RÉPONSE D'HYDRO-QUÉBEC
À L'ENGAGEMENT NUMÉRO 15

Engagement 15 :

Fournir extraits pertinents des manuels APPA et NARUC auxquels réfère le document HQD-12, Document 4.1, à la page 6.

Réponse à l'engagement 15 :

Ce document présente les informations relativement à l'engagement énoncé précédemment.

American Public Power Association (APPA), Cost of Service Procedures for Public Power Systems, Washington, D.C.

Classification of Distribution Plant—Primary Versus Secondary Voltage Levels

As previously indicated, distribution plant is a fixed investment in facilities which do not vary with the consumption of energy and which are closest to the point of use. Therefore, distribution plant is classified as a demand and customer related cost. Distribution plant facilities include such items as land, structures, substations, lines, transformers, services and meters. Before classifying distribution plant costs to demand and customer, it is necessary to consider the classification of distribution plant between the primary and secondary levels of service.

The separation of distribution plant investment by primary and secondary levels of service is usually challenging and can be time consuming. Many public power systems have not recorded cost data by primary and secondary levels of service. A first step in determining a cost separation for primary and secondary investment can be to analyze distribution substations on the power system, identify those which provide service at 12 KV versus 4 KV or other levels, and review work orders to make a cost determination for the equipment installed. Other cost items, however, such as labor, other materials and overhead, may be difficult to identify.

An investment estimate can be determined for primary versus secondary allocation methods by ratioing the demands imposed on 12 KV and 4 KV feeders. If such demands are not available, the maximum capacities of substation transformers may be ratioed to determine a cost separation.

For a primary versus secondary separation of overhead and underground lines, an alternative method may be used. Here, the objective is to select a sample of feeders representative of customer density and conductoring to compile footages of primary and secondary conductor by size and type. Average costs are used to price the footages of primary and secondary conductor and estimate proportions of investment in primary and secondary plant.

In Exhibit IX-1, Line 36-39, the assumed investment in overhead and underground conductors, conduit and devices, computed as described above, is 30% primary and 70% secondary investment. Hence, investment in distribution plant is separated accordingly by levels of service. Line transformers are classified to primary and secondary levels of service in accordance with the classification of overhead and underground lines. The investment classified to the secondary level will then be allocated to only those customer classes receiving service at that level.

Classification of Distribution Plant—Demand Versus Customer Related

In classifying distribution plant, direct assignment of investment and primary-secondary cost separations having been made, the cost classification between the demand and customer related cost components may be performed.

Land and land rights and structures and improvements have traditionally been classified all demand related in accordance with the classification of station equipment (distribution substations). In the case example, however, these items have been classified one-half to demand and one-half to customer on the basis that a portion of such plant serves the common investment in facilities related to providing service to customers on the system.

Station equipment has been classified as all demand related investment in accordance with the traditional concept that such facilities are sized to meet noncoincidental capacity requirements.

The classification of land, structures and overhead and underground conductors, conduit and devices to demand and customer cost components is performed in Exhibit IX-1 on an arbitrary basis assigning one-half to demand and one-half to customer, recognizing that poles, conductor, transformers, etc., are required to serve customers regardless of demand requirements. Such an arbitrary 50-50 split may be acceptable when there is a lack of information upon which to make a more precise estimate. The 50-50 separation is considered a reasonable approximation of the separation which would occur if additional investigation of cost were to occur. Considerable variation, however, would be expected on a utility-to-utility basis. Actual analysis of cost is preferred if time and cost are not prohibitive, particularly for large power systems. For smaller utilities, the arbitrary method may be used.

Two methods used to more accurately identify the customer cost component of conductor and devices, conduit and line transformers are as follows:

1. *The Minimum Size Method*. This method assumes that the current cost of installing the minimum size pole, conductor, transformer, etc., is reasonably reflective of the customer related portion of investment in distribution plant. The current cost on a unit basis is multiplied by an appropriate number of customers per unit factor to determine the total dollar investment in plant that may be classified as customer related.

The minimum size method is considered the least desirable, but simplest, of the two methods described here to use in determining a customer cost separation of distribution plant

on the basis that current, rather than embedded costs are used to determine the separation.

