MEMORANDUM TO: Brian W. Sheron, Director
Division of Engineering

June 12, 1997

FROM: José A. Calvo, Chief (Original /s/ by J. Calvo)
Electrical Engineering Branch
Division of Engineering

SUBJECT: MID-AMERICA INTERCONNECTED NETWORK (MAIN) -- 1997 SUMMER CAPACITY ASSESSMENT

Attachment 1 presents a summary assessment of the capacity situation for the Mid-America Interconnected Network (MAIN). The combination of the projected unavailability of 4,700 to 6,500 MW of nuclear generation and limited transmission import capability is likely to result in electricity supply shortages, particularly in the Northern Illinois, Wisconsin-Upper Michigan, and South Central Illinois Subregions.

MAIN is prepared to implement significant load management actions including controlled interruption (rotating blackouts) of loads. These actions should make available sufficient capacity margin to ensure that the backbone of the transmission network remains energized following major disturbances, and barring unforeseeable circumstances, this would ensure the availability of offsite power to the nuclear power plants.

In view of the sensitive situation in the MAIN Region and the high potential for voltage perturbations in the electric grid that may lead to the loss-of-offsite power to nuclear power plants, EELB suggests that the NRR Division of Reactor Projects III and IV and/or the Region III communicate with the licensees to assure that precautionary measures are being taken and are prepared to mitigate safely the consequences of the loss-of-offsite power including the prompt restoration of it if such an event should occur. Further details on these recommendations are presented in Attachments 1 and 2.

Attachments:
1. MAIN 1997 Summer Capacity Assessment - Summary
2. MAIN 1997 Summer Capacity Assessment - Background
3. Table - Scenario 1, "4,606 MW Total Inoperable Capacity"
4. Table - Scenario 2, "6,125 MW Total Inoperable Capacity"
5. Table - Scenario 3, "7,179 MW Total Inoperable Capacity"

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MID-AMERICA INTERCONNECTED NETWORK (MAIN)
1997 SUMMER CAPACITY ASSESSMENT

SUMMARY

Mid-America Interconnected Network (MAIN) is one of the ten regional councils under the North American Reliability Council (NERC). MAIN is a voluntary association of electric utilities, encompassing subregions of Northern Illinois (NI), Wisconsin-Upper Michigan (WUMS), Eastern Missouri (EMO), and South Central Illinois (SCIL).

The MAIN Region does not have facilities for regional control of generating capacity or major switching stations rather there are 13 control areas and each controls its own generating capacity in accordance with procedures set in the MAIN operating guides and procedures established by NERC. The MAIN Coordination Center, located in Lombard, Illinois, ensures that the region will meet its load requirements with the interconnected network. To accomplish this, the Center coordinates the scheduled outages of transmission and generation facilities, provides information regarding generating capacity reserves, analyzes system operation, and assists members during critical conditions. In the event of an emergency, such as a severe generating shortage or the sudden loss of power in a neighboring region, individual control areas of MAIN have the authority to shed load independently. The control areas in the MAIN Region are operated as separate entities.

During severe generation shortage situations, MAIN has an Emergency Load Conservation Procedure in place that implements actions such as voltage reductions, exercise interruptible demand agreements and customer appeals to reduce the use of electricity to ensure that the load demand matches the available power generation. When all load demand side actions have been exhausted and there is still a need for further reduction, load shedding or controlled rotating blackouts would be used in MAIN only when it is necessary to protect against a widespread failure of the power system.

MAIN has established a reliability goal of 1 day in 10 years for loss of load. The installed generating capacity, which includes non-utility generators in MAIN, is approximately 52,000 MW. There are 16 nuclear power plants that provide about 25 percent of the total generation of the MAIN Region.

The MAIN Region, particularly the Northern Illinois, Wisconsin-Upper Michigan, and South Central Illinois Subregions will need to take extraordinary measures this summer to ensure an adequate supply of power to meet expected load demands. This situation is due mainly to the expected unavailability of 4,700 to 6,500 MW of nuclear generation in Northern Illinois and Wisconsin.

