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THE DESIGN AND IMPLEMENTATION OF A TIME-
SHARED COMPUTER BASED CONSTRUCTION COST
ESTIMATING SYSTEM FOR AN ELECTRIC UTILITY

BY

THOMAS ARNOLD WESTPHAL

A THESIS

PRESENTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF SCIENCE IN MANAGEMENT ENGINEERING

AT

NEWARK COLLEGE OF ENGINEERING

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NEWARK, NEWJERSEY
1974

ABSTRACT

The work of the distribution department of an electric utility involves a great deal of medium to heavy construction. This work is vital to serve the energy needs of the public. An electric utility constantly builds, reinforces, and repairs electric distribution facilities. The material and labor used to accomplish this construction is expensive. Money in sufficient amounts is seldom, if ever, available to finance all proposed construction projects. Therefore, the cost of proposed projects must be estimated in advance, so that management may decide on an economic basis which projects will be authorized.

The need for accurate construction cost estimates is imperative to the economic operation of an electric utility. This thesis delves into the problem of the design and implementation of a computer based cost estimating system to insure the accuracy and timeliness of estimates.

In order to accomplish the design, a series of eight main program modules was written in the BASIC language for use on the General Electric Mark III foreground system. These programs access individually tailored sequential and random disk files using third generation real time computer techniques. The system was made available to eight field locations via remote terminal facilities. The immediacy and flexibility of the time sharing environment proved to be valuable selling points in the implementation of the new system.

At this writing, the new estimating system has met with the approval of the field project engineers, and is well on the way to replacing the manual system. Input simplification has enabled the company to use less technically skilled personnel for the estimating function, with resulting cost savings. Results thus far have shown the system to be flexible, timely, and accurate.

APPROVAL OF THESIS

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BY

THOMAS ARNOLD WESTPHAL

FOR

DEPARTMENT OF INDUSTRIAL ENGINEERING
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BY

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PREFACE

The problem of obtaining consistent, accurate, and timely cost estimates must be solved in order to insure the smooth economic operation of any construction oriented industry. Difficulty in meeting the above criteria marked the operation of the manual estimating system employed by the Electric Distribution Department of the Public Service Electric and Gas Company of New Jersey. The author, a computer applications engineer employed by that company, was assigned to investigate the estimating procedure, with the goal of implementing a computer based system to replace the manual one.

A review of the literature showed that other utilities had implemented computer based estimating techniques, and had found them to be quite satisfactory. The author was not completely satisfied with any single system found in the literature. He set out instead, to develop a hybrid design incorporating some of the ideas of the reviewed systems. The author felt that cost estimating was a natural application for a time shared computer system. The system he developed was adapted from the best features of the manual system incorporating the author's ideas and those from the literature.

The idea of reducing the complexity of input in order to allow less technically sophisticated users to access and execute the system appears to be a unique solution to the the estimating problem. The author feels that this in no small way contributed to the success the system has experienced during implementation.

Sincere appreciation is extended to Prof. I.R. Goldstein, thesis advisor, who offered guidance and advice whenever called upon; to Mr. K. F. Mullaney who supplied considerable expertise in explaining the methods of the manual system; to Mrs. M. Murray who typed the final copy from a note ridden draft; and finally to my wife Terri and son Tommy Jr. who offered patience and understanding during the lengthy preparation of this volume.

THOMAS A. WESTPHAL

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FOREWORD

The purpose of this thesis is the design and implementation of a real-time computer based construction cost estimating system for the Electric Distribution Department of the Public Service Electric and Gas Company of New Jersey. While the system will be specifically designed for electric utility construction cost estimating, the techniques employed are applicable to other industries.

Chapter I will describe the work of an electric utility. The founding and development of the Public Service Company is covered. The Scope of the work of the Electric Distribution Department will be introduced with emphasis on the role of cost estimating within that department.

Chapter II will acquaint the reader with the fundamentals of electric distribution construction. The various types of work crews will be introduced, and the methods of installing overhead and underground cable will be discussed. This material will be included to give the reader a better understanding of the remainder of the chapter; a discussion of three existing computer based cost estimating systems.

The first two systems to be discussed are the Louisiana Power and Light system, and the Detroit Edison system. Both

systems are batch oriented and represent solutions found for resolving the estimating problem by other utilities. The former sets forth concepts of data organization, while the latter introduces the concept of unitized kits of materials. Both will prove useful in aiding the author in the design of his system. The third system to be reviewed is one written by the University of Illinois Civil Engineering Laboratory for building and highway construction cost estimating. This system employs real time computer techniques beneficial for rapid estimating turn-around and local file maintenance.

Chapter III will acquaint the reader with the manual method of construction cost estimating currently used by Public Service. The preparation of the necessary data will be discussed first. The chapter will stress the complexity of estimating construction costs accurately, and the necessity of using highly qualified personnel to do estimates. The three estimate reports; the estimate general, the estimate summary, and the material list will be presented and illustrated in this chapter. Finally, the author will set forth his contention that a properly designed computer based estimating system could take much of the complexity out of the function. Such a system would make it possible to use

lesser skilled personnel for cost estimating. Accuracy could be improved, costs lowered, and turn-around time shortened.

Chapter IV will set up the basic criteria for designing a real-time computer based cost estimating system. The design of the required input will be introduced and proposed data sheets will be illustrated. The output from the computer will serve as a direct replacement for the manually produced reports which will be illustrated in Chapter III. A cost effectiveness study will be conducted among various vendor time-sharing services in order to select the most economic system.

Having selected a computer service, the problem of selecting an appropriate computer language will be tackled next. The FORTRAN IV and BASIC language will be compared for use in writing the system. After selecting a computer language, the layout and structure of the necessary data files will be discussed.

The latter part of Chapter IV will set up the general design criteria for the main program modules to be used in the proposed system. The system will contain eight modules divided functionally as to purpose. The first two will be designed to check and sort user input data. The second two will handle cost calculations for overhead construc-

ion. The fifth module will handle cost calculations for underground construction. The last three modules will produce the required estimate reports.

The final section of Chapter IV will deal with the problem of increased terminal usage required by the new cost estimating system. The load will be analyzed using queueing techniques. The results will show if more terminals are required.

In order to give the reader an understanding of how a cost estimating system could be written on a time-shared computer, Chapter V will dissect the operation of the main overhead module. This chapter will cover the operation of the module from the reading of the user input, through the cost calculation, ending with the output to a work file. Special emphasis will be placed on the use of a multi-structured random binary file for simplifying input.

Chapter VI will discuss the implementation of the new computerized construction cost estimating system in the eight field divisions of the Electric Distribution Department. Subsequent to the introductory phase, test cases will be run in each division to compare manual and computer estimate results. After the test runs are satisfactorily accomplished, a parallel run of the new and old system will be done.

Chapter VII will show whether the use of a computer based cost estimating system is economically justified. An analysis will be done which will determine the total fixed and variable costs associated with a manual and a computer estimate. Based on the estimated annual number of estimates prepared, a net benefit or loss will be shown.

The techniques used in the estimating system for file access and data handling will be shown to be applicable to other industries. The techniques used illustrate how a relatively small amount of available computer core space can be used to handle large programs and data files. The author hopes that the reader will gain some insight into the design and implementation of a computer based cost estimate system from the reading of this thesis.

CHAPTER I

ELECTRIC UTILITY INDUSTRY

Introduction

The need for accurate cost estimates is imperative in the Electric Distribution Department of Public Service. It will be the purpose of this paper to describe how a computer-based estimating system may be researched, designed and implemented by the author for this department.

In order to understand the role of cost estimating in the Electric Distribution Department of a large electric utility, it is necessary to have a basic understanding of the industry itself. The author will attempt to discuss the origins of the industry and of the specific utility that will serve as a framework for this paper; Public Service Electric and Gas Company of New Jersey. He will describe how electricity is distributed by this company. He will then focus on the organization of the Electric Distribution Department within the wider organization of the Electric Department. Having accomplished this the author will further focus on the project cost estimating cycle within the Electric Distribution Department.

Electric Utility Origins

The Electric Utility Industry got its start in the United States when Thomas Edison turned his attention to the problem of electric lighting in 1877.¹ In order to accomplish the task, he had to tackle six problems simultaneously.

- (1) Develop an economical generator.
- (2) Devise a conductor distribution system.
- (3) Invent a technique for voltage regulation.
- (4) Invent a practical lamp.
- (5) Develop a way of feeding current to multiple bulbs.
- (6) Devise a metering system.

Edison formed an electric light company and raised the required capital by selling shares. The concept of privately owned electric utilities was an early one in this country. In a four year span all the essential work was completed to meet the above six objectives. In 1881 all the required components for a central station lighting system were readied for service in New York City.

The first electric system was station oriented. The generators were small and could handle only localized load. The distribution system required such a heavy investment

1. Vennard, E., The Electric Power Business, New York, McGraw Hill Book Company, 1970, pp.4.

in copper cable that the area a generating station could handle was cost bound. The Pearl Street Station, located in downtown New York City, was Edison's first attempt at constructing a commercial electric station.² It could transmit electricity about five thousand feet from the generator. There were six such generators with a capacity of one hundred and twenty kilowatts each. When it began operations on September 4, 1882, it had a grand total of fifty-nine customers.³

In the next twenty years, a series of inventions and improvements made it possible for costs to be lowered so that the electric utility business became more of a commercial reality. The development of alternating current by George Westinghouse and his chief engineer, William Stanley, made long distance transmission of power possible. A radial type distribution system was developed that radically reduced the required amount of copper conductor and greatly reduced the costs of building distribution lines. The improvement of incandescent lamps in 1890 resulted in a fifty percent drop in their cost of operation. These factors and others moved the electric utility from the luxury field into the realm of necessity.

2. Collier's Encyclopedia, Volume 8, New York, P.F. Collier pp. 1121

3. Ibid. pp. 1122

After 1900 one of the most notable trends in the industry was the consolidation of small, individually owned stations into larger systems. This trend was noted by Thomas Nesbitt McCarter, then Attorney-General of the State of New Jersey. New Jersey, like many other states, was a patch-work of tiny electric utilities. It was McCarter's vision to combine these utilities under one company.⁴ The idea was to lease these companies for 999 years at rentals sufficient to cover their fixed charges and, if possible, dividend requirements.⁵ The new company was incorporated on May 6, 1903 under the name, Public Service Corporation of New Jersey

Public Service Electric Department

The Electric Department of Public Service provides electric service to an area of the state of New Jersey known as the "industrial corridor". This corridor is a forty mile wide strip of land between New York and Philadelphia. It contains nearly 80% of the state's population and industry. For the past twenty years electrical load has doubled in magnitude every ten years. The Company has grown in size from its modest start under McCarter to serve approximately 1,655,989 metered customers using 27,311,104,206 kilowatt hours of electrical energy.

4. Editors, "To Develop the State of New Jersey", Fortune Magazine, Nov. 1937, pp.100.

5. Ibid. pp.101.

This vast load is serviced by the company's Electric Department. It is the job of the Electric Department to plan, and supervise the construction of all major plant additions, such as generating stations, switching stations, and substations. It also plans, designs, and builds the system for transmitting the electricity from the generating stations to the user. The latter facet of the operation of the department falls under the jurisdiction of the Electric Distribution Department, a subdivision of the Electric Department. Before proceeding, it would be of benefit to the reader to become acquainted with the techniques of distributing electric energy.

How Electricity is Distributed

The illustration marked Figure 1.1 shows how electricity is transmitted from a generating station through various stages and equipment to customers.

The majority of power leaving the generating system is conducted over more than 893 miles of 138,000 volt and 230,000 volt transmission lines to 32 switching stations located in major load areas of the territory. Unlike the days of Edison, today's generating stations are located many miles from the ultimate user. The transmission system is supported on the familiar steel tower for the most part, however, some 90 miles are underground in high pressure oil

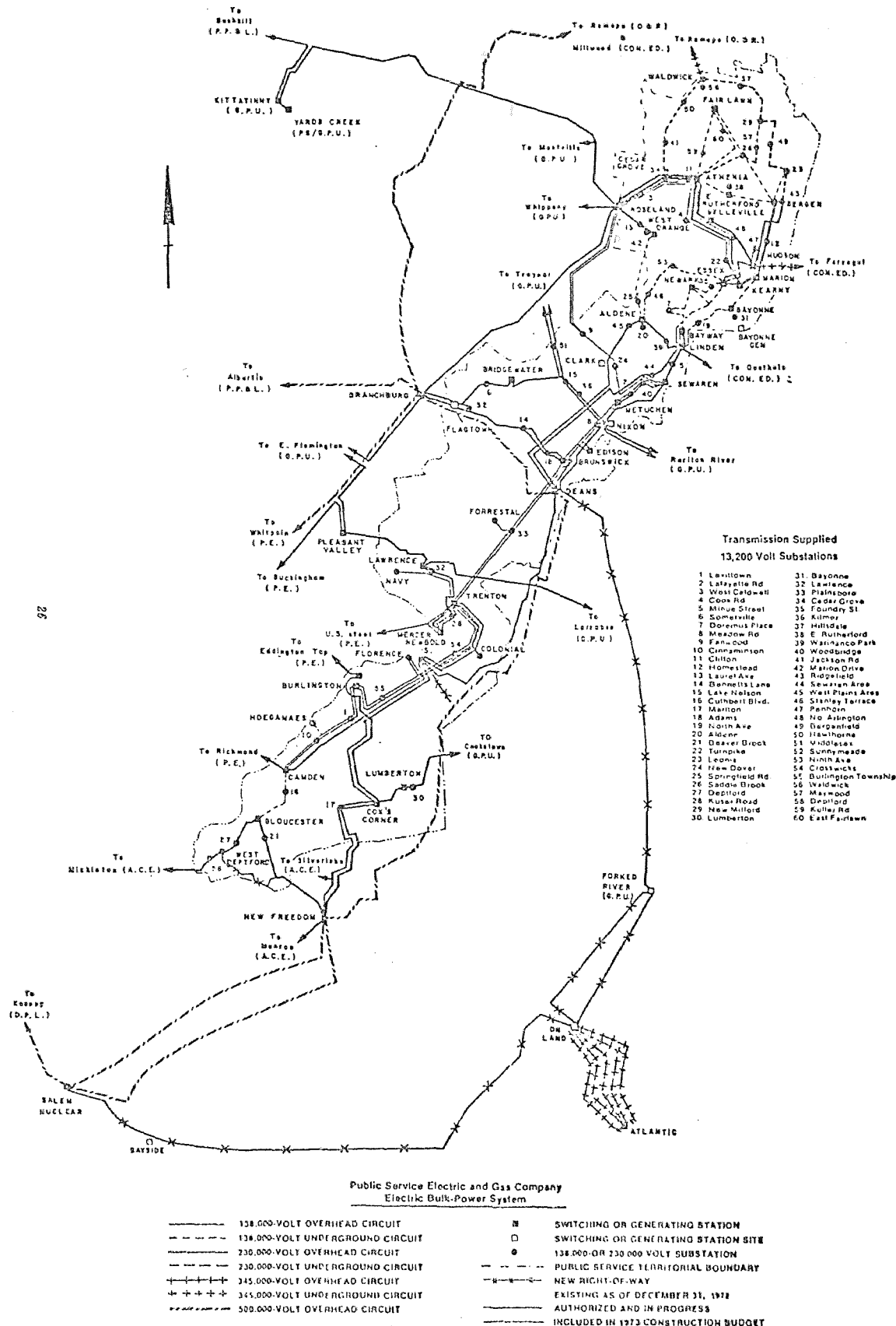
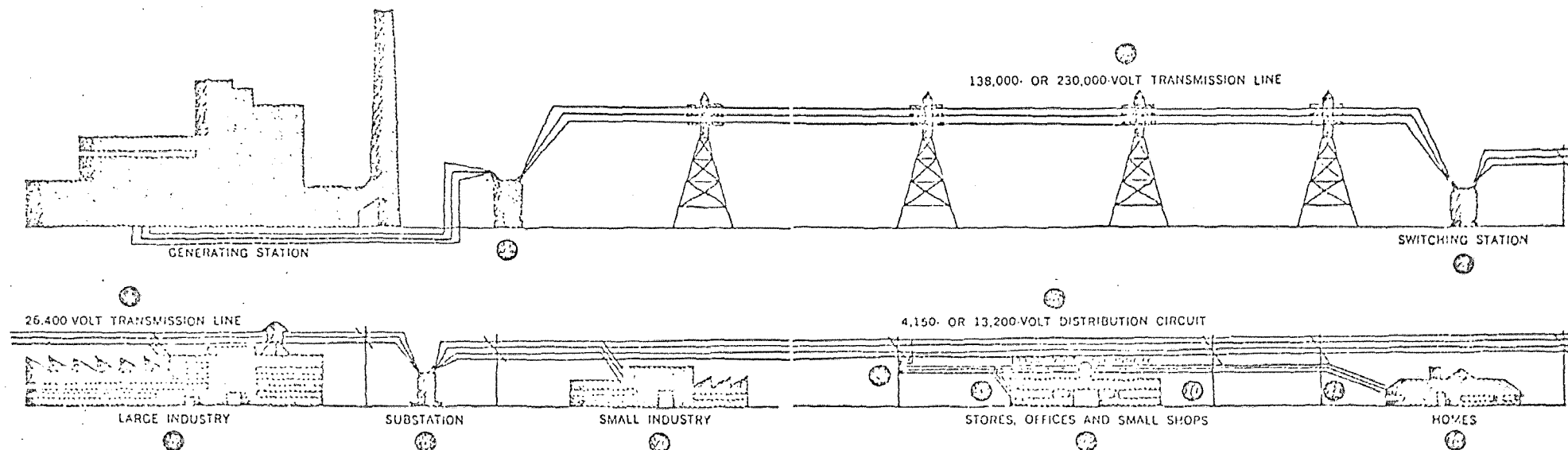


Figure 1.1 - Public Service Bulk Power System

pipe type cable. The design, construction and maintenance of the transmission system is part of the work of the Electric Distribution Department

When it reaches the switching stations, the power is stepped down by means of large transformers to 26,400 volts for transmission in smaller blocks to local areas. While stepping down the voltage to lower or subtransmission voltage is sometimes considered the primary function of switching stations, the control or switching of the large quantities of power which pass through these stations is also an important function. Therefore, the typical switching station is equipped with a number of high capacity circuit breakers for connecting and disconnecting the incoming and outgoing circuits. The switching stations are maintained and in part operated by the Electric Distribution Department.

The transmission system is linked with other companies in the Pennsylvania-New Jersey-Maryland (PJM) interconnection through 500,000, 230,000, and 138,000 volt lines connecting Public Service with other electric utilities in their respective states. The locations of transmission lines, switching stations and interconnections are shown in Figure 1.2.



The voltage at which the electricity is generated at the stations is raised by transformers (1) to 138,000 or 230,000 volts for economical transmission over the steel-tower lines (2) to the switching stations (3) and to some substations (6). In some instances, the generating stations deliver a portion of their output at the generated voltage of 13,200 volts or through transformation to 26,400 volts to subtransmission circuits (4) which supply substations (6) in their vicinity. At the switching stations (3), transformers reduce the incoming electrical voltage to 26,400 volts to serve the subtransmission system (4). The subtransmission circuits (4) radiate from the switching stations on wood pole lines to carry electricity to large industries (5) which purchase power at this voltage, and to numerous

substations (6) where the voltage is further reduced to 4150 or 13,200 volts — the primary distribution voltages. Certain users (7) of electrical energy frequently find it desirable and economical to purchase energy at these primary circuit voltages. The primary lines (8) feed transformers (9), which further reduce the voltage to 120/240 volts or other appropriate utilization voltage. The electricity then goes out over the secondary lines (10) and service wires (11) to stores, offices, and small shops (12), and homes (13). In congested areas or locations where overhead construction is not practicable or desirable, underground cables and equipment are used for either or both transmission and distribution. At the customers' premises the electricity is metered and then performs the many tasks and services which we have come to accept as a part of our everyday life.

Figure 1.2 - Basic Transmission and Distribution Voltages
Used by Public Service Electric and Gas Co.

Power is transmitted from the switching stations, or in some cases more directly from the generating station, to more than 244 substations and 193 customer owned substations by means of subtransmission lines operating at 26,400 volts. Subtransmission circuits of these voltages are often routed on wood pole lines, however, in congested areas, underground conduits are used. The subtransmission system is designed, constructed, and maintained by the Electric Distribution Department.

The past ten years have seen the increasing use of substations tapped directly to high voltage transmission sources. In 1972 approximately 44% of all Public Service electric load was fed in this manner. The use of subtransmission is by-passed with this method.

Substations, which transform the electric energy to a lower voltage for distribution over a local area, vary in size from 2000kVA (Kilo Volt Ampere) self-contained unit type substations serving a single distribution circuit to large multiple circuit substations of over 60,000kVA capacity. Substations are equipped with large circuit breakers, voltage regulation equipment, and complex relaying devices. While they are not designed and built by the Electric Distribution Department, they are operated and maintained by it.

