GPA Distribution Planning Guide

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GPA Five-Year Capital Improvement Planning

PURPOSE: The purpose of GPA's medium range distribution planning is to:

- prepare Five-year Capital Improvement Project plans
- provide justification and guidance in preparing annual CIP design and construction budgets

The medium-range plan (5-Year CIP Plan) is a management tool and a guide that:

a. identifies the most practical and economical means of serving future distribution loads while maintaining high quality service to the consumers.

b. provides an outline for anticipated system changes in terms of major facilities, demand levels and associated costs.

c. prepares an indication of future system costs for financial planning and decision making.

PLANNING FUNCTIONS AND GENERAL GUIDELINES

There are four major functions of GPA's distribution planning procedure:

- development of circuit and substation load forecasts
- development of the 5-Year distribution system capital improvements plan identifying the time frame for constructing anticipating improvements;
- annual review of the plan to verify the continued applicability of the projects especially those with proposed expenditures for the upcoming budget year

GPA's distribution planning is a continuing dynamic process that is sufficiently broad to cover foreseeable problems and flexible enough to allow revision to cover changing circumstances.

In the planning process, the planner sorts out available information to determine the best approach for the system to use to provide adequate capacity and quality of service in a reliable, economical, and environmentally acceptable manner.

-The plan is updated annually and may or may not require significant revisions based on the latest information available.

-The plan analyzes the system for a 5-year period beyond the present design requirements.

-The plan provides a guide for developing the existing system toward the 5-year end of the planning period through construction of new facilities and expansion or replacement of existing facilities at appropriate times. This ensures that any interim change or system addition will be compatible with the requirements of the 5-year CIP plan.

The plan has the following basic provisions:

a. Orderly system development to minimize waste due to early obsolescence or inadequacy of facilities.
b. System expansion investment is in step with expected loads and maximizes the use of opportunities to improve the quality of service at minimal cost.
c. Provides for future decisions to incorporate appropriate developments in equipment design and application.

GPA distribution planning process can be divided into the following tasks:

a. maintaining and continuously updating basic data to facilitate the evaluation of proposed alternatives throughout the 5-year planning period.
b. analyses to ascertain the system's ability to serve present and projected requirements and identify/determine what additional capacity is needed and what facilities will need replacing during the 5-year planning period.
c. formulating various alternative plans that will satisfy the system requirements ensuring that each alternative provides for adequate quality of service and environmental acceptability
d. application of present worth analysis to select the optimum plan for the projected requirements.
e. preparation of work plans to budget and construct those facilities demonstrated to be most appropriate and necessary in the coming year.

DISTRIBUTION PLANNING PROCESS

The general procedure of the GPA distribution planning process is summarized in the following:

Preliminary Conference:

The T&D Manager, the Engineering Manager, the PSCC Manager, the SPOR Manager, and members of their respective staff meet to discuss the 5-Year CIP planning report. At this meeting, the team lays out the planning process and discusses basic data requirements:

Engineering Data

a. Up-to-date copies of one line diagrams for all existing distribution circuits.
b. Local zoning maps or other data regarding existing and projected (I) population density; (ii) zoning and land use; and (iii) areas known to be environmentally sensitive.
c. Locations of existing and expected future housing developments, large power, and special loads.
d. Cost summaries for recent construction of various types of facilities in the existing system and other records of operations on which cost estimates may be based

PSCC Data

e. Detailed outage records for the distribution system, transmission system and power generation system.
f. The latest available data concerning load factors of the feeders and substations.
g. Results of all recent voltage and current investigations, phase balance and sectionalizing studies and information on power factor of the system and of distinct areas of the system.

