ComEd Secondary and Service Loss Study

OFFICIAL FILE
I.C.C. DOCKET NO. 12-0321
ComEd Exhibit No. 17.1
Witness Boam
Date 9/25/12 Reporter

Commonwealth Edison Company

August 6, 2012

Summary
Distribution system energy loss factors are utilized to determine the amount of energy consumed in the delivery of power to end use customers. These factors are used to formulate the values listed in the ComEd Rate RDS tariff. The purpose of this study is to provide the basis for estimating the peak losses in secondary and service conductors by customer class. The results of this analysis will be used to determine overall distribution energy loss factors by customer class.

Study Approach
Various configurations of secondary and service conductors are used to provide service to ComEd customers. The location of customer and company facilities; magnitude of peak load; and design standards in effect at the time of installation result in differences in the facilities to supply individual customers. For the purpose of this study, conductor types and configurations contained in current ComEd engineering standards were utilized.

A random sample of 10 customers in each of the customer classes was used to determine the frequency of occurrence of overhead, underground or high-rise configuration for the secondary and service conductors. An electrical power flow model for one to three configurations used to provide service to each customer class was developed to determine secondary and service power losses separately. Secondary and service losses in each model were divided by the applicable load on each type of conductor to determine losses as a percent of the load. For customer classes that are supplied by more than one model of secondary and service conductors, the losses for that class were determined by weighting the losses of the applicable models by the frequency of occurrence of the applicable model in the sample of customers by class.

The maximum secondary loss and maximum service loss among all classes is used to determine the general "I2R loss%" value for secondary and service losses in Appendix D of the "2011 ComEd Distribution System Loss Study". The secondary and service loss percentage for each class is divided by the maximum for all classes to determine the "Percent of Class Load Through Elements" listed in Appendix C of the "2011 ComEd Distribution System Loss Study".

Secondary and service losses were not calculated for the Railroad, HV or Primary service classes since only primary conductors are used to provide service to these customers.

Conductor Size, Length and Configuration
For the Single Family Residential classes, the size, type and length was taken from Figure 1 of Engineering Standard Practice (ESP) 5.3.6.2 for suburban overhead installations and from the similar configuration in Figure 1 of ESP 5.3.6.4 for buried conductor installations.

Since there are no standard design documents for multi-family residential and non-residential classes, typical conductor lengths were determined for each class were

determined from the customer class samples. Service conductors were selected for loading using standard conductor sizes in the range of 25 – 50% of the conductor thermal capacity.

A configuration diagram for each of the loss models is contained in Appendix 2. The results of the power flow simulation for each model shows the conductor type, length, service voltage, single or three phase configuration, loading and losses by conductor section as well as the total service and secondary losses and losses in percent of the load in the file Sec_Svc_Losses_6_13_12.xls. For the customer classes of 400 kW and greater, secondary conductor was not identified as being used by the sample customers, so it is not utilized in the power flow models.

Loads

The load used in the power flow model was selected to approximate the peak load by a customer in that class that would be supplied using the conductor model that was used for the class. For the non-residential customer classes, a load in the middle of the class range was generally used. Based on the methods of service identified for the sample customers, three phase service conductors were used for class models at 100kW and higher. Class models above 400kW used conductors operated at 480V

Changes to Secondary and Service Loss Study dated July 26, 2011

- A third Single Family Residential model was added to account for overhead residential installations in urban areas.
- Secondary and service conductor selection was updated by material and length based upon field review and discussion.
- Loss results have been updated based upon studies completed with the updated conductor lengths and materials.

Secondary and Service Loss Models

Class	Loss Model	Configuration Diagram
SF	1	Single Family Overhead - Suburban
	2	Single Family URD
	20	Single Family Overhead - Urban
MF	3	Shared Secondary
	4	Service Only
	5	Low Voltage Riser
SF_SH	6	Single Family Overhead
	7	Single Family URD
MF_SH	4	Service Only
	8	Service Only
	9	Service Only
WH	3	Shared Secondary
	4	Service Only
0-100 kW	10	Service Only
	11	Service Only
	18	Shared Secondary
	19	Shared Secondary
100-400 kW	12	Service Only
	13	Service Only
	14	Shared Secondary
400-1000 kW	15	Service Only
1-10 MW	16	Service Only
>10 MW	17	Service Only
Lighting	3	Shared Secondary
	4	Service Only

Results

The study results are listed in the file Sec_Svc_Loss_Results 6_13_12.xls and are utilized in the "Ex 16.2 2011 Dist Loss factors 08_06_12.xlsx".

