

Table A1*Table of System Effects on 13–14 March*

Date	Time (UT)		Geomag Latitude	System	Effect
	Start	End			
13	01.28		50	TAT-8 submarine cable	75-V voltage excursion
13	06.19	08.35	64	Manitoba Hydro	Voltage drops
13	06.19		56.5	Minnesota Power	Capacitor trips
13	06.19		53	Niagara Mohawk	Capacitor tripped
13	06.19		50.5	PJM interconnection	Alarms
13	06.53		51.3	Nebraska	Frequency alarms
13	07.33		51.3	Nebraska	Frequency alarms
13	07.40		51.3	Nebraska	Frequency alarms
13	07.40	07.50	57	Eastern North Dakota	Voltage fluctuations
13	07.43	07.45	56.5	Minnesota Power	Voltage fluctuation and capacitor trips
13	07.44		55	Vattenfall (Sweden)	130-kV lines tripped
13	07.45		60	Hydro-Québec	System-wide blackout
13	07.45		55.5	Ontario Hydro	Generator trip
13	07.45		50.5	PJM interconnection	Swing in reactive power generation
13	07.46		57	WAPA	Fargo SVC trip
13	09.58		53	New York Power Pool	Generator trip
13	11.06	11.18	53	Niagara Mohawk	Capacitors tripped
13	11.08	11.19	51	Central Hudson	Capacitor tripping
13	11.10		50	TAT-8 submarine cable	300-V voltage excursion
13	11.10	11.30	50.5	PJM interconnection	Voltage and generation fluctuations
13	11.15		51	Allegheny	Seven capacitors tripped
13	11.15		53	Iowa (IIGE)	Voltage fluctuations
13	11.15	11.25	49	Virginia Power	Capacitors tripped
13	12.27	13.19	50.5	PJM interconnection	Alarms and voltage dips
13	14.26		64	Manitoba Hydro	Radisson-Churchill line tripped
13	16.02		64	Manitoba Hydro	Radisson-Churchill line tripped
13	16.31		64	Manitoba Hydro	Radisson-Churchill line tripped
13	16.59		64	Manitoba Hydro	Radisson-Churchill line tripped
13	17.02		49	Virginia Power	Capacitor tripped
13	20.20	20.40	48	NGC (United Kingdom)	30 alarms from BT standby generators
13	20.28		64	Manitoba Hydro	Radisson-Churchill line tripped
13	20.45		51	Central Hudson	Capacitor tripping
13	21.00	21.55	50.5	Atlantic Electric	Volt and MVAR fluctuations
13	21.00	22.01	50.5	PJM interconnection	Alarms and capacitors tripped
13	21.00	22.30	48	NGC (United Kingdom)	Alarms at small control centers
13	21.15		50.5	PJM interconnection	Generator trip
13	21.30		41	SC Edison	Increased neutral current and transformer noise
13	21.34		48	NGC (United Kingdom)	Transformer at Norwich Main switched out
13	21.40	21.48	48	NGC (United Kingdom)	150 alarms from BT standby generators
13	21.43		55	Vattenfall (Sweden)	130-kV line tripped
13	21.44		55	Vattenfall (Sweden)	Increased reactive power: max 540 MVAR
13	21.45		50	TAT-8 submarine cable	450-V voltage excursion
13	21.45	01.00	55	Wisconsin Power and Light	Voltage problems, regulators hunting
13	21.51	22.11	53	Niagara Mohawk	Capacitors tripped
13	21.55		56.5	Minnesota Power	Voltage fluctuations
13	21.58		55	WAPA	Miles City line trip
13	21.58		57	BC Hydro	4% voltage fluctuation
13	21.58		51	BPA	Capacitor tripping
13	21.58		55.5	Ontario Hydro	Demand fluctuates by 200 MW
13	21.58		55.8	West Kootney Power	Alarms
13	22.00		53	Iowa (IIGE)	Voltage fluctuations
13	22.00		56.5	UPA, Elk River, Mn	Voltage fluctuations
13	22.00		51	Long Island Lt Co	Voltage fluctuations
13	22.01		55.5	Ontario Hydro	Overvoltage alarm
13	22.01	22.23	49	Virginia Power	Capacitor tripped
13	22.08		56.5	UPA, Elk River, Mn	Capacitor switching
13	22.09		55	WAPA	Miles City line trip
13	22.09		55.7	WAPA	Bole, Montana, transformer trip
13	22.09		57	WAPA	Fargo SVC trip
13	22.20		56.5	UPA, Elk River, Mn	Voltage swing
13	22.20	22.30	57	Eastern North Dakota	Voltage fluctuations
13	22.40		55	Vattenfall (Sweden)	Oscillating reactive power
13	22.42		50.5	PJM interconnection	Alarm
13	23.27	23.29	49	Virginia Power	Capacitor tripped
13	23.30		51.4	Philadelphia	Voltage fluctuations
13	23.32		53	NEPOOL	Capacitor tripped
14	00.10		49	Virginia Power	Capacitor tripped
14	01.00	01.30	53	NEPOOL	Widespread voltage and MVAR swings
14	01.00	02.00	51	Long Island Lt Co	Voltage fluctuations
14	01.11		53	Niagara Mohawk	Capacitor tripped
14	01.11	01.18	49	Virginia Power	Capacitor tripped
14	01.14		53	New York Power Pool	Voltage drop
14	01.14	01.32	50.5	PJM interconnection	Alarms and capacitors tripped
14	01.16		55.5	Ontario Hydro	Belleville capacitor tripped
14	01.16		55.5	Ontario Hydro	Phase imbalance at Bruce
14	01.19		55	Wisconsin Electric Power	Alarms
14	01.20		55.5	Ontario Hydro	Chats Falls generator power fluctuations
14	01.20		51	Allegheny	Transformer heating
14	01.20		50.5	Atlantic Electric	Volt and MVAR fluctuations
14	01.20	01.22	56.5	UPA, Elk River, Mn	Alarms and line trip
14	01.20	01.40	57	Eastern North Dakota	Voltage fluctuations
14	01.24	01.54	56.5	Minnesota (CPA)	Voltage fluctuations, high-voltage alarms, capacitors on and off
14	01.27		48	NGC (United Kingdom)	Transformer at Norwich Main switched out
14	01.30		50	TAT-8 submarine cable	700-V voltage excursion
14	01.52		48	NGC (United Kingdom)	Transformer at Indian Queens switched out
14	04.00	05.00	51.4	Philadelphia	Voltage fluctuations

Note. BC Hydro = British Columbia Hydro and Power Authority; BPA = Bonneville Power Administration; NEPOOL = New England Power Pool; WAPA = Western Area Power Administration; IIGE = Iowa-Illinois Gas and Electric Company; NGC = National Grid Company; SC Edison = Southern California Edison; UPA = United Power Association.