SPOR Data

h. Plans for any new transmission additions and substation voltage changes.
i. Existing and future fault current (or impedance) and voltage limit calculations from short circuit studies.
j. A copy of the energy conservation plan together with information on any existing or proposed load management system and conservation initiatives.
k. The cost and availability of new capital (Trends should be established, on an embedded cost of capital for the life of the CIP.
l. The correct determination of the borrower's fixed charge rate(s) which is used for selection of economic system improvements. Determine applicable fixed charge rates for distribution or transmission or communication projects .
m. The assumptions and methods used in arriving at the financial criteria

The team will review the above information and

a. establish and develop the procedure for updating the basic data file which will be uses in future planning activities.
b. recommend methods of and locations for voltage and current investigations
c. agree on the methods for extracting the necessary load data from computerized billing files for the load forecasts (data is valuable for rate analysis and long range financial forecasts).

The team will also review the basic data for adequacy and

a. determine any necessary additional data
b. recommend improvements in programs used for regular data collection and record-keeping.
c. ensure availability of sound data for continuing system planning activities.

Analysis of Existing System :

The initial step in the planning study is the analysis of the existing system. This study should indicate where alternate proposals are most likely to be economical and provide insight into the development of a practical transition from the existing to the proposed long-range system.

The analysis will determine how the system load will be distributed among the various feeders of the system. To predict with reasonable accuracy the requirements of the various substations and distribution circuits, information is needed on the number of consumers, load per consumer, load growth potential, density, types of load expected, and total load for various regions of the service areas in the present and the projected

system.
In addition to internal GPA databases, valuable growth information will be obtained from local land use planning organizations, chambers of commerce, etc. An econometric model, if available from an Integrated Resource Plan, may provide some of this data.

The analysis of the present system should determine how well the existing facilities are meeting the current needs of the system as indicated by metering and billing data. The analysis will identify parts of the system that have difficulty achieving acceptable levels of system performance. This information, along with the system growth patterns, indicate the areas where the most drastic or immediate action is needed.

In this analysis, the team will consider transformer capacity of existing substations and review the space limitations for increasing the capacity of substations. In addition, the team will determine if there is room for installing recommended new circuits at the substation and along existing rights-of-way.

The analysis will determine those

- **a.** areas of the system are voltage limited
- **b.** areas of the system that are thermally limited
- **c.** and if some facilities are so old that they will need replacement during the planning period.

The team will review system aging data provided by Engineering and T&D on the power distribution facilities and analyze the age of the supply facilities those that will be beyond their useful life before the end of the planning period. The final report should document this data and the methodology and assumptions used in deriving the data.

PSCC will provide service interruption records for the preceding five year period for the team to review with particular attention given to interruption averages for each distribution feeder and for each substation. By comparing the performance of various areas of the system, the team will identify those sections that will benefit the most from improvement efforts.

- **a.** The results of voltage, current and power factor measurements, and voltage drop calculations for critical feeder points will be reviewed.
- **b.** A service reliability study will indicate areas of the system which need special attention and may indicate the general type of work that will be most cost effective in correcting such service deficiencies. Consumer-hr per consumer/yr outage data averaged or trended over 5 years should be determined and compared against prior years.
- **c.** The demand losses at peak time, and energy losses in kWh per year and in percent will be determined for substation and each 13.8 kv circuit on the system. This information will be obtained from results of power flow simulations and through review of substation operating records. Areas/circuits with excessive line losses will be identified and possible corrective measures, namely installation of power factor correction capacitors analyzed.
  Power factor analysis should be used to arrive at an economic power factor for the

distribution systems to decrease the cost of losses.

d. The T&D Manager will present an analysis of O&M expense allocations on the system such factors as cost of labor, load density, number, size, and age of facilities. The analysis will identify circuits and facilities with inordinately high operating expense rates. The team will evaluate suggested methods of reducing those expenses.
O&M items which are not receiving adequate funds should be compared with outage and inspection reports to ascertain if additional emphasis is required to reduce O&M expenses by orderly replacement of certain obsolete components.

Based on the analysis of the existing system, the team will recommend capital improvements and enhancements of procedures to improve system performance and increase system capacity for expansion. The team will also recommend more detailed measuring or record keeping for those areas where data is incomplete or inadequate.