Each substation feeds a specific geographic area, which may range in extent from one to many square miles, by means of primary distribution circuits operating at 4150 or 13,200 volts. There are over 1400 of these primary circuits. Some circuits are overhead operating on more than 600,000 wood poles, other are underground in conduit, and still others are direct buried in trenches. Ordinarily, primary circuits are from one to five miles in length, however, in rural areas they may extend to ten miles or more. The design, construction, operating and maintenance of primary circuits form the bulk of the work of the Electric Distribution Department.

Approximately 150,000 distribution transformers are connected to the primary distribution lines. These transformers serve the purpose of stepping down the primary voltage to the proper utilization voltage. Typically, this voltage is the 120/240 volt service which is a country-wide standard. The wires which carry power from distribution transformers to the customer are called the secondary system. The secondary system may be overhead on pole lines or underground. A majority of the customers in the Public Service system are served at 120/240 volts. Installation and maintenance of the secondary transformer and conductor system is another major function of the Electric Distribution Department.

Geographic Division of the Electric Distribution Department

The author has briefly introduced the principle components of the transmission and distribution systems. Each of these is composed of many devices, apparatus, and equipment. In order to install, operate, and maintain this equipment a great deal of manpower is required. About 4,300 employees are on the job to do this work. Obviously, it would be poor planning to operate so wide spread a system from one central location, therefore, the following eight locations are used:

- (1) Bergen Division, Hackensack
- (2) Camden Division, Moorestown
- (3) Elizabeth Division, Elizabeth
- (4) Essex Division, Irvington
- (5) Hudson Division, Secaucus
- (6) New Brunswick Division, New Brunswick
- (7) Passaic Division, Clifton
- (8) Trenton Division, Trenton

At the division level, a functional breakdown takes place with each organized as follows.

- (1) Substation Department - concerned with operation and maintenance of substation equipment.
- (2) Transmission Department - concerned with the installation and maintenance of high voltage tower lines.

- (3) Meter Department - concerned with the installation, testing and maintenance of watt-hour meters.
- (4) Service Engineering Department - concerned with providing electric service to new customers.
- (5) Line Department - concerned with the physical work entailed in constructing and maintaining overhead and underground, primary and secondary distribution systems.
- (6) Distribution Engineering Department - concerned with the planning, designing, estimating, and construction layout of the primary and secondary distribution systems.

It can easily be seen that department (5) and (6) above are closely allied. The Distribution Engineering Department is really the staff service group of the Line Department. It is in the Distribution Engineering Department that the project job cycle starts. Load forecasts from the Electric System Department in the Company's General Office in Newark supplemented with local division forecasts will indicate problem areas on subtransmission and distribution circuits. The Division Planning Engineer must find ways to alleviate these problem areas. It is his job to suggest alternative circuit rearrangements and reinforcements. He will also work with the major projects group of his local division to determine

a best feasible circuit route.

The Role of Cost Estimating

Formal requests for cost estimates are most often originated in the Project Sponsors Group in the Distribution Department's General Office staff. The estimates are prepared locally, in the appropriate field division. The estimates are based on the request and the plan devised by the local Planning Engineer. The estimate serves as a basis for requesting money in the annual capital construction budget.

The cost estimate plays a very important role in determining the feasibility of a project. On a local basis it is often the determining factor in deciding among several proposed alternative plans to accomplish the necessary load relief. On a departmental basis it serves as a basis for allocating capital construction funds among the eight field divisions.

Cost estimates serve as a basis for local division manpower planning. Since estimates are made well in advance of actual work, they are a valuable tool in determining required capital manhours for the coming year. Required operating and maintenance can also be forecasted based on the capital manhours described in the cost estimates.

Cost estimates also provide an invaluable aid in the area of construction cost control. As a project leaves the planning stage and is being worked on in the field, it would be impossible to determine the level of efficiency of job performance without the standard provided by the cost estimate. The estimate provides many details of a project including; material requirements, manhours, detailed costs, etc.; to act as standards by which to control the actual job.

The need for accurate cost estimates is imperative in the Electric Distribution Department of Public Service. It will be the purpose of this paper to describe how a computer-based estimating system will be researched, designed and implemented by the author for this department.

CHAPTER II
DISTRIBUTION CONSTRUCTION
AND
COST ESTIMATING SYSTEMS

Introduction

The purpose of this chapter is to acquaint the reader with the fundamentals of electric distribution construction. The various types of work crews will be introduced and the methods of installing overhead and underground cable will be discussed. This will be done to give the reader a better understanding of the latter part of the chapter which will discuss three computer-based cost estimating systems.

The first two such systems to be discussed are batch oriented and were written for estimating electric distribution construction. The final system to be reviewed was not designed for electric utility work, but is rather a general construction cost estimating system. This system is included because it was written using real time techniques.

Types of Line Crews - Overhead

Overhead construction is done by using various combinations of three basic crews. The three crews are:

- (1) The two-man Chief Lineman's crew
- (2) The three-man Chief Lineman's crew
- (3) The five-man Foreman's crew

Each crew can be used for many purposes and can best be defined by limitations agreed to in the union contract.

The two-man Chief Lineman's crew consists of a Chief Lineman and a Grade 1 or Grade 2 lineman operating a single bucket aerial lift truck. The crew is used to perform primarily street light and secondary cable installation and maintenance. This crew cannot work on energized primary wire operating at 13,200 volts.

The three-man Chief Lineman's crew consists of a Chief Lineman and two Grade 1 linemen. This type of crew operates a double bucket aerial lift truck. This type of crew can install transformers on energized construction. They can set poles up to forty-five feet in length. The limiting factor on the three-man crew is that it cannot install more than two phases of new primary construction.

The Foreman operated crew consists of five men. The make up of the crew can vary, but it normally has two Grade 1 linemen, one Grade 2 lineman and a line helper. This crew can do any type of overhead work including the installation of three phase primary wire.

Current practice has seen a decline in the number of Foreman operated crews and an increase in the Chief Lineman operated crews. A Chief Lineman is the highest step in the

unionized work force. He assumes some supervisory responsibilities, but not all. In practice, several Chief's crews are supervised by one roving Foreman. Operating efficiency has been increased in this way. Often, when three phase wire is to be installed, a roving Foreman can be used in combination with a three-man and a two-man Chief's crew.

Types of Line Crews - Underground

Underground crews are a bit more specialized than overhead crews. There are five basic crew types, including:

- (1) Splicing Crew Grade 2
- (2) Splicing Crew Grade 1
- (3) Chief Splicer Crew
- (4) Cable Pulling Crew
- (5) Trenching Crew

Each type of crew is used for specific applications in the underground operation.

The Splicing Crew Grade 2 is the most widely used crew. It consists of a grade 2 splicer and helper. The grade 2 crew can perform most types of straight splices used in underground construction. These splices can be made on cables under the 26,000 volt class.

The Splicing Crew Grade 1 consists of a grade 1 splicer and his helper. They can perform all the work of a grade 2

crew and also can make splices on 26,000 volt cables. They cannot make branch splices, however.

The Chief Cable Splicer functions much like the Chief Lineman in the overhead. He can perform some supervisory duties. Working in combination with grade 1 and grade 2 splicers, cable pieceouts and 26,000 volt branch splices can be performed.

The Cable Pulling Crew consists of a Foreman or Chief Mechanic, a mechanic grade 1, a winch truck driver and two helpers. This type of crew specializes in installing cable in underground conduit.

The Trenching Crew can be formed with any number of men from two to five. It is usually made up of a Chief Mechanic in addition to the required amount of underground helpers. The function of this crew is to trench and install conduit.

Distribution Construction

As stated earlier, the work of the Distribution Engineering Department is primarily concerned with the installation and maintenance of overhead construction. Primary overhead and underground cables can be of several voltage classes including 69-kV, 26-kV, 13-kV and

4-kV. In addition to differing voltage classes, cable can be purchased in many different current carrying capacities. Cable can be installed in several different configurations giving rise to a multiplicity of materials and varying labor requirements. The next two sections will give the reader an idea of what is involved in overhead and underground work; and to provide him with some background on the task involved in accurately estimating the cost of such work.

Overhead Construction

Overhead construction accounts for the majority of existing circuit miles on the Public Service system. Overhead construction is much less expensive to install than equivalent underground construction. This type of construction is most often used in suburban and rural areas of relatively low load density. Overhead circuits are radial in design, with tie points provided for load restoration during circuit failure.

Overhead construction uses wood poles for support. Wood poles come in a large variety of sizes and thicknesses. The Table in Figure 2.1 illustrates wood poles commonly used by Public Service. The estimator must be familiar with the application of each type and he must also know the cost of each type. The typical installation will

		CREOSOTED PINE									
CLASS OF POLE		0		1	2	3	4	5	7	APPROXIMATE WEIGHTS OF POLES OF DIMENSIONS OUTLINED	
TOP CIRC. INCHES		33"	29"	27"	25"	23"	21"	19"	15"		
POLE LENGTH	SETTING DEPTH	CIRCUMFERENCE 6' FROM BUTT (INCHES)								AVERAGE	MAXIMUM
25	6'			33.5				25.5		990	1188
30	5½'				34.0	32.0	29.5	27.5	23.5	454-CL7 660-CL5 921-CL3	638-CL7 875-CL5 1240-CL3
35	5½'		43.0**	39.0	36.5	34.0	31.5	29.0		1004-CL4 1343-CL2 1628-CL0	1337-CL4 1766-CL2 2429-CL0
40	6'	49.5**		41.0	38.5	36.0	33.5	31.0		1219-CL4 1622-CL2 3049-CL0	1678-CL4 2162-CL2 3659-CL0
45	6½'	52.5**		43.0	40.5	37.5	35.0			1731-CL3 1987-CL2 3009-CL0	2414-CL3 2162-CL2 4427-CL0
50	7'			45.0	42.0	39.0				2303	3060
55	7'			46.5	43.5	40.5				2670	3335
60	7½'			48.0	45.0					3916	4503
65	8'			49.5						4555	5284
70	8'			51.0						5242	5976
75	8½'			52.5						5857	6605
80	9'			54.0						6656	7322
85	9½'			55.0						7468	8087
90	10'			56.0						8466	8974

20.

Table 1.

* SETTING DEPTH SHALL BE 6' ON RURAL TYPE CONSTRUCTION WHERE SECTION LENGTHS AVERAGE OVER 150 FEET.

** CLASS 0 POLES WILL USUALLY REQUIRE EXTRA SETTING DEPTH AND/OR CRIBBING TO UTILIZE THEIR GREATER STRENGTH.

1. POLES WITH DIMENSIONS HEAVILY OUTLINED ARE THE STANDARD SIZES AND CLASSES PURCHASED BY PUBLIC SERVICE.

2. DIMENSIONS ARE THE MINIMUMS ALLOWED BY PURCHASE SPECIFICATIONS.

3. WHERE SOLID ROCK IS ENCOUNTERED, EITHER AT OR BELOW THE GROUND LINE, THE SETTING DEPTH FOR POLES MAY BE REDUCED AS SHOWN BELOW.

DEPTH BELOW GROUND LINE AT WHICH SOLID ROCK IS ENCOUNTERED	PERMISSIBLE MINIMUM TOTAL SETTING DEPTH				
	30' OR 35' POLE	25' OR 40' POLE	45' POLE	50' OR 55' POLE	60' POLE
0'-0"	3'-8"	4'-0"	4'-4"	4'-8"	5'-0"
0'-6"	3'-10"	4'-2"	4'-6"	4'-10"	5'-2"
1'-0"	4'-2"	4'-6"	4'-10"	5'-2"	5'-6"
1'-6"	4'-4"	4'-8"	5'-0"	5'-4"	5'-8"
2'-0"	4'-6"	5'-0"	5'-4"	5'-8"	6'-0"
2'-6"	4'-10"	5'-2"	5'-6"	5'-10"	6'-2"
3'-0"	5'-0"	5'-4"	5'-8"	6'-0"	6'-4"
3'-6"	5'-4"	5'-8"	6'-0"	6'-4"	6'-8"
4'-0"	5'-6"	5'-10"	6'-2"	6'-6"	6'-10"
4'-6"	5'-6"	6'-0"	6'-4"	6'-8"	7'-0"
5'-0"	5'-0"✧	6'-0"	6'-6"	6'-10"	7'-2"
5'-6"	5'-6"	5'-6"✧	6'-6"	7'-0"	7'-6"
6'-0"		6'-0"	6'-0"✧	7'-0"	7'-6"
6'-6"			6'-6"	6'-6"✧	7'-6"
7'-0"				7'-0"	7'-0"✧
7'-6"					7'-6"

✧ PROVIDED THE ADJACENT POLES IN BOTH DIRECTIONS ARE SET AT THE FULL STANDARD SETTING DEPTH.

4. ANY PERMITS REQUIRED BY THE AUTHORITIES AND NECESSARY CONSENTS OR PERMITS FROM PROPERTY OWNERS, COVERING SETTING OF POLES, MUST BE OBTAINED BEFORE STARTING WORK.

Figure 2.1 - Tables of Common Wood Poles and Setting Depths

usually call for a 35 foot class four thickness pole. This, of course, pre-supposes an uncluttered location in a straight run of wire where average height and mechanical strength will suffice. In installations where additional height is required to clear an obstruction or to provide necessary clearance for Bell Telephone Company cables, poles up to 90 feet in height may be used. The class number denotes thickness. A class 5 pole is thin while a class 0 pole is thick. Thicker poles are used for mechanical strength.

Poles are set by a three or five man crew. In general, the smaller crew can handle smaller poles in easy access areas. In order to install a pole, the crew must haul it from a stockyard to the installation site. Secondly, a hole is dug to a specified depth defined by the pole to be set. The hole can often be dug mechanically with a truck-mounted borer. In special cases, the hole may be dug with a shovel, a jack-hammer, or may even be blasted with dynamite. The estimator must know the conditions under which the pole will be set in order to accurately estimate the labor requirement.

Guying and anchoring - After the poles are set, the use of proper guying and anchoring must be employed to give the pole line needed strength. A pole line under stress from

the installation of conductors requires guy and anchors to avoid mechanical failure. The estimator must choose from a host of guy and anchor materials, including:

- (1) 3/8 in. galvanized guy wire
- (2) 5/16 in. galvanized guy wire
- (3) Light duty anchors
- (4) Heavy duty anchors
- (5) Swamp anchors
- (6) Power installed anchors

Each arrangement has a unique material cost requirement and associated labor cost.

Conductor Configurations - Overhead

Unlike underground construction, overhead conductors can be installed on poles in many different configurations. Conductors operating at the same voltage with similar current carrying characteristics can be installed on poles in different ways. The estimator must be familiar with the various configurations because each will use substantially different insulating and support material.

Open wire armless configuration - Three phase open wire armless construction uses three current carrying conductors and a non-supporting neutral. It is supported on the wood poles with an epoxy insulated V-bracket and an epoxy ridge pin. This type of construction is illustrated in Figure 2.2.

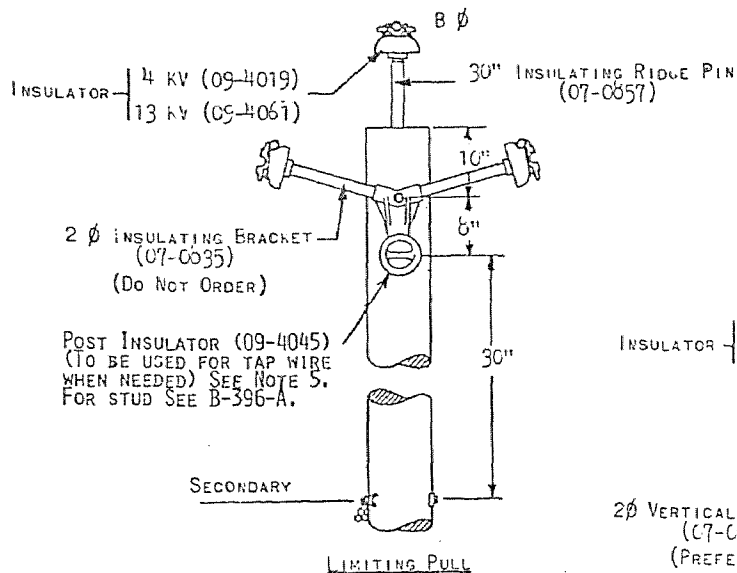


FIGURE 1

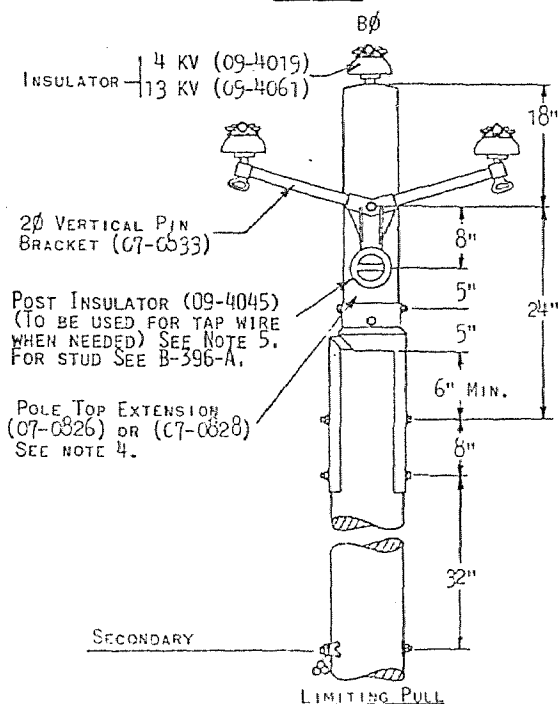


FIGURE 2

(TO BE USED ON EXISTING POLES
WHERE ADDITIONAL HEIGHT IS REQUIRED.)

FIGURE 3

1. SECONDARY CABLE OR A NEUTRAL WIRE MUST BE PRESENT AT THE SECONDARY LEVEL.
2. CONSTRUCTION SHOWN IN FIGURES 1 AND 2 MAY BE INSTALLED ON A 35 FT. POLE WITH LASHED SECONDARY.
3. IF PULL IS GREATER THAN 17 FT. (20), THE 30" INSULATING RIDGE PIN (07--857) MAY BE INSTALLED ON THE SIDE OF THE POLE USING EXISTING PREDRILLED HOLES TO HELP PREVENT POLE TOP SPLITTING.
4. (07-0826) FITS POLE WITH 21 - 28 INCH CIRCUMFERENCE, (07-0828) FITS POLE WITH 27 - 34 INCH CIRCUMFERENCE.
5. USE (09-4080) WHEN SUPPLY OF (09-4045) IS EXHAUSTED.

Figure 2.2 - Open Wire Armless Construction

This type of construction is preferred by Public Service because of its appearance, lightning protection ability, and good current carrying capacity.

The estimator must be familiar with the insulating brackets used for normal pole tops as well as construction used for special purpose pole tops including:

- (1) Dead end pole top - used to stop a run of wire or as part of other special purpose pole tops.
- (2) Small angle pole top - used when conductors form a small angle at the pole causing stress.
- (3) Large angle pole top - used when conductors form a large angle at the pole.
- (4) Riser pole top - used at the termination of underground cable at a point where it taps into the overhead.
- (5) Lightning arrester pole top - used for lightning protection installations.
- (6) Extension pole tops - used for extra height when an existing pole is too short.
- (7) Side extension pole tops - used when it is necessary to clear an obstruction.
- (8) Switch or recloser pole top - used when a break or tie point is to be installed.

The estimator must be familiar with the various types of crossarms, brackets and insulators necessary to build these

pole tops in each configuration type.

Spacer cable configuration - Spacer cable was once widely used on the Public Service system but has fallen into some disfavor because of lightning protection problems. However, it is still used where room is critical. Spacer cable is supported by a high strength neutral messenger. The individual conductors are separated by plastic or porcelain spacers depending on voltage class and application. The spacers are attached to the supporting messenger to effect a uniform loading. Spacer cable is illustrated in Figure 2.3.

The estimator must be aware of the uses of spacer cable. He must be aware of the additional lightning protection requirements and the higher cost of installation associated with this type of construction.

Open wire configuration - Open wire construction is an older, but still used method of installing overhead wire. It is often used in areas where there is poor access for repair. Conductors are installed on eight to ten foot crossarms using steel ridge pins and porcelain insulators. Conductors are widely and unevenly spaced, resulting in greater reactance losses, but better lightning protection. Open wire construction is illustrated in Figure 2.4.

