Commonwealth Edison Company's Response to
Illinois Commerce Commission ("Staff") Data Requests
OUT 1.01 – 1.07
Date Received: July 19, 2011
Date Served: September 1, 2011

REQUEST NO. OUT 1.03:

The Storm

a) Provide a complete factual description of the storms that led up to the interruption of electric service to over 800,000 ComEd customers on July 11, 2011.

b) Characterize the severity and magnitude of the storms in comparison to previous storms in the ComEd service territory.

c) Explain the timing and the path of the storm.

d) Explain the damage that the storm caused to ComEd's electricity delivery system. Include a discussion of distribution, transmission, and substation facilities.

e) Explain the stresses that the storm placed on ComEd's facilities and why the facilities failed.

f) Quantify the number of customers who were out of service during and after the storm and provide a table or graph that shows how many customers were without service for increasing durations until all customers were back in service.

g) Provide an explanation of the causes of the outages of circuits and equipment. Provide a list or table that shows how many outages and how many customer service interruptions were caused by each outage cause.

RESPONSE:

a. Thunderstorms developed southwest along the cold front and by midnight formed a huge line from Western Wisconsin into Northwestern Iowa and Northeast Nebraska all the way into Northwestern Kansas. Early in the morning the storms in Iowa developed into a squall line with some bowing of the line, an indication of very strong winds. It had all the characteristics of a Derecho. A Derecho is a widespread and long lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. This band of showers and thunderstorms is usually curved in shape (these bowed lines are called bow echoes). A Derecho can be associated with a single bow echo or multiple bow echoes. The bow echoes may vary in scale and may die out and redevelop during the life of the Derecho. In addition, winds can be enhanced on a smaller scale by embedded cells within the line of storms that produce microbursts.

This Derecho would reach the Mississippi River about 6:00 a.m., then rapidly sweep across and affect all of the ComEd's service territory north of Interstate I-80, including all of Southern Wisconsin. It reached the Chicago Metropolitan area about 8:00 a.m. and was east of the area by 9:00 a.m. It only slightly decreased in intensity by the time it reached Ohio around 11:00 a.m. This Derecho continued all the way to the East Coast by late in the day. Numerous reports of wind gusts of 50 - 80 mph were reported across Iowa and Northern Illinois, including 72 mph at Mundelein in Lake County as well as Burbank and Evergreen Park in Cook County. Officially at O'Hare Airport at 8:04 a.m. a wind gust of 63 mph was recorded, while 75 mph was recorded at Midway Airport at 8:14 a.m. Further south, winds at Plainfield in Will County reached 65 mph.

The most intense part of this Derecho moved across two sections of Northern Illinois. One moved eastward across Jo Daviess, Winnebago, Boone, and McHenry Counties into Lake and Northern Cook Counties. Another part moved near Interstate I-88 from Whiteside to Lee, Southern DeKalb and Kane then into DuPage and Central Cook Counties.

b. The review indicates that it was close to the severity and type of event that occurred on June 18, 2010. During the week between June 18, 2010 to June 26, 2010, ComEd experienced 987,314 customer interruptions that included four storm events: June 18, 21, 23 & 26, 2010. However, ComEd's outages in any given event can be affected by the number and severity of storms that preceded it, *e.g.*, a wind storm had cases of widespread tree damage in May, and then in June, a stronger event occurs but with fewer outages.

Murray & Trettel, Inc., ComEd's weather service provider stated:

Considering the <u>geographic area affected</u>, <u>severity</u> and <u>timeframe</u> of the event, the following are the top three (3) most severe meteorological events across Northern Illinois since 1980:

July 11, 2011
June 18, 2010
March 8, 1998

Looking at severe thunderstorm events back to 1980, and using the same criteria, July 11, 2011 would probably rank number one (# 1). Meteorologically, the ice storm of March 8, 1998 would still rank as the most destructive because of the extent of damage without leaves on the trees.