Criteria for Medium- Range System Planning :
Since the Plan is used to guide the development of the system for the 5-year period beyond the present year, the criteria used in formulating the plan is of critical importance.

The plan anticipates that the system improvements will provide adequate and reliable electric service to the consumers over a long period.

Service reliability standards provide a basis on which management can evaluate system performance. Thus, the importance of service reliability must be reflected in the medium-range system plan.
These standards must use indices comparable to those used by other utilities and address customer interruption frequency and duration.
Since customers are not concerned with the source of an interruption, all sources of interruption should be considered for possible improvement in service reliability.

The team may use additional criteria after due consideration and careful evaluation of benefit to cost.

DESIGN CONSIDERATIONS:
The system should be designed to provide adequate, reliable, and quality service at a reasonable cost to all consumers. Many decisions made in formulating the Plan will affect or be affected by the system design.
Transmission System: Transmission and Distribution Planners should coordinate planning based on a “one system” concept. The planners must consider the capacity and adequacy of all existing and prospective transmission supplies. If the transmission system is unable to supply the necessary quantity of power to its substations, if the transmission interruption record is poor, or if voltage levels will be inadequate, then alternative transmission supplies should be investigated.
Interruption data should be recorded and evaluated on a regular basis for all existing transmission sources and interruption rates for prospective lines should be estimated

based on outage records for the transmission system.

Substations:

A major decision to be made in medium and long-range planning is the optimum number and size of substations needed to provide services to the system. The planners must perform cost and reliability comparisons of additional substations against the cost and reliability of other alternatives. The plan may identify probable sites of proposed substations and provide characteristics of each site. The decision on the size and number of substations needed may be made based in part on system experience with the source of interruption hours and the cost of improving reliability in those areas.

Reliability:

The planner must consider various factors that impact reliability:

- generally, shorter lines from smaller substations will lead to higher reliability;
- line reclosing and sectionalizing will improve reliability especially on long lines.
- multiple substation transformers
- loop subtransmission feeds into substations,
- availability of a mobile transformer or mobile substation all improve reliability.

The most economical system configuration may not meet system standards for voltage levels, service reliability and economy. Service reliability should be improved to any portion of the line of supply to the consumer where it can be done at a reasonable expense. The plan should provide estimates of the incremental improvement in service reliability developed from experience.

Primary Distribution Lines

Whether primary lines are constructed overhead or underground, effective planning is needed to avoid premature obsolescence of facilities.

It is necessary to consider many factors in determining whether distribution line construction should be overhead or underground. Overhead lines have lower construction costs and are easier to construct and extend and maintain.

Underground lines generally have less environmental concerns, are much less affected by storms, have lower line losses and less voltage drop for a given ampacity. However, underground lines are sometimes subject to certain technical problems, such as difficulty in adding voltage control or sectionalizing equipment, and high replacement costs.

Distribution lines should meet the voltage standards required by ANSI Voltage Standard C84.1

GPA uses substation transformer TCUL to regulate primary circuit voltage and maintain adequate voltage levels at extremities of distribution lines.

GPA installs shunt capacitors (fixed and switched) on distribution lines to provide voltage boost and improve and control power factor. These improvements usually result in some demand reductions, energy conservation and lower power costs.

Voltage regulation can be achieved with the judicious sizing and locating of (usually switched) capacitor banks.

DEVELOPMENT OF THE PLAN

Because the plan should be based on the planning criteria, design considerations, basic data, and the analysis of existing system, the major steps discussed below should be taken to develop the Plan.

Plan Development

Approved planning criteria and design considerations established are followed in developing the 5-year Plan. The plan makes maximum economical use of existing facilities and corrects major problems while satisfying the planning criteria to the greatest extent possible. System standards for voltage, service reliability, equipment loading, etc., are maintained by those facilities installed during the transition from the existing to the end of the 5-year planning period.