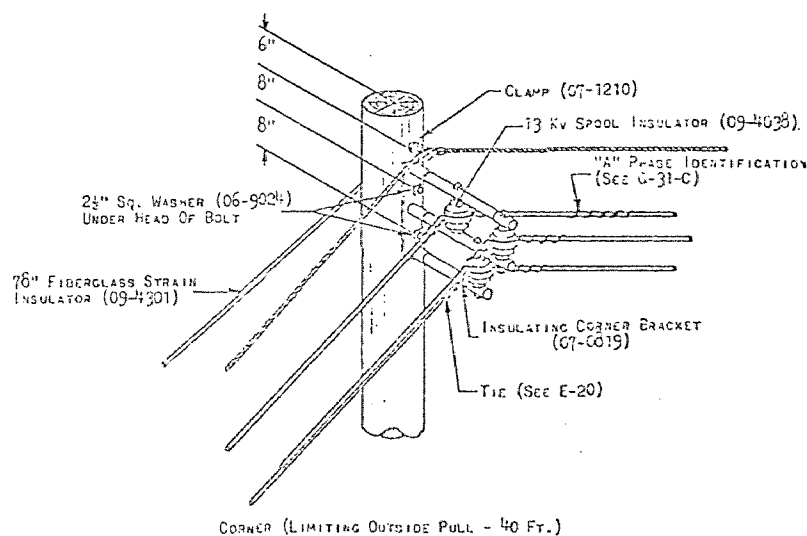
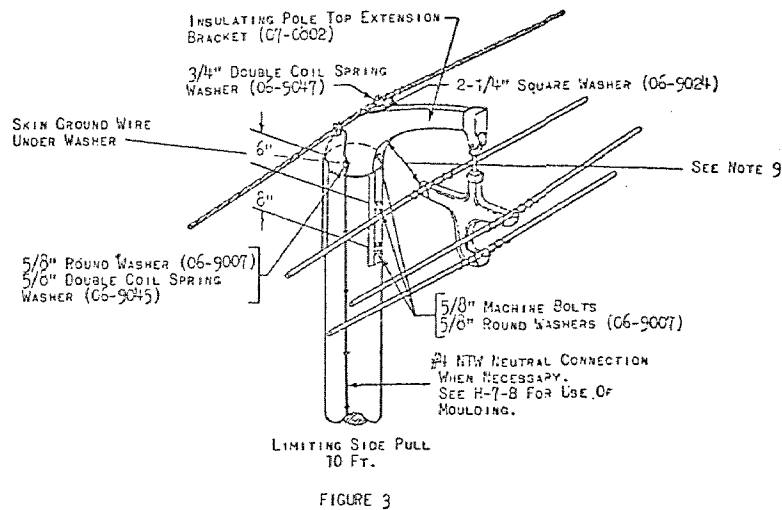
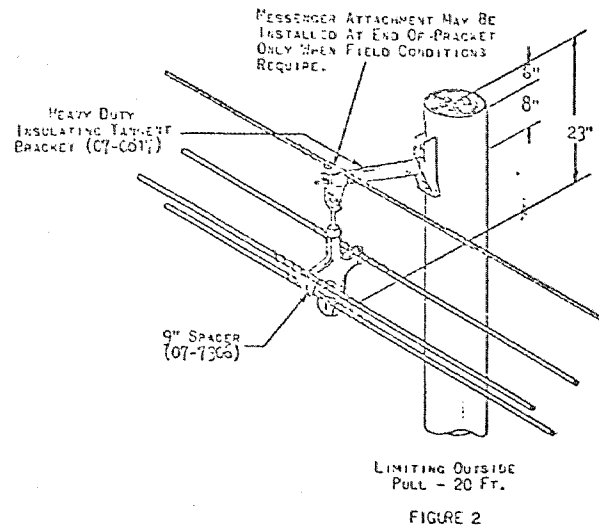
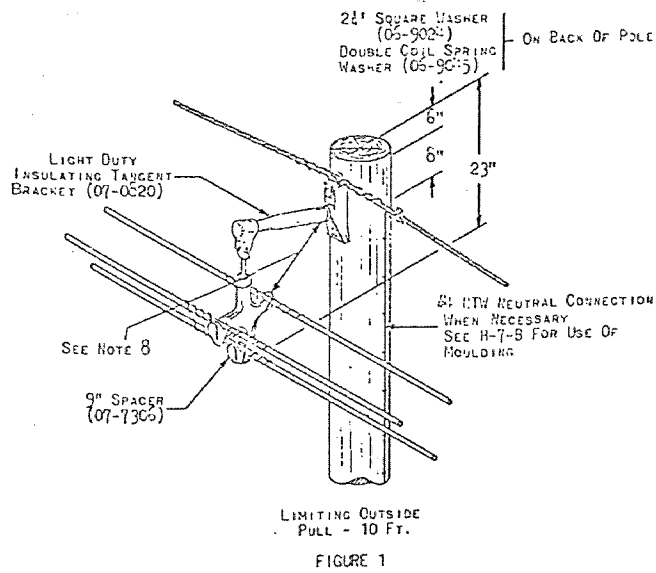


Figure 2.3 - Spacer Cable Construction

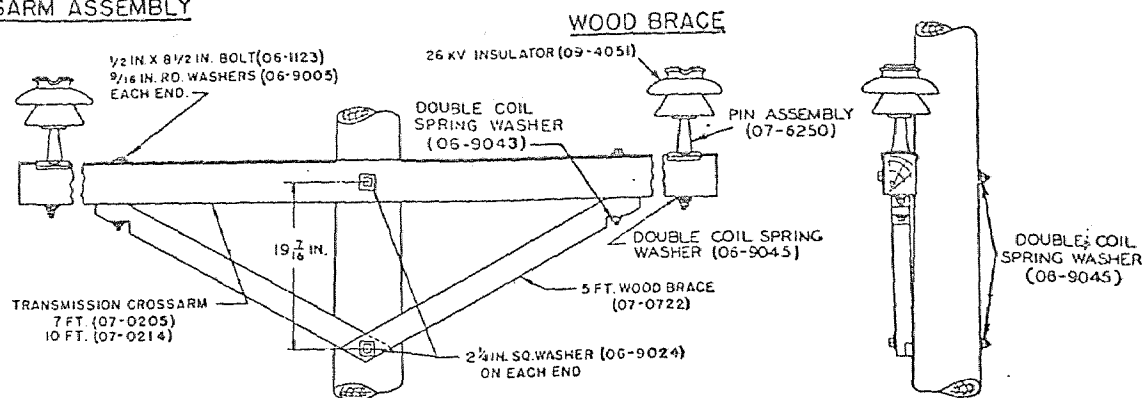
CROSSARM ASSEMBLY

FIG. 1

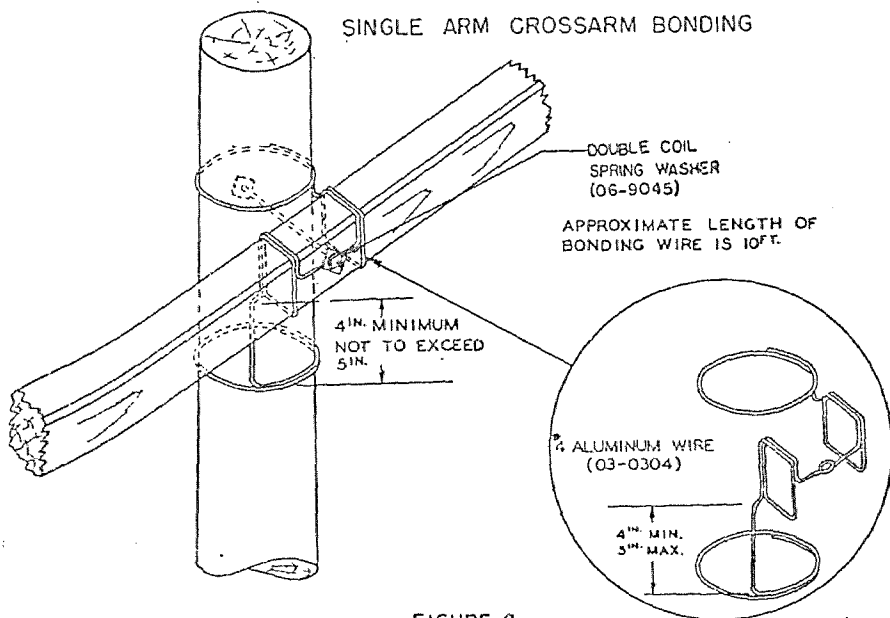
SINGLE ARM CROSSARM BONDING

FIGURE 2

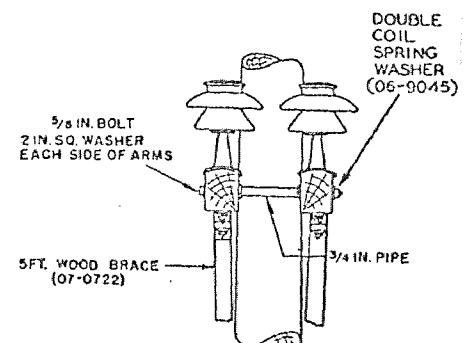
DOUBLE ARMS
(SEE NOTE 7)

FIGURE 3

1. DOUBLE ARMS (FIG. 3) SHALL BE INSTALLED WHERE GUYS ARE REQUIRED, WHERE SPAYS EXCEED 175 FT. AND CROSSING OVER MAIN LINE RAILROADS AND COMMUNICATION LINES, OPEN WIRE OR CABLE, AND WHEN REQUIRED BY F-2013, OPERATION OUTSIDE PLANT.
2. BONDING SHALL BE INSTALLED ON POLES WHERE SPECIFIED TO PREVENT POLE BURNING. DIRTY INSULATORS AND LOOSE HARDWARE CAN CAUSE POLE BURNING. THESE CONDITIONS SHOULD BE CHECKED AND CORRECTED ON ROUTINE POLE TOP INSPECTION AND WHEN INSTALLING BONDING.
3. BONDING SHALL NOT BE INSTALLED ON CROSSARMS ON WHICH PROTECTOR TUBES ARE MOUNTED.
4. BONDS AT DIFFERENT CROSSARM LEVELS SHALL NOT BE INTERCONNECTED.
5. STAPLES (06-7713) SHALL BE USED TO HOLD BONDING WIRE IN FIRM CONTACT WITH WOOD. TWO STAPLES ARE TO BE USED IN EACH OF THE THREE AVAILABLE CROSSARM FACES AND ADDITIONAL STAPLES SPACED AT THREE INCH INTERVALS AROUND THE POLE.
6. ON DOUBLE ARM POLES THE SECOND BONDING WIRE SHALL BE INSTALLED FROM THE SECOND CROSSARM AND THE TWO BONDING WIRES SHALL BE STAPLED WHERE THEY ENCIRCLE THE POLE.

Figure 2.4 - Open Wire Construction
(P.S.E.&G. Constrn Mnl.)

The estimator must be aware of the proper insulators used for different voltage classes used in this type of construction. Since this type of configuration is most often installed in areas of difficult access, the estimator must calculate the additional labor requirement to install the construction project.

Lashed cable configuration. This type of construction was once popular because of ease of installation. It has limited use now, because of the frequency of failures experienced with it. Lashed cable is made up of a bundle of conductors surrounded by a metal strip wound around them. It is supported by a neutral messenger. This type of construction requires no insulating brackets or crossarms. See Figure 2.5.

Aerial Cable. Aerial cable is really underground type cable run along a pole line. The cable is run through rings and is supported by a messenger. It is used where extreme reliability is required in an overhead application. This type of construction is illustrated in Figure 2.6.

The estimator must be familiar with the types of underground cable suitable for this application. He must know the proper support rings to use. He must also be aware of the installation and splicing methods required.

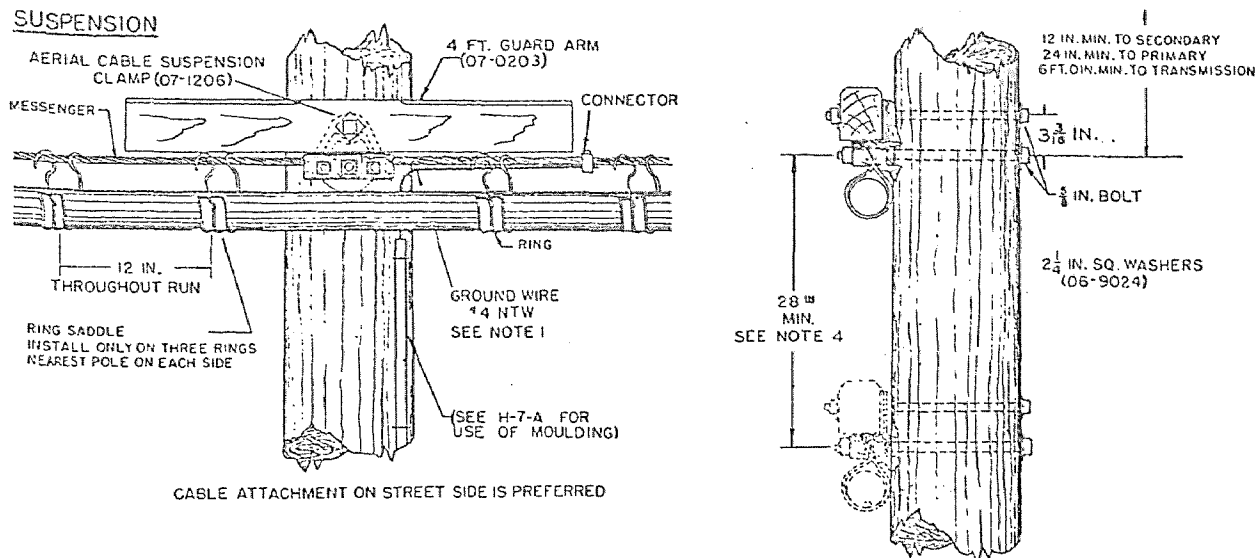


FIG. 1

MESSENGER		RINGS	RING SADDLES
MATERIAL	CODE NO.	CODE NO.	CODE NO.
1/16" COPPERWELD	03-5106	07-6615	07-7006
5/16" COPPERWELD	03-5108	07-6616	07-7007
5/16" GALVANIZED	03-5007	07-6601	07-7001

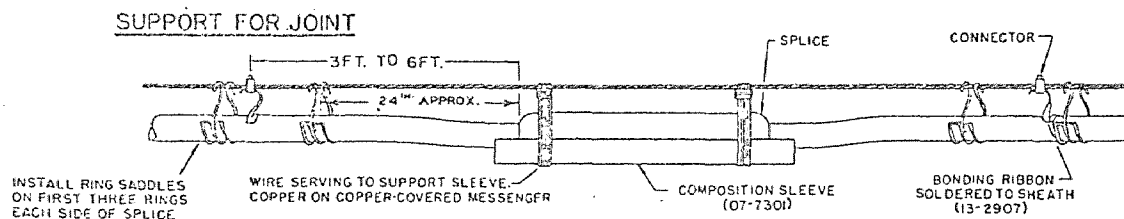


FIG. 2

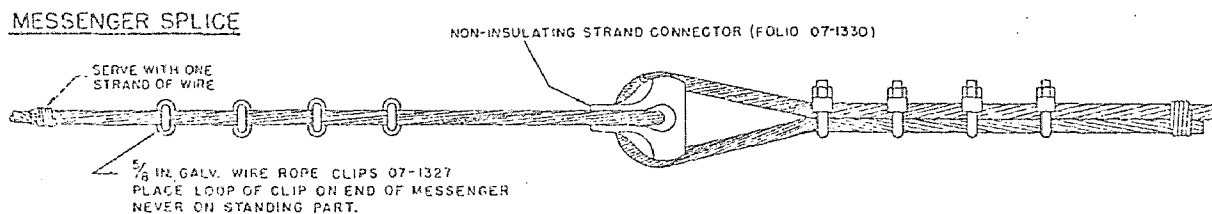


FIG. 3

Figure 2.6 - Aerial Cable Construction
(P.S.E&G. Constrn. Mnl.)

Underground Construction

Overhead construction is used in light to medium load density areas. In urban areas of heavy load density the distribution system is installed underground. Choice between overhead and underground depends on a number of widely differing factors. Comparative economics is the most powerful factor influencing the choice. The capital cost of an underground system may be five to ten times greater than that for an overhead system.⁶

Underground distribution systems as constructed by Public Service Electric and Gas Company use conduit sections carrying insulated cable. The conduit sections are run between manholes below street or sidewalk grades. Conduit, cable, and manhole locations are almost infinite in variety.

Conduit Construction. Conduits are the hollow tubes in which cables are installed. Conduits are seldom installed singularly, but rather in groups called duct banks. The size of the duct bank depends on the diameter of the largest cable to be installed, the length of cable to be run between manholes, and the number of bends. Conduit comes in a large number of sizes. However, little is gained by using smaller sizes. The four inch and five inch conduit are the commonly used sizes.

6. Skrotzki, G. A., Electric Transmission and Distribution, New York: McGraw Hill Book Company Inc., 1954, Page 184

The number of ducts depends upon local load requirements. Provision should be made for required circuits and for future expansion. Eight to sixteen ducts in a bank is the usual requirement for a main run, while four to six ducts on side branches will suffice. Ducts are also made of various materials including:

- (1) Concrete
- (2) Concrete-Asbestos
- (3) Poly Vinyl Chloride

Selection of proper duct material depends on installation requirements.

Installation of a conduit system begins with trenching. Trenching is normally contracted out to various independent contractors. However, a certain amount will be done by a trenching crew. A trench approximately three feet wide averaging five feet in depth is dug between manhole locations. Factors which effect required manhours for trenching include:

- (1) Location of trench - street, sidewalk, open field.
- (2) Condition of soil for digging - sand, mud, rock.
- (3) Use of mechanical equipment.

The estimator must properly decide on required trenching labor to accurately arrive at costs.

Coincident with trenching would be the larger excavations required for manhole locations. The three factors

mentioned above also influence the required labor for manhole installations.

After trenching and manhole installation is completed, comes the installation of the conduit in banks which connect manholes. The selected type and number of ducts are arranged into standard banks. This is illustrated in Figure 2.7. The ducts are held in place by temporary forms. Cement is poured into the forms to make a permanent arrangement. The trenches and excavations are back-filled and streets and sidewalks are repaved to complete the job.

Cable Installation. Interdependent with duct selection and sizing is the choice of cable. Most underground cable is lead sheathed, and also, oil-impregnated, paper-insulated. Cable comes in various sizes according to the load it is expected to carry and voltage at which it is to operate. A table of commonly used cable is shown in Figure 2.8.