c. The severe line of thunderstorms, or in this case the Derecho, primarily affected all of Northern Illinois, north of Interstate I-80 northward into Southern Wisconsin to about the Madison-Milwaukee line. It started in Nebraska late on July 10th and ended on the Delmarva region by late July 11th. In Illinois, it arrived on ComEd's western boundary approx. 6:30 a.m., Route 52 at 6:55 a.m., Interstate I-39 at 7:15 a.m., Route 47 at 7:40 a.m., Interstate I-355 at 7:55 a.m., Interstate I-294 at 8:00 a.m. and Chicago's Lake Front at 8:25 a.m.

d. These weather conditions caused unpreventable damage to a number of elements of ComEd's delivery system including: poles, conductors, transformers, and surge arresters. The damage occurred in several different ways including direct and indirect damage caused by wind and lightening. Photographs of the damage are included in subpart (e) of this response. As a result of this damage, there were over 900,000 customers that lost power. The greatest impact was to ComEd's distribution system. The details of the outages are included in subpart (g) of this response.

e. ComEd designs its distribution delivery system construction standards to meet the requirements of the 83 Illinois Administrative Code 305 which, in turn, adopts certain parts of the National Electrical Safety Code (NESC).

Section 25 of the NESC takes into consideration variations in weather conditions across the country. The NESC considers three factors in calculating loads on conductors and structures. These three are 1) temperature, 2) wind, and 3) ice. The NESC has divided the country into loading areas. Northern Illinois falls into the "heavy" loading area. This means that 0°F, a 4 lb. per square foot wind plus ½ inch of ice is used as the criteria in ComEd's service territory for structures or poles under 60 feet tall.

The NESC also requires certain structures to be designed to withstand extreme wind speeds. It is important to note that only structures taller than sixty feet must meet these extreme wind criteria. Most distribution structures do not fall into this category.

Of course, ComEd's own distribution delivery system construction standards do not apply to trees and structures that may fail and cause damage to ComEd's system. During severe weather, such as snow, ice, or wind storms, trees may be uprooted and fall onto the power lines, often under conditions that do not exceed NESC standards for the utility facilities themselves. Rapidly growing trees are particularly susceptible to storm damage. Some common tree species including Chinese elm, silver maple, box elder and various poplars have brittle wood which is easily broken. In addition, trees in ComEd's service territory are commonly damaged throughout the year by windstorms, ice and snow accumulations, lightning or other mechanical sources (automobiles, vandalism, etc.). Damage usually consists of broken branches. However, more severe damage such as splitting or pulling apart of branch forks, removal of large areas of bark, twisting and splitting of the trunk, or even uprooting may occur.

In the case of the July 11, 2011 storm system, much of the reported damage to ComEd facilities was associated with wind that knocked down entire trees or broke limbs that resulted in contact with lines or caused broken utility poles. The remaining outages were associated with equipment failures, wind-blown debris, lightning, etc.

ComEd's vegetation management/line clearance program is designed to minimize power interruptions and hazards caused by tree branches and other types of vegetation that come in contact with power lines. ComEd clears limbs, trees, vines, and other plants away from power lines before they have a chance to damage facilities or equipment. Further, ComEd's vegetation management contractors are specially trained and qualified to trim and remove trees in close proximity to electrical conductors. They are also trained in the proper arboricultural techniques. The pruning techniques utilized meet the standards set by the National Arborists Association and the International Society of Arboriculture. However, as demonstrated by the photos below, even a properly designed and executed vegetation management program cannot prevent tree, limb, and debris contact, especially during storm conditions. Although the distribution system must be constructed to withstand normal exposure to winds, icing, and temperature extremes, it is not practical however to build a line that can withstand blowing debris or large branches and falling trees.

Trees across power lines in Leyden Township

Trees across power lines in Park Ridge

Trees across power lines in Des Plaines

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Fallen tree on Highmoor Rd in Highland Park

The translation of the NESC criteria of 4 psf wind at 0 degrees F and ½ inch of ice into wind speed will vary depending on the particular type of pole's design requirements for overload and strength.

