of a similar blackout, and should report the results of its analysis to the Commission.

- Detroit Edison should conduct an engineering analysis of the operation of its rupture disks to determine if any modifications are warranted and report the results of its analysis to the Commission.

**Section 5.3: Emergency Response**

- There should be a review of the Emergency Electrical Procedures adopted in Case No. U-4128, which have not been updated since 1979.

- The Public Service Commission should designate in advance the Staff assigned to the State Emergency Operations Center and provide training for that assignment.

# Appendix A

1. Governor's Statement to the People of Michigan
2. Executive Proclamation State of Emergency
3. Executive Order No. 2003-10
4. Executive Order No. 2003-11
5. Executive Order No. 2003-12
6. Executive Order No. 2003-16
7. Tips For Buying And Using A Portable Generator
8. Surviving Electrical Power Outages
9. MPSC Press Release, August 15, 2003

**Appendix A-1**

## Governor's Statement to the People of Michigan

**Aug. 15, 2003**

*The following is the text of Governor Jennifer M. Granholm's statement to Michigan residents regarding the power outage, which was broadcast via satellite on Thursday evening:*

Let me begin by reiterating what you all heard the President of the United States say just an hour ago. The electrical outage that we are experiencing here in Michigan is not the result of a terrorist attack, but appears to be the result of some other natural occurrence – that caused an outage at a power plant in New York State earlier this afternoon. That outage in New York rippled across the Eastern United States and Canada, actually stopping here in Michigan.

At this hour, utility crews are working to restore power in the affected areas. As you know by now, the outage affects mostly residents in the middle and southeast parts of the state. Detroit Edison serves 2.1 million customers in these areas, all of which are still out of power as I speak. In addition, 100,000 Consumers Energy customers are without power.

Detroit Edison is saying that they are beginning to power-up their plants and they will continually be bringing customers back online. The utility cannot confirm exactly when all power will be fully restored, but they are hopeful that most customers will be back online before the end of the weekend. This will be a gradual restoration, but I am pleased to report that thanks to the swift response of utility crews and the power conservation of our citizens, reports are beginning to trickle-in that power is slowly coming back on in some locations.

Oakland, Macomb and Wayne Counties have declared LOCAL states of emergency. At 8:30 p.m. we fully activated the state's Emergency Management Operations Center, which allows us to have a central point of communication between the all state, local and federal agencies.

Some people may have questions about steps they can take to remain safe and protect their families. We urge citizens, first and foremost, to remain calm. Also, for your safety, try to stay off the roads. If you must drive, treat all intersections a*s* four-way stops.

Beyond these important first steps, we encourage citizens to take the same basic precautions that you would in any other power outage situation.

Unplug your appliances and major electronics – like computers, for instance. When power comes back on there may a surge which could damage these products.

Importantly, while we encourage people to stay hydrated to stay cool, citizens should take steps to conserve water. Water is pumped to your faucet through pumps, which, of course, use electricity.

As the evening and tomorrow progresses, we expect more communities to come back on-line. I want to thank all of the utility workers and emergency personnel who have been working so hard to restore power.

Finally, this is truly one of the instances where we are all in this together. So please be calm, be supportive of your neighbor, and take those extra precautions. Thank you.

Appendix A-2

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JOHN D. CHERRY, JR.
LT. GOVERNOR

## EXECUTIVE PROCLAMATION

## STATE OF EMERGENCY

WHEREAS, beginning on August 14, 2003, significant portions of the State of Michigan are experiencing the effects of a severe power outage, resulting in the loss of electrical power for countless Michigan residents, communities, and businesses, causing serious hardship for the citizens of the State of Michigan;

WHEREAS, this power outage has resulted in the loss of power in numerous other states in the region, including Connecticut, Michigan, New Jersey, Ohio, Vermont, and the province of Ontario;

WHEREAS, the power disruption has impaired and or threatens to impair the maintenance of essential public services, and therefore constitutes a danger to the health, safety, and welfare of the general public;

WHEREAS, this event was caused by a utility failure and represents a threat of widespread or severe damage, injury, or loss of life or property;

WHEREAS, it is in the best interests of the State of Michigan and its citizens that appropriate measures be taken to assure that essential needs are met, and where necessary, discretionary needs are met;

WHEREAS, the areas affected include the counties of Macomb, Monroe, Oakland, Washtenaw, and Wayne;

NOW, THEREFORE, I, JENNIFER M. GRANHOLM, Governor of the State of Michigan, pursuant to powers vested in me by the Michigan Constitution of 1963 and the provisions of the Emergency Management Act, 1976 PA 390, MCL 30.401 to 30.421, and 1982 PA 191, MCL 10.81 to 10.87, proclaim:

1. A state of emergency, including an energy emergency, exists in the counties of Macomb, Monroe, Oakland, Washtenaw, and Wayne.