After the installation of conduit and manholes comes the installation of underground cable. The new conduit is tested for continuity by passing a rod through it. A rope is attached to the rod and pulled through the conduit. The rope in turn is used to pull a steel cable attached to the underground cable. The cable is pulled through the

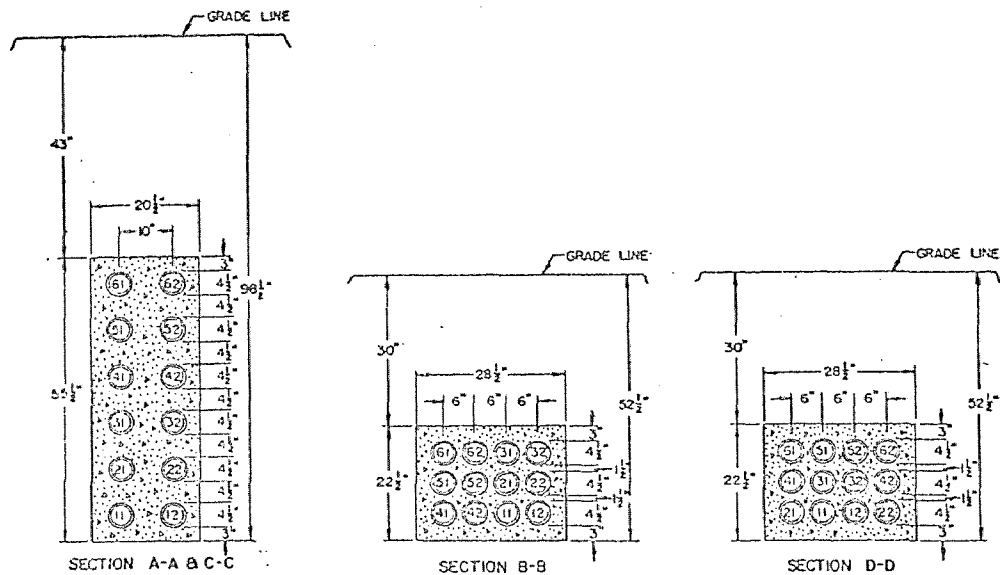
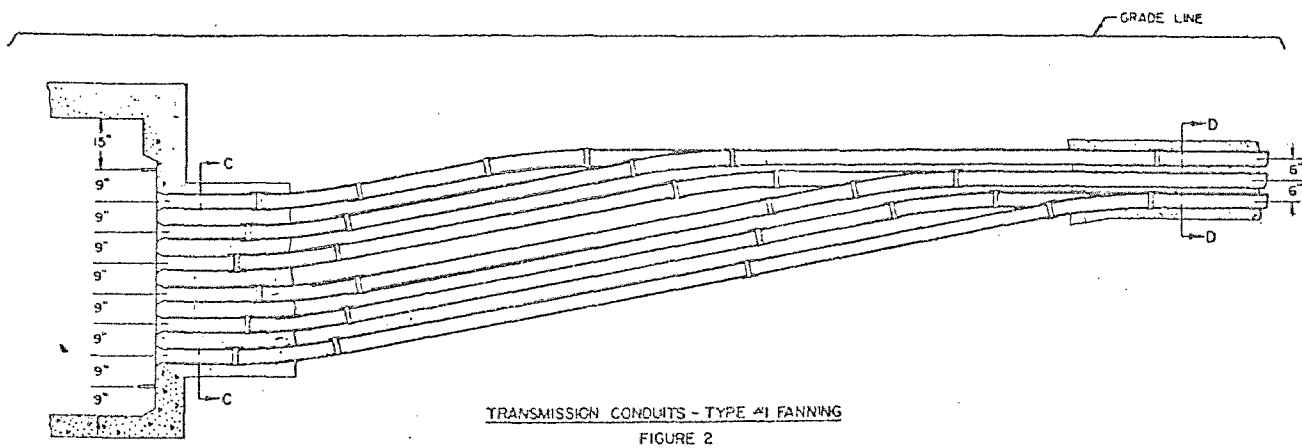
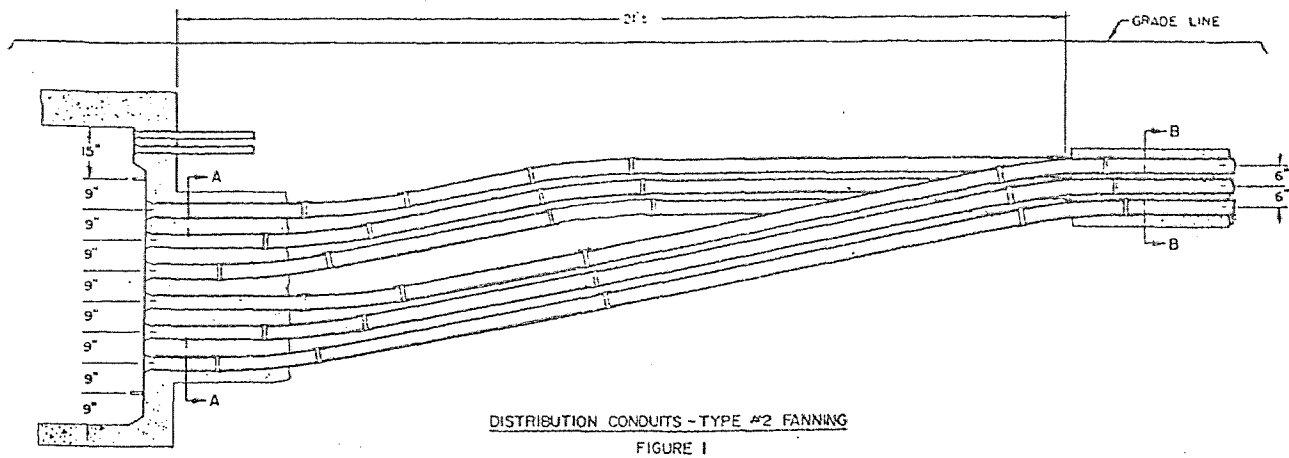


Figure 2.7 - Typical U.G. Duct and Conduit Arrangements
(P.S.E.&G.)

UNDERGROUND CABLE CONSTANTS (SEE NOTE 1)

	SIZE	TYPE ⁺	R AT 65°C (Ω/1000 FT.)	X	Z
<u>4-KV DISTRIBUTION</u>					
	#4	3/C	.300	.036	.302
		3-1/C	.300	.050	.305
	#1	3/C	.150	.033	.154
		3-1/C	.150	.045	.157
	2/0	3/C	.096	.030	.101
		3-1/C	.096	.041	.104
	4/0	3/C	.062	.029	.068
		3-1/C	.062	.040	.074
	350	3/C	.038	.027	.047
		3-1/C	.038	.038	.054
	500	3/C	.028	.026	.038
		3-1/C	.028	.035	.045
	750	3-1/C	.020	.034	.039
	800	3/C	.019	.025	.031
<u>13-KV DISTRIBUTION</u>					
	2/0	3/C	.096	.035	.102
		3-1/C	.096	.047	.107
	500	3/C	.028	.030	.041
		3-1/C	.028	.038	.047
	800	3/C	.019	.027	.033
		3-1/C	.019	.036	.041
<u>13-KV SUBTRANSMISSION</u>					
	2/0	3/C	SOLID .096	.035	.102
	350	3/C	SOLID .038	.030	.048
	500	3/C	SOLID .028	.029	.040
	800	3/C	SOLID .019	.027	.039
	2/0	3/C	LPGF .096	.033	.102
	350	3/C	LPGF .038	.032	.050
	500	3/C	LPGF .028	.029	.040
	800	3/C	LPGF .019	.026	.032
<u>26-KV SUBTRANSMISSION</u>					
	2/0	3/C	SOLID .096	.042	.105
		3-1/C	SOLID .096	.052	.109
	350	3/C	SOLID .038	.035	.052
		3-1/C	SOLID .038	.041	.056
	500	3/C	SOLID .028	.033	.043
		3-1/C	SOLID .028	.039	.048
	800	3/C	SOLID .019	.030	.036
		3-1/C	SOLID .019	.036	.041
	2/0	3/C	LPGF .096	.039	.104
	350	3/C	LPGF .038	.037	.053
	500	3/C	LPGF .028	.033	.043
	800	3/C	LPGF .019	.030	.036

*3-1/C INDICATES THREE SINGLE-CONDUCTOR CABLES INSTALLED TOGETHER
IN ONE DUCT.

NOTE 1 - VALUES OF R, X AND Z ARE OHMS TO NEUTRAL ON VOLTAGE BASE CORRESPONDING
IN EACH CASE TO THE INDICATED VOLTAGE RATING.

NOTE 2 - VALUES IN THIS TABLE ARE AVERAGE FIGURES FOR THE SEVERAL INSULATION
THICKNESSES THAT HAVE BEEN USED AT THE VARIOUS VOLTAGES.

Figure 2.8 - Partial Listing of U.G. Cables
(P.S.E.&G. Constrn. Mnl.)

duct by means of a winch on a truck at the adjoining man-hole. This process is illustrated by Figure 2.9.

Underground cable is very expensive. Most cable costs in excess of ten dollars a foot. The cable is ordered in very precise lengths to avoid waste. The cable is purchased in lengths so that it can be pulled through the conduit leaving enough extra at each end for racking and splicing. The estimator must be very exact when estimating the cost of underground cable. Prices tend to fluctuate rapidly on this type of cable due to the high content of copper and lead. An estimate done with today's prices may be too low in a year's time.

Cable Splicing. After the cable is pulled, it must be spliced. As mentioned earlier, most splices can be done by a Grade 1 or Grade 2 splicing team. Splicing an underground cable requires the peeling back of the lead sheath, and the stripping of the paper insulation from the three conductors. After this is done, copper connectors are placed on the conductors and are compressed and soldered in place. Insulation is wound back on the conductors and the spliced area is covered with a lead sleeve. The sleeve is soldered to the lead sheath of the cable, making the unit water tight.

Splicing is a time consuming operation. Each cable

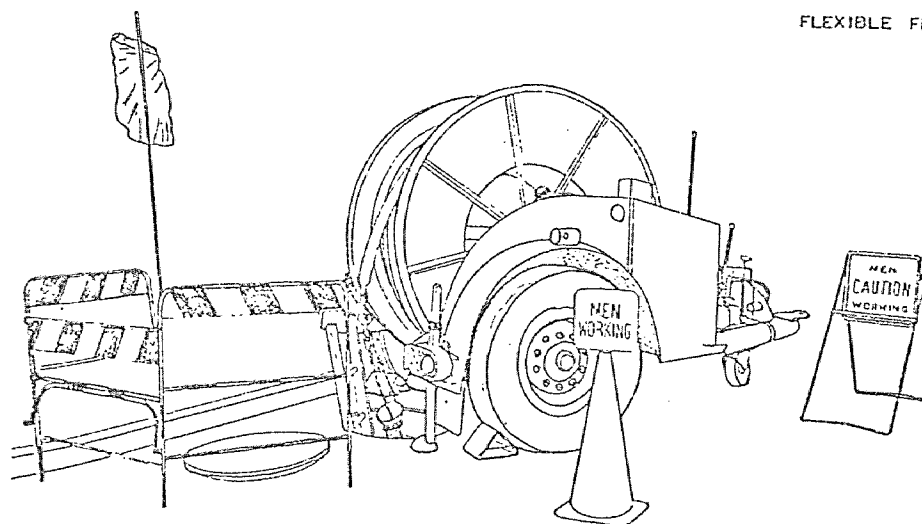
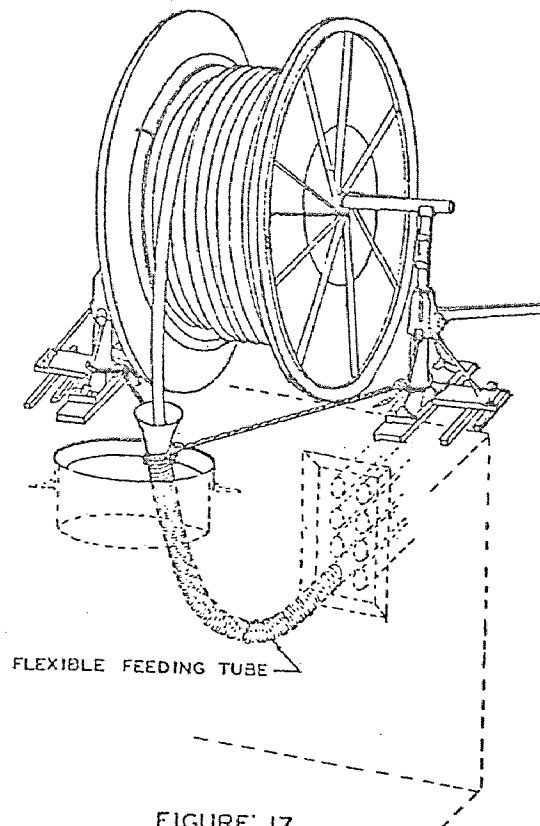
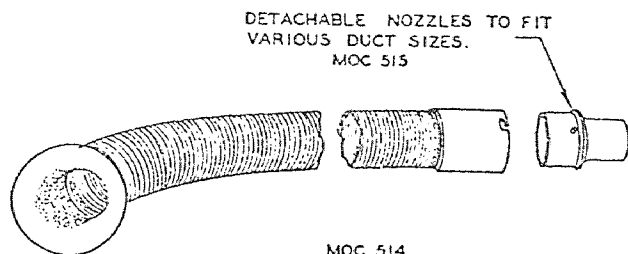


Figure 2.9 - U.G. Cable Pulling Gear
(P.S.E.&G. Constrn. Mnl.)

type, of which there are approximately forty, requires a different splicing time. The straight splice described requires about eight manhours to execute. Splices on gas-filled cable may take as long as thirty hours.

The Estimating Task

The task of estimating overhead and underground construction is not an easy one. The estimator must have full knowledge of the construction with which he is working. He must work with large varieties of material and know current costs. He must know the component parts that make up a construction unit. The previous sections give an idea of the scope of this problem.

Perhaps more difficult than the material portion of the estimate is the calculation of the required labor. Distribution work is done in the field, not in the confines of a factory. Field conditions vary greatly. Base labor hours may be applied to major units of construction. However, sufficient room must be left for engineering judgment of field conditions. Labor is not constant on similar jobs done in different locations. It is not constant for similar jobs done during different seasons. Varying traffic conditions may change the required labor for a job. All these factors must be borne in mind by the estimator.

Using manual estimating systems, field construction estimators are burdened with considerable record keeping. In addition to the record keeping, there is a considerable amount of calculation required in cost estimating. Estimating appears to be an excellent task to assign to electronic computers. Before designing such a system, it will be helpful to review what others have done in this area. The following section will review three such computer systems.

Review of Three Construction Cost Estimating Systems

Researching the literature available on cost estimating turned up many systems programmed for computer use. Quite a few of the systems are similar in concept. Included for discussion here are three which the author feels are representative. Each has some features which are worthwhile for inclusion in a cost estimating system designed for Public Service Electric Distribution Department.

Louisiana Power and Light Cost Estimating System

This system was investigated because it is one of the earliest attempts by the utility industry to computerize the cost estimating function. Louisiana Power and Light has used an electronic computer to some extent in the cost estimating area since 1958.⁷ The current form of the system was designed in 1962 and implemented in 1965.

7. Kittrel, Lee L., "Job Estimating by Computer", 1969 PICA Conference Proceedings, IEEE Publishing Co. N.Y. pp. 318.

The basic concept of this system is the construction plan. See Figure 2.10. The construction plan form was designed to be used by the field engineer. It was designed to help set up engineering specifications for line construction in an orderly way. The specifications required in the L.P. & L. system are written in the form of codes and quantities. The specifications written in such a way are used by the programs to provide the required costs for each job.

The construction plan is divided into three major parts:

- (1) Title Block
- (2) Drawing Area
- (3) Notes Area

The notes area is subdivided into sections down the page and across the page as either the pole or span columns. The form is designed to handle installs, removals, transfers, and salvage. On the drawing, each pole location where work is to be done is identified with a pole number which, in turn, correlates with an entry on the bottom half of the sheet. The tabular bottom section of the form is used for describing the work to be done and the materials to be used to accomplish the job.

The L.P. & L. system uses a logical system of names, each of which described a type of structure or unit. In order to completely specify a type of structure or unit for

INSIDE AND TOWNS OF 2500 & OVER <input type="checkbox"/> INSIDE AND TOWNS OF LESS THAN 2500 <input type="checkbox"/> INSIDE UNINC. TOWNS <input type="checkbox"/> OUTSIDE OF ALL TOWNS PARISH <u>ORLEANS</u> WARD <u>3</u> DIST <u>5</u>		TEL. REQUEST NO. <u>1497</u> RURAL <input type="checkbox"/> URBAN <input checked="" type="checkbox"/> 12' TALL CLEAR <input checked="" type="checkbox"/> 15' TALL CLEAR <input type="checkbox"/> POINT OF RAY <input type="checkbox"/> TOWER TERMINUS <input checked="" type="checkbox"/> POLE W. L.S. <input checked="" type="checkbox"/> L.S. ADDED <input type="checkbox"/> NEW <input type="checkbox"/> L.P.B. <input checked="" type="checkbox"/> RED <input type="checkbox"/>		LOUISIANA POWER & LIGHT CO. NEW ORLEANS, LA. NEW ORLEANS - SERVICE TO 538 OAK STREET		DRAWN BY <u>L. L. K.</u> DATE <u>12-1-68</u> CHECKED BY <u>R. A. Z.</u> OFFICE NO. <u>3-66-1734</u> APPROVED BY <u>H. L. D.</u> SCALE <u>NONE</u> REVISION <u> </u> SHEET <u>1 OF 1</u>	
--	--	--	--	--	--	---	--

RIGHT OF WAY		20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
X-TYPE		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
POLE DATA	PRISM	0	04															
	NEU	11	01															
	SEC	3	407															
		3																
POLE DATA	PRISM	14		04														
	NEU	5		04														
	SEC	16		407														
		17																
SPAN		25		300	270	300	270											
POLE NUMBER		4	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
COORDINATES X-Y		21																
HUT W. RA		72																
P	30	30																
	35	31																
	40	32																
	45	33																
	50	34																
	55	35																
E	60	36																
	65	37																
	70	38																
	75	39																
	80	40																
	85	41																
S	90	42																
	95	43																
	100	44																
	105	45																
	110	46																
	115	47																
A	120	48																
	125	49																
	130	50																
	135	51																
	140	52																
	145	53																
C	150	54																
	155	55																
	160	56																
	165	57																
	170	58																
	175	59																
M	180	60																
	185	61																
	190	62																
	195	63																
	200	64																
	205	65																
S	210	66																
	215	67																
	220	68																
	225	69																
	230	70																
	235	71																

Figure 2.10 - L.P.&L. System Data Sheet

the computer, additional characteristics must be disclosed. These basic characteristics include the type of conductor, voltage, span length, and whether the particular structure is to be worked while energized or de-energized. The construction plan has been organized so that information is described once for a pole or span, and will automatically be associated with the various rows of that column.

The voltage row describes the primary voltage for the entire line, or for each span as the case may be. The conductor section relates to the type of wire, the number of wires, and the type of conductor for each span. Span length in feet is shown in the span row, and poles that are to be worked with lines in an energized condition are indicated by an "H" in the appropriate column of the hot work row.

The remaining rows are used for specifying the various structure types at each location. Since the characteristics of the specified structures are already indicated, the L.P. & L. program can determine the particular variation to be used when a unit is called for on the rest of the form.

The L.P. & L. system incorporates a data checking routine. A listing of detected errors accompanies the store requisitions so that corrections can be made. Cards, which are the input to the main processing program, can be corrected and the program may be rerun if necessary.

The main data files are stored on magnetic tape, and must be converted to disk file units prior to processing. This is accomplished through a utility program which also reformulates the file adding required accumulator space.

The main processing program is written in COBOL. L.P.& L. explains the use of this language by stating; "COBOL is used since the majority of the activity consists of input-output, table lookup, and file definition."⁸

Upon entering the individual jobs into the computer, the voltage, conductor, span and hot work tables are compiled for separate pages within the jobs. As itemized units are read and analyzed, these tables are accessed in order to pick out the variations of the specified unit. The disk file is searched for the proper entry. When it is found, the temporary storage locations or accumulators are posted to record a use for the particular unit. When a desired variation does not exist, a diagnostic is printed out. The procedure continues until all units are posted to the units file as usage or have been skipped due to an error.

After the unit processing stage has been completed, the L.P.& L. program enters the phase in which the cost estimate is prepared, and the material quantities are

8. Ibid. pp 332.

posted to the material item file. The disk file is searched for units which were used to do the job. As the units are read back in, the appropriate accumulators in core are posted and totaled, indicating the new construction, maintenance, or removal figures. Each item that makes up the unit must be posted and updated so as to yield the correct amount of new construction materials desired. The above process is continued until all units that showed a usage have been processed.

The used units also have been read back into the computer and processed in order according to certain classifications and categories. This is done so that the construction cost estimate, Figure 2.11, can be printed out once a given category has been processed and completed. When the program completes the cost estimate, it enters the bill of material phase. The material item disk file is now searched for items that have indicated a usage on new construction work. This file will be printed out indicating the quantity used, class item or stock number and the item description. The material report is shown as Figure 2.12. When the estimate is completed, the accumulators in core and the disk file are initialized to zero and the next estimate is started.