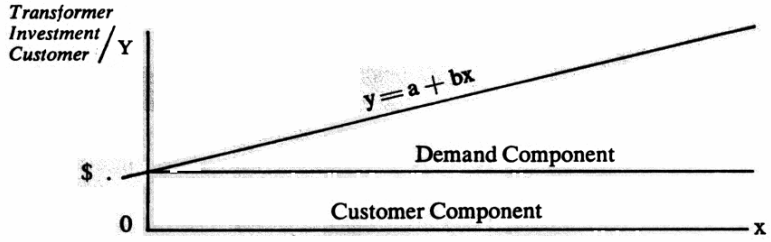
2. *The Minimum Intercept Method.* In Exhibit IX-1, for purposes of simplicity, 60% of the investment in line transformers was classified as customer related and the remainder of investment as demand related. Line transformers, however, represent the best example of distribution plant which is conducive to identifying customer related cost.

The minimum intercept method seeks to identify a common investment per customer made in a line transformer related to a no-demand situation. This method requires data and a computer to relate the installed unit cost of transformers to transformer size. The least squares, or other nonlinear regression techniques, may be used to derive the dollar value of the common investment in transformers, or other types of distribution plant.

To compute the least squares regression equation ($Y = a + bx$) when Y equals the investment cost per transformer and X equals the size of transformer, a simplified summary of the data required might be as follows:

Transformer Investment/ Customer (Y)	*Transformer Size In KVA* (X)
$ 95	10
130	25
180	37.5
315	100
730	250

The least squares regression model is graphed as follows:



Solution of the least squares equation for the data above provided a value of *a* of $68. Thus, it would be included that when demand (or KVA size) is zero, the minimum intercept

investment in a line transformer would be $68—all additional investment cost for a transformer would be related to larger size or demand requirements.

Multiplication of the value of *a* by the number of customers provides the total dollar amount of the customer cost component for a distribution plant item.

Two problems limit use of the minimum intercept method of determining the customer cost component. They are lack of data availability from the public power system and the fact that negative values of the *a* coefficient sometimes occur in the regression equations. In addition, size may not be the only variable which explains variations in the unit costs of various distribution plant items.

The minimum size or minimum intercept approaches to identification of customer cost may be applied to conductor, conduit, services and meters.

Services and meters are installed at customer request when service is to be provided. These items traditionally have been classified as all customer related cost and are so classified in Exhibit IX-1.

Classification of General Plant

General Plant consists of a variety of facilities not related to the demand or energy requirements of customers. Traditionally, the method used to classify general plant to demand, energy and customer related cost components is by classifying general plant in accordance with the classification of production, transmission and distribution plant to demand, energy and customer. There is no classification of general plant to energy under traditional methods of average cost of service unless hydroelectric plant is a part of production plant. This method of classifying general plant is applied in Exhibit IX-1.

General plant facilities house staff and materials supportive of all direct functions of utility operations and, therefore, could reasonably be classified to cost components in the same proportions that other plant is classified.

Another basis sometimes applied is to use operating labor as a basis for classifying general plant. This, however, requires a separate analysis of labor by functions of the utility system.

It is indicated that classification of general plant on the basis of labor may assign noticeably more cost to the customer cost component.

Classification of Other Rate Base Items

Other Rate Base Items consist of the accumulated reserve for depreciation and contributions in aid of construction, deductions from electric plant, and working capital allowance, an

National Regulatory Utility Commissionners, Electric Utility Cost Allocation Manual, Washington, D.C.

CHAPTER 6

CLASSIFICATION AND ALLOCATION OF DISTRIBUTION PLANT

Distribution plant equipment reduces high-voltage energy from the transmission system to lower voltages, delivers it to the customer and monitors the amounts of energy used by the customer.

Distribution facilities provide service at two voltage levels: primary and secondary. Primary voltages exist between the substation power transformer and smaller line transformers at the customer's points of service. These voltages vary from system to system and usually range between 480 volts to 35 KV. In the last few years, advances in equipment and cable technology have permitted the use of higher primary distribution voltages. Primary voltages are reduced to more usable secondary voltages by smaller line transformers installed at customer locations along the primary distribution circuit. However, some large industrial customers may choose to install their own line transformers and take service at primary voltages because of their large electrical requirements.

In some cases, the utility may choose to install a transformer for the exclusive use of a single commercial or industrial customer. On the other hand, in service areas with high customer density, such as housing tracts, a line transformer will be installed to serve many customers. In this case, secondary voltage lines run from pole-to-pole or from handhole-to-handhole, and each customer is served by a drop tapped off the secondary line leading directly to the customer's premise.

I. COST ACCOUNTING FOR DISTRIBUTION PLANT AND EXPENSES

The Federal Energy Regulatory Commission (FERC) Uniform System of Accounts requires separate accounts for distribution investment and expenses. Distribution plant accounts are summarized and classified in Table 6-1. Distribution expense accounts are summarized and classified in Table 6-2. Some utilities may choose to establish subaccounts for more detailed cost reporting.