2. The response and recovery aspects of the Michigan Emergency Management Plan and the emergency operation plans of affected political subdivisions are activated to manage the state of emergency.

**3.** The Emergency Management Division of the Michigan Department of State Police ("EMD") shall coordinate and maximize all state resources which may be activated to assist the affected areas in responding to the impact of the power outage and facilitate the restoration of power in the affected areas. The EMD may call upon all state departments to utilize resources at their disposal to assist in the emergency area pursuant to the Michigan Emergency Management Plan.

**4.** Termination of this state of emergency will occur at such time as emergency conditions no longer exist and appropriate programs have been implemented to recover from the effects of this emergency, but in no event longer than September 14,2003, unless extended as provided by the Emergency Management Act, 1976 PA 390**,** MCL 30.401 to 30.421.

This proclamation is effective immediately.

Given under my hand and the Great Seal of the State of Michigan this 15th day of August, 2003.

JENNIFER M. GRANHOLM
GOVERNOR

BY THE GOVERNOR:

Secretary of State

FILED WITH SECRETARY OF STATE
ON 8.15.03 AT 9:15 Am

Appendix A-3

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JOHN D. CHERRY, JR.
LT. GOVERNOR

# EXECUTIVE ORDER
## 2003 – 10

## TEMPORARY SUSPENSION OF ADMINISTRATIVE RULES FOR GASOLINE VAPOR PRESSURE

WHEREAS, because significant portions of the State of Michigan have been experiencing the effects of a severe power outage, resulting in the loss of electrical power for countless Michigan residents, communities, and businesses, and causing serious hardship for the citizens of the State of Michigan, a state of emergency was declared by proclamation on August 15,2003 in the counties of Macomb, Monroe, Oakland, Washtenaw, and Wayne ("State of Emergency");

WHEREAS, Section 5(l)(a) of the Emergency Management Act, 1976 **PA** 390, MCL 30.405, empowers the Governor to suspend a regulatory statue, order, or rule prescribing the procedures for the conduct of state business when strict compliance with the statute, order, or rule would prevent, hinder, or delay necessary action in coping with the disaster or emergency:

NOW, THEREFORE, I, JENNIFER M. GRANHOLM, Governor of the State of Michigan, pursuant to powers vested in me by the Michigan Constitution of 1963 and the provisions of the Emergency Management Act, 1976 PA 390, MCL 30.401 to 30.421, order:

1. Administrative rules promulgated by the Department of Agriculture, Laboratory Division, dealing with gasoline vapor pressure, entitled, "Regulation No. 561-Dispensing Facility Reid Vapor Pressure," 1997 AACS, R 285.561.1 to 285.561.10, are suspended in the areas of the State of Michigan subject to the State of Emergency and the counties of St. Clair and Livingston for the duration of the State of Emergency.

This Order is effective immediately.

Given under my hand and the Great Seal of the State of Michigan this 15th day of August, 2003.

JENNIFER M. GRANHOLM
GOVERNOR

BY THE GOVERNOR:

Secretary of State

F''ED WITH SECRETARY OF STATE
ON 8-15-03 AT 12:55P.M

Appendix A-4

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JOHN D. CHERRY, JR.
LT. GOVERNOR

**EXECUTIVE ORDER**
**2003 – 11**

STATE **OF ENERGY EMERGENCY**

WHEREAS, Article V, Section 1 of the Michigan Constitution of 1963 vests the executive power of the State of Michigan in the Governor;

WHEREAS, Section 3 of 1982 PA 191, MCL 10.83, authorizes the Governor to declare a State of Energy Emergency upon notification of an impending energy emergency by the Energy Advisory Committee, or upon the Governor's own initiative if the Governor finds that an energy emergency exists or is imminent;

WHEREAS, on August 14,2003, a widespread and unprecedented loss of electrical power affected significant portions of the State of Michigan;