Comments on the L.P. & L. System. The L.P. & L. system presents some good ideas on organizing input data. The use

LOUISIANA POWER AND LIGHT COMPANY
CONSTRUCTION COST ESTIMATE

JOB 3-66-1234 NEW ORLEANS - SERVICE TO 538 OAK STREET

DEC. 1, 1968

ITEM	TYPE WORK	NEW QTY.	CONSTRUCTION		MAINTENANCE		REMOVALS		
			LABOR	MATERIAL	QTY.	LABOR	QTY.	LABOR	RETIRE SALVAGE
RIGHT-OF-WAY CLEAR AND TRIM CONDUCTOR			50.00	.00		.00		.00	.00
OA	COLD	1958	88.11	91.52		.00		.00	.00
40T	COLD	979	97.98	274.12		.00		.00	.00
POLES									
B	COLD	1	10.00	6.43		.00		.00	.00
45/3	COLD	1	30.00	50.19		.00		.00	.00
PRIMARY									
A1	COLD	3	12.00	16.67		.00		.00	.00
A5	HOT 13		.00	.00		.00	1	4.70	1.50 7.02
A5	COLD	1	7.80	11.81		.00		.00	.00
A6	HOT 13	1	27.95	24.83		.00		.00	.00
SECONDARY									
S1C	COLD	3	18.60	12.36		.00		.00	.00
S5C	HOT 13	1	8.65	3.64		.00		.00	.00
S5C	COLD	1	6.50	3.64		.00		.00	.00
TRANSF. + DEVICES									
T5100	COLD	1	6.30	28.14		.00		.00	.00
ARR10	COLD	1	6.30	12.40		.00		.00	.00
Z5BY	COLD	1	38.00	8.62		.00		.00	.00
ANCHORS									
AN10NW	HOT 13		.00	.00		.00	1	7.20	8.89 .00
AN10NW	COLD	1	12.00	19.01		.00		.00	.00
DG5F	HOT 13		.00	.00		.00	1	6.00	12.80 9.47
DG5F	COLD	1	10.00	11.71		.00		.00	.00
GG	HOT 13		.00	.00		.00	1	1.50	.00 1.43
GG	COLD	1	2.50	2.86		.00		.00	.00
TOTALS			432.69	577.95		.00		19.40	23.19 17.92

MAN-HOURS 121.2 TOTAL COST \$1,012.12

LOUISIANA POWER AND LIGHT COMPANY
MATERIALS LISTING

JOB 3-66-1234 NEW ORLEANS - SERVICE TO 538 OAK STREET

DEC. 1, 1968

ACCOUNT	QUANTITY	UNIT	CLASS-ITEM	ITEM DESCRIPTION
364.0				
	1	EA	300-0347	POLE, 45/3
	1	EA	304-0604	TIMBER, 6 X 8 X 8FT TRYD
	50	FT	317-0994	WIRE, 5/16 IN. GUY
	11	EA	330-0110	BOLT, 5/8 X 10 IN. HCH.
	12	EA	330-0112	BOLT, 5/8 X 12 IN. HCH.
	1	EA	330-0162	BOLT 3/4 X 12 HACH
	3	EA	330-0218	BOLT, 5/8 X 18 IN. D.A.
	1	EA	330-0226	BOLT, 5/8 X 26 IN. D.A.
	1	EA	330-0250	BOLT, 5/8 X 10 IN. EYE
	4	EA	330-0635	EYELET, 5/8 IN. GALV.
	1	EA	330-0647	GUY ATTACHMENT
	2	EA	330-0648	GUARD, 8 FT. GUY
	4	EA	330-0753	PIN, 15 IN. STR POLE TOP
	1	EA	330-0804	SCREW, 1/2 X 4 IN. LAG
	37	EA	330-0954	WASHER, 2 IN. SQUARE
	1	EA	330-1019	PLATE, LIFT CURVED 7 IN
	1	EA	330-1142	ANCHOR 10 IN. 3-HELIX
	6	EA	330-1207	BOLT, 1/2 X 1 1/2 IN HCH
	2	EA	330-1736	GUY GRIP, 5/16 IN. AUTO.
	1	EA	332-0410	INSULATOR, SHORT FIB ROD
	6	EA	332-0810	RACK, 1-WIRE SEC.
365.0				
	1	EA	304-0051	MOULDING, 1 IN X 8 FT
	1	LB	310-0040	WIRE, 6 SOL BARE 5 D COP
	12	FT	312-0755	CABLE, 2 75TR TW COP
	223	LB	315-0121	CABLE, 1/0 A C S R
	24	FT	315-0468	CABLE, 4/0 INSUL AL.

Figure 2.11 - L.P. & L. System Output

of certain key factors, such as voltage class, construction type, and span length to uniquely identify input data is a valuable one. Much time can be saved in processing the data when the inputs can be grouped. The use of random access disk files is also a plus factor for this system. Tape file must be read sequentially and construction units are seldom sequential in nature. Random access to unit files is imperative to run a cost estimating system in reasonable time.

The L.P. & L. system, however, leaves something to be desired in a few respects. It is a batch system requiring card input. The author feels that an estimating system should be available on-line to the user in real time for rapid turn around. The L.P. & L. system produces reports formatted in a very general way. The author intends to design a system which will produce a letter sized report which will directly replace the typewritten report which currently accompanies a reply to a request for an estimate. Another deficiency is the lack of an underground portion on the estimate.

The Detroit Edison Cost Estimating System. Detroit Edison has produced an estimating system which in operation is similar to the Louisiana Power and Light system. The D.E. system, however, incorporates the use of precoded

packages of components to simplify input. The use of pre-coded construction packages is a significant departure from the L.P. & L. system in that it does away with much tedious detail.

The task group responsible for designing the D.E. system determined that three categories of construction had to be recognized.

(1) Subtransmission construction is relatively standard, and the number of variables, such as crossarms, conductor configuration, types of conductors and insulators was not excessive. All material represented on one engineering drawing could be handled easily by one complete detail. Approximately 160 complete details were required for all subtransmission construction and maintenance work on the system.⁹

(2) Street lighting construction uses a multiplicity of components in many different combinations. If each likely combination were to constitute a separate detail, a large number of details would be needed. The solution is to include several small complete packages of components. Through

9. Dayton, Manley, "Computer Takes Over Line Estimating", Transmission and Distribution, Nov. 10, 1969, Page 66.

program logic, the estimator can generate desired combinations from these packages. The computer will then summarize these component packages.¹⁰

- (3) The same technique as shown in 2 above was used for guying details. Variables such as type of anchor, guy wire size, length of guy, type and number of guy insulators, and guy guards, are coded. The primary system operates under two voltages, 4.8-kV and 13.2-kV, 120/240 V and 240/480 V. If all combinations possible on a pole were to be generated, many thousands of complete different details would have to be stored on the computer. Instead, we decided to set up complete basic packages of details by voltage class for various pole top structures which would give the common material needed to support the line conductors.¹¹

As their next step, Detroit Edison set up kits of materials. The kits included much detail including: the proper tie wire, connector bolts, and deadend clamps for specific conductors. These kits are inserted into the basic data through the use of a one letter conductor code. The

10. Ibid Page 67.

11. Ibid Page 67.

process of packaging pole top detail is illustrated in Figure 2.13.

The desired secondary conductor combination is added to the primary line conductor detail by using another one letter code. The only requirement which the estimator must meet is that the two details be compatible in structure type.

Other auxiliary detail packages provide for the materials required to mount components and equipment on the pole. Additional code letters added to these details designate such items as primary and secondary taps, arresters, fuse holders, transformers and capacitors.

Comments on the Detroit Edison System. Detroit Edison has made a significant advance over the L.P. & L. system described earlier. The improvement is in the area of simplifying the required input to the computer by packaging components. This package or unit concept is very useful for reducing the multiplicity of items required for the typical distribution project. Line design is simplified for the technician, which not only saves time, but also increases the accuracy of the estimate and the material list.

It is possible to take the initial design of the unit system, as described in the Detroit Edison system, a step

DETAIL - ESTIMATING ORDERING FORM
DE FORM OL 112 1-68

CLASSIFICATION SUBTRANSMISSION 1 DISTRIBUTION 2 STREET LIGHTING 3 SYSTEM COMMUNICATION 4 O.P.L. 5 DEPT. ORDER NO. 6703

PACKAGED DETAILS											GENERATED DETAILS													
QUAN- TITY	COLUMNS										CODE	QUAN- TITY	COLUMNS										CODE	
	1	2	3	4	5	6	7	8	9	10			1	2	3	4	5	6	7	8	9	10		
4	0	5	X	3	0	B	1	D			D	2	1	4	E	4	4	P	1	P			G	
2	0	5	X	3	0	B	7	M			D	2	1	4	E	4	3	P	1	P			G	
1	0	5	X	3	0	B	1	D	5		D												G	
2	0	6	P	2	4	C	B	A			D													G
1	P	5	X	3	0	L	2	B			D													G
1	T	5	X	2	0	J	7	B	5	4	D													G
1010	B										D													G
1010	R										D													G

See note 2 & detail 179
for grounding disconnect
bracket

No. 6 BC at 13 kv
No. 6 WPX at 4.8 kv

Arresters on bracket
for detail B

No. 2 WPX

Base line
35' max
to grade

Elastimold cable
termination and
trouser by UGL

Durabute cutout
ed. no 706-0101, shown

Fuse
sign

See note 7

Phase
tags

3'-0"

Neutral zone
for 4.8 kv if no
line secondary

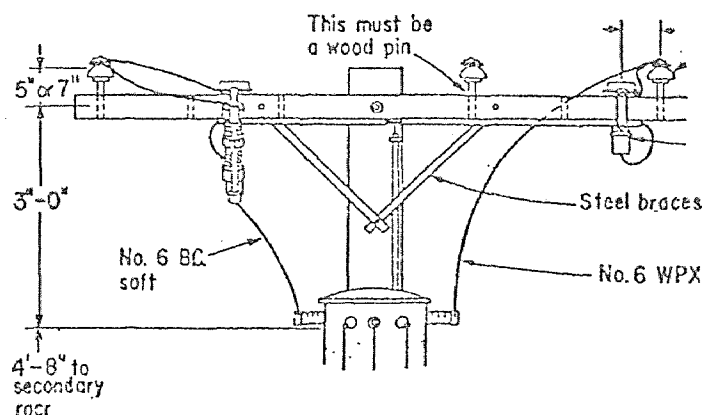
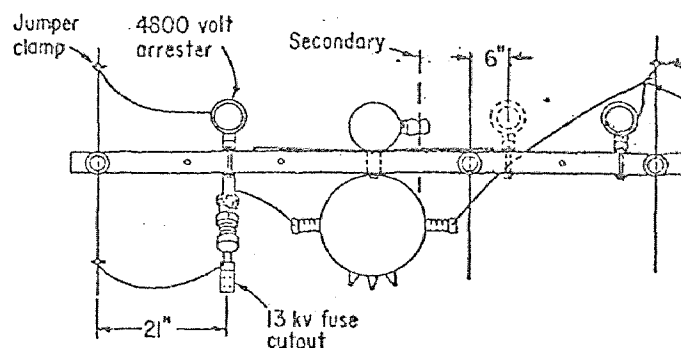
Neutral zone for 13 kv
if no line secondary

DETAIL 2023-P7A30 (13 kv armless)

DETAIL 2023a-P7X30 (13 kv crossarm)

DETAIL 2023b-P5A30 (4.8 kv crossarm)

DETAIL 2023c-P5X30 (4.8 kv crossarm)



DETAIL 1726a-T5X20

Discrete construction details are the basis for the mechanization of line detail estimating. By breaking down primary construction on a given pole into a prescribed package, and secondary into another package, these can be selected by coded symbols and modified for special circumstances by the addition of suffixes which specify that particular variation.

Figure 2.12 - Detroit Edison's Material Packages

further. If it is possible for an estimator to select a package of components out of a finite list, then it is also possible for the computer to select these packages given enough basic information about the design of the line. This will reduce the work of the estimator by a considerable degree, and lessen the expertise required to properly estimate a project.

The C.E.S.L. Estimating System. The concept of using computers in real time in a time sharing environment is a relatively current one. The third generation of computer hardware provided the resources necessary to accomplish the feat. The emergence of time sharing can be traced back to Dartmouth University and the work done on the development of the BASIC computer language in 1967. The ability for field estimators to have hands-on access to an estimating system would provide power and flexibility not available with batch oriented systems. Such a system has been written by the University of Illinois Civil Engineering Department.

The University of Illinois Civil Engineering Systems Laboratory estimating program is a time-shared, remote terminal system used by contractors, engineering firms, and civil engineering students. Each user has direct access to the system through a terminal similar to an electric typewriter.

According to C.E.S.L. documentation, no knowledge of computer procedures or programming is necessary on the part of the user to run the system. The C.E.S.L. programs are designed so that all input is error checked. Although the user has the initial responsibility of entering his data correctly, cross checks are made between input and stored data. The use of direct conversation techniques allows a user to update and print out stored data while he sits at his terminal.

The steps in using the C.E.S.L. system are as follows:

- (1) Define the estimating accounts. These are six character identifiers. For example, EXCAVN, FOUNDN, ROOFG, etc.
- (2) Perform the calculations necessary to provide quantities of material from the construction drawings.
- (3) Enter the estimating accounts with the quantities of work units.
- (4) Assign history file descriptors and access the historical data files via terminal.
- (5) Enter for each account defined:
 - (a) a lump sum cost
 - (b) a unit cost

- (c) a productivity factor for each craft and equipment used.
- (6) Create a resource cost file.
- (7) Request preparation of the estimate by the computer.
- (8) Review the results and modify the estimate as desired.

The procedure used in the computer for calculating the cost estimate is similar to the method used in the L.P. & L. system. Three reports are generated by the computer. A detailed report which shows the estimated items and associated quantity and cost for each account. A summary sheet is produced which shows the estimated costs that were calculated using resource enumeration and costing for each estimating account. Finally, a second summary sheet is produced which shows a combination of calculated costs and entered costs. The three reports are shown in Figures 2.14, 2.15, and 2.16. After studying the results the user can modify his input data and rerun the estimate as desired.¹²

Comments on the C.E.S.L. system. Although this system is not specifically designed for electric utility estimating, it presents some useful concepts. The idea of an on-line system available for use when needed is very desirable for

12. Boyer L.T., "Remote Terminal Cost Estimating", Journal of the American Society of Civil Engineers, Vol 98 COL mar 1972 pp 14

ID	DESCRIPTION	QUANTITY	UNITS	LABOR		EQUIPMENT		MATERIAL		TOTAL	
				UP	TOTAL	UP	TOTAL	UP	TOTAL	UP	TOTAL
1000	PRELIMINARIES										
1100	SITE CLEARING	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	1132.60	1132.60
511000	PRELIMINARIES				0.00		0.00		0.00		1132.60
2000	EXCAVATION										
2101	EXCAVATION 2 CY LOADER	1700.0	CY	0.12	197.80	0.05	51.09	0.00	0.00	0.14	274.89
2102	MACHINE-TRENCHER	100.0	CY	0.51	51.00	0.57	57.00	0.00	0.00	1.08	108.00
2200	HAUD EXCAVATION	20.0	CY	2.80	56.01	0.00	0.00	0.00	0.00	2.80	56.01
2300	BACKFILL	100.0	CY	0.10	9.51	0.04	4.04	0.00	0.00	0.14	13.55
2400	GRADE PREPARATION	45.0	CY	0.12	10.44	0.00	0.00	0.00	0.00	0.12	10.44
512000	EXCAVATION				324.76		142.13		0.00		466.89
3000	CONCRETE FORMS										
3100	FOOTING FORMS	210.0	SF	0.47	99.29	0.00	0.00	2.01	590.63	3.29	689.91
3200	STOCKING & DRIVES	600.0	LF	0.06	35.99	0.00	0.00	0.06	32.49	0.12	70.48
513000	CONCRETE FORMS				135.28		0.00		625.11		760.39
4000	CONCRETE POURS										
4100	FOOTING CONCRETE	35.0	CY	1.48	269.32	0.00	0.00	24.20	671.20	31.68	1140.52
4200	4 IN. ON GRADE SLAB	92.0	CY	1.40	128.80	0.00	0.00	32.30	2471.40	33.70	3100.40
4300	SIDEWALKS & DRIVES	37.0	CY	2.22	51.66	0.00	0.00	31.20	1154.40	33.42	1736.36
514000	CONCRETE POURS				480.08		0.00		4947.70		5427.78
5000	MASONRY										
5100	BLOCK-12 IN-41 GRADE	1670.0	SF	1.13	1686.19	0.00	0.00	0.05	77.27	1.18	1863.46
5201	BRICK-FACE-GRADE/151	1692.0	SF	1.46	2511.40	0.00	0.00	0.34	581.20	1.83	3092.60
5202	BRICK-FACE-PAVING	6500.0	SF	1.65	10719.80	0.00	0.00	0.34	2232.75	1.99	12952.55
515000	MASONRY				15047.40		0.00		2866.72		17913.42
6000	ROUGH CARPENTRY										
6101	WALL FRAMING - 1ST FL.	4762.0	SF	0.17	827.21	0.00	0.00	0.12	550.01	0.29	1377.22
6102	WALL FRAMING - 2ND FL.	8706.0	SF	0.19	1654.21	0.00	0.00	0.12	1005.54	0.31	2659.75
6103	WALL FRAMING - 3RD FL.	8676.0	SF	0.22	1913.62	0.00	0.00	0.12	1019.40	0.33	2933.22
6202	FLOOR JOISTS - 2ND FL.	5473.0	SF	0.12	657.97	0.00	0.00	0.13	790.72	0.25	1473.69
6203	FLOOR JOISTS - 3RD FL.	5471.0	SF	0.12	647.57	0.00	0.00	0.13	707.68	0.25	1350.76
6300	ROOF JOISTS	5876.0	SF	0.13	738.10	0.00	0.00	0.13	777.77	0.26	1515.87
6400	SUBFLOORING - PLYWOOD	11652.0	SF	0.06	678.69	0.00	0.00	0.20	2326.07	0.27	3702.76
6500	ROOF SHEATHING	5826.0	SF	0.08	437.34	0.00	0.00	0.20	1164.03	0.27	1801.36
6600	EXTERIOR SHEATHING	7106.0	SF	0.09	622.39	0.00	0.00	0.20	1419.78	0.29	2042.17
516000	ROUGH CARPENTRY				6420.29		0.00		9763.02		16183.31
7000	FINISH CARPENTRY										
7100	FINISH CARPENTRY	1.0	EACH	5000.00	5000.00	0.00	0.00	12692.00	12692.00	17692.00	17692.00
517000	FINISH CARPENTRY				5000.00		0.00		12692.00		17692.00
TOTAL	TOTAL DIRECT COSTS				29407.81		142.13		30963.55		61646.09
8000	SUBCONTRACTS										
8100	PLUMBING	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	12000.00	12000.00
8200	MECHANICAL	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	6432.00	6432.00
8300	ELECTRICAL	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	5042.00	5042.00
8400	INTERIOR SHEATHING	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	2632.00	2632.00
8500	LANDSCAPING	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	1632.00	1632.00
8600	TILE	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	3726.23	3726.23
8700	PAINTING	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	4173.00	4173.00
518000	SUBCONTRACTS				0.00		0.00		0.00		37697.23
TOTAL	TOTAL SUBCONTRACTS				0.00		0.00		0.00		37697.23
9000	INDIRECT COSTS										
9100	INSURANCE	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	1230.00	1230.00
9200	BONDS	1.0	EACH	0.00	0.00	0.00	0.00	0.00	0.00	123.46	123.46
519000	INDIRECT COSTS				0.00		0.00		0.00		1357.46
TOTAL	TOTALS FOR JOB				29407.81		142.13		30963.55		100090.70

Figure 2.13 - C.E.S.L. System Summary Sheet.

JOB	PAYROLL ACCOUNT	DESCRIPTION
JOB9	RY1 6102	WALL FRAMING - 2ND FL.
JOB6	RY1 6102	WALL FRAMING - 2ND FL.
JOB7	RY1 C672	FRAME WALLS 2ND FLOOR

QUANTITIES	INITIAL	ESTIMATED	REVISED	FINAL
JOB				
JOB9	6706.00 SF	0.00 SF		
AVE.	7605.40 SF	0.00 SF		7827.20 SF
JOB6	8300.00 SF	8510.00 SF		7012.00 SF
JOB7	7560.00 SF	8120.00 SF		5823.00 SF

2010	CARPENTER				JOURNEYMAN							

EXAMPLE OF HISTORY REPORT FOR ACCOUNT 6102 ON JOB JOB9

1010	LABOR	JOURNEYMAN								
		ESTIMATED					FINAL			
	ST-TIME	OV-TIME	TOTAL	PRODUCTIVITY		ST-TIME	OV-TIME	TOTAL	PRODUCTIVITY	
	HOURS	HOURS	HOURS			HOURS	HOURS	HOURS		
JOB										
JOB9										
AVE.	0.0(0%)	0.0(0%)	62.4	125.09 SF/HR		0.0(0%)	0.0(0%)	55.9	140.07 SF/HR	
JOB6	57.5(100%)	0.0(0%)	57.5	148.00 SF/HR		42.5(84%)	8.0(16%)	50.5	138.85 SF/HR	
JOB7	59.7(100%)	0.0(0%)	59.7	136.00 SF/HR		45.5(91%)	4.4(9%)	49.9	116.69 SF/HR	

2X4	PINE	ESTIMATED			FINAL			
JOB		TOTAL QUANTITY	QUANTITY PER UNIT			TOTAL QUANTITY	QUANTITY PER UNIT	
JOB9								
AVE.		6236.0 BF	0.80 BF	/SF		0.0 BF	0.00 BF	/SF
JOB6		6693.1 BF	0.81 BF	/SF		0.0 BF	0.00 BF	/SF
JOB7		6577.2 BF	0.81 BF	/SF		0.0 BF	0.00 BF	/SF

NAILS							
	1	ESTIMATED		1	FINAL		1
	1	TOTAL		1	TOTAL		1
JOB	1	QUANTITY	QUANTITY	1	QUANTITY	QUANTITY	1
	1		PER UNIT	1		PER UNIT	1
JOB9	1			1			1
	1			1			1
AVE.	1	110.0 LBS	0.01 LBS /SF	1	0.0 LBS	0.00 LBS /SF	1
JOB6	1	85.1 LBS	0.01 LBS /SF	1	0.0 LBS	0.00 LBS /SF	1
JOB7	1	81.2 LBS	0.01 LBS /SF	1	0.0 LBS	0.00 LBS /SF	1

Figure 2.14 - C.E.S.L. System History Report

TOTAL COST = 1132,600				UNIT COST = 1132,600 \$/EACH							
511000		PRELIMINARIES		LABOR 0,000		EQUIPMENT 0,000		MATERIAL 0,000		TOTAL 1132,600	
7000		EXCAVATION									
2101		EXCAVATION 2 CY LOADER									
		INITIAL QUANTITY =		1700,000 CY							
LABOR		ID	ST HOURS	RM HOURS	TOTAL HOURS	ST COST	RM COST	FB COST	TOTAL COST		
		4010	15,300	1,700	17,000	64,150	14,075	7,450	105,675		
		1010	15,300	1,700	17,000	77,675	12,117	7,191	91,978		
								14,641	197,804		
EQUIPMENT		ID	TOTAL HOURS			TOTAL COST					
		1010	17,000			81,090			81,090		
		TOTAL COST =		278,694		UNIT COST =		0.164 \$/CY			
2102		MACHINE-BENCHER									
		INITIAL QUANTITY =		100,000 CY							
LABOR		ID	ST HOURS	RM HOURS	TOTAL HOURS	ST COST	RM COST	FB COST	TOTAL COST		
		4010	4,545	0,000	4,545	25,000	0,000	2,273	27,273		
		1010	4,545	0,000	4,545	21,591	0,000	2,136	23,727		
								4,409	51,000		
EQUIPMENT		ID	TOTAL HOURS			TOTAL COST					
		2070	4,545			57,000			57,000		
		TOTAL COST =		108,000		UNIT COST =		1.080 \$/CY			
2200		HAND EXCAVATION									
		INITIAL QUANTITY =		20,000 CY							
LABOR		ID	ST HOURS	RM HOURS	TOTAL HOURS	ST COST	RM COST	FB COST	TOTAL COST		
		1010	8,000	2,000	10,000	38,000	14,250	3,760	56,010		
								3,760	56,010		
		TOTAL COST =		56,010		UNIT COST =		2.801 \$/CY			
2300		BACKFILL									
		INITIAL QUANTITY =		100,000 CY							
LABOR		ID	ST HOURS	RM HOURS	TOTAL HOURS	ST COST	RM COST	FB COST	TOTAL COST		
		4010	0,647	0,000	0,647	4,661	0,000	0,424	5,085		
		1010	0,647	0,000	0,647	4,025	0,000	0,358	4,428		
								0,822	9,508		
EQUIPMENT		ID	TOTAL HOURS			TOTAL COST					
		1010	0,647			1,042			1,042		

Figure 2.15 - C.E.S.L. System Detailed Report

cost estimating. Rapid turn-around, and the ability to modify the input data for result comparison, adds a needed dimension to computer-based cost estimating.