Generally, only major items such as substations, transmission lines, and distribution feeder main lines and major lateral lines, are considered.

The following are typical considerations for exploratory plans:

- **a.** Increase capacity of existing substations and reconductor the distribution lines.
- **b.** Install additional substations, effectively shortening the distribution lines.
- **c.** Install loop feed transmission lines to substations.
- **d.** Install radial feed transmission lines to substations.
- **e.** Convert areas to a higher voltage class.
- **f.** Install additional feeders from existing substations.

Due to the nature of the 5-year Plan and the approximations made in various projections, cost estimates for the last four years of the 5-year plan are based on planning accuracy calculations. Budget level estimates are made for projects to be implemented the impending fiscal year.

In most cases, the plan will identify two or three alternate designs considered to correct anticipated system deficiencies. In rare cases where the planning or operating criteria prove too restrictive, the planning team may recommend modifying the criteria.

For each year of the planning horizon, the plan will show the major facilities required to provide a transition from the existing to the 5-year system in terms of capacity, costs and estimated years of expenditures.

Comparison of Alternatives Plans: The following are typical of the comparisons and considerations which should be made in connection with developing project alternatives.

Reliability of service should be examined under each of the projects compared. The incremental increase in reliability and cost of each alternative should be evaluated.

Project Selection: The development of the 5-year Plan should not be restricted by the limitations of the existing system. Although there are certain inherent benefits associated with the continued use of installed facilities, alternative proposals should be adopted if the projected benefits from the change will exceed the cost of the change. Several factors must be considered in selecting the recommended project.

The primary concern in project selection is comparative economics. In evaluating alternative plans, it will frequently be necessary to compare plans with widely varying time/cost distribution, i.e., one plan may have high first cost and another plan may have high annual costs.

Simply selecting on the basis of lowest first cost or lowest annual costs may eliminate the alternative that provides the best service at the most reasonable cost to the customer. GPA uses the minimum present worth of annual revenue requirements method (PWARR) for performing economic comparisons that considers the following factors:

- **a.** time value of money
- **b.** inflation of labor and material costs
- **c.** GPA annual fixed charge rates (general administrative, O&M, insurance, etc.)
- **d.** demand and energy losses

When the economic comparison indicates the costs of two alternative plans are within 10 percent of each other, a sensitivity analysis should be performed to verify the validity of assumptions. Increases in interest, inflation, energy losses, growth rate, etc., should be considered to determine if the selected plan is likely to become less feasible after implementation. The results of the economic analysis and sensitivity will be included in the 5-Year Plan report.

If two plans are still close after analyzing their sensitivity to overall cost changes, other factors will be considered:

a. Energy Conservation - Although energy losses were considered in the economic analysis, if two plans will cost roughly the same amount but one plan will result in a net energy savings, then that plan will be given a priority credit.

b. Excess Capacity - Although each plan must provide the minimum capacity required to serve the projected system load, one plan may provide more excess capacity at the end of the evaluation period. In that respect the plan with excess capacity is superior.

c. Service Reliability - Although each plan must provide for minimum levels of service reliability, one project may involve inherently better service reliability. In that respect this project is superior.

d. Flexibility - One project may be superior in its capability of further expansion beyond the 5-year Plan level while the other will require radical changes in basic design parameters at that point. For instance, a superior option would be one which has a longer useful life than other options.

On the other hand, the plan which defers major expenditures has the value of increased flexibility to take advantage of future developments.

e. Solution of Chronic Problems - One plan may eliminate a problem which has given management continuous service problems while the other plan does not. This should also be considered.

The techniques of cost benefit analysis will be helpful in evaluating alternatives based on

the above factors.
Although economic comparison is the primary basis for plan selection, there is no substitute for good judgment based on all available facts. In some instances, indeterminate factors may necessitate the inclusion of an alternative plan to the selected 5-year Plan.