WHEREAS, the power outage adversely impacted operations at eight petroleum refineries throughout the United States and Canada, and damaged Michigan's only refinery, which may be unable to meet demand for gasoline in the near future, resulting, without further action, in a lack of adequate available gasoline in parts of this state;

WHEREAS, on August 20, 2003, the Public Service Commission notified the Energy Advisory Committee of an impending and imminent energy emergency involving a dwindling supply of gasoline in Southeast Michigan due to the power outage and damage to the refinery;

WHEREAS, it is in the best interests of the State of Michigan that appropriate measures be taken in response t o an imminent energy emergency to ensure that gasoline supplies will remain sufficient and t o assure the health, safety, and welfare of Michigan residents and visitors;

NOW, THEREFORE, I, JENNIFER M. GRANHOLM, Governor of the State of Michigan, pursuant to powers vested in the Governor by the Michigan Constitution of 1963 and 1982 PA 191, MCL 10.81 to 10.87, order the following:

1. The State of Emergency proclaimed on August 15, 2003 for the counties of Macomb, Monroe, Oakland, Washtenaw, and Wayne is rescinded.

2. A State of Energy Emergency is declared. Pursuant to Section 3 of 1982 PA 191, MCL 10.83, the State of Energy Emergency is effective until the earlier of either of the following:

a. A finding by the Governor that the energy emergency no longer exists

b. November 19,2003.

.

This Order is effective upon filing.

Given under my hand and the Great Seal of the State of Michigan this 21st day of August, 2003.

Jennifer M. Granholm
GOVERNOR

BY THE GOVERNOR:

SECRETARY OF STATE

FILED WITH SECRETARY OF STATE
ON 8-21-03 AT 4:00P.M.

Appendix A-5

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JOHN D. CHERRY, JR.
LT. GOVERNOR

# EXECUTIVE ORDER
## 2003 – 12

## TEMPORARY SUSPENSION OF RULES FOR GASOLINE VAPOR PRESSURE

WHEREAS, under 1982 PA 1981, MCL 10.83, during an energy emergency the Governor may by executive order suspend a rule of a state agency if strict compliance with the rule will prevent, hinder, or delay necessary action in coping with the emergency;

WHEREAS, Executive Order 2003-11 declared a State of Energy Emergency beginning on August 21,2003;

WHEREAS, appropriate measures must be taken in response to the energy emergency to ensure that gasoline supplies will remain sufficient and to assure the health, safety, and welfare of Michigan residents and visitors;

NOW, THEREFORE, I, JENNIFER M. GRANHOLM, Governor of the State of Michigan, pursuant to powers vested in the Governor by the Michigan Constitution of 1963 and Michigan law, order that the Regulation No. 561, entitled, "Dispensing Facility Reid Vapor Pressure," promulgated by the Laboratory Division of the Department of Agriculture, 1997 AACS, R 285.561.1 to 285.561.10, be suspended for the duration of the energy emergency declared in Executive Order 2003-11. Additionally, Executive Order 2003-10 is rescinded.

Given under my hand and the Great Seal of the State of Michigan this 21st day of August, 2003.

Jennifer M. Granholm
GOVERNOR

BY THE GOVERNOR:

SECRETARY OF STATE

FILED WITH SECRETARY OF STATE
ON 8·21·03 AT 4:02 P.M.

P.O. BOX 30013 • LANSING, MICHIGAN 48909
www.michigan.gov

**Appendix A-6**

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JOHN D. CHERRY, JR.
LT. GOVERNOR

# EXECUTIVE ORDER
# 2003 – 16

## END OF STATE OF ENERGY EMERGENCY

WHEREAS, Article V, Section 1 of the Michigan Constitution of 1963 vests the executive power of the State of Michigan in the Governor;

WHEREAS, under Section 3 of 1982 PA 191, MCL 10.83, a state of an energy emergency declared by the Governor is effective for the shorter of 90 days or until a finding that the energy emergency no longer exists;

WHEREAS, the Chairperson of the Energy Advisory Committee has advised that the energy emergency recognized by Executive Order 2003-11 no longer exists;

NOW, THEREFORE, I, JENNIFER M. GRANHOLM, Governor of the State of Michigan, pursuant to powers vested in the Governor by the Michigan Constitution of 1963 and Michigan law, order the following:

1. The state of energy emergency proclaimed on August 21, 2003 under Executive Order 2003-11 is rescinded, effective immediately.
2. Executive Order 2003-12 is rescinded, effective immediately.