The ability to manipulate data files and create files for special purposes would work well in a de-centralized operation such as the Electric Distribution Department of Public Service. Each of the Company's field locations would be able to set up and maintain data files which would more accurately describe local productivity than a general file stored Company-wide.

Summary

This chapter has attempted to acquaint the reader with the scope of electric distribution construction. The various crew types used to do this work were introduced. The basic types of construction were explained. The reason for doing this was to give some appreciation of the complexity of estimating this type of work.

The latter part of the chapter introduced the concept of using the computer for cost estimates. Three existing systems were reviewed. Two systems were designed specifically for electric distribution construction estimation: the Louisiana Power and Light system and the Detroit Edison system. The L.P. & L. system presents some good ideas on

organizing input data, and on the use of random access methods for handling data files. The Detroit Edison system introduced the concept of construction packages or units in order to simplify the required input. The third system investigated was the University of Illinois Civil Engineering Laboratory estimating system. While it was not designed for electric distribution estimating, it uses real time concepts which the author feels would be beneficial.

CHAPTER III
MANUAL METHOD FOR COST ESTIMATING

Introduction

The purpose of this chapter is to acquaint the reader with the currently used manual methods of construction cost estimating in the Electric Distribution Department of Public Service Electric and Gas Company. The preparation of the necessary data will be discussed first. The gathering of cost and productivity information is then covered. Finally, the preparation of the estimating forms is reviewed.

General Steps for Estimate Preparation

The preparation of a cost estimate is a relatively complex function. The job consists of the following basic steps.

- (1) The evaluation of proposed circuit routes.
- (2) The determination of required material and labor.
- (3) The gathering of cost information.
- (4) The preparation of the estimate form.
- (5) The preparation of the estimate summary.
- (6) The preparation of a stores requirement listing.

Evaluation of Proposed Circuit Routes

When a plan is received by the major projects group

from the planning group, the first step is to check primary and secondary circuit prints in the office. This is done as an initial step to check the feasibility of the proposed route. Having done this, the engineer will survey the proposed route in the field. The field check is performed because circuit prints do not indicate obstacles and route problems that may actually exist.

In the course of the field check, the engineer looks for such things as; tree problems, existing pole conditions, guying problems, telephone construction, to name a few. Primary circuit routes are measured with a wheel device. Underground cable routes are measured with a tape, since very accurate cutting lengths are required for the expensive conductors.

Determination of the Required Material

During the field check, the engineer will take notes on a secondary print which shows the street plan in a one inch to one hundred feet (1" = 100') scale. The notes indicate the major items of material required to do the job. After returning to the office, he will review the prints to determine the total amounts of each material item needed. The resulting material summary includes wire and cable lengths by stock type, number of poles of each size and class, pole brackets, insulators, crossarms,

transformers, etc. The development of such a summary from print and field surveys requires a thorough knowledge of construction.

Gathering of Cost Information

Current costs of various material items are gathered by the engineer from the monthly stock ledger. However, in order to use the ledger, the engineer must be familiar with the class and code number assigned to the material for which he seeks a cost. Labor costs are not so uniformly arrived at. Current practice is for each engineer to develop his own figures for work units based on his experience in his division. Labor costs are calculated from productivity figures using base labor rates unique to the local field division. The rate is unique because it is partially loaded to reflect the non-productive time for each division.

After the base costs are assembled for each unique job unit, they must be sorted into proper electric utility accounts as required by the State Public Utility Commission. The engineer is supplied with a material accounting guide by the clerical group to help him with this procedure. A page from such a manual is shown as Figure 3.1. Even with the aid of the manual, the sorting procedure is time consuming.

			NEW	REPLACE	REMOVE	PRU
	CAPACITOR, CABLES					
03-ALL	ALL SIZES OF COLORED CONTROL		583.1	583.1	583.1	NO
14-ALL	" " " " "		583.1	583.1	583.1	NO
	CAPS, CABLE					
10-ALL	ALL TYPES		979	979	979	NO
	CHANNEL					
07-1178	TANGENT BRACKET EXTENSION		365	593.2	108.13*	NO
	CUTOUTS					
05-ALL	STREET LIGHT FILM	O.H.	373.41	596.1	108.13*	NO
		U.G.	373.42	596.2	108.13*	NO
13-0361	50 A. NON-IND. HOLDER	LINE	365	365	108.13	YES
		TRANSF	368.21	368.21	108.13	YES
		ST.LT.	373.12	373.12	108.13	YES
13-0363	100 A. NON-IND. BOX	LINE	365	365	108.13	YES
		TRANSF	368.21	368.21	108.13	YES
13-0364	100 A. BAYONET	LINE	365	365	108.13	YES
		TRANSF	368.21	368.21	108.13	YES
		ST.LT.	373.12	373.12	108.13	YES
13-0367	200 A. IND. DOOR BOX	LINE	365	365	108.13	YES
		TRANSF	368.21	368.21	108.13	YES
		ST.LT.	373.12	373.12	108.13	YES
13-0376	400 A. 7.2 KV. FOR 2/0 13KV ALUM	LINE	365	365	108.13	YES
		TRANSF	368.21	368.21	108.13	YES
13-0382	100 A. IND. DOOR CO-2 SOLID	LINE	365	365	108.13	YES
	FUSED	TRANSF	368.21	368.21	108.13	YES
13-0384	200 A. DOOR - SOLID	LINE	365	365	108.13	YES
	-FUSED	TRANSF	368.21	368.21	108.13	YES
13-0184	CO-2 CARTRIDGE FOR 13-0382		368.21	595.1	108.13*	NO
	EXTENSIONS					
04-1921	4' WOOD - 8" DIA.		364.2	364.2	108.13	YES
04-1922	" " - 9 1/2" DIA.		364.2	364.2	108.13	YES
04-1923	" " - 11" DIA.		364.2	364.2	108.13	YES
07-0862	STEEL - ITEM 4 - 3' Long		364.2	364.2	108.13	YES
07-0866	" - ITEM 4A - 4'7" LONG		364.2	364.2	108.13	YES

Figure 3.1 - P.S.E.& G. Material Accounting
Guide Example

Preparation of the Estimate Form

After the costs are spread into the proper accounts, the estimate form can be prepared. The layout of this form is shown in Figures 3.2 and 3.3. A brief set of instructions for filling out the form is as follows:

- (1) The required loading for labor and material is different in each division but are approximately the following:
 - (a) labor loading is 130% of direct labor.
 - (b) material loading (OH) is 50% of material.
 - (c) material loading (UG) is 25% of material.
- (2) E364.1, shown in Column 1 of Figure 3.2, is the pole account. Some thirty different poles are used with 100 possible labor productivities. See Figure 3.3 for a partial listing from a table used by a field division in their manual estimating system.
- (3) E364.2, shown in Column 1 of Figure 3.2, is the crossarm, bracket, and guying account. A partial table from the same source as above is shown in Figure 3.3.
- (4) E365, shown in Column 1 of Figure 3.2, is the account which contains the major costs

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

ELECTRIC DEPARTMENT

ESTIMATE-GENERAL

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SUBJECT _____

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DATE _____

DICTATOR'S INITIALS _____

FILE NO. _____

ACCOUNT NO.	QUANTITY	ITEM	LABOR	MATERIAL AND EXPENSE	TOTAL
E364.1		Poles - Distn.			
	--	Poles, Wood 35'	--	--	
	--	Poles, Wood 40'	--	--	
	--	Poles, Wood 45'	--	--	
	--	etc.	--	--	
		Overheads -- %L -- %M	--	--	--
E364.2		Pole Fixtures - Distn.			
		Crossarms and braces	--	--	
		Guys and anchors	--	--	
		Brackets	--	--	
		Overheads %L %M	--	--	--
E365		Overhead cond. and devices - Distn.			
	--	1/0 AAAC - O.W.A.	--	--	
	--	397.5 MCM - O.W.A.	--	--	
	--	397.5 MCM 13 KV spacer	--	--	
	--	etc.	--	--	
		Misc.	--	--	
		Arrestors and switches	--	--	
		Overheads %L %M	--	--	--
E368.21		Line transformer devices - Distn.	--	--	
		Overheads	--	--	--
			--	--	--
WITHDRAWAL DATA			OVERHEAD	UNDERGROUND	TOTAL
COST OF REMOVAL					
SALVAGE					
LOCATION			DATE ESTIMATE NO.		
DESCRIPTION AND REASON FOR WORK			JOB OR AUTHORIZATION NO.		
			DIVISION		
			MUNICIPALITY		
			ESTIMATED TIME TO COMPLETE		
			PREPARED BY		
			DEPARTMENT OR DIVISION		
SHOW SKETCH ON REVERSE SIDE OR ATTACH			CHECKED BY		
			APPROVED		

95-0219 (C 921) 30M 1-65

Figure 3.2 - Sample Manual Estimate

ELECTRIC DEPARTMENT

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SUBJECT

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DICTATOR'S INITIALS

FILE NO.

[illegible]

Figure 3.3 - Sample Manual Estimate page 2

POLE SETTING - MAN HOURS

<u>Pole size</u>	<u>Machine Dig</u>	<u>Hand Dig</u>
35'	3	12
40'	3	12
45'	3	12
50'	5	17
55'	6	21
60'	7	23
65'	15	25
70'	16	26
75'	23	30
80'	25	32
85'	27	34
90'	29	37

- Guys and Anchors - Material cost = \$20.00 - pole to pole or anchor
Labor = 2 man hours - pole to pole
Labor = 4 man hours - anchor guy
- Crossarms and braces - Material cost = \$4.00
Labor = 2 man hours
- Pole pin brackets
 - Per 1000' of 1/0 AAAC 1Ø
Material cost = \$80
Labor = 10 manhours
 - Per 1000' of 2Ø construction
Material cost = \$150
Labor cost = 12 man hours
 - Per 1000' of 3Ø O.W.A. construction
Material cost = \$235
Labor cost = 21 manhours
 - For conversion jobs
Per 1Ø pole top bracket - material = \$8
labor = 1 man hours
Per 2Ø pole top bracket - material = \$15
labor = 1 man hour
Per 1Ø corner bracket - material = \$11
labor = 1 man hour

E-365

<u>Type construction</u>	<u>Cost Material</u>	<u>Cost Labor (Man Hours)</u>
1) 1/0 AAAC - 1Ø	\$ 80	30 + 2/deadend
2) 1/0 AAAC - 3Ø O.W.A.	\$240	75 + 5/de
3) 2/0 4KV spacer	\$1100	125 + 5/de
4) 2/0 13KV spacer	\$1100	125 + 5/de
5) 397 4KV spacer	\$1100	90 + 5/de
6) 397 13KV spacer	\$1500	90 + 5/de
7) 397 O.W.A. (3Ø)	\$560	80 + 5/de
8) 1/0 #4 2W Twist	\$ 90	20
9) 2/0 2cd 3w sec	\$300	35
10) 2/0 3cd 4w sec	\$390	60
11) 397 3cd 4w sec	\$825	80

E-365

ARRESTORS & SWITCHES

<u>Item</u>	<u>Material</u>	<u>Labor</u>
1. 4KV arrester location - 3Ø	\$ 25	5 man hours
2. 13KV arrester location - 3Ø	\$ 45	5 man hours
3. 3 - 600 amp switches	\$120	30 man hours
4. 3 - open type 13KV cutouts	\$120	30 man hours
5. 1 - recloser (either type)	0	40 man hours

FOR CONVERSION JOBS:

- Per tangent bracket - material = \$20
labor = 2.5 manhours
- Per 3Ø corner bracket - material = \$25
labor = 5 manhours
- Per spacer - material = \$4
labor = 0.7 manhours
- Per pin insulator - material = 0
labor = 0.5 manhours
- Per disc insulator - material = 0
labor = 1.5 manhours

* The total of these items would show up under a heading of Misc. within the E-365 account.

Notes:

- For heavy trees increase labor 30%
- For heavy traffic increase labor 20%
- For replacing 3Ø with 3Ø increase labor 50%
- For replacing 2Ø with 3Ø increase labor 40%
- For replacing 3Ø with 2Ø increase labor 25%

Figure 3.4 - Manual Estimate Cost Sheet

of overhead construction. Costs for installing all overhead wire and cable are shown here. A partial listing of cable material and labor costs are shown in Figure 3.3.

- (5) E366 is the underground trenching and conduit account. Costs are based on difficulty of digging and the type and amount of conduit used.
- (6) E367, Column 7, Figure 3.2, page 65, is the underground cable account. It will normally contain the major costs of the underground portion of the cost estimate.
- (7) Escalation costs must be applied to all accounts so that an estimate prepared today will take into account the ingraces of inflation. Cost data on all estimates should be accurate as of January 1 of the year following their preparation. The estimate of escalation will begin at that point and be calculated at a given percentage of labor, material, and overhead burden costs per month until the estimated start of the job. From the start of construction to the end of construction this cost is estimated at one half the above

percentages. The entire calculation is done according to the following formula:

$$\text{Escalation Cost} = (T1 + T2/2)(xL + yM + z(OH))$$

Where:

- T1 is the estimated time in months from January 1 to the start of construction.
- T2 is the estimated time in months from the start to completion of construction.
- x is the monthly escalation rate for labor.
- y is the monthly escalation rate for material.
- z is the monthly escalation rate for overheads.
- L is the estimated labor cost for the account.
- M is the estimated material cost.
- (OH) is the total estimated burden cost

Preparation of the estimate form requires much calculation. Costs must be added and summarized. Cost units must be sorted into proper accounts. Labor and material loadings must be calculated for each account. Escalation must be calculated for each account according to the equation shown above. Each account must be subtotaled. Each subtotal must be totaled to yield a final total.

Preparation of an Estimate Summary

In addition to the above work, the preparation of an estimate summary must be accomplished. The estimate summary form is illustrated in Figure 3.4. The summary is a

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Figure 3.5 - Manual Estimate Summary Sheet

re-sorting and reduction of the information shown on the estimate form. The summary shows all direct overhead labor and material as one figure which is the sum of all overhead accounts shown on the estimate form. The sum of all burdens is shown next as a separate entry for labor and material. Total escalation costs are shown in summation for all overhead accounts as the next entry. The next section in the overhead summary is a listing of manhour requirements needed to do the overhead portion of the job. The hours are summarized for direct overhead labor, operating and maintenance manhours, construction removal manhours, and a final total for all required manhours.

Following the overhead summary a similar summary is prepared for the underground portion of the work. Finally, a total project summary is developed showing; total direct labor and material, total burden costs, total escalation costs, and a grand total of the above.

Preparation of a Stores Requirement Listing

The material for the project must be ordered well in advance of the proposed starting date of the required construction. A form must be submitted to the stores group requesting the material. The form shows each major item of material needed as well as the required delivery date. All delivery dates will not be the same. It is desirable to spread delivery dates over the length of the project.

The estimator must be aware of the sequence of events involved in the project in order to spread deliveries properly.

Paper Flow - Manual System

The manual system requires that an Assistant Engineer or a Senior Engineering Plant Assistant prepare the estimate, estimate summary, and the stores requirement listing. The estimate is checked by the group leader involved. The overhead portion is checked by the Overhead Engineer; the underground portion by the Underground Engineer. The completed estimate is reviewed by the Planning Engineer and submitted to the department head, the Distribution Engineer for department approval. Having passed departmental approval, the estimate is submitted to the Division Superintendent for final division approval before it is submitted to the General Office for inclusion in the Distribution Department Budget.

It should be noted that if the estimate is found to be in error on the various levels of checking, it is re-submitted to the original estimator for recalculation and retyping. The manual system is very tedious for error correction. A computerized system could contain the input data in an on-line file during the approval stage. If

errors were found, the necessary corrections could be made to the data file and the estimate rerun. A considerable time savings would result.

After an estimate has been approved and included in the Budget, the original estimator is designated as the project sponsor. If the original estimator is not available, the work will be done by an equivalent member of the original work group.

Summary

This chapter has attempted to acquaint the reader with the manual estimating system currently used in the Electric Distribution Department of Public Service Electric and Gas Company. It has followed the current method from the gathering of data to the preparation of the final estimate forms. It should be apparent to the reader that the estimating function is a complex and time consuming operation. The preparation of estimates is confined at present to the more technically skilled union people of higher classifications or to management personnel.

The author feels that a properly designed real time computer program or series of programs can take much of the complexity out of the function. Also, such a system could reduce the time required to do an estimate considerably. In fact, the author envisions a relatively

large economic benefit can be derived from computerizing the cost estimating function.

CHAPTER IV

DESIGNING AN ESTIMATING SYSTEM

Introduction

The purpose of this chapter is to set forth the basic criteria for designing a real time computer cost estimating system. Topics to be covered will start with the required input and proceed to the required output. The intention is to introduce the design in general terms; more specific discussions will be included in chapters to follow.

General Design Criteria

The design of any computer system written to replace a manual operation follows a pattern. The following is a list of topics to be covered in designing the cost estimating system to replace the manual methods currently used by Public Service.

- (1) Design of the required input.
- (2) Design of the required output.
- (3) Selection of a time sharing computer system.
- (4) Selection of a computer language.
- (5) File layout and structure.
- (6) Basic layout of the programs.
- (7) Analysis of additional load on existing terminals.

Design of the Required Input

The design of the required input will be done so as to minimize the work of the estimator. This, of course, will place an added burden on the design and programming of the system, but it is felt that extra hours spent in this area will more than be repaid in subsequent time saved by the users of the system. It is the author's experience that many computer systems fail to gain user acceptance because of overly demanding input requirements.

Where possible, input will be dependent only upon general job knowledge and currently used code descriptions. For example, yes or no answers to questions set forth on the data sheets often simplifies input for a user. The use of commonly used codes to describe wire and cable will be employed, thereby defeating the need for new codes in the data.

To cite a specific example, a typical line of data input for describing the installation of an overhead run of cable would include the following:

- (1) Cable Code - commonly used stock ledger code.
 - (a) Example; 031854 is 13kv h.d.p. 397 kcmil al.
- (2) Number of poles in run of wire - this is easily arrived at from a map or field survey. '

(3) Construction code - a short list of codes must be devised to describe construction type and voltage class.