Review Conference:
Engineering will prepare a draft summary planning report.
The CIP team will review the draft 5-year Plan report to verify that the plan:

> **a.** Is the result of adequate and appropriate data, engineering analysis and judgment.
>
> **b.** Provides sufficient data to serve as a guide for preparation of construction work plans and medium-range financial forecasts.

Preparation of the 5-Year CIP Plan: The 5-Year Plan will present the analysis of the existing system and the recommended improvement plan over the next five year period.

- Alternative projects will be included in the plan if there are indeterminate factors.
- The plan will contain sufficient explanatory data and summaries of engineering analyses of the plans.
- The economic superiority of the proposed plan and the cost differentials will be shown in dollars.
- Small sketches of the system, or sections of the system, should be used to simplify or replace written descriptions.
- Summaries of basic data, economic comparisons, costs data and engineering analysis be presented in the form of tables and graphs.

New construction and major system improvement items will be tabulated with approximate cost estimates and the proposed year of installation. Groups of other system improvements, including increase in capacity of services and transformers will be tabulated with cost estimates for each year of the plan.

The estimated annual costs of ordinary replacements will be tabulated as a separate item in the cost summary, as will maintenance and system improvements for each year of the plan. The cost of replacements in connection with system improvements will be included in the investment figures for the system improvements.
The cost data tabulations should be broken down by types of facilities such as distribution and transmission. The report will include graphs or tabulations of the projected kW demand as related to time for each substation area or areas which have different levels of usage. Management will thus be able to relate investment in facilities to the time of installation for use in preparation of long-range financial forecasts.
The year on which cost estimates are based must be noted. Normally, all cost estimates should be based on present price levels with appropriate escalation factors used to estimate future construction costs.
A circuit diagram should be prepared for each major step in the transition including the existing system and for the long range system. The diagrams should show regulated and

unregulated voltage drops resulting from system loading at each step with and without the recommended improvements.
Summaries of findings and assumptions used should be included to help GPA management determine the continued validity of and make revisions to the study. Also, a bibliography which identifies all data, external documents and judgment sources should be included.

The 5-year Plan information should be summarized in a format similar to the sample form in Appendix I.

Acceptance of Plan: The long-range engineering plan is presented to management and subject to acceptance by GPA management and the CCU.

CONTINUING PLANNING ACTIVITIES

GPA planning is a continuing process. GPA continuously collects data on line loadings, outages and their causes, and equipment failures to compare the performance of the distribution system and to aid in preparing updates to the existing 5-year plan. Good system planning requires methods for revising the plan and implementing timely installation of needed facilities.

The CIP plan will provide a coordinated construction program and also provide much of the basic data needed in preparing the system's budget for additional capital investment. GPA reviews its 5-Year Plan annually and updates the plan prior to the preparation of the CIP budget for the upcoming fiscal year. The basic data, design criteria, and assumptions used in its preparation are compared to actual system developments and operating conditions.
The review team composed of GPA managers will confirm the validity of the CIP projects proposed for the upcoming year and to be included in the construction budget. Any revisions to the plan are identified and made part of the annual 5-Year Plan update. The report and the CIP projects are submitted to GPA management and to the Consolidated Commission on Utilities for approval.

The annual review (and revision as necessary) of the 5-year Plan will confirm the need for projects as scheduled, may defer project implementation, or eliminate the need for some projects. Many things can happen to cause revising the 5-year Plan: loads may develop faster than projected in some areas and slower than projected in other areas; necessary rights-of-way may not be obtainable; laws and ordinances may change (such as requirements for underground line construction); and technological developments may occur.
Any one of these may be reason for adjustment the plan. Even if no major changes are needed, numerous minor revisions may necessitate updating the 5-year Plan. The cost of planning activities should be considered as an investment which may minimize necessary expenditures. Thus long-range planning may be one of the most cost effective actions available to power distribution system management.