Calculations and Supporting Documents

File	Description
Sec_Service_Losses.mdb	CYME Power Flow simulation base file
Sec_Svc_loss_results 6_13_12.xls	CYME Power Flow raw results
Analyzed Samp Acc for D loss study.xls	Random sample of ComEd accounts used in analysis

Engineering Standard Practice References

5.3.6.2 – Design of Overhead Transformer, Secondary and Service Combinations
5.3.6.4 – Transformer, Buried Secondary ad Service Combination Design
5.3.8.2 – Underground Distribution Cable Selection and Application
5.3.7.1 – Standard Conductor Sizes and Application and Installation Guidelines

Power Flow Simulation Application

Cyme 5.0 revision 15

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Appendix 1 – Weighted Average results per class

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
SF	1	12	10	4	1-4/0 AA	140	1.60	1	1-#4 AL	50	1.06	120/240	25%
SF	2	12	10	4	1-4/0 AL	140	1.57	1	1-2/0 AL	70	0.44	120/240	40%
SF	20	20	5	8	1-4/0 AA	180	1.52	1	1-#4 AL	40	0.41	120/240	35%

Class Weighted Average Percent (%): Sec – 1.560 Svc – 0.585

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
MF	3	40-50	3.7	28	1-4/0 AA	90	2.33	4	1-#4 AL	40	1.31	120/240	30%
MF	4	16	3.7	0	-	-	-	16	1-350 AL	40	0.61	120/240	60%
MF	5	428	2	428	2-500 CU 3 ph	75	1.51	107	2-4/C-500 CU	84	0.83	120/208	10%

Class Weighted Average Percent (%): Sec – 0.850 Svc – 0.842

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
SF_SH	6	12	10	4	1-4/0 AA	140	1.65	1	1-#4 AL	50	1.03	120/240	60%
SF_SH	7	12	10	4	1-4/0 AL	140	1.57	1	1-2/0 AL	70	0.44	120/240	40%

Class Weighted Average Percent (%): Sec – 1.618 Svc – 0.794

Appendix 1 – Weighted Average results per class (Continued)

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
MF_SH	4	16	3.7	0	-	-	-	16	1-350AL	50	0.77	120/240	80%
MF_SH	8	18	3.7	0	-	-	-	3	1-500CU	60	1.04	120/240	10%
MF_SH	9	6	3.7	0	-	-	-	6	1-500CU	40	0.17	120/208	10%

Class Weighted Average Percent (%): Sec – 0 Svc – 0.737

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
WH	3	40-50	3.7	28	2-4/0 AA	90	2.33	4	1-#4 AL	40	1.31	120/240	50%
WH	4	16	3.7	0	-	-	-	16	1-350 AL	40	0.61	120/240	50%

Class Weighted Average Percent (%): Sec – 1.165 Svc – 0.960

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
0-100 kW	10	1	25	0	-	-	-	1	1-1/0 AL	65	1.38	120/240	17%
0-100 kW	11	1	25	0	-	-	-	1	1-1/0 CU	65	0.88	120/240	11%
0-100 kW	18	23	25	5	477 AA	83	0.94	1	1-1/0 AL	65	1.41	120/240	44%
0-100 kW	19	9	25	5	4-1/0 CU	83	1.42	1	1-1/0 CU	65	0.90	120/240	28%

Class Weighted Average Percent (%): Sec – 0.81 Svc – 1.21

Appendix 1 – (Weighted Average results per class) Continued

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
Lighting	3	4	3.7	2	1-4/0 AL	90	0.55	1	1-#6 AL	40	0.51	120/240	40%
Lighting	4	16	3.7	0	-	-	-	1	1-#6 AL	40	0.51	120/240	60%

Class Weighted Average Percent (%): Sec – 0.222 Svc – 0.510

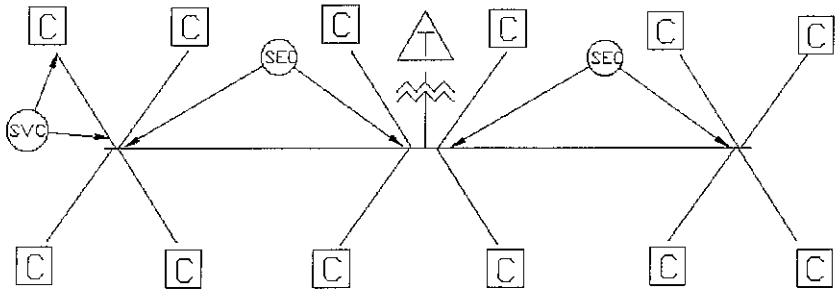
Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# 3 Ø sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# 3 Ø sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
100-400 kW	12	1	154	0	-	-	-	1	2-4/0 AA	45	0.73	120/240	34%
100-400 kW	13	1	154	0	-	-	-	1	1-500 CU	45	0.43	120/208	44%
100-400 kW	14	37	154	2-3	2-4/0 AA	45	1.02	1	2-4/0 AA	45	0.74	120/240	22%