The calculation in OUT 1.03_Attach 1 is the equivalent design wind speed on a pole of a 4 psf wind at 0 degrees F and ½ inch of ice including the NESC structure design requirements for overload and strength for a typical newly installed pole. ComEd calculated the value by applying the NESC Overload Factors per NESC Table 253-2 and the Associated Strength Factors per NESC Table 261-1B to a newly installed, approximate 40 foot tall Class 2 Southern Yellow Pine pole, Grade C Construction, cross arm construction carrying three 477 kcmil AAC bare conductors and one bare 1/0 AWG neutral conductor attached 48 inches from the top of the pole, 200 foot spans and flat terrain.

These weather conditions caused unpreventable damage to a number of elements of ComEd's delivery system including: poles, conductors, transformers, and surge arresters. The damage occurred in several different ways including, direct and indirect damage caused by wind and lightening.

ComEd's design overload criteria are based upon the NESC strength requirements for ComEd's geographic area.

While sustained winds on July 11, 2011 were typically below the NESC's design criteria in most portions of ComEd's 11,300 square mile service territory, localized winds reached higher speeds and both unrecorded wind gusts in excess of the NESC's design criteria are likely to have influenced the number of ComEd distribution outages.

Wind speed at official recording stations is not required to exceed ComEd design standards for damage to occur to properly designed, constructed, and maintained systems.

Weather conditions on July 11, 2011, exceeded the capability of ComEd facilities causing direct damage to those facilities. Those conditions were not limited to sustained winds only. Rather, the damage to ComEd facilities was caused by a combination of sustained winds, wind gusts, and wind blown debris, which ComEd believes exceeded applicable design criteria at many locations. Damage resulting from these weather conditions caused the interruptions.

Components of ComEd's systems were damaged by contact with foreign objects. Prime examples of this mode of damage are:

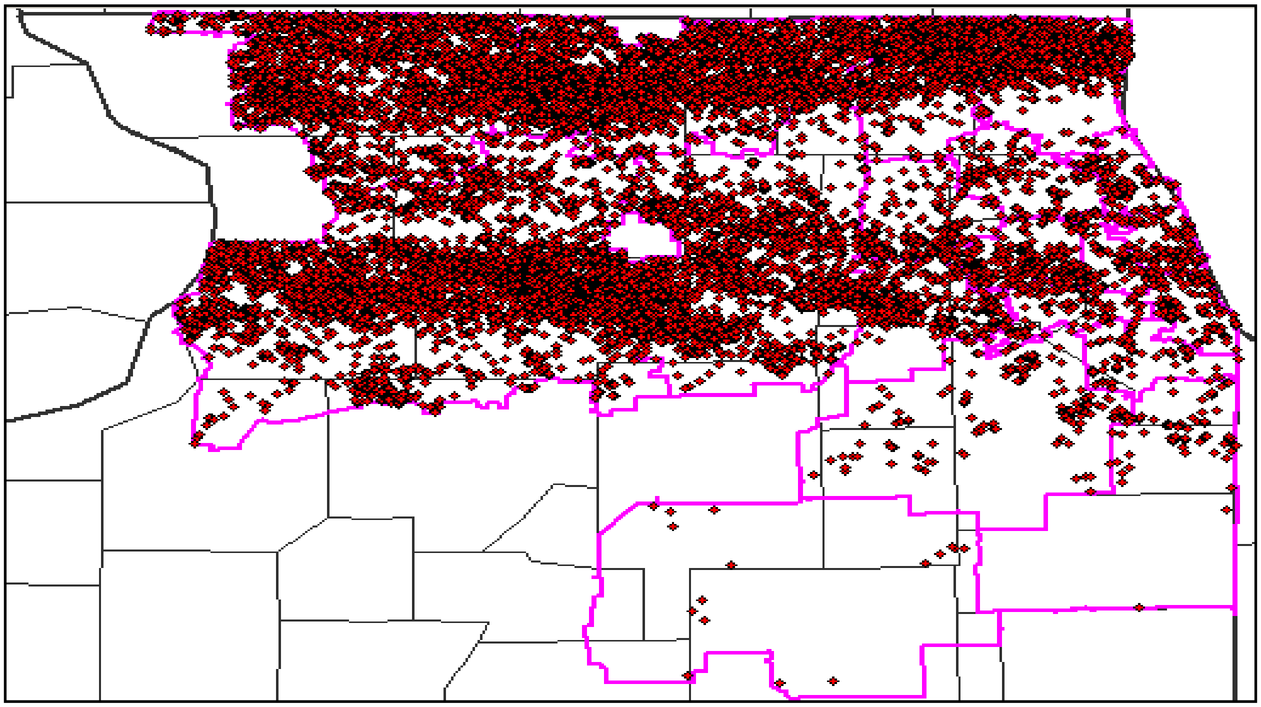
(1) Trees and tree limbs being knocked down and striking ComEd's facilities causing both physical and electrical damage.

