EI-0387

NEBRASKA PUBLIC POWER DISTRICT

Date February 18, 2000

To D. E. Grennan

From R. R. Lindstrom

FOR INTRA-DISTRICT BUSINESS ONLY

Subject **June 10-11, 1997 Disturbance**

During the evening of June 10th and early morning hours of June 11th the MAPP region experienced some extreme loading conditions affecting major tie line power flows into the MAIN and SPP regions. The MAPP regional load levels were low and there was a significant amount of nuclear generation off-line in the MAIN region. The SPP region also had some large units off due to maintenance, of particular interest were Lacygne and Iatan. Due to the light load condition and low cost MAPP generation, there were high simultaneous exports into the MAIN and SPP regions.

During the late afternoon of June 10th, powerflows across a critical Minnesota - Wisconsin tie line had reached a limit. The King - Eau Claire 345 kV tie line flow reached 945 MW with an Eau Claire bus voltage of 340 kV. Due to the heavy loading conditions, NSP called for MAPP schedules in preparation for Line Loading Relief (LLR). Schedules were reported, but LLR was not called for as the King - Eau Claire loading dropped due to the schedule collection alone. As the tie line loading dropped to around 850 MW, NSP released the LLR request at around 7:30 PM.

As the evening progressed, tie line flows across the Cooper South interface (Cooper - Fairport & Cooper - St. Joe 345 kV) continued to increase. NPPD monitored the Cooper South flow as it approached and eventually exceeded the 1100 MW operating limit. At 10:20 PM, NPPD contacted OPPD to verify the 1124 MW Cooper South flow and inquire as to what was planned for mitigation. OPPD indicated that they were going to reduce generation at the Nebraska City plant. Cooper South flow continued to rise reaching 1202 MW at 11:00 PM. Also, the Eau Claire 345 kV voltages had declined to 338 kV, prompting NSP to call for schedules at 11:15 PM. At 11:20 PM, OPPD reported to MAPP that the Cooper South flow was at 1280 MW and they called for MAPP LLR schedules. No MAPP LLR was invoked and the Cooper South flow continued at around 1300 MW over the next half hour. The Cooper South flow increased to 1347 MW at midnight when OPPD finally called for MAPP LLR.

Shortly after midnight, the Arpin - Rocky Run 345 kV line tripped due to a relay problem. Following a reclose and some capacitor bank problems at Eau Claire, the Eau Claire - Arpin 345 kV line tripped due to overloads. At approximately 6 minutes after midnight, the critical 345 kV path into Wisconsin was open and the high phase angle conditions would not allow reclosure. The result of this outage pushed the Cooper South flow to 1554 MW and the Cooper - St. Joe flow to 884 MW. This resulted in the 800 MVA CT's and associated metering at St. Joe to be over driven and triggered overload alarms at NPPD's Cooper substation. Also, low voltages in the eastern Iowa area prompted MEC to bring on combustion turbines for voltage support. MAPP LLR cuts were made across the half hour and the Cooper South flow was reduced to 1210 MW by 1:00 AM. Schedule cuts continued to reduce the Cooper South flow to 1054 MW by 1:30 AM. The Eau Claire - Arpin 345 kV line was returned to service shortly after 2:00 AM which reduced the Cooper South flows to levels where LLR could be canceled.

System Planning analyzed this disturbance to evaluate system security for the region. A loadflow case was developed utilizing a 50% summer peak case and incorporated all transmission and generation outages scheduled during this timeframe. In order to match the simultaneous transfer conditions, 4100 MW of incremental transfers were modeled from MAPP into MAIN and SPP. The base case matched quite well with SCADA tie line information obtained from Doniphan. The Eau

Claire - Arpin 345 kV line was outaged which resulted in 1527 MW on Cooper South and the

Cooper - St. Joe 345 kV line flow was 882 MW which closely followed the recorded values. Also at this point, the loadflow indicated numerous overloads on 345 kV and 161 kV ties between MAPP and MAIN/SPP. The major concern surrounded the potential 900 MW trip setting associated with the Cooper - St. Joe line. The protective relays on the Cooper - St. Joe 345 kV line are set such that powerflows in excess of 900 MW will infringe upon the characteristics and operation is possible depending on the VAR flows on the line. Since the 884 MW recorded flow was so close, a powerflow was run to evaluate the impacts of loss of the Cooper - St. Joe 345 kV line.