TABLE 6-1

CLASSIFICATION OF DISTRIBUTION PLANT[1]

FERC Uniform System of Accounts No.	Description	Demand Related	Customer Related
	Distribution Plant [2]		
360	Land & Land Rights	X	X
361	Structures & Improvements	X	X
362	Station Equipment	X	-
363	Storage Battery Equipment	X	-
364	Poles, Towers, & Fixtures	X	X
365	Overhead Conductors & Devices	X	X
366	Underground Conduit	X	X
367	Underground Conductors & Devices	X	X
368	Line Transformers	X	X
369	Services	-	X
370	Meters	-	X
371	Installations on Customer Premises	-	X
372	Leased Property on Customer Premises	-	X
373	Street Lighting & Signal Systems [1]	-	-

[1]Assignment or "exclusive use" costs are assigned directly to the customer class or group which exclusively uses such facilities. The remaining costs are then classified to the respective cost components.

[2]The amounts between classification may vary considerably. A study of the minimum intercept method or other appropriate methods should be made to determine the relationships between the demand and customer components.

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TABLE 6-2

CLASSIFICATION OF DISTRIBUTION EXPENSES[1]

FERC Uniform System of Accounts No.	Description	Demand Related	Customer Related
	Operation [2]		
580	Operation Supervision & Engineering	X	X
581	Load Dispatching	X	-
582	Station Expenses	X	-
583	Overhead Line Expenses	X	X
584	Underground Line Expenses	X	X
585	Street Lighting & Signal System Expenses [1]	-	-
586	Meter Expenses	-	X
587	Customer Installation Expenses	-	X
588	Miscellaneous Distribution Expenses	X	X
589	Rents	X	X
	Maintenance [2]		
590	Maintenance Supervision & Engineering	X	X
591	Maintenance of Structures	X	X
592	Maintenance of Station Equipment	X	-
593	Maintenance of Overhead Lines	X	X
594	Maintenance of Underground Lines	X	X
595	Maintenance of Line Transformers	X	X
596	Maint. of Street Lighting & Signal Systems [1]	-	-
597	Maintenance of Meters	-	X
598	Maint. of Miscellaneous Distribution Plants	X	X

[1]Direct assignment or "exclusive use" costs are assigned directly to the customer class or group which exclusively uses such facilities. The remaining costs are then classified to the respective cost components.

[2]The amounts between classifications may vary considerably. A study of the minimum intercept method or other appropriate methods should be made to determine the relationships between the demand and customer components.

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To ensure that costs are properly allocated, the analyst must first classify each account as demand-related, customer-related, or a combination of both. The classification depends upon the analyst's evaluation of how the costs in these accounts were incurred. In making this determination, supporting data may be more important than theoretical considerations.

Allocating costs to the appropriate groups in a cost study requires a special analysis of the nature of distribution plant and expenses. This will ensure that costs are assigned to the correct functional groups for classification and allocation. As indicated in Chapter 4, all costs of service can be identified as energy-related, demand-related, or customer-related. Because there is no energy component of distribution-related costs, we need consider only the demand and customer components.

To recognize voltage level and use of facilities in the functionalization of distribution costs, distribution line costs must be separated into overhead and underground, and primary and secondary voltage classifications. A typical functionalization and classification of distribution plant would appear as follows:

Substations:		Demand
Distribution:	Overhead Primary	
		Demand
		Customer
	Overhead Secondary	
		Demand
		Customer
	Underground Primary	
		Demand
		Customer
	Underground Secondary	
		Demand
		Customer
	Line Transformers	
		Demand
		Customer
Services:	Overhead	
		Demand
		Customer
	Underground	
		Demand
		Customer
Meters:		Customer
Street Lighting:		Customer
Customer Accounting:		Customer
Sales:		Customer

From this breakdown it can be seen that each distribution account must be analyzed before it can be assigned to the appropriate functional category. Also, these accounts must be classified as demand-related, customer-related, or both. Some utilities assign distribution to customer-related expenses. Variations in the demands of various customer groups are used to develop the weighting factors for allocating costs to the appropriate group.

II. DEMAND AND CUSTOMER CLASSIFICATIONS 0F DISTRIBUTION PLANT ACCOUNTS

When the utility installs distribution plant to provide service to a customer and to meet the individual customer's peak demand requirements, the utility must classify distribution plant data separately into demand- and customer-related costs.

Classifying distribution plant as a demand cost assigns investment of that plant to a customer or group of customers based upon its contribution to some total peak load. The reason is that costs are incurred to serve area load, rather than a specific number of customers.