(a) For example:

3 could represent open wire armless

4 could represent open wire

5 could represent spacer cable

(b) Voltage class

.0 could represent 4-kV

.1 could represent 13-kV

.2 could represent 26-kV

(c) Combining (a) and (b) yields a construction code.

3.0 would be 4-kV open wire armless

3.1 would be 13-kV open wire armless

3.2 would be 26-kV open wire armless

The construction code formed in such a manner would not be difficult for the user to understand and would be sophisticated enough to describe all installation variations.

(4) Number of phases - this will be either 1, 2, or 3. It is derived from the planning sketch.

- (5) Special purpose pole top construction. This will not require the input of special codes on the user's part. The user will indicate in the appropriate column the amount of such special pole tops required. This will greatly simplify the amount of knowledge required by an estimator to do an estimate. The computer will develop the proper material based on the construction code and the number of phases.
- (6) Labor factors - Data files will contain normal labor productivity for all material units. However, it is often necessary to increase or decrease labor content to fit the specific nature of the job. For example, a run of wire installed on a busy street will take longer than similar construction on a quiet street. Factors which effect productivity include:
- (a) Existing construction
 - (b) Traffic conditions
 - (c) Tree conditions

Each line of cable data will provide for factors to vary labor through direct multiplication.

The factor 1.1 will increase labor by 10%.

The factor .90 will decrease labor by 10%.

The point is that the factors really require no special tables.

Input for other categories will be designed in the same manner. These categories include:

- (1) Pole installation
- (2) Service wire installation
- (3) Guy and anchor installation
- (4) Switch and recloser installation
- (5) Overhead wire installation
- (6) Trench and conduit installation
- (7) Underground cable installation
- (8) Street lighting installation
- (9) Miscellaneous under construction
- (10) Miscellaneous accounts

A set of proposed data sheets can be seen on Figures 4.1 and 4.2.

Desired Output

The cost estimating system will be designed to produce reports formatted to exactly replace the manually typed versions illustrated in Figures 3.2 and 3.4. The system will also produce a material listing including stock codes, quantities, item descriptions, and required delivery dates.

300 ☐ NUMBER OF LINES OF POLE DATA WHICH FOLLOW
(IF NONE ENTER ZERO) SEE POLIS*

	(A) POLE SIZE AND CLASS	(B) NUMBER TO BE SST	(C) TYPE OF SET
301			
302			
303			
304			
305			
306			

4= MACH
5= HAND
6= BLAST
7= AIR

THROUGH LINE 320

330 ☐ NUMBER OF JOINT POLES REPLACED FOR P.S.
CONSTRUCTION PURPOSE ONLY (FOR TRANSFER CHARGES)

340 ☐ GUY AND ANCHOR DATA
IF ENTRY IS TO BE MADE, INSERT #1
IF NO ENTRY IS TO BE MADE, INSERT ZERO

150

(A) NUMBER OF POLE TO POLE GUYS	(B) NUMBER OF POLE TO ANCHOR GUYS	(C) NUMBER OF MEDIUM DUTY ANCHORS	(D) NUMBER OF HEAVY DUTY ANCHORS	(E) NUMBER OF EX-HEAVY DUTY ANCHORS	(F) NUMBER OF SHARP ANCHORS	(G) NUMBER OF SPAN ANCHORS	(H) % OF ANCHORS POWER INSTALLED (DECIMAL FORM)

360 ☐ NUMBER OF LINES OF CUTOUT, SWITCH AND RECLOSER
DATA TO FOLLOW (IF NONE ENTER ZERO) SEE GUYLS*

	(A) STOCK CODE OF ITEM	(B) NUMBER OF ITEMS	(C) ENTER #1 IF SWITCH OR CUTOUT IS USED FOR RISER OR TIE POINT ENTER #2 FOR TRANSFORMER INSTALLATION
361			
362			
363			
364			
365			
366			

THROUGH LINE 360

400 ☐ NUMBER OF LINES OF SERVICE WIRE DATA TO
FOLLOW (IF NONE ENTER ZERO) SEE OCHLS*

	(A) STOCK CODE SERV. WIRE	(B) NUMBER OF SERV.	(C) AVERAGE LENGTH OF SERV.	(D) % OF BACK YARD INSTALLATIONS (DECIMAL FORM)
401				
402				
403				
404				
405				
406				

THROUGH LINE 420

Figure 4.2a- Input Sheet - page 2

500

NUMBER OF LINES OF WIRE DATA TO FOLLOW
(REQUIRED INPUT FOR WIRE INSTALLATION OR RE-INSULATION)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
	STOCK CODE OF WIRE (USE LATEST ONCLIS*)	LENGTH OF WIRE RUN IN FEET (DISTANCE FROM FIRST POLE TO LAST POLE) CIRCUIT FEET	SINGLE PHASE = 1 TWO PHASE = 2 THREE PHASE = 3	TYPE OF CONSTRUCTION (TABLE A CODE)	TOTAL NUMBER OF POLES TO BE INSTALLED IN RUN OF WIRE	NUMBER OF POLES EXTENSION BRACKETS	NUMBER OF POLE TOP TURNS	NUMBER OF VERTICAL TURN BRACKETS	NUMBER OF TURNS REQUIRING TURN BRACKETS	NUMBER OF RISERS	NUMBER OF DEADENDS	NUMBER OF JUNCTIONS	ARRESTER LOCATIONS	RE-INSULATION CODE (TABLE A)	REPLACEMENT CODE (TABLE B)	INSTALLATION FACTOR (TABLE C)	Q/JN FACTOR (TABLE D)	TREE TRIMMING (TABLE E)
501	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
502	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
503	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
504	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
505	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
506	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
507	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	

THROUGH LINE 520

Figure 4.2b- Proposed Input Sheet - page 3

UNDERGROUND DATA SHEET (1)

600 ☐ NUMBER OF CONDUIT
AND TRENCH LINE DATA
(IF NONE ENTER ZERO)
SEE CONLS*:

	A CONDUIT CODE	B TRENCH FEET	C ENG'R FACTOR	D 1: NORMAL 2: SUBSTATION 3: ST. LIGHT 4: B.U.D.	E 1: EARTH 2: STREET 3: SIDEWALK
601					
602					
603					
604					
605					

THROUGH 620

630 ☐ NUMBER OF LINES FOR
STREET LIGHTING
(IF NONE ENTER ZERO)
SEE STLS*:

	A CABLE STOCK CODE	B FEET	C POLE STOCK CODE	D NUM. POLES	E BRACKET STOCK CODE	F NUM. BRKTS	G LUMINAIRE STOCK CODE	H NUM. LUM.
631								
632								
633								
634								
635								

THROUGH 650

660 ☐ NUMBER OF LINES OF CABLE DATA
(IF NONE ENTER ZERO)
SEE UCCLS*:

	A CABLE STOCKCODE	B FEET OF CABLE	C NUMBER OF M.H. TO M.H. PULLS	D NUMBER OF M.H. TO RISER PULLS	E NUMBER OF STRAIGHT SPLICES	F NUMBER OF BRANCH SPLICES	G NUMBER OF POTHEAD LOCATIONS	H DUCT FACTOR	I RETAG LOCATIONS	J CUTOVER LOCATIONS	K 1: REGULAR 2: SUBSTATION 3: B.I.D.
661											
662											
663											
664											
665											
666											
667											
668											
669											
670											
671											
672											
673											
674											
675											
676											
677											
678											

THROUGH 680

Figure 4.2 - Proposed Input Sheet - page 4

UNDERGROUND DATA SHEET (2)

700

NUMBER OF MANHOLES
(IF NONE ENTER ZERO)

SEE CONLS*

	A MANHOLE CODE	B STREET 2-SIDEWALK	C ENG'R FACTOR	D HOW MANY	E NUMBER OF MANHOLE BREAK INS
701					
702					
703					
704					
705					

THROUGH 720

730

NUMBER OF
STANCHIONS
(IF NONE
ENTER ZERO)

SEE MISLS*

	A STANCHION STOCK CODE	B HOW MANY
731		
732		
733		
734		
735		

THROUGH 750

760

NUMBER OF
PIECEOUTS
(IF NONE ENTER ZERO)

SEE UGCLS*

	A CABLE STOCK CODE	B HOW MANY	C NUMBER TO BE RACKED
761			
762			
763			
764			
765			

THROUGH 780

MISCELLANEOUS U.G. DEVICES

790

NUMBER OF ITEMS ENTERED
(IF NONE ENTER ZERO) SEE MISLS*

A	B	C	D	E
CLASS/CODE	FEET/ITEMS	ENG'R FACTOR	ACCOUNT	ACCOUNT TITLE

791				
792				
793				
794				
795				

THROUGH 810

The intent is to do away with all manual reports, summaries, and material listings. This will result in approximately a four hour time saving per estimate over the manual system.

Selecting the Computer System

It may seem odd at first glance to select a computer system before the programs are designed. However, it is difficult, if not impossible, to do any design work without knowing what tools will be available. Computer salesmen would have you believe that all high level languages and file structures are directly transferable from one machine to another. In reality, such is almost never the case. Therefore, it is necessary to know what machine you are designing for before you start.

As mentioned earlier, the estimating system will reside in a time-sharing computer. The following comparison will therefore, only consider time-sharing service vendors. The very size of the system will automatically eliminate many small capacity computer service vendors. The programs will occupy approximately 100 K of core in smaller program segments of 5 to 15 K of 36 bit words at a time. For the comparison, the author has selected the following services:

- (1) General Electric's Mark I system
- (2) General Electric's Mark III foreground system
- (3) Applied Logic's Al/Comp system
- (4) Graphic Control's GC-10 system

Below is a table of costs encountered with each of the four systems:

TABLE OF COMPUTE VS. I/O

System Name	COMPUTE BOUND			I/O BOUND		
	Connect Min.	CPU Sec.	Cost \$	Connect Min.	CPU Sec.	Cost \$
GE Mark I	1.17	39.33	1.72	3	4.17	.54
GE Mark III	.15	3.61	1.22	3	.19	.61
Al/Comp	.30	10.7	1.37	3	.48	.61
GC-10	1.10	16.1	1.72	3	.91	.64

FIGURE 4.3

A good test for any system is a check of running costs for two different kinds of programs; one mostly computational, and the other all input-output. The table shown above and marked as Figure 4.3 depicts how the four systems compare under both situations.

The results are shown plotted in Figure 4.4. The graph indicates that the General Electric Mark III foreground

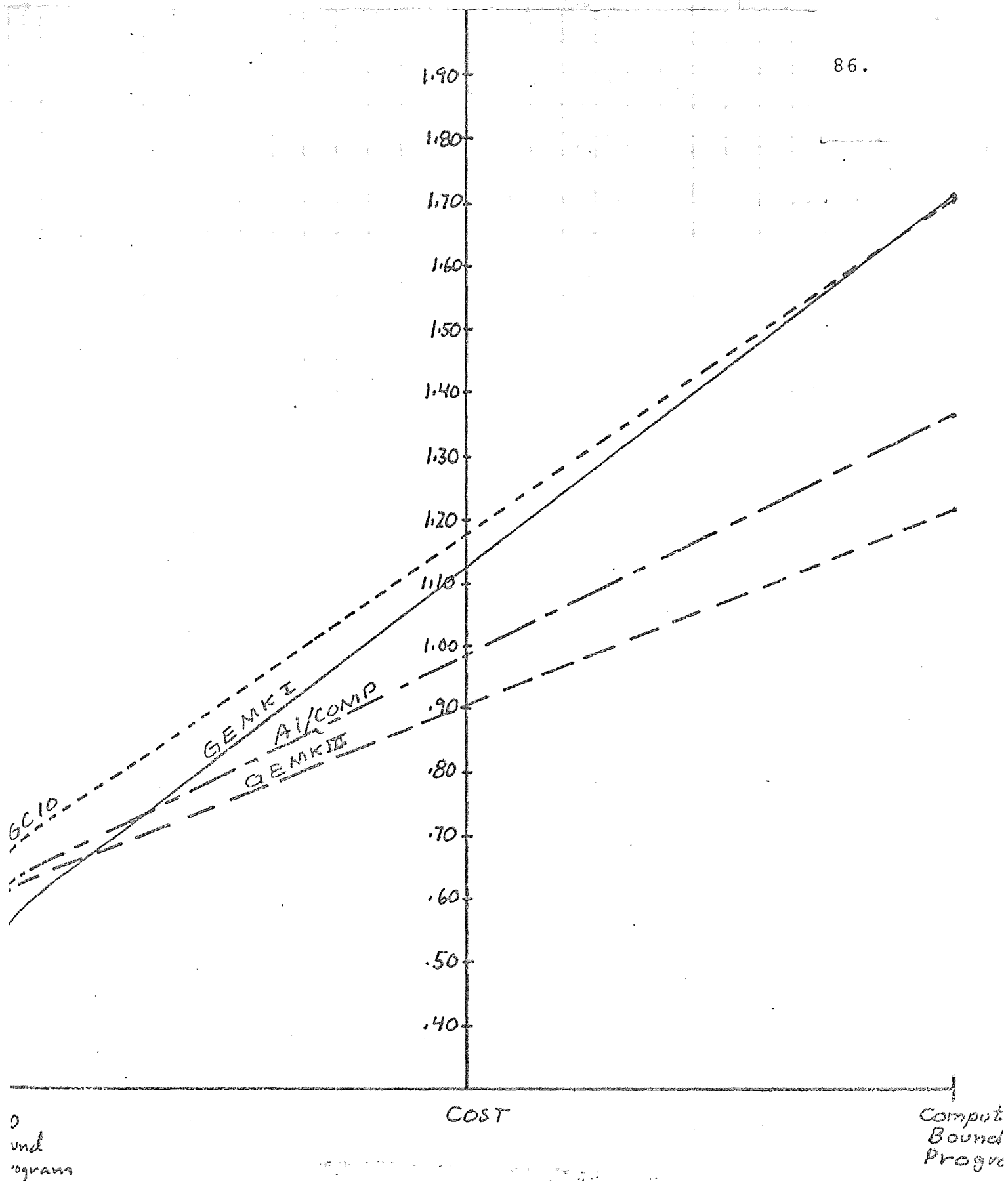


Figure 4.4 - Cost Comparison of Vendor Services

system is the most economical for all but the most I/O bound programs. The estimating system will be a mixture of heavy computation and lengthy I/O. Therefore, the Mark III system is the economic choice. Another cost advantage of this system is the availability of local phone lines throughout the state, thereby reducing what could be large phone bills to access the system.

Selection of a Computer Language

The General Electric Mark III foreground system has two powerful time sharing languages available.

(1) FORTRAN IV

(2) BASIC

FORTAN IV is a powerful scientific language incorporating the original FORTRAN language elements, augmented with sophisticated file handling abilities. It was developed for General Electric by an independent software house especially for the Honeywell 635 computer on which it resides. It compiles to form an extremely efficient object code with resulting savings in C.P.U. costs.

A drawback of the language is the limitation imposed on alpha-numeric variables. FORTRAN IV limits alpha-numeric strings to four characters. The estimating system will need to handle strings of up to

forty characters. FORTRAN IV will pose a problem in this area.

Fortunately, the General Electric Mark III foreground system also has a very sophisticated version of the BASIC compiler available. BASIC was originally developed by Dartmouth College for use on a prototype Mark I system using a General Electric 265 computer. The language was designed as a simplified subset of FORTRAN with special features for the time-sharing environment. In the eight years since its inception, the language has undergone many changes. Today, it rivals FORTRAN in many areas, and offers some real advantages over than language, including:

- (1) Sequential file reading
- (2) Powerful matrix manipulating functions
- (3) String variables up to 119 characters in length
- (4) ASCII and Binary file handling capabilities

BASIC is, therefore, the obvious choise for a file oriented system using long string descriptors such as the cost estimating system that the author envisions.

File Layout and Structure

The cost estimating system will rely heavily on data files. A set of files will be stored separately for each

of the eight field divisions. This will be done because productivity information varies depending on the division doing the work. The breakdown shown earlier in the chapter for the data input serves well to define the files needed for the estimating system.

Separate files will be set up to service program modules for poles, guys, anchors, switches, overhead cable, pole top hardware, conduit, manholes, underground cable, etc. Most of the above files will be of small size; however, eight versions of each file will be stored to service each division. Total file storage space will be large because of the above reason.

In general, the files will be stored on disk devices for rapid access. Most of the files will be stored in the sequential ASCII mode. These files will be directly listable on a user terminal for easy updating and review. The files will be similar in concept and structure. Each will contain a code (usually the commonly used company stock ledger code), a material cost, and productivity figures for one or multiple circumstances. The differing labor units will result in different record sizes for each file.

The large file needed to store pole top hardware

information will be stored in random binary format. Such files are not directly listable on a terminal device, therefore, listing and editing programs must be provided for the user. Binary files must be precisely defined prior to initial storage. Record lengths must be defined, as well as the total number of records to be stored. Such files are not dynamically expandable as are the ASCII files described. Binary files offer some real advantages over other file structures in the areas of direct access to a particular record, and lower storage costs.

Basic Layout of the Programs

The cost estimating system will be modular in concept. Each program will be called into core when needed. The program will call the proper files to do the estimate as defined by the user input. Calculations will be performed by the program to arrive at material and labor costs. The cost figures, along with the proper string descriptors, will be written to an intermediate work file. After execution of the program module currently in core, the next program needed will be called into core to do the subsequent part of the estimate. This will continue until all parts of the estimate as defined by the input data are complete. At that point, the terminal

sequence programs will be called in as required to produce the types estimate on the user terminal. This program module will call on the work file which was being appended during the execution of the primary stages of the system. The file will be read and sorted into ascending account order and finally a report will be produced on the user terminal.

Program names and functions. The following is a list of the main program modules and the functions performed by them.

- (1) ESTCK\$ - The function of this program is to check user input data. Data will be checked for syntax errors, and for rationality. A report will be generated on the user terminal listing the input data line by line. Correct data will not be altered. However, incorrect data will be appended with diagnostic messages. Compiler aborts will be disabled, and the file will be processed in one pass. If all data is correct, the user will be chained to the main processing module. If the data contains errors, the user will be advised to make the necessary corrections and run the ESTCK\$ program again.

- (2) ESTRES\$ - This is the main processing module. After the data has been checked by the ESTCK\$ program, this program will be called. The function of this program is to read in user input data and sort it into the proper work files for the execution of the rest of the system. For example, data for the pole installation module will be written into the file D3641. This program also records the user number, the date, the time, and the name of the estimate into the usage file USAGE. The program will finally decide which program will be called next, based on user input. If the estimate contains overhead data for pole installation, the program E3641 will be called. If the estimate contains no overhead data, the program E366 will be called.
- (3) E3641\$ - This program will call in the files POLES, D3641, and COMINFO. These files are necessary to do cost estimating for pole installations. User input is stored in D3641, cost information is stored in POLES, and labor rates are stored in COMINFO. The costs are calculated and written to DMISC. The material required is written to the file MATFILE.

- (4) E365W* - This program will be called into core after the completion of E3641\$. The operation of this program is the most complex of the system and will be discussed in detail in the next chapter. For the purpose of this section, the function of this program is to read in the user input from file D365 and the files associated with overhead costs including: OHCABLE, BRPTOP, GYANSW, and COMINFO. Costs are calculated and written to DMISC. Material requirements are written to MATFILE. If an underground estimate is needed, the next program called is E367W*.
- (5) E367W* - This program is the one which produces the costs and material necessary for the underground portion of the estimate. It calls in the user input data from the file D367. It also called in the underground data files STLIGHT, UGCABLE, CONMAN, and UGMISC. The program produces the cost and material information and writes it to the files DMISC and MATFILE. The program then called in the next program in sequence, MISCP*.
- (6) MISCP* - This is the first program of the closing sequence of the system. Its purpose is to call

in the files produced by the calculating section of the system, DMISC and MATFILE. This program sorts the cost data stored in file DMISC into ascending account order. It loads the estimate for indirect labor and material based on percentages stored in the file COMINFO. It produces the estimate in the same format as the former, manually typed report as illustrated in Figure 3.2. Based on user needs, as denoted on the input data sheet, the system will stop at this point or call in the next program in sequence, SUMRY*.

- (7) SUMRY* - The function of this program is to produce an estimate summary report. The report is produced using information dumped to the data file SCRPAD by the program MISCP*. The summary will be of the form shown in Figure 3.4, Again, depending on user needs, the system will stop here or chain into the final program module, MATLS*.
- (8) MATLS* - The function of this program is to read the data produced by prior program modules, stored in the file MATFILE, and to print out a

material list. The raw data contained in MAT-FILE is sorted into ascending material stock code order. The codes are then matched with the proper material description by using cross-matching procedures with the data file MATNM.

A complete flow chart of the system is shown in Figure 4.5. The flowchart shows the inter-relationships of files and programs discussed above.