(2) Tree branches and limbs being pushed into contact with ComEd facilities, principally causing electrical damage due to faults and burn through.

(3) Other wind blown debris coming into contact with ComEd's facilities, causing physical and/or electrical damage.

As a result of vegetation and other material striking a utility's facilities, the facilities often "fail" at wind speeds significantly less than those that would cause direct failure of utility facilities even when proper vegetation management practices are followed in a timely manner.

In addition to the winds, approximately 18,000 lightning strokes were recorded in the ComEd service territory.



Lightning is a transient discharge between a charged cloud and the earth or another cloud, involving high peak currents usually lasting a few hundred microseconds.

The effect of a lightning stroke is highly dependent on the magnitude and duration of the surge.

Lightning Detection Equipment indicates that ComEd experiences lightning strokes that vary from approximately 10,000 amps to over 300,000 amps in magnitude.

An EPRI study (T&D System Design and Construction for Enhanced Reliability and Power Quality. EPRI, Palo Alto, CA 2006. 1010192) characterizes lightning into two categories: Direct Strikes and Induced Voltages.

Direct strikes cause the most damage by directly striking an overhead phase wire, pole, structure or static wire and injecting an enormous current surge- also creating a very large voltage surge.

The EPRI report indicates that virtually all direct strokes cause flashover of insulators, equipment damage and arrester failure. Additionally, the massive current may start a pole fire or burn through the conductors.

Fortunately, only a small percentage of cloud to ground strokes result in a direct strike to the system.

More common than direct strokes are the nearby lightning strikes that, while not directly hitting the system, do induce high voltage on equipment.
Induced voltages are caused when lightning strikes a tree, a structure or even the ground in close proximity to a line. The EPRI report indicates that induced voltages are much less severe than direct strikes, but close strikes can induce sufficient voltage to flashover insulators.

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Two methods (not mutually exclusive) have been used to mitigate the effects of lightning on the system.

On the 34 kV system, many lines have been built with a shield (or static) wire that is designed to “shield” the phase conductors from a direct lightning stroke.

Additionally, lightning surge arresters have been employed to protect the electrical system from the high voltages caused by lightning strikes on or near overhead conductors.

A distribution surge arrester is used to protect equipment insulation such as transformers and regulators. The function of a surge arrester is to hold the voltage on a line or across a piece of equipment to a non-destructive value. The surge arrester conducts the surge current to ground while limiting the voltage on the equipment. Surge arresters absorb energy whenever an overvoltage occurs. The response of an arrester to a surge current depends greatly on the magnitude and duration of the thermal runaway, a condition in which the heat generated exceeds the heat dissipated. If the temperature of the arrester reaches high enough, failure of the arrester can occur.

Regardless of rating, no surge arrester (or other overhead equipment) can survive a direct lightning strike.

f. Attached as OUT 1.03_Attach 2 is a table quantifying the number of customers out of service during and after the storm until all customers were back in service.

g. Attached as OUT 1.03_Attach 3 is a table showing how many outages and how many customer service interruptions were caused by each outage cause.