The results of that simulation were quite alarming. Every remaining 345 kV and 161 kV tie into SPP and MAIN was overloaded to levels which would have resulted in relay operations on those facilities. Of particular interest was the 1225 MW on the Cooper - Fairport (MINT) line which could trip for flows exceeding 800 MW. Just which tie line would have tripped first is the only remaining question, but the reality is that we definitely would have separated the MAPP region away from the SPP and MAIN regions. Following the tie line trips, the MAPP region would have experienced generation tripping due to overfrequency and probably even underfrequency load shedding as the islanded system oscillated to a new operating point. Underfrequency load shedding in the MAIN and SPP areas also would have occurred. What islands would have existed at that point are not necessarily known, but the process would mirror a smaller scale of the blackouts which occurred in the Western U.S. last summer.

This event should not be filed away as just another close call. We need to recognize just how close we were to collapsing portions of the Eastern Interconnection and adjust operating guides and reporting practices to avoid reoccurrence. There are real limits to the transfer capability out of the MAPP region and those limits are interdependent. This event is an alarming representation of how the MAPP regional interconnected system is being operated at and even beyond it's capabilities.

cc: P. L. Pope
R. O. Gunderson
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SPP-598 (Op Rev Subcom (Syst Disturbances) - F-4)
rrl/disturb

No.	Date	Time	Region	Utilities	Type	MW	Cust.	Restored
10	06/11/97	0006 CDT	MAPP & MAIN	Eastern MAPP-Western MAIN Interface	UO	0	0	Initial: 0023 CDT Final: 0209 CDT

Comments: A section of the major 345 kV transmission line (King-Eau Claire-Arpin-Rocky Run-North Appleton) connecting Minnesota and Wisconsin opened on June 11 at 0006 CDT during a scheduled transfer of electricity from Minnesota (MAPP) to Wisconsin (MAIN). The initial electricity flow condition was due to a large export from MAPP to MAIN (1,349 MW) and MAPP to SPP (2,107 MW). The transmission line loads were about 50% of the peak values. MAPP to MAIN transfers heavily depend on one west to east 345 kV line in Wisconsin and a single north to south 345 kV line in eastern MAPP (Prairie Island-Byron). System protection at Rocky Run incorrectly opened the circuit at an ampere level below its setting, possibly due to an unbalanced load. The line opening and reclosure at Rocky Run plus the line opening at Arpin led to a sudden decrease, increase, and finally stoppage of electricity flow from Eau Claire to Arpin.

This line loss resulted in low voltages in the southwestern Wisconsin, eastern Iowa and western Illinois (Cordova), heavy loading of parallel, lower voltage transmission systems, and a large phase angle across the open tie at Arpin. Redispatch of generation — ramping up generation in MAIN and ramping down generation in MAPP — was necessary to correct these conditions and to permit reclosing the open line. With the prevailing conditions, MAPP and MAIN were heavily dependent on the single 345 kV line from Minneapolis east into Wisconsin to support these transactions. Relay settings at Rocky Run and Arpin were increased on June 13 to avoid future unexpected line openings at valves less than the line ratings. Also, guides were developed to permit faster generation rescheduling to reduce the time required to reclose the interconnection should it reopen.

When the Rocky Run breaker opened, extremely high loading occurred on the already heavily loaded 345 kV Cooper to St. Joseph and the Cooper to Fairport lines between Nebraska and Missouri due to the export schedules from MAPP to SPP and to MAIN. These loading conditions were near system protection limits and triggered overloading alarms at Nebraska Public Power District's (NPPD) Cooper Station.

No.	Date	Time	Region	Utilities	Type	MW	Cust.	Restored
11	06/20/97	2027 EDT	MAAC	Potomac Electric Power Company	INT	350	18,000	Initial: 2115 EDT Final: 2145 EDT

Comments: A 230 kV breaker failure occurred at the Burches Hill Substation. This event precipitated a subsequent operation of equipment at the Palmers Corner substation, which in turn caused the loss of the two 230 kV supplies to the Potomac River Generating Station. As a result, the Potomac River station was disconnected from the transmission system. When the station became "islanded," the mismatch of generation and demand caused the units to trip off line and the demand supplied by the plant switchyard (six substations in the District of Columbia) was interrupted affecting 15,000 to 18,000 customers in the northwest and southeast sections of the District. These areas included the major business district, government offices, and Georgetown.