EXAMPLES OF MAJOR BULK ELECTRIC SYSTEM POWER OUTAGES

DATE	STATES/PROVINCES AFFECTED	CUSTOMERS AFFECTED	DURATION	DESCRIPTION
November 9, 1965	Virtually all of New York, Connecticut, Massachusetts, Rhode Island, and small segments of northern PA and northeastern NJ; substantial areas of Ontario, Canada.	30,000,000; over 20,000 MW of demand	Up to 13 hours	A backup protective relay operated to open one of five 230-kV lines taking power north from the Beck plant in Ontario to the Toronto area. When the flows redistributed instantaneously to the remaining four lines, they tripped out successively in a total of 2½ seconds. The resultant power swings resulted in a cascading outage that blacked out much of the northeast.
July 13, 1977	New York City	9,000,000 people; 6,000 MW of demand	Up to 26 hours	A series of events triggering the separation and total collapse of the Con Ed system began when two 345 kV lines on a common tower line in Northern Westchester were struck by lightening and tripped out. Over the next hour, the Con Ed dispatcher tried to save his system, but in the end the system electrically separated from surrounding systems and collapsed. Generation inside New York City was not adequate, by itself, to serve the load inside the city.
July 2, 1996	Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, Washington and Wyoming in the United States; Alberta and British Columbia in Canada; and Baja California Norte in Mexico.	2,000,000 (10 % of the customers in the Western Interconnection); 11,850 MW of demand	From a few minutes to several hours	The outage began when a flashover occurred between a 345,000-volt transmission line and a tree that had grown too close to the line in Idaho. Protective devices detected the short and de-energized the line. A protective relay on a parallel transmission line also detected the fault and erroneously opened the second line. Disconnecting these two lines nearly simultaneously greatly reduced the ability of the system to carry power away from a near-by generating plant, causing other protective devices to shut down two of the four generating units at that plant. With the loss of these two units, frequency in the entire Western Interconnection began to decline. For 20 seconds the system struggled to remain in balance, but the system was becoming unstable. At this point, automatic protection systems were initiated to allow the system to bend, but not break. Scattered customer outages occurred to help the system regain balance. The interconnected system separated into five pre-engineered islands designed to minimize customer outages and restoration times.
August 10, 1996	Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah,	7,500,000 customers; 28,000 MW of demand shed by underfrequency load-shedding relays	Up to 9 hours	Triggered by a combination of random transmission line outages and resulting system oscillations, the Western Interconnection separated into four electrical islands, with significant loss of load and generation.

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DATE	STATES/PROVINCES AFFECTED	CUSTOMERS AFFECTED	DURATION	DESCRIPTION
	Washington and Wyoming in the United States; Alberta and British Columbia in Canada; and Baja California Norte in Mexico.			Prior to the disturbance, the 500 kV and underlying interconnected transmission system from Canada south through Washington and Oregon to California was heavily loaded due to (1) relatively high demand caused by hot weather throughout much of the WSCC Region, and (2) excellent hydroelectric conditions in Canada and the Northwest that lead to high electricity transfers (including large economy transfers) from Canada into the northwest and from the northwest to California. Failure to trim trees and remove others identified as a danger to the system caused flashovers (short circuits) from of several 500 kV transmission lines, the last of which led to overloads and cascading outages throughout the Western Interconnection. Also, operators were unknowingly operating the system in a condition in which one line outage would trigger subsequent cascading outages because adequate operating studies had not been conducted.
June 25, 1998	Minnesota, Montana, North Dakota, South Dakota and Wisconsin in the United States; Ontario, Manitoba and Saskatchewan in Canada.	152,000 customers; 950 MW of demand	19 hours	A severe lightning storm in Minnesota initiated a series of events, causing a system disturbance that affected the entire Mid-Continent Area Power Pool Region and the northwestern Ontario Hydro system of Northeast Power Coordinating Council. Lightning struck a 345,000-volt line, and system protection de-energized the line. Underlying lower voltage lines began to overload, and protective devices began to de-energize those lines, further weakening the system. Shortly thereafter, lightning struck a second 345,000-volt line, taking that line out of service. Following the outage of the second 345,000-volt line, the remaining lower voltage transmission lines in the area became significantly overloaded and system protection began removing them from service. This cascading removal of lines from service continued until the entire northern MAPP Region was separated from the Eastern Interconnection, forming three islands and resulting in the eventual blackout of the northwestern Ontario Hydro system.