Compute a Wind Velocity (with Bare Wires) Equivalent to Designing a Typical ComEd Distribution Pole to NESC (Heavy Loading District) Requirements

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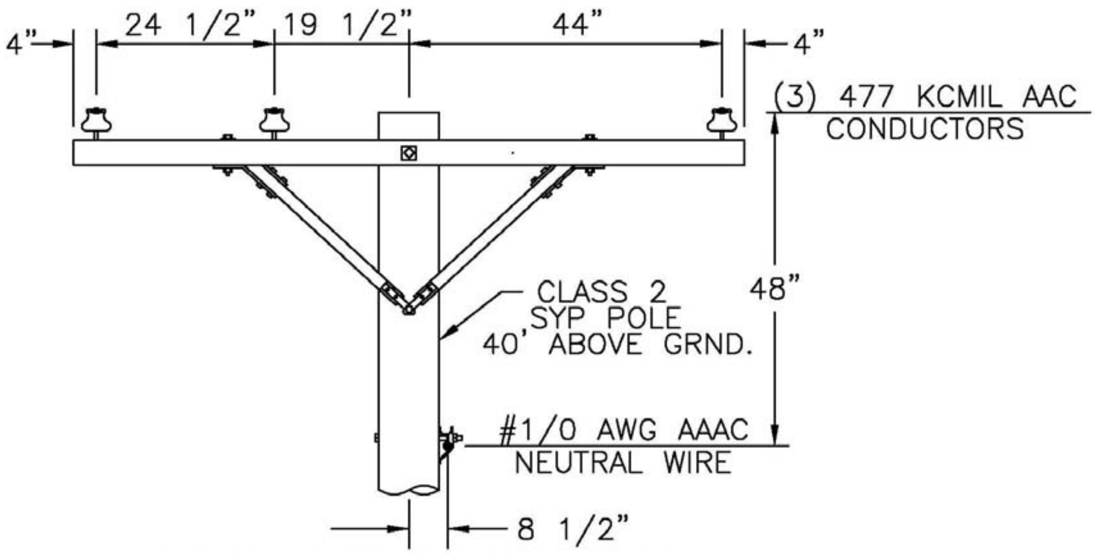
Assume a 3-phase, single-arm pole as shown below:



TYPICAL COMED 3–PHASE SINGLE ARM
DISTRIBUTION LINE POLE

<u>Assumptions</u>:

This pole is 40 feet above ground, has a top diameter of 7.96 inches (0.663 ft.) and a groundline diameter of 12.53 inches (1.044 ft.), corresponding to the ANSI Std-05.1 wood pole minimum circumferences for a Class 2 Southern Yellow Pine pole.

Each of the three conductors is a 477 kcmil AAC having a bare diameter of 0.792 inches and a bare unit weight of 0.4468 lbs./ft.

The one neutral wire is a #1/0 awg AAAC having a bare diameter of 0.398 inches and a bare unit weight of 0.1157 lbs./ft.

The actual wire span lengths are 200 feet and the terrain is essentially flat such that the wind span and the weight span are both 200 feet.

The equivalency for wood pole design will be computed based on maintaining the same bending moment in the pole at the groundline.

For NESC design requirements, refer to the 2002 version of the NESC, Chapters 25 and 26. Combined (Heavy District) Ice and Wind Loading (NESC Rule 250B) applies. Use Grade C Construction. Apply NESC Overload Factors (OLF's) per NESC Table 253-2 and Associated Strength Factors per NESC Table 261-1B.

Therefore, for the NESC Design requirements, apply the following parameters and OLF's:

Ice = 0.5" (radial thickness)   Wind = 4 psf

OLF for Wind forces = 2.00,   OLF for Vertical forces = 2.20

Use a pole Strength Factor = 1.00

Unit Wire Loads Under NESC Heavy District Ice and Wind Loading (per NESC Table 250-1), without OLF's:

Conductor Horiz Unit Force = [0.792" + 2(0.5")]/12 in./ft. x 4 psf = 0.597 lbs./ft.

Neutral Wire Horiz Unit Force = [0.398" + 2(0.5")]/12 in./ft. x 4 psf = 0.466 lbs./ft.