Distribution substations costs (which include Accounts 360 -Land and Land Rights, 361 - Structures and Improvements, and 362 -Station Equipment), are normally classified as demand-related. This classification is adopted because substations are normally built to serve a particular load and their size is not affected by the number of customers to be served.

Distribution plant Accounts 364 through 370 involve demand and customer costs. The customer component of distribution facilities is that portion of costs which varies with the number of customers. Thus, the number of poles, conductors, transformers, services, and meters are directly related to the number of customers on the utility's system. As shown in Table 6-1, each primary plant account can be separately classified into a demand and customer component. Two methods are used to determine the demand and customer components of distribution facilities. They are, the minimum-size-of-facilities method, and the minimum-intercept cost (zero-intercept or positive-intercept cost, as applicable) of facilities.

A. The Minimum-Size Method

Classifying distribution plant with the minimum-size method assumes that a minimum size distribution system can be built to serve the minimum loading requirements of the customer. The minimum-size method involves determining the minimum size pole, conductor, cable, transformer, and service that is currently installed by the utility. Normally, the average book cost for each piece of equipment determines

the price of all installed units. Once determined for each primary plant account, the minimum size distribution system is classified as customer-related costs. The demand-related costs for each account are the difference between the total investment in the account and customer-related costs. Comparative studies between the minimum-size and other methods show that it generally produces a larger customer component than the zero-intercept method (to be discussed). The following describes the methodologies for determining the minimum size for distribution plant Accounts 364, 365, 366, 367, 368, and 369.

1. **Account 364 - Poles, Towers, and Fixtures**

   - Determine the average installed book cost of the minimum height pole currently being installed.
   - Multiply the average book cost by the number of poles to find the customer component. Balance of plant account is the demand component.

2. **Account 365 - Overhead Conductors and Devices**

   - Determine minimum size conductor currently being installed.
   - Multiply average installed book cost per mile of minimum size conductor by the number of circuit miles to determine the customer component. Balance of plant account is demand component. (Note: two conductors in minimum system.)

3. **Accounts 366 and 367 - Underground Conduits, Conductors, and Devices**

   - Determine minimum size cable currently being installed.
   - Multiply average installed book cost per mile of minimum size cable by the circuit miles to determine the customer component. Balance of plant Account 367 is demand component. (Note: one cable with ground sheath is minimum system.) Account 366 conduit is assigned, basedon ratio of cable account.
   - Multiply average installed book cost of minimum size transformer by number of transformers in plant account to determine the customer component. Balance of plant account is demand component.

4. **Account 368 - Line Transformers**

   - Determine minimum size transformer currently being installed.

- Multiply average installed book cost of minimum size transformer by number of transformers in plant account to determine the customer component.

5. **Account 369 - Services**

   - Determine minimum size and average length of services currently being installed.
   - Estimate cost of minimum size service and multiply by number of services to get customer component.
   - If overhead and underground services are booked separately, they should be handled separately. Most companies do not book service by size. This requires an engineering estimate of the cost of the minimum size, average length service. The resultant estimate is usually higher than the average book cost. In addition, the estimate should be adjusted for the average age of service, using a trend factor.

B. The Minimum-Intercept Method

The minimum-intercept method seeks to identify that portion of plant related to a hypothetical no-load or zero-intercept situation. This requires considerably more data and calculation than the minimum-size method. In most instances, it is more accurate, although the differences may be relatively small. The technique is to relate installed cost to current carrying capacity or demand rating, create a curve for various sizes of the equipment involved, using regression techniques, and extend the curve to a no-load intercept. The cost related to the zero-intercept is the customer component. The following describes the methodologies for determining the minimum intercept for distribution-plant Accounts 364, 365, 366, 367, and 368.

1. **Account 364 - Poles, Towers, and Fixtures**

   - Determine the number, investment, and average installed book cost of distribution poles by height and class of pole. (Exclude stubs for guying.)
   - Determine minimum intercept of pole cost by creating a regression equation, relating classes and heights of poles, and using the Class 7 cost intercept for each pole of equal height weighted by the number of poles in each height category.
   - Multiply minimum intercept cost by total number of distribution poles to get customer component.

- Balance of pole investment is assigned to demand component.

- Total account dollars are assigned based on ratio of pole investment. (Transformer platforms in Account 364 are all demand-related. They should be removed before determining the account ratio of customer- and demand-related costs, and then they should be added to the demand portion of Account 364.)

2. Account 365 - Overhead Conductors and Devices

- If accounts are divided between primary and secondary voltages, develop a customer component separately for each. The total investment is assigned to primary and secondary; then the customer component is developed for each. Since conductors generally are of many types and sizes, select those sizes and types which represent the bulk of the investment in this account, if appropriate.