ATTACHMENT 1

MAIN has analyzed a range of capacity scenarios that consider the unavailability of power, mostly nuclear generation, during the summer of 1997. In the most optimistic scenario (Zion 1 and 2, LaSalle 1 and 2, and 372 MW of fossil generation out of service) and with full-responsibility firm transactions included (purchase of imported power), the capacity margins in MAIN during peak periods could be as low as 11.5 percent. In the most pessimistic scenario (Zion 1 and 2, LaSalle 1 and 2, Point Beach 1 and 2, Kewaunee, Clinton, and 465 MW of fossil generation out of service), the capacity margin in MAIN during peak periods could be as low as 6.6 percent. In both scenarios, the worst deficiencies are in the Northern Illinois Subregion (2.6 percent capacity margin for the Subregion). The utilities of MAIN are taking extra measures to deal with these situations.

- Utilities in the three affected Subregions are contracting for supplemental firm capacity with firm transmission service to replace the unavailable generation.

- The actual and potential outage, particularly, of nuclear generating units, create voltage-level control problems as a result of the unavailability of the excitation systems for these units to control MVAR. Therefore, significant additions of reactive support are being installed to ensure that adequate transmission system voltage levels are maintained at all times. NI and WUMS are adding about 3,000 MVARs.

- The transmission network capability both within and exterior to MAIN is not designed to import electricity into the Region at the levels expected to be necessary this summer. Implementation of several transmission operating procedures is expected to be required to import sufficient replacement resources even for the optimistic scenario.

MAIN appears to be ready to meet the challenges for 1997 summer operating conditions which include ensuring that the backbone of the transmission network remains energized following the major grid disturbances, and barring unforeseeable circumstances, this would ensure the availability of offsite power to the nuclear power plants.

Recommendations

Despite the extensive preparations and planning by MAIN and its members, the combination of generator unavailability and limited transmission capability coupled with unanticipated circumstances such as extreme weather conditions could result in electricity supply shortages.

In view of the sensitive situation in the MAIN Region and the high potential for voltage perturbations in the electric grid that may lead to the loss-of-offsite power to nuclear power plants, EELB suggests that the NRR Division of Reactor Projects III and IV and/or the Region III should communicate with the licensees of nuclear power plants operating in the MAIN Region to inform them that discretionary emergency diesel generator maintenance should not be scheduled for June through late September 1997. This action would help to maximize the number of emergency power sources available in the event of a loss-of-offsite power.

The Division of Reactor Projects III and IV and/or the Region III should also communicate with the licensees to request that operators of nuclear power plants should place special emphasis on refreshing their knowledge of procedures related to response to loss-of-offsite power to the plant. In addition, the plant should closely communicate with the corresponding MAIN Region control area to be aware of particularly critical situations as they occur.

MID-AMERICA INTERCONNECTED NETWORK (MAIN)
1997 SUMMER CAPACITY ASSESSMENT

BACKGROUND

Following the 1965 blackout in the northeastern United States and southeastern Ontario, Canada, electric utilities formed the North American Reliability Council (NERC) in 1968 to promote the reliability of the electricity supply in North America. NERC consists of ten regional reliability councils and one affiliate, whose members account for virtually all the electricity supplied in the United States, Canada, and a portion of Baja California Norte, Mexico. The members of these councils are from all segments of the electricity supply industry, including investor-owned, Federal, rural electric cooperative, State/municipal, provincial utilities, independent power producers, and power marketers.

NERC develops planning principles and guides that describe good practices for bulk electric system planning. The regional councils, subregions, pools, and individual systems, which have the primary responsibility for the reliability of bulk electric supply, develop the following:

- Reliability criteria applicable to their region or area for use in planning and constructing bulk electric systems.
- Criteria dealing with the application and coordination of automatic underfrequency load shedding, load forecasting considerations, and system parameter recording.
- Arrangements to ensure that interregional effects on reliability are reviewed and encouragement of regional planning coordination.

The planning principles and guides developed by NERC, along with criteria developed by the regional councils, serve as a basis on which the utility industry performs self-monitoring in providing a reliable supply of electricity.

One of the ten Regional Councils is the Mid-America Interconnected Network (MAIN), which is the subject of this report.

MAIN

MAIN encompasses four subregions: Northern Illinois (NI), Wisconsin-Upper Michigan (WUMS), South Central Illinois (SCIL) and Eastern Missouri (EMO).

ATTACHMENT 2

The MAIN Coordination Center located in Lombard, Illinois ensures that the region will meet its load requirements with the interconnected network. To accomplish this, the Center coordinates the scheduled outages of transmission and generation facilities, provide information regarding generating capacity reserves, analyze system operation and assist members during critical conditions.

