

# MAGNETIC DISTURBANCES THAT HAVE AFFECTED ELECTRICAL SYSTEMS AT THE EARTH'S SURFACE

- 1847**, Mar. 19      Spontaneous deflections observed in the needles of the electric telegraph in England.  
Sept. 24-25      It was noticed that the largest deflections occurred when ever aurora were visible.  
Oct. 23-25      (Barlow, 1849; also see Varley, 1873).
- 1848**, Oct 27-28      Occasion of heavy disturbances on the telegraph (Burbank, 1905). Matteucci remarked the coincidence of aurora with interruptions in telegraphic communications, produced by telluric currents (Angot, 1897, p 138).
- Nov. 17              Appearance of the aurora coincided with effects on the electric telegraph between Florence and Pisa (Prescott, 1866, p 317).
- 1851**, Sept.              Prescott (1866) reports, " a remarkable aurora, which took complete possession of all the telegraph lines in New England, and prevented any business from being transacted during its continuance".
- 1852**, Feb. 19              Brilliant auroral display observed. Associated with it were currents that burnt through the chemical paper used with the Bain's chemical telegraph in the northeastern US (Prescott, 1866, p 318).
- 1859**, Aug. 28              Mr O. S. Wood, Superintendent of the Canadian telegraph lines, says: "... so completely  
- Sept. 2              were the lines under the influence of the aurora borealis, that it was found utterly impossible to communicate between the telegraph stations, and the line was closed for the night". Problems also reported by telegraph operators in New York, Washington, Philadelphia, Vermont and Massachussets (Prescott, 1860, 1866; also see Clement, 1860) and Gothenburg, Sweden (Rubenson, 1882). At all telegraphic stations in France service was impeded during the whole of September 2 (Blavier, 1859; see also Angot, 1897).
- 1869**, May 30              Out of the sixteen lines which terminated in the telegraphic office at Basle, six were almost useless during the two hours that the phenomena lasted (Angot, 1897, p 141).
- 1870**, April 5              Coincidences between aurora borealis and telluric currents in telegraphic service noted  
& Oct 24              by Angot (1897), p 142.
- 1872**, Feb 4              The telluric currents attained an extraordinary development during the aurora which was one of the most extensive known. The disturbances in telegraphic communication were not less extensive. In Germany all the lines were affected, and communication was for a long time impossible between Cologne and London. Telluric currents were also observed in England, France, Austria, Switzerland, Italy and Turkey. Transmission of messages was also prevented on submarine cables, especially on the line from Lisbon to Gibraltar, on the line from Suez to Aden, and from Aden to Bombay, and on the transatlantic cable from Brest to Duxbury (Angot, 1897; see also Arrhenius, 1903).

- 1872 - 1873** Earth current effects on Atlantic cables (Graves, 1873), wrongly attributed to earthquakes.
- 1882, Nov 17** Telluric currents observed in England were, according to Preece [Superintendent of the Telegraph] five times as strong as the current usually employed in telegraphy. Communication was interrupted as long as the disturbance lasted (Angot, 1897, p 143).
- 1891** Electromotive force of 768 volts was recorded on the Western Union lines between New York and Buffalo, the circuits varying from 450 to 480 miles in length. On several occasions the strength of the earth current reached nearly 300 mA, compared to normal working currents that did not exceed 35 mA (Finn, 1903).
- 1892, July 16** Serious interruption of wire service in US (Sanders, 1961). Burbank (1905) gives details of voltages observed on various lines, including 210 volts, about 9 V/km, on line from New York to Elizabeth, N.J.
- 1894, Mar 30-31** Telegraph operators had been supplied with telephones and heard a variety of sounds produced by earth currents in the lines (Preece, 1894).
- 1903, Oct 31** Practically the world's whole telegraph system was upset, and information from England, France, the United States and other lands shows that for several hours communication was almost completely interrupted (Lockyer, 1903; see also Finn, 1903).
- 1921, May** Karsberg et al (1959) report that induced currents caused fires in telegraph equipment in Sweden. Exact date is not given, but Chapman and Bartels (1940) show that a great magnetic storm occurred on May 13 - 15, 1921.
- 1938, Apr. 16** Several hundred volts on wires in Norway (Chapman and Bartels, 1940). Problems on telegraph system in Norway same as occurred in 1940 (Harang, 1941).
- 1940, Mar. 24** First reported effects on power systems, with voltage dips, large swings in reactive power, and tripping of transformer banks, reported from power companies in the US and Canada (Davidson, 1940). Effects also observed on the telephone and telegraph systems in US (Germaine, 1940; Stetson, 1947) and Norway (Harang, 1941; repeated in Ramleth, 1982).
- 1946, Mar 28** Transformers tripped at Port Arthur and Crow River, Ontario (Acres, 1975).  
**Sept. 22** Transformer tripped out of operation at Port Arthur, Ontario (Acres, 1975).
- 1957, Jan. 21** Disturbances on power feeding circuits on transatlantic submarine cables (Axe, 1968).
- 1957, Sept. 22** Power system effects: trip of 230kV breaker due to saturation of transformer cores and excessive 3rd harmonic currents in ground relays (Slothower and Albertson, 1967).
- 1958, Feb. 10** Toronto area suffered from a blackout (Lanzerotti and Gregori, 1986).  
 Abnormal power flows in Minnesota (Slothower and Albertson, 1967).  
 TAT-1 transatlantic cable suffered a disruption of service (Winckler et al, 1959).
- 1960, Nov. 13** Disturbances on power feeding circuits on Transatlantic cables (Axe, 1968). Tripping of 30 line circuit breakers in Sweden (Tillberg and Andersson, 1977; Elovaara et al, 1992).