APPENDIX I

Suggested Table of Contents for Medium-Range Engineering Plan

I. Introduction
II. Purpose of Report
III. Summary of Report, Conclusion and Recommendations
IV. Analysis of Existing System and Basic Data
- A. Introduction
- B. Purpose of Analysis
- C. Summary of Analysis, Conclusion and Recommendations
- D. System Growth Patterns
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- E. Capacity of Existing System
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        - c. Demand and Energy Losses
        - d. Operating Expenses
- F. Environmentally Sensitive Areas
- G. Adequacy of Basic Data

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- B. Voltage Levels
- C. Special Loads
- D. Service Reliability
- E. Financial Criteria
- F. Other Criteria
- G. Assumptions
- H. Facilities and Equipment

VI. Five-Year Improvement Plan
- A. The Recommended Plan
- B. Alternate Recommendations
- C. Plan Selection
    1. Examination of the Transition
    2. Economic Justification
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VII. Exhibits
- A. Tabulations of Supporting Data
- B. Sketches, Maps and Circuit Diagrams
- C. Copies of Pertinent Correspondence
- D. Bibliography

E. Other Exhibits

APPENDIX II

Fixed Charge Rate Calculation Guide

Following is some data to assist in the calculation of a Fixed Charge Rate. A fixed charge rate is composed of several factors: the cost of capital, operation & maintenance, taxes, insurance and depreciation. Calculating the cost of insurance as a percent of investment is difficult, and the result makes little difference; therefore, it can be ignored for most applications. The fixed charge rate is not an exact figure, but an estimate which is dependent on the quality of the assumptions involved in its calculation.

I. COST OF CAPITAL:

A. It is important to recognize the cost of capital, which is greater than the cost of debt. The return on equity portion of this calculation can be figured in several ways. The Goodwin method includes the cycle of capital credits in calculating the return on equity. Or, one may adopt a return on equity that a state regulatory authority has declared to be adequate for electric utilities. Or, a TIER-based calculation such as is illustrated below, may be used.

B. Net TIER (Times Interest Earnings Ratio):
For future projects, TIER should be selected in accordance with the owner's Equity Management Plan.
For comparison, TIER for a past year could be calculated from data on historical data:
TIER = Interest + Margins = ____________

C. CAPITAL STRUCTURE:
1. For future projects, the debt ratio should be in accordance with the owner's Equity Management Plan. Line of credit or short-term borrowing should be taken into consideration in long-term financial decisions.
2. For comparison, the debt ratio for a past year could be calculated from historical data :
Debt ratio = Long Term Debt x 100 = __________%
LTD + Total Margin. & Equity

D. COST OF CAPITAL:
1. For future projects the cost of debt should be estimated carefully, taking long-term trends into account. A suggested form would be:
Proportion of Long-range estimated debt of interest rate Component
2. In case one needs to calculate the embedded cost of debt for a past year, it can be calculated from the historical data:
3. Cost of capital: weighted cost rate of debt x TIER =
(from I.D.2. above) (from I.B. above)
__________________ x _______________ = ___________% (CC)

II. OPERATION & MAINTENANCE:
A. For future projects, O&M should be selected to agree with the various plan alternatives. If a more costly alternative promises lower O&M, it should be reflected here.
B. For comparison, a historic distribution-plant O&M could be calculated using figures from Accounting.

Net Distribution Plant, last year   = $___________
Net Distribution Plant, 2 years ago   = $___________
Average Net Distribution Plant last year = $___________ (a)
Distribution Operations: = $___________ (b)
Distribution Maintenance: = $___________ (c)
O&M as a % of Average Net Distribtn Plant [(b)+(c)]/(a) x 100; or estimated from II. A., above
__________% (O&M)

III. DEPRECIATION:
Use an appropriate depreciation figure for the project alternative(s) being studied. GPA uses straight-line depreciation where the depreciation rate is the reciprocal of the asset's life.
Annual rate for distribution plant or for classes of plant ___________% (Dep)

IV. Total Annual Fixed Charge Rate = Cost of Capital (CC) + Oper. & Main. (O&M) + Depreciation (Dep) = ___________%