Conductor Vert Unit Force = 0.4468 + [[1" + 2(0.792")]π/(4 x 144) x 57] = 1.250 lbs./ft.

Neutral Wire Vert Unit Force = 0.1157 + [[1" + 2(0.398")]π/(4 x 144) x 57] = 0.674 lbs./ft.

Ultimate NESC Moment (at Groundline) Due to Wind on Pole:

Wind Area of Pole = (1.044' + 0.663')/2 x 40' = 34.14 squ. ft.

Location of Centroid of this Area Above Groundline (Moment Arm) =

(40'/3) x [1.044' + 2(0.663')]/[1.044' + 0.663'] = 18.51 ft.

Ultimate NESC Moment Due to Wind on Pole = 4 psf x 2.00 OLF x 34.14 squ. ft. x 18.51' = 5,055 ft-lbs.

Ultimate NESC Moment (at Groundline) Due to Wind on Conductors:

NESC Moment Due to Wind on Conductors = 3 x 0.597 lbs./ft x 200 ft. x 2.00 OLF x 40' = 28,656 ft-lbs.

Ultimate NESC Moment (at Groundline) Due to Wind on Neutral Wire:

NESC Moment Due to Wind on Conductors = 1 x 0.466 lbs./ft x 200 ft. x 2.00 OLF x (40' – 4') = 6,710 ft-lbs.

Ultimate NESC Moment (at Groundline) Due to Eccentric Vertical Wire Loads on Pole:

NESC Moment Due to Eccentric Vert Loads = [1 x 1.250 lbs./ft x 200 ft. x 2.20 OLF x (19.5"/12)] –[1 x 0.674 lbs./ft. x 200 ft. x 2.20 OLF x (8.5"/12)] = 684 ft-lbs.

Total Ultimate NESC Moment (at Groundline):

NESC Moment = 5,055 ft-lbs + 28,656 ft-lbs. + 6,710 ft-lbs. + 684 ft-lbs. = 41,105 ft-lbs

Now, for wind pressure on bare wires, compute the moment at the groundline in terms of "w", where "w" is a variable that represents the wind pressure in psf:

Wind Moment (at Groundline) Due to Wind on Pole:

Wind Area of Pole = (1.044' + 0.663')/2 x 40' = 34.14 squ. ft.

Location of Centroid of this Area Above Groundline (Moment Arm) =

(40'/3) x [1.044' + 2(0.663')]/[1.044' + 0.663'] = 18.51 ft.

Moment Due to Wind on Pole = w psf x 34.14 squ. ft. x 18.51' = 632w ft-lbs.

Wind Moment (at Groundline) Due to Wind on Conductors:

Moment Due to Wind on Conductors = 3 x w psf x (0.792"/12) x 200 ft. x 40' = 1,584w ft-lbs.

Wind Moment (at Groundline) Due to Wind on Neutral Wire:

Moment Due to Wind on Neutral Wire = 1 x w psf x (0.398"/12) x 200 ft. x (40' – 4') = 239w ft-lbs.

Wind Moment (at Groundline) Due to Eccentric Vertical Wire Loads on Pole:

Moment Due to Eccentric Vert Loads = [1 x 0.4468 lbs./ft x 200 ft. x (19.5"/12)] – [1 x 0.1157 lbs./ft. x 200 ft. x (8.5"/12)] = 129 ft-lbs.

Total Wind Moment (at Groundline) in terms of Wind Pressure, "w" psf:

Wind Moment = 632w ft-lbs + 1,584w ft-lbs. + 239w ft-lbs. + 129 ft-lbs. = (2,455w + 129) ft-lbs

Now, we can set the Total Ultimate NESC Moment equal to the Wind on Bare Wire Moment and solve for the variable "w":

41,105 ft-lbs. = (2,455w + 129) ft-lbs

w = (41,105 ft-lbs. – 129 ft-lbs.)/2,455 = 16.69 psf

To convert this wind pressure to a velocity, we can use the formula from NESC paragraph 250C:

Load in lbs. = $0.00256V^2 \times k_z \times G_{RF} \times I \times C_d \times A$, or

Pressure in psf = $0.00256V^2 \times k_z \times G_{RF} \times I \times C_d$

Where V is the wind velocity in mph

Per NESC table 250-2, k_z is approximately 1.05 at a height of 40'.