- 1972**, Aug. 4      Outage of the L-4 cable system in the continental US (Anderson et al, 1974).  
Problems also experienced on power systems (Albertson and Thorson, 1974).
- 1980**, Oct.        Trip of 500 kV line from Manitoba to Minnesota (Aspnes et al, 1981).
- 1981**, Apr.        Trip of 500 kV line (again) from Manitoba to Minnesota. (Aspnes et al, 1981).
- 1982**, July 13      Four transformers and 15 lines tripped in Sweden (Elovaara et al, 1992).  
- July 14          Railway traffic signals were turned to red by the induced voltage (Wallerius, 1982).
- 1989**, Mar. 13      Blackout of Québec for 9 hours, and effects on other power systems across North  
America  
- Mar. 14          including burnout of power transformers (Allen et al, 1989; Cucchi and Ponder, 1991).  
Five 130 kV lines were tripped in Sweden (Elovaara et al, 1992).
- 1989**, Sept 19      Transformer damage on Public Service Electric & Gas system (Bozoki et al, 1996).
- 1989**, Oct 20      SC tripped by neutral unbalance protection (Bozoki et al, 1996).  
Nov 17-18        SC tripped by neutral unbalance protection (Bozoki et al, 1996).
- 1990**, Mar 30      SC tripped by neutral unbalance protection (Bozoki et al, 1996).
- 1991**, Mar. 24      Nine 220 kV lines and one transformer were tripped in Sweden (Elovaara et al, 1992).  
Low voltage, zero-sequence capacitor neutral and transformer harmonic alarms and  
tripping of capacitor bank and SVC in US (Bozoki et al, 1996).
- 1991**, Apr 28      SC removed from service on Allegheny Power System in US (Bozoki et al, 1996).  
May 16            Capacitor neutral harmonic alarm on Allegheny Power system (Bozoki et al, 1996).  
May 28            Filter arrester failed on Québec - New England DC link (Dickmander et al, 1994).  
June 4-5          BC Hydro 138 kV line tripped on ground overcurrent (Bozoki et al, 1996).  
June 10          Transformer removed from service and several SC trips in US (Bozoki et al, 1996).  
Nov 8             Minor effects on US power systems (Bozoki et al, 1996).
- 1991**, Oct. 28      The Québec - New England DC line tripped out of service (Blais and Metsa, 1993).  
In the US, capacitor banks and transformers tripped out, voltage dips occurred and the  
New Mexico HVDC terminal tripped (Allen and Wilkinson, 1993, Bozoki et al, 1996).
- 1992**, Sept 10      115 kV SC tripped on Central Hudson Gas & Electric in US (Bozoki et al, 1996).  
Nov 11            115 kV SC tripped on Central Hudson Gas & Electric in US (Bozoki et al, 1996).