Class Weighted Average Percent (%): Sec – 0.224 Svc – 0.600

Class Name	Model #	# Customers on Transformer	kW Load/ Customer	# of Customers on each Secondary	Sec Size (# 3 Ø sets)	Sec Length (ft)	Sec Loss %	# of Customers on each Service	Svc Size (# 3 Ø sets)	Svc Length (ft)	Svc Loss %	Sec_Svc Voltage (V)	% Weight by Class
400-1000 kW	15	1	465	0	-	-	-	1	2-500CU	25	0.09	277/480	100
1-10 MW	16	1	5,500	0	-	-	-	1	15-500CU	20	0.12	277/480	100
>10 MW	17	1	11,682	0	-	-	-	1	31-500CU	30	0.18	277/480	100

Appendix 2 – Configuration Diagrams

Single Family Overhead - Suburban

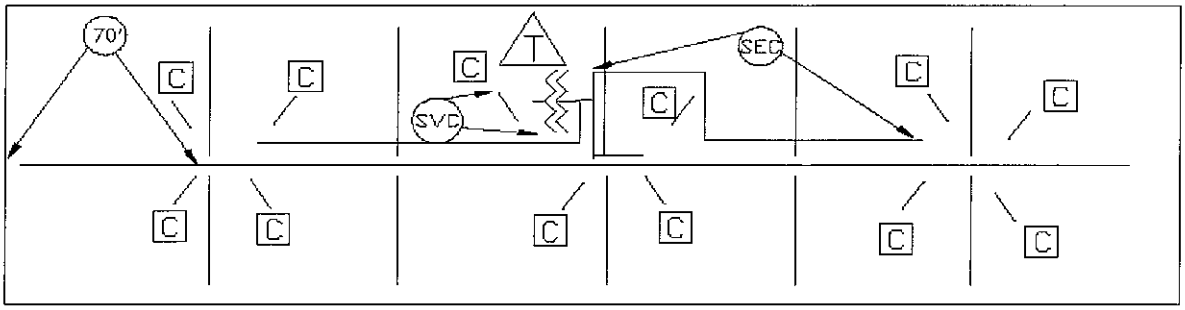


Legend
T – Transformer
C – Customer
SEC – Secondary
SVC - Service

Used in Models 1 and 6

Appendix 2 – Configuration Diagrams (continued)

Single Family URD

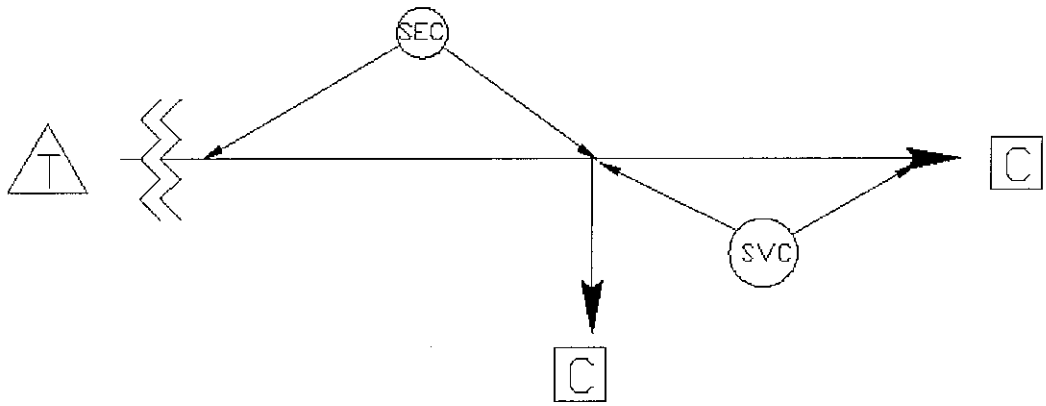


Legend
T – Transformer
C – Customer
SEC – Secondary
SVC - Service

Used in Models 2 and 7

Appendix 2 – Configuration Diagrams (continued)

Shared Secondary

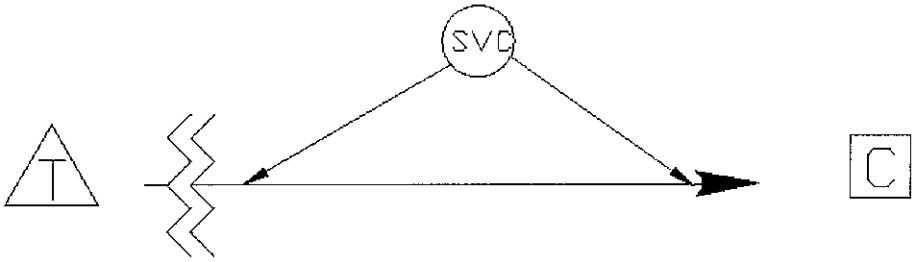


Legend
T – Transformer
C – Customer
SEC – Secondary
SVC - Service

Used in Models 3, 14, 18, and 19

Appendix 2 – Configuration Diagrams (continued)