Per NESC table 250-3, G_{RF} is approximately 0.96 at a height of 40' and a span length of 200'.

The drag factor, $C_{d,}$ for a round object such as a wire or wood pole can be taken as 1.00 (per NESC paragraph 252B, 2, a).

The importance factor, I, for utility structures can be taken as 1.00 (per NESC paragraph 250C), therefore, the above equation reduces to:

Pressure in psf = $0.00256V^2 \times 1.05 \times 0.96 \times 1.00 \times 1.00 = 0.00258V^2$

Solving for the corresponding wind velocity, V:

$$V = \sqrt{w/0.00258}$$

$$V = \sqrt{16.69/0.00258}$$

$$V = 80.4 \text{ mph}$$

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Date/Time	Cust Without Power
7/11/11 7:00	7,213
7/11/11 8:00	260,478
7/11/11 9:00	600,075
7/11/11 10:00	577,241
7/11/11 11:00	574,444
7/11/11 12:00	542,696
7/11/11 13:00	521,411
7/11/11 14:00	493,676
7/11/11 15:00	471,348
7/11/11 16:00	444,153
7/11/11 17:00	425,462
7/11/11 18:00	401,318
7/11/11 19:00	377,342
7/11/11 20:00	358,481
7/11/11 21:00	333,748
7/11/11 22:00	325,388
7/11/11 23:00	312,249
7/12/11 0:00	309,061
7/12/11 1:00	299,883
7/12/11 2:00	292,559
7/12/11 3:00	288,451
7/12/11 4:00	282,552
7/12/11 5:00	278,260
7/12/11 6:00	273,906
7/12/11 7:00	274,432
7/12/11 8:00	269,447
7/12/11 9:00	265,914
7/12/11 10:00	261,777
7/12/11 11:00	255,233
7/12/11 12:00	248,359
7/12/11 13:00	239,626
7/12/11 14:00	228,541
7/12/11 15:00	216,374
7/12/11 16:00	205,447
7/12/11 17:00	202,045
7/12/11 18:00	186,096
7/12/11 19:00	178,235
7/12/11 20:00	166,397
7/12/11 21:00	156,621
7/12/11 22:00	154,356
7/12/11 23:00	148,414
7/13/11 0:00	147,681
7/13/11 1:00	144,101
7/13/11 2:00	141,195
7/13/11 3:00	140,061
7/13/11 4:00	138,743
7/13/11 5:00	135,321
7/13/11 6:00	133,967
7/13/11 7:00	133,111
7/13/11 8:00	132,465
7/13/11 9:00	134,401
7/13/11 10:00	131,824
7/13/11 11:00	128,741
7/13/11 12:00	126,692

Date/Time	Cust Without Power
7/13/11 13:00	123,587
7/13/11 14:00	111,141
7/13/11 15:00	104,293
7/13/11 16:00	100,451
7/13/11 17:00	98,326
7/13/11 18:00	91,485
7/13/11 19:00	84,236
7/13/11 20:00	79,141
7/13/11 21:00	72,475
7/13/11 22:00	69,924
7/13/11 23:00	68,010
7/14/11 0:00	67,570
7/14/11 1:00	66,680
7/14/11 2:00	65,496
7/14/11 3:00	64,477
7/14/11 4:00	64,053
7/14/11 5:00	64,369
7/14/11 6:00	64,244
7/14/11 7:00	64,390
7/14/11 8:00	64,207
7/14/11 9:00	64,341
7/14/11 10:00	64,945
7/14/11 11:00	64,640
7/14/11 12:00	61,085
7/14/11 13:00	62,136
7/14/11 14:00	58,379
7/14/11 15:00	53,624
7/14/11 16:00	49,397
7/14/11 17:00	47,131
7/14/11 18:00	45,234
7/14/11 19:00	44,286
7/14/11 20:00	41,470
7/14/11 21:00	38,737
7/14/11 22:00	37,511
7/14/11 23:00	35,598
7/15/11 0:00	35,447
7/15/11 1:00	34,464
7/15/11 2:00	35,273
7/15/11 3:00	31,767
7/15/11 4:00	31,043
7/15/11 5:00	31,643
7/15/11 6:00	32,181
7/15/11 7:00	31,933
7/15/11 8:00	30,556
7/15/11 9:00	29,073
7/15/11 10:00	28,761
7/15/11 11:00	27,949
7/15/11 12:00	26,236
7/15/11 13:00	24,965
7/15/11 14:00	22,929
7/15/11 15:00	24,185
7/15/11 16:00	22,076
7/15/11 17:00	18,717
7/15/11 18:00	18,049