The MAIN Region does not have facilities for regional control of generating capacity of major switching stations rather there are 13 control areas in MAIN and each controls its own generating capacity in accordance with operating guidance and procedures established by MAIN and NERC. In the event of an emergency, such as a severe generation shortage or the sudden loss of power in a neighboring region, individual control area of MAIN have the authority to shed load independently. The control areas in the MAIN Region are operated as separate entities.

MAIN and its four subregions has reported the following installed capacity for the month of June 1997.

Capacity Resources in MW	NI	WUMS	SCIL	EMO	MAIN (Total)
Owned Capacity	22,307	10,778	10,509	8,072	51,666
Independent Power Producers	37	253	47	2	339
TOTALS:	22,344	11,031	10,556	8,074	52,005

The actual capacity resources available to meet load demand projected during this summer for three scenarios of inoperable capacity (which are reasonably expected - see definition of "Adequacy") are addressed under MAIN Region Summer 1997 Capacity Assessment section of this report.

The total nuclear generation capacity available in the States of Illinois and Wisconsin is approximately 13,620 MW, which represents about 25 percent of the total installed capacity resources of approximately 52,000 MW assigned to MAIN. A breakdown of the nuclear generation capacity is presented below.

Illinois

Station/Unit	Size (MW)	Owner
Braidwood 1	1,090	Commonwealth Edison Co.
Braidwood 2	1,090	Commonwealth Edison Co.
Byron 1	1,090	Commonwealth Edison Co.
Byron 2	1,090	Commonwealth Edison Co.
Clinton 1	930	Illinois Power Co. Soyland Power Cooperative, Inc
Dresden 2	773	Commonwealth Edison Co.

Station/Unit	Size (MW)	Owner
Dresden 3	773	Commonwealth Edison Co.
LaSalle 1	1,048	Commonwealth Edison Co.
LaSalle 2	1,048	Commonwealth Edison Co.
Quad Cities 1	577	Commonwealth Edison Co. MidAmerican Energy Co.
Quad Cities 2	577	Commonwealth Edison Co. MidAmerican Energy Co.
Zion 1	1,040	Commonwealth Edison Co.
Zion 2	1,040	Commonwealth Edison Co.
Total	12,166	

Wisconsin

Kewaunee	520	Wisconsin Public Service Corp. Wisconsin Power & Light Co. Madison Gas & Electric Co.
Point Beach 1	493	Wisconsin Electric Power Co.
Point Beach 1	441	Wisconsin Electric Power Co.
Total	1,454	

GRID OPERATING CRITERIA AND SPECIAL OPERATING PROCEDURES

NERC addresses electrical system reliability by considering two basic and functional aspects of the electrical system -- adequacy and security.

Adequacy: The ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.

Security: The ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss-of-system elements.

MAIN's operating criteria state that the power pool should, at all times, have sufficient generation available to meet demand plus maintain an operating reserve large enough to cover major disturbances such as the sudden loss of a major generating or transmission facility. These criteria address both the adequacy and security aspects of electric system reliability.

MAIN will implement their "Emergency Load Conservation Procedure" whenever operating reserves are running low due to insufficient available generation. This would help preserve a portion of the required reserves and thus would ensure uninterrupted service to continue for most customers throughout the

MAIN Region. Typical sequence of Emergency Load Conservation Procedure actions that can be taken by MAIN and member utilities during a generating shortage are listed below.

- Bring spinning reserve from peaking units and all fossil-fuel generators to maximum output.
- Purchase emergency power from neighboring regions.
- Implement region-wide five-percent voltage reduction.
- Curtail coal handling loads.
- Request neighboring spinning reserve.
- Request load curtailment by utilities.
- Request outputs above environmental limits.
- Exercise interruptible demand agreements.
- Make radio and TV appeals to the general public for voluntary conservation.

While these actions normally apply to MAIN as a whole, they can be selectively implemented in any one of the 13 control areas affected by a generating shortage. In the event that these actions are not sufficient to keep operating reserves from being further depleted, load shedding would be required. When the transmission system cannot deliver sufficient generating capacity to meet the load demand, system security will be maintained by disconnecting load as necessary to balance the remaining demand with the generating capacity that the transmission system can deliver reliably at any particular moment.

Load shedding or controlled rotating blackouts would be implemented by MAIN member utilities after the other load demand side actions have been exhausted. Services would be cut off to groups of customers on a rotating basis so that no one group would be out of electricity for a prolonged period. Load shedding or controlled blackouts would be used in MAIN only when it is necessary to protect against a widespread failure of the power system. MAIN has established a reliability goal of 1 day in 10 years for this loss of load.