Service Only

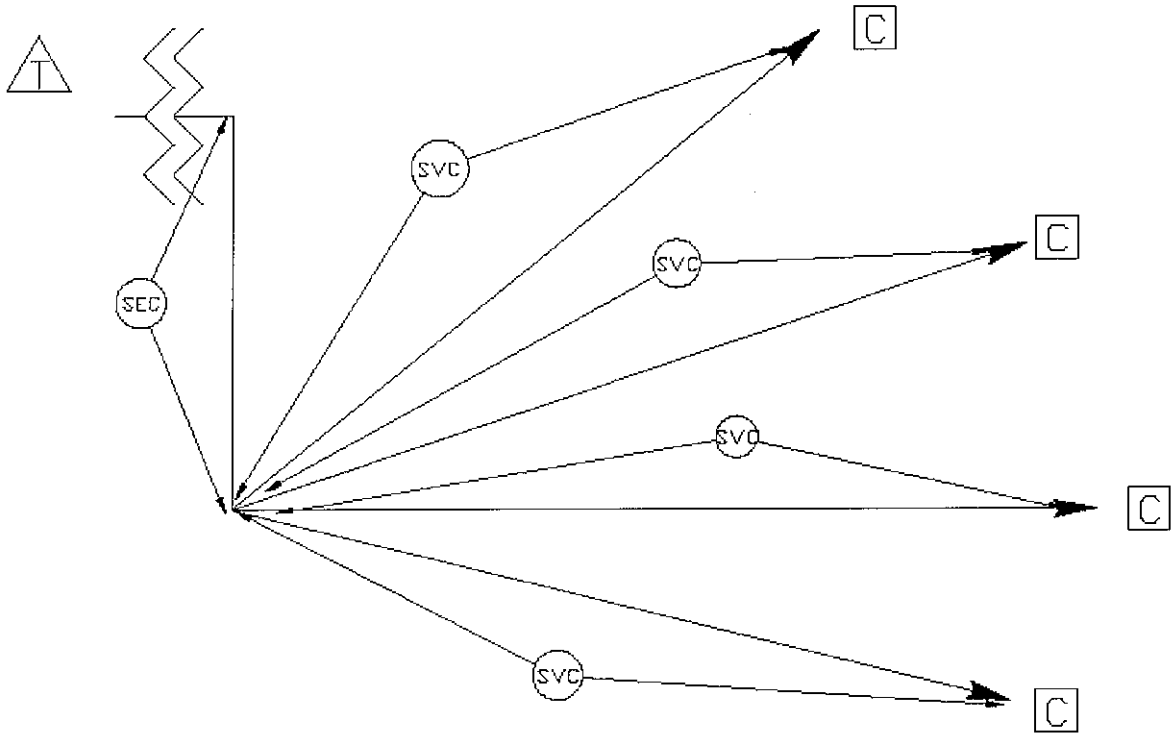


Legend
T – Transformer
C – Customer
SVC - Service

Used in Models 4, 8 -13 and 15-17

Appendix 2 – Configuration Diagrams (continued)

Low Voltage Riser

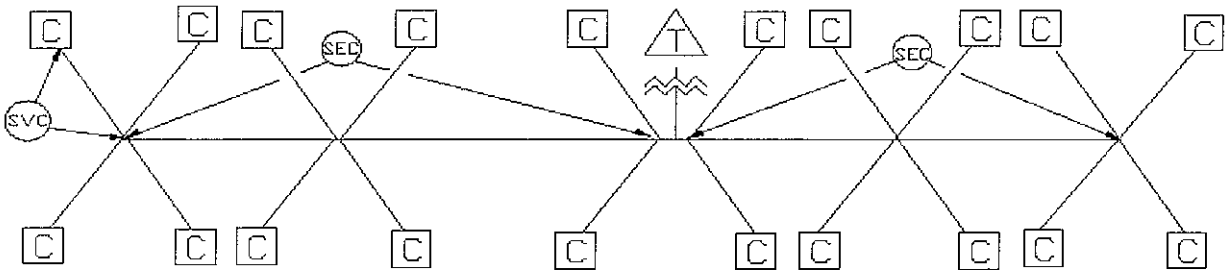


Legend
T – Transformer
C – Customer
SEC – Secondary
SVC - Service

Used in Model 5

Appendix 2 – Configuration Diagrams (continued)

Single Family Overhead - Urban



Legend
T – Transformer
C – Customer
SEC – Secondary
SVC - Service

Used in Model 20