Given under my hand and the Great Seal of the State of Michigan this 30th day of September, 2003.

Jennifer M. Granholm
GOVERNOR

BY THE GOVERNOR:

SECRETARY OF STATE

FILED WITH SECRETARY OF STATE
ON 9.30.03 AT 10:58 AM

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www.michigan.gov

**Appendix A-7**

MICHIGAN PUBLIC SERVICE COMMISSION

# CONSUMER ALERT

Subject: Portable Generators

Contact: Margaret VanHaften
(517) 241.6165
(mrvanha@michigan.gov)
800.292.9555

## TIPS FOR BUYING AND USING A PORTABLE GENERATOR

In the event of an electrical power outage, many Michigan homeowners and businesses rely on portable power generators to keep lights and appliances running until service is restored. A portable generator is designed to run a limited number of appliances at a time and is typically powered by gasoline or diesel fuel. Generators usually cost between $600 and $3,000 -- depending on size and features. The Michigan Public Service Commission (MPSC) wants you to consider some important points when deciding to buy and use a portable generator.

**Sizing**

To determine the size of the generator you will need, total the wattage of the lights and appliances you will need to power. *For example*:

| Appliance | Wattage Needed to Run Appliance* |
|---|---|
| **Furnace (1/3 HP blower)** | 1,200** |
| **Refrigerator** | 600** |
| **Microwave oven** | 700 |
| **Two 100-watt light fixtures** | 200 |
| **Total** | 2,700 |
| | |
| *Appliance wattage varies -- these figures represent averages.<br>**Allow up to three times the normal running watts for starting these appliances or cycling their compressors. | |

A typical portable generator is rated at 2,400 to 7,500 watts. Most household appliances are rated at 120 volts. Some larger electric appliances (e.g., electric range, electric clothes dryer, well pump, air conditioner) are rated at 240 volts. If you want to power this type of appliance as well as smaller ones, you will need a generator that is rated at 120-240 volts.

## Installation

Always read and follow all installation and operation instructions for your generator. There are two ways to safely install and operate a portable generator:

### Direct Hook-up

Portable generators are designed to power a limited number of plug-in appliances like your refrigerator, freezer, and lights or any other combination of appliances you determine to be essential. These and other home appliances not permanently wired to the electrical system can be powered directly from the generator through a heavy-duty (at least 12 gauge), polarized extension cord. The extension cord should be less than 100 feet long to prevent power loss and overheating.

### Safety Transfer Switch

Some generators can be permanently connected to your electric system to energize your home's wiring in the event of a power outage. This type of installation requires a safety transfer switch. Before starting your generator, you must activate the switch. The switch disconnects your home's wiring system from the electric company's system and allows electricity to flow from the generator to your home's circuitry. The switch prevents the generator from back-feeding electricity into the power lines and possibly causing injury or death to unsuspecting workers trying to restore power. The switch also prevents damage to your generator, wiring, and appliances when electric service is restored. Only a licensed electrician should install a transfer switch.

## Safety

- Always follow the safety instructions in the manufacturer's instruction manual.
- Always follow local, state, and national fire and electric codes. A permit may be required for installation.
- Always use a heavy-duty (at least 12 gauge) UL-listed extension cord (less than 100 feet long) from the generator to your appliances -- being careful not to overload the cord.
- Always make sure that the total electric load on your generator does not exceed the manufacturer's rating.
- Always properly ground the generator according to the manufacturer's instructions.
- Never operate a generator indoors or in an unventilated area. It produces deadly carbon monoxide fumes.
- Always store gasoline and diesel fuel in approved containers and keep it out of the reach of children.
- Never refuel a generator while it is running. Shut it off and let it cool for 10 minutes before refueling to minimize the danger of fire.
- Parts of the generator are very hot during operation. Avoid contact and keep children away.
- Protect the generator from rain and other moisture sources to prevent electrocution.
- When not in use, store the generator in a dry location such as a garage or shed.

A portable generator can be a good, temporary source of electricity during a power outage. To avoid serious safety hazards when using a generator, it is important to follow all operation and safety instructions provided by the manufacturer.