- When developing the customer component, consider only the investment in conductors, and not such devices as circuit breakers, insulators, switches, etc. The investment in these devices will be assigned later between the customer and demand component, based on the conductor assignment.

  Determine the feet, investment, and average installed book cost per foot for distribution conductors by size and type.

  - Determine minimum intercept of conductor cost per foot using cost per foot by size and type of conductor weighted by feet or investment in each category, and developing a cost for the utility's minimum size conductor.

  - Multiply minimum intercept cost by the total number of circuit feet times 2. (Note that circuit feet, not conductor feet, are used to get customer component.)

  - Balance of conductor investment is assigned to demand.

  - Total primary or secondary dollars in the account, including devices, are assigned to customer and demand components based on conductor investment ratio.

3. Accounts 366 and 367 - Underground Conduits, Conductors, and Devices

- The customer demand component ratio is developed for conductors and applied to conduits. Underground conductors are generally booked by type and size of conductor for both one-conductor (1/c) cable and three-conductor (3/c) cables. If conductors are booked by voltage, as between primary and secondary, a customer component is

developed for each. If network and URD investments are segregated, a customer component must be developed for each.

- The conductor sizes and types for the customer component derivation are restricted to I/c cable. Since there are generally many types and sizes of I/c cable, select those sizes and types which represent the bulk of the investment, when appropriate.
  - Determine the feet, investment, and average installed book cost per foot for I/c cables by size and type of cable.
  - Determine minimum intercept of cable cost per foot using cost per foot by size and type of cable weighted by feet of investment in each category.
  - Multiply minimum intercept cost by the total number of circuit feet (I/c cable with sheath is considered a circuit) to get customer component.
  - Balance of cable investment is assigned to demand.
  - Total dollars in Accounts 366 and 367 are assigned to customer and demand components based on conductor investment ratio.

4. Account 368 - Line Transformers

- The line transformer account covers all sizes and voltages for single- and three-phase transformers. Only single-phase sizes up to and including 50 KVA should be used in developing the customer components. Where more than one primary distribution voltage is used, it may be appropriate to use the transformer price from one or two predominant, selected voltages.
  - Determine the number, investment, and average installed book cost per transformer by size and type (voltage).
  - Determine zero intercept of transformer cost using cost per transformer by type, weighted by number for each category.
  - Multiply zero intercept cost by total number of line transformers to get customer component.
  - Balance of transformer investment is assigned to demand component.
  - Total dollars in the account are assigned to customer and demand components based on transformer investment ratio from customer and demand components.

C. The Minimum-System vs. Minimum-Intercept Approach

When selecting a method to classify distribution costs into demand and customer costs, the analyst must consider several factors. The minimum-intercept method can sometimes produce statistically unreliable results. The extension of the regression equation beyond the boundaries of the data normally will intercept the Y axis at a positive value. In some cases, because of incorrect accounting data or some other abnormality in the data, the regression equation will intercept the Y axis at a negative value. When this happens, a review of the accounting data must be made, and suspect data deleted.

The results of the minimum-size method can be influenced by several factors. The analyst must determine the minimum size for each piece of equipment: "Should the minimum size be based upon the minimum size equipment currently installed, historically installed, or the minimum size necessary to meet safety requirements?" The manner in which the minimum size equipment is selected will directly affect the percentage of costs that are classified as demand and customer costs.

Cost analysts disagree on how much of the demand costs should be allocated to customers when the minimum-size distribution method is used to classify distribution plant. When using this distribution method, the analyst must be aware that the minimum-size distribution equipment has a certain load-carrying capability, which can be viewed as a demand-related cost.

When allocating distribution costs determined by the minimum-size method, some cost analysts will argue that some customer classes can receive a disproportionate share of demand costs. Their rationale is that customers are allocated a share of distribution costs classified as demand-related. Then those customers receive a second layer of demand costs that have been mislabeled customer costs because the minimum-size method was used to classify those costs.

Advocates of the minimum-intercept method contend that this problem does not exist when using their method. The reason is that the customer cost derived from the minimum-intercept method is based upon the zero-load intercept of the cost curve. Thus, the customer cost of a particular piece of equipment has no demand cost in it whatsoever.

D. Other Accounts

The preceding discussion of the merits of minimum-system versus the zero-intercept classification schemes will affect the major distribution-plant accounts for FERC Accounts 364 through 368. Several other plant accounts remain to be classified. While the classification of the following distribution-plant accounts is an important step,