MAIN REGION SUMMER 1997 CAPACITY ASSESSMENT

The Mid-America Interconnected Network (MAIN) Region, particularly NI, WUMS, and SCIL Subregions, will need to take extraordinary measures to ensure an adequate supply of power to meet expected load demands while also ensuring the security of the electric system. This situation is due mainly to the expected unavailability of 4,700 to 6,500 MW of nuclear generation in Northern Illinois and Wisconsin. The following discussion addresses a range of capacity deficiency scenarios and resulting capacity margin for each scenario during each summer month in 1997 for each of the four subregions of MAIN.

Supply Adequacy

MAIN has analyzed a range of capacity scenarios that consider the unavailability of power, mostly nuclear generation, during the summer of 1997. These scenarios are as follows:

- Scenario 1. The expectation is that only two units at both the Zion (2,080 MW) and LaSalle (2,096 MW) nuclear generating stations and one fossil steam unit (372 MW) will be out of service this summer.

- Scenario 2. In addition to the units identified in Scenario 1, assumes that two additional nuclear units, Clinton (930 MW) and Point Beach 1 (493 MW) and one additional fossil steam unit (96 MW) will be unavailable for service this summer.

- Scenario 3. In addition to the units identified under Scenario 1, assumes that four additional nuclear units will remain out of service during the summer period. These units are Point Beach 1 and 2 (934 MW), Kewaunee (520 MW), and Clinton (930 MW). Also, two additional fossil units (93 MW) are assumed to be unavailable.

In the most optimistic scenario (Scenario 1), and with full-responsibility firm transactions included (purchases of imported power), the capacity margins in MAIN during peak periods could be as low as 11.5 percent. In the most pessimistic scenario (Scenario 3), the capacity margin in MAIN during peak periods could be as low as 6.6 percent. In both scenarios, the worst deficiencies are in the NI Subregion (2.6 percent capacity margin for the Subregion). Further details about the resulting available capacity margins for each of the four MAIN Subregions are presented in Attachments 3, 4 and 5.

Utilities in the three affected Subregions are contracting for supplemental firm capacity with firm transmission service to replace the unavailable generation.

Transmission System Limitations

The transmission systems in MAIN were designed to deliver the generation resources to the demand centers as an integrated system, with generating units supporting the voltage and adjusting flows on the transmission system. However, the integrated network was never designed to import electricity into the Region at the levels expected to be necessary this summer.

Therefore, use of several emergency transmission operating procedures is expected to be required to import sufficient replacement resources even for the optimistic Scenario 1 situation. Incremental transmission import capability is generally adequate for Scenario 1, but mostly inadequate to import sufficient replacement resources during peak demands for Scenarios 2 and 3. However, the impact is not uniform throughout the MAIN subregions. Specifically, import transfer capabilities are:

- adequate in EMO for all three scenarios;
- adequate in WUMS for Scenario 1, but only marginally adequate for Scenarios 2 and 3;
- marginally adequate in SCIL for Scenarios 1 and 2, but inadequate for Scenario 3; and
- adequate in NI for Scenario 1, but inadequate for Scenarios 2 and 3.

Operational Readiness

MAIN has made extensive preparations for 1997 summer operating conditions, including: significant additions of reactive support (NI and WUMS Subregions are adding about 3,000 MVARs), replacement of transformers, accelerated transmission line inspection and maintenance, rights-of-way maintenance (including tree trimming), and additional relay testing.

Utilities in the NI Subregion have analyzed voltage stability for a variety of contingency conditions and found that the voltage stability margin criteria will be met. Additionally, the MAIN Coordination Center is upgrading its system security analysis capability and is preparing to run daily voltage stability analyses. Generation and transmission outages are being coordinated within MAIN and with utilities in adjoining Regions. Additional emergency operating procedures are being developed and system operators will be trained on the new procedures. System operators are also reviewing system restoration procedures. MAIN is planning for increased communications among its members and control areas.

Overall Assessment

Despite the extensive preparations and planning by MAIN and its members, the combination of generator unavailability and limited transmission capability coupled with unanticipated circumstances such as extreme weather conditions could result in electricity supply shortages. If the nuclear generation is not returned to service as scheduled, above-average temperatures occur, or other unanticipated equipment problem arise, utilities in portions of the MAIN Region will have to take such actions as public appeals, voltage reductions, and exercise interruptible demand agreements to reduce overall customer demands. They may have to curtail supply to firm customers (load shedding or rotating blackouts) to maintain the overall integrity of the interconnected electric network.