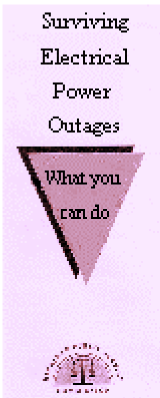
The Michigan Public Service Commission is an agency within the Department of Consumer and Industry Services.

Alert 99-12

September 30, 1999

**Appendix A-8**

## SURVIVING ELECTRICAL POWER OUTAGES - WHAT YOU CAN DO IF YOU LOSE YOUR ELECTRIC SERVICE




### PREPARE FOR A POWER OUTAGE BEFORE IT HAPPENS

Set aside and designate for emergency use:

- Flashlight
- Battery-powered radio
- Extra batteries
- Blankets
- First-aid kit
- Bottled water
- Battery-operated lantern
- Candles

Keep a list of emergency numbers near the telephone.
Protect electrical equipment such as a TV, VCR, microwave, or home computer with a voltage surge suppressor. A suppressor can eliminate the surge before it enters the equipment, thus protecting it from damage. A variety of devices are available for different forms of protection. If the equipment is not protected, unplug them before the storm begins to prevent lightning damage.

### WHEN POWER IS LOST

- Check the fuse box to see if a fuse is blown or tripped. Check with the neighbors to see if their power is out.
- Call your local utility company and let its personnel know that you have lost power. Also, advise if there is emergency medical equipment in the home.
- Turn off and unplug most lights and appliances to prevent electrical overload when power is restored.
- Keep refrigerator door closed as much as possible. Move milk, cheese, meats, etc. into the freezer compartment of the refrigerator. If the freezer is only partially full, group packages together so they form an "igloo" to keep each other cold. Cover freezer with a blanket. Purchase dry ice and place in freezer. It will help keep food frozen for an extended period of time.
- Make sure you have enough water for cooking and drinking.
- Avoid downed power lines.

### ADDITIONAL STEPS WHEN POWER IS LOST AND OUTSIDE TEMPERATURE IS COLD

- If city water, open faucets so there is a constant drip so pipes won't freeze.
- Hang cardboard or blankets over windows and doorways - find a well insulated room for living until power is restored.
- Dress warmly - wear a hat because it helps prevent loss of body heat, since body heat escapes through the top of the head.
- Fireplaces may be used to provide light as well as heat. Always keep the damper open for proper ventilation.
- Store perishable food outside in a cold and shaded area or in an unheated garage.

## WHEN POWER I

Wait a few minutes before turning on lights. Plug in appliances one at a time.

Appendix A-9

**J. Peter Lark, Chair**
**Robert B. Nelson, Commissioner**
**Laura Chappelle, Commissioner**

**Contact: Gary Kitts 517.241.6193 or 517.241-3323** www.michigan.gov/mpsc

Michigan Public Service Commission Urges Energy Conservation in Light of the Recent Blackouts

**August 15, 2003**

The Michigan Public Service Commission urges Michigan citizens to take all reasonable steps to conserve energy today in light of the devastating blackout through the Northeast.

"Although power restoration is underway, the ability to complete and maintain that restoration will depend on the amount of demand on the system," said Commission Chair J. Peter Lark. "We are asking all Michigan citizens to assist in this effort by conserving energy today to minimize the stress on the electric system. Almost 2 million Michigan customers remain without power this morning. Although most of the electric generating plants that went down are expected to be operating today, it may be several days before some of them are returned to service."

Here are some recommendations to help businesses and residential customers reduce your electric use:

- If you're away from home for the day or your business is closed, turn off your central air conditioner or raise its setting above 78 degrees;
- When home or at your business, raise the temperature on your central air conditioner to 78 degrees or the highest setting comfortable;
- Close off unoccupied areas and shut air-conditioning vents;

**(more)**

- Close blinds, shades and drapes to keep your home or office more comfortable at higher temperature settings and help your fans and air conditioners work more efficiently;

- Turn off all unnecessary lights, equipment and appliances;

- Prepare meals that require little or no cooking;

- Delay running your dishwasher, clothes washer and dryer until late evening;

- Set fax machines and printers for sleep mode when not in use. Network one printer for several users;

- Make sure the power management feature is enabled on computers and set to the shortest acceptable time for your operation. Use laptops instead of personal computers.

In most cases, regular telephone service will be available even though electric power is not.

The MPSC is an agency within the Department of Consumer and Industry Services.

# # #