Date/Time	Cust Without Power
7/15/11 19:00	16,781
7/15/11 20:00	15,227
7/15/11 21:00	12,936
7/15/11 22:00	11,104
7/15/11 23:00	9,072
7/16/11 0:00	8,200
7/16/11 1:00	8,090
7/16/11 2:00	9,596
7/16/11 3:00	8,167
7/16/11 4:00	7,848
7/16/11 5:00	9,217
7/16/11 6:00	7,559
7/16/11 7:00	8,463
7/16/11 8:00	8,723
7/16/11 9:00	7,815
7/16/11 10:00	7,647
7/16/11 11:00	6,812
7/16/11 12:00	5,702
7/16/11 13:00	5,297
7/16/11 14:00	3,997
7/16/11 15:00	2,925
7/16/11 16:00	2,309
7/16/11 17:00	1,434
7/16/11 18:00	970
7/16/11 19:00	754
7/16/11 20:00	425
7/16/11 21:00	280
7/16/11 22:00	183
7/16/11 23:00	172
7/17/11 0:00	98
7/17/11 1:00	98
7/17/11 2:00	98
7/17/11 3:00	93
7/17/11 4:00	61
7/17/11 5:00	59
7/17/11 6:00	14
7/17/11 7:00	14
7/17/11 8:00	13
7/17/11 9:00	13
7/17/11 10:00	13
7/17/11 11:00	13
7/17/11 12:00	13
7/17/11 13:00	13
7/17/11 14:00	13
7/17/11 15:00	13
7/17/11 16:00	2
7/17/11 17:00	1
7/17/11 18:00	1
7/17/11 19:00	0

Cause Category	Cause Detail	Outages	Customer Interruptions
Tree Related	Limb Broken - Primary	1,852	394,720
	Limb Broken - Service Drop	629	725
	Tree Contact - Primary	342	49,329
	Tree Contact - Service Drop	160	213
	Uprooted Tree - Primary	89	44,802
	Uprooted Tree - Service Drop	20	20
	Limb Broken - Secondary	6	10
	Tree Contact - Secondary	2	3
Weather Related	Wind / Tornado	775	152,357
	Lightning	697	163,125
	Extreme Heat	2	68
Underground Equipment Related	Underground Failure	197	21,010
	Malfunction	18	215
Intentional	Emergency Repairs	143	31,994
	Protection of System Integrity	21	2,304
Overhead Equipment Related	Malfunction	127	24,140
	Broken Fuse Link	19	502
	Contamination	4	4
Unknown	Unknown	75	3,481
Animal Related	Squirrels	40	803
	Birds	11	1,153
	Animal - Other	10	194
Other	Other	55	4,874
Public	Vehicles	14	1,878
	Dig-in by Others	4	24
	Accident by Others	3	3
	Fire	3	3
	Vandalism	2	9
	Foreign Object	1	1
ComEd/Contractor Personnel-Errors	Switching Error	4	1,804
	Dig-in by ComEd	2	89
	Accident by ComEd Contractor	1	1
Transmission and Substation Equipment Related	Substation Equipment	3	9,411