RECOMMENDATIONS

In view of the sensitive situation in the MAIN Region and the high potential for voltage perturbations in the electric grid that may lead to the loss-of-offsite power to nuclear power plants, EELB suggests that the NRR Division of Reactor Projects III and IV and/or the Region III should communicate with the licensees of nuclear power plants operating in the MAIN Region to inform them that discretionary emergency diesel generator maintenance should not be scheduled for June through late September 1997.

This action would help to maximize the number of emergency power sources available in the event of a loss-of-offsite power.

The Division of Reactor Projects III and IV and/or the Region III should also communicate with the licensees to request that operators of nuclear power plants should place special emphasis on refreshing their knowledge of procedures related to response to loss-of-offsite power to the plant. In addition, the plant should closely communicate with the corresponding MAIN Region control area to be aware of particularly critical situations as they occur.

REFERENCE

North American Electric Reliability Council - 1997 Summer Assessment, Reliability of Bulk Electricity Supply in North America

Scenario 1 — 4,606 MW Total Inoperable Capacity

	MAIN	Eastern Missouri	Northern Illinois	South Central Illinois	Wisconsin-Upper Michigan
June					
Available Resources (MW)	47,206	8,419	18,772	9,497	10,518
Net Internal Demand (MW)	40,496	6,739	17,238	7,778	8,741
Available Margin (%)	14.2	20.0	8.2	18.1	16.9
July					
Available Resources (MW)	50,339	8,862	19,441	9,959	12,077
Net Internal Demand (MW)	44,533	7,694	18,928	8,516	9,395
Available Margin (%)	11.5	13.2	2.6	14.5	22.2
August					
Available Resources (MW)	50,339	8,845	19,441	9,956	12,137
Net Internal Demand (MW)	44,189	7,421	18,928	8,286	9,554
Available Margin (%)	12.2	16.1	2.6	16.8	21.3
September					
Available Resources (MW)	50,818	8,712	20,556	9,820	11,730
Net Internal Demand (MW)	38,282	6,141	15,808	7,663	8,670
Available Margin (%)	24.7	29.5	23.1	22.0	26.1

Scenario 2 — 6,125 MW Total Inoperable Capacity

	MAIN	Eastern Missouri	Northern Illinois	South Central Illinois	Wisconsin-Upper Michigan
June					
Available Resources (MW)	45,660	8,419	18,745	8,471	10,025
Net Internal Demand (MW)	40,496	6,739	17,238	7,778	8,741
Available Margin (%)	11.3	20.0	8.0	8.2	12.8
July					
Available Resources (MW)	48,820	8,862	19,441	8,933	11,584
Net Internal Demand (MW)	44,533	7,694	18,928	8,516	9,395
Available Margin (%)	8.6	13.2	2.6	4.7	18.9
August					
Available Resources (MW)	48,860	8,845	19,441	8,930	11,644
Net Internal Demand (MW)	44,189	7,421	18,928	8,286	9,554
Available Margin (%)	9.6	16.1	2.6	7.2	18.0
September					
Available Resources (MW)	49,299	8,712	20,556	8,794	11,237
Net Internal Demand (MW)	38,282	6,141	15,808	7,663	8,670
Available Margin (%)	22.4	29.5	23.1	12.9	22.8

Scenario 3 — 7,179 MW Total Inoperable Capacity

	MAIN	Eastern Missouri	Northern Illinois	South Central Illinois	Wisconsin-Upper Michigan
June					
Available Resources (MW)	44,606	8,419	18,745	8,378	9,064
Net Internal Demand (MW)	40,496	6,739	17,238	7,778	8,741
Available Margin (%)	9.2	20.0	8.0	7.2	3.6
July					
Available Resources (MW)	47,766	8,862	19,441	8,840	10,623
Net Internal Demand (MW)	44,533	7,694	18,928	8,516	9,395
Available Margin (%)	6.6	13.2	2.6	3.7	11.6
August					
Available Resources (MW)	47,806	8,845	19,441	8,837	10,683
Net Internal Demand (MW)	44,189	7,421	18,928	8,286	9,554
Available Margin (%)	7.6	16.1	2.6	6.2	10.6
September					
Available Resources (MW)	44,245	8,712	20,556	8,701	10,276
Net Internal Demand (MW)	38,282	6,141	15,808	7,663	8,670
Available Margin (%)	20.7	29.5	23.1	11.9	15.6