Analysis of Additional Load on Existing Terminals

The implementation of computer-based cost estimating via remote terminals in each of the eight field divisions will result in additions to the existing queues waiting to access various other computer programs and systems. With this in mind, it would seem appropriate to determine whether the developing queues would be of an intolerably large size, and consequently result in excessively long waits. It will be the purpose of this section to determine whether additional terminal equipment will be required as a result of the additional work load imposed by a cost estimating system.

A study of terminal traffic was conducted in Essex, Hudson, and Trenton Divisions by the author in September,

ESTIMATE SYSTEM

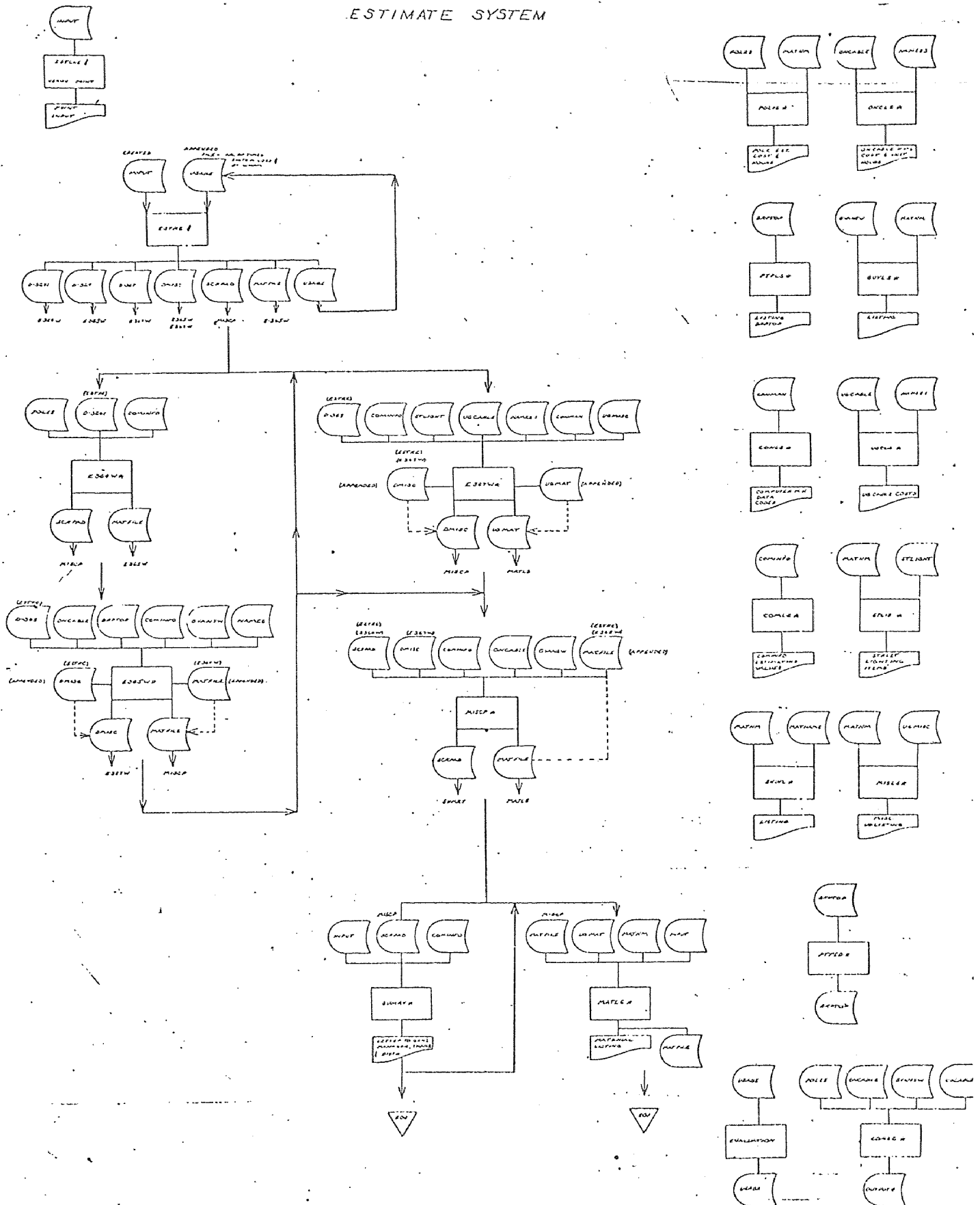


Figure 4.5 - Complete Estimate System Flowchart

TABLE OF QUEUEING VALUES

<u>Division</u>	CF_{73}	CF_{74}	\bar{n}_5	\bar{n}_e	\bar{n}	\bar{n}'	\bar{s}	ρ
Bergen	5.2	7.8	.16	.50	.17	.19	8.76	1.49
Camden	7.1	10.6	1.16	1.24	.23	.25	8.76	2.02
Elizabeth	5.5	8.2	.89	.97	.18	.20	8.76	1.58
Essex	9.3	14.0	1.53	1.62	.31	.33	8.76	2.72
Hudson	3.0	4.5	.49	.57	.10	.12	8.76	.88
New Brunswick	1.7	2.6	.28	.36	.06	.08	8.76	.08
Passaic	2.9	4.4	.48	.56	.10	.12	8.76	.88
Trenton	1.0	1.5	.16	.24	.03	.05	8.76	.26

CF_{73} is the 1973 division conversion factor

CF_{74} is the 1974 division conversion factor

\bar{n}_5 is the mean number of arrivals per 5 minutes

\bar{n} is the mean number of arrivals per minute

\bar{n}_e is the mean number of arrivals per 5 min after est imp.

\bar{n}' is the mean number of arrivals per min after est imp.

\bar{s} is the mean service rate

ρ is the overall facility utilization

Figure 4.6 - Table of Queueing Values

October, and November of 1973.¹³ One of the results of this study was the establishment of a conversion factor for each division which indicates the relative amount of terminal work done by the division. This conversion factor is normalized with respect to Trenton, the smallest division, and is shown in the Table in Figure 4.6. The study showed that arrivals at the existing terminals were distributed according to the Poisson distribution. For Trenton, the mean arrival rate was found to be .109 persons per five minute interval. For each division, .109 was multiplied by CF_{74} to give the mean arrival rate in 1974. The term \bar{n}_5 is then divided by five to give the mean arrival rate per minute. The quantities \bar{n}_5 and \bar{n} are tabulated by division in the table in Figure 4.6.

The additional time to run a cost estimate is approximately 10 minutes per run. Since most of the yearly estimate work takes place in the months of March and April, 80 percent of the load is shown for that period. The idea is to examine terminal load for that time segment. If it is excessively high, additional terminals will be required.

The average number of estimates run per year per division is about 200. Therefore, $200 \times .80 = 160$ estimates per two month period per division. Hence:

13. Westphal T. A., "Remote Terminal Study", PSE&G Co., Distribution Dept. Report., 12/12/73.

TABLE OF QUEUEING VALUES

<u>Division</u>	<u>ρ_o</u>	<u>M</u>	<u>ρ</u>	<u>\bar{q}/M</u>	<u>\bar{tq}/s</u>	<u>\bar{tq}</u>	<u>B</u>
Bergen	1.49	2	.74	1.6	2.2	19.3	.64
Camden	2.02	3	.67	.8	1.1	8.3	.35
Elizabeth	1.58	2	.79	2.1	2.6	22.8	.70
Essex	2.72	3	.91	3.5	3.8	30.1	.81
Hudson	1.88	2	.99	2.9	2.7	28.7	.76
New Brunswick	.53	1	.53	1.1	2.1	18.4	.53
Passaic	.88	2	.44	3.4	3.1	19.2	.65
Trenton	.26	1	.26	.4	1.4	12.3	.26

ρ_o is overall facility utilization

M is number of 300 baud terminals

ρ is net facility utilization

\bar{q} is mean number of persons at terminal incl user

\bar{tq} is mean time spent at terminal incl wait & use

B is probability that all terminals will be busy

Figure 4.7 - Table of Queueing Values for Existing Terminals

$$\bar{n}_5 = \frac{160}{2 \times 10 \times 50} = .16 \text{ arrivals per 5 min per.}$$

$$\bar{n} = \frac{.16}{5} = .032 \text{ arrivals per min.}$$

The above results are added to the appropriate columns in the table in Figure 4.6 to arrive at \bar{n}_e and \bar{n}' .

Existing terminal configurations are shown for each division in the table in Figure 4.7. All terminals are shown under the M column of the table. All terminals are capable of 300 baud transmission rates.

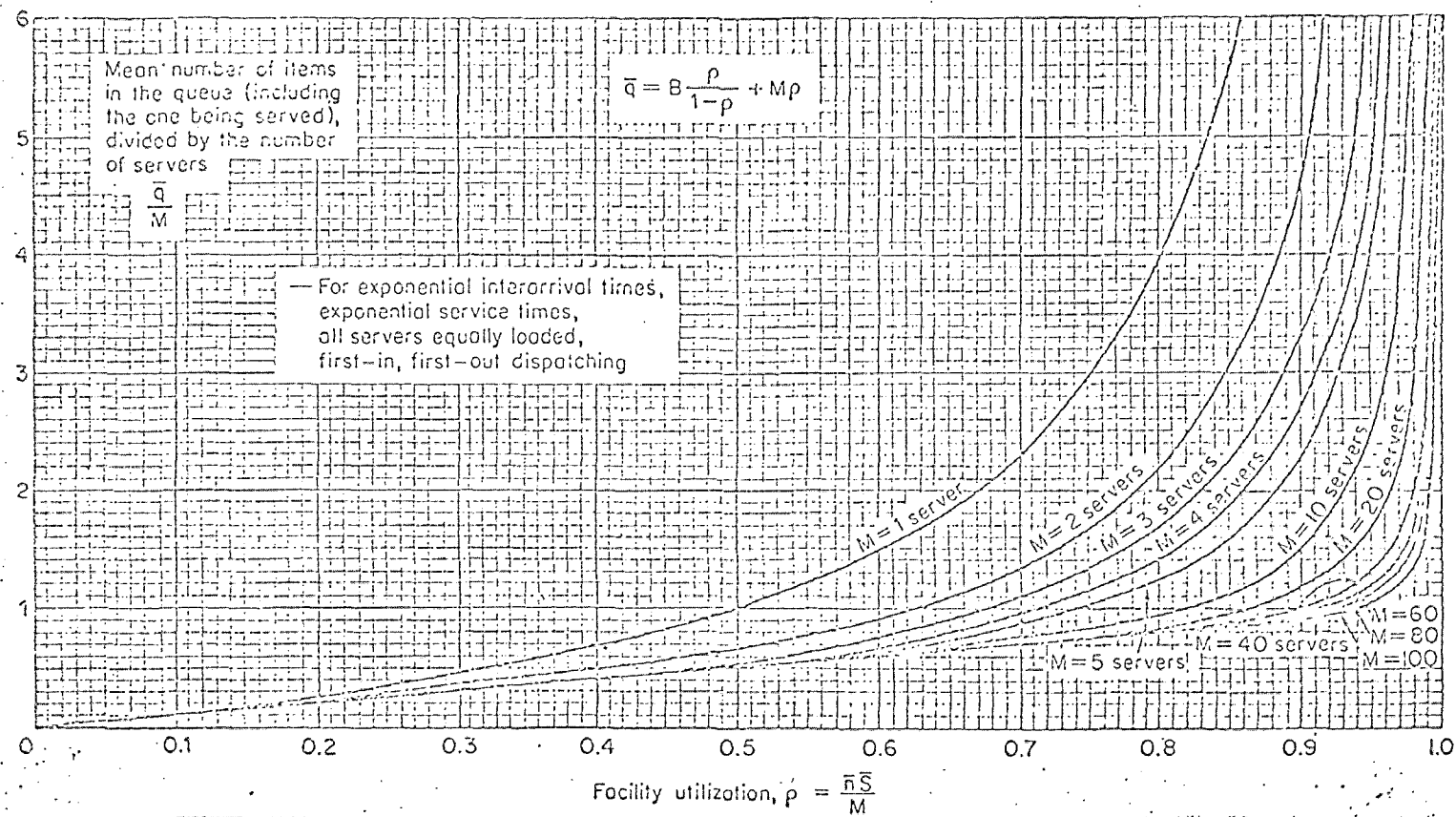
In order to carry out an analysis of the present system, it was necessary to determine the mean system response time \bar{N} , that is the time it takes to access a program. At the present time, the mean system response time has averaged about 2 minutes per inquiry. This time is divided into 1 minute for request input, and 1 minute for response output including communication time, computer time, and other system time.

The mean number of requests per session is multiplied by the mean system response time to obtain the mean service time \bar{s} or mean number of minutes per inquiry.

$$\bar{s} = 4.38 \times \bar{r}$$

Overall facility utilization P_o is defined as:

$$P_o = \bar{n} \times \bar{s}$$



(Source- Public Service Statistical Manual)

Figure 4.8 - Graph of mean persons in queue/no. Terminals

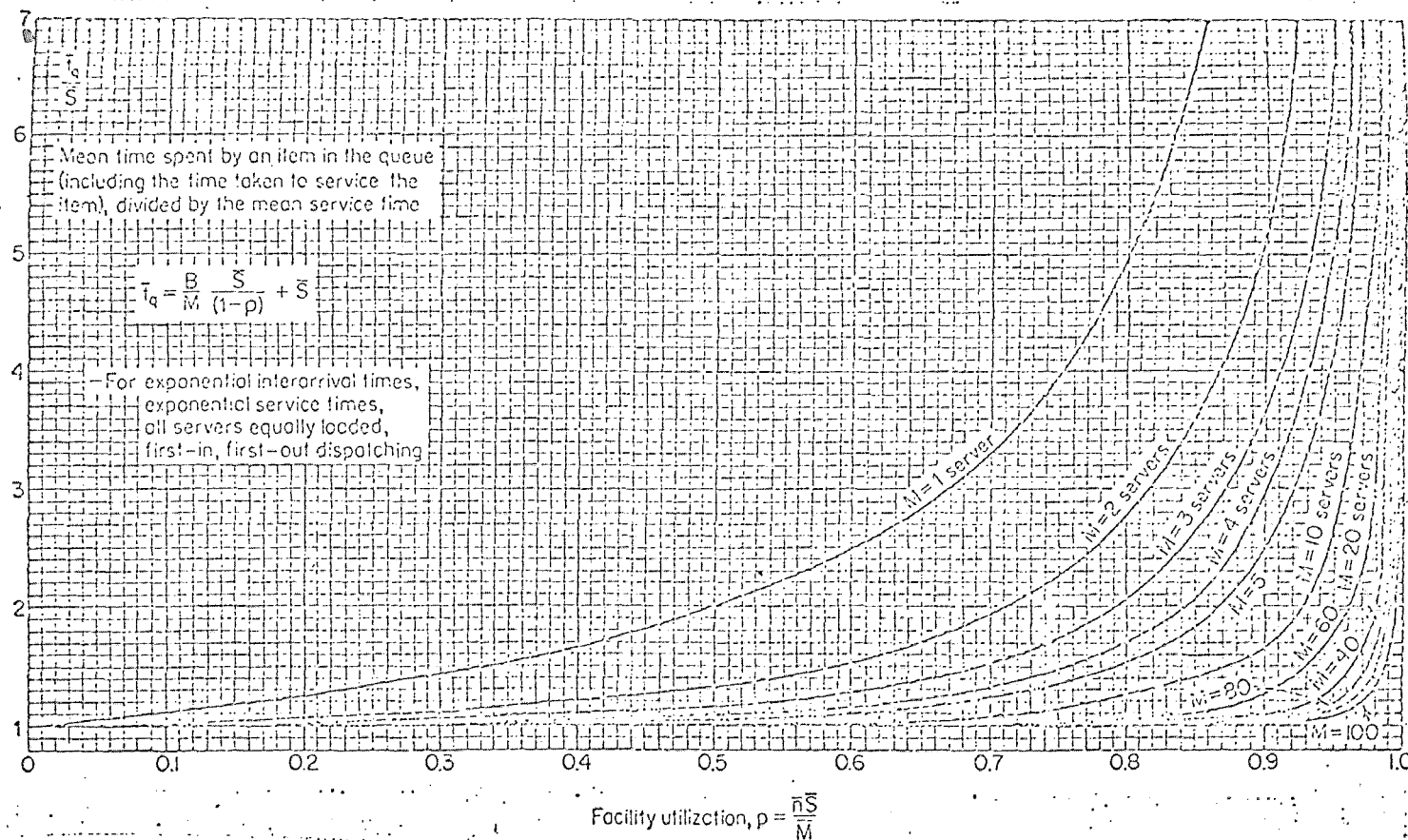
P_0 is a quantity which indicates the extent to which the terminals are used. Values of \bar{n} , \bar{s} , and P_0 for each division are tabulated in the table in Figure 4.7.

To obtain net facility utilization, overall facility utilization is divided by the number of terminals.

$$P = P_0/M$$

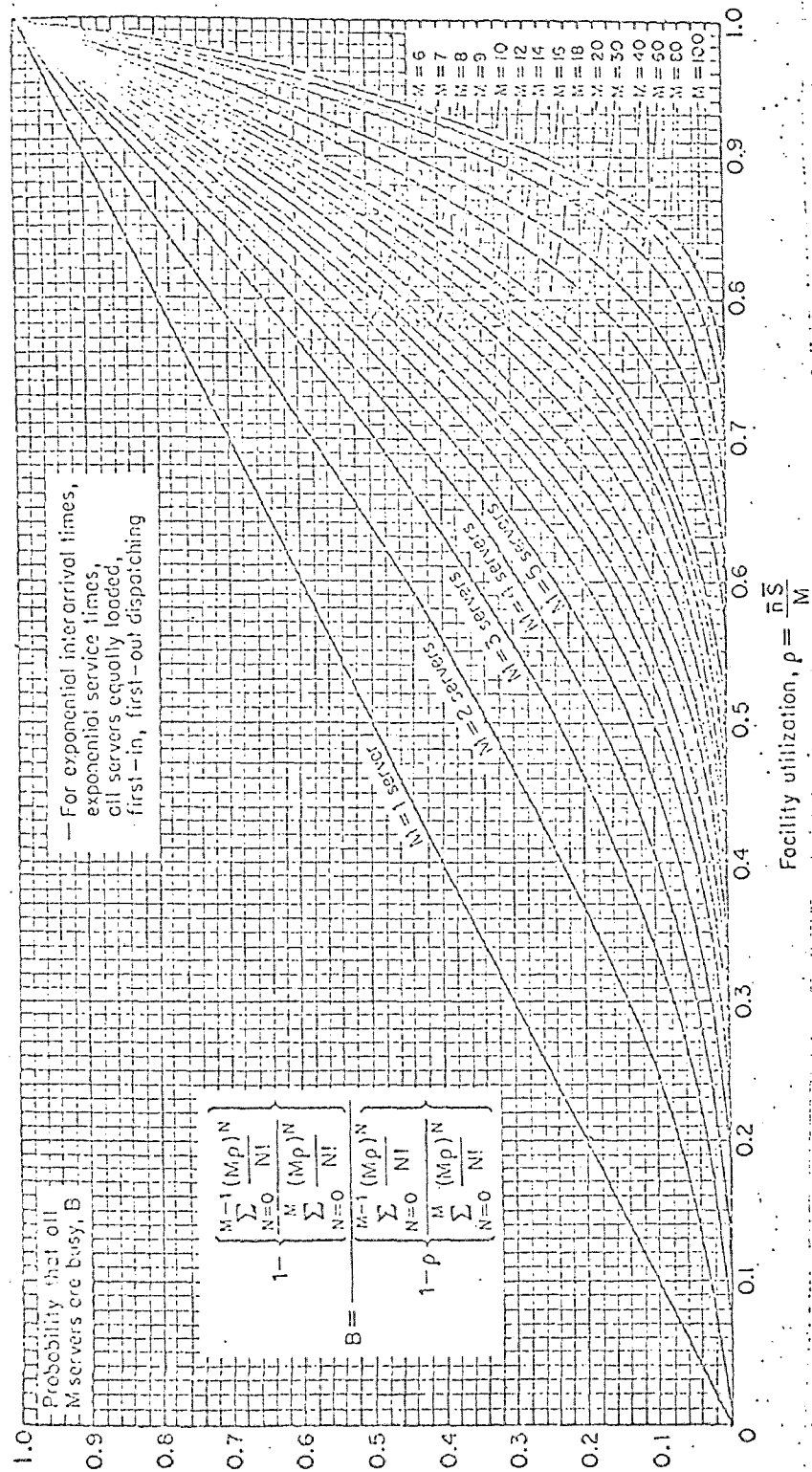
P is used as the horizontal coordinate for the graphs shown in Figures 4.8, 4.9 and 4.10. Graph 1 is used to calculate the mean number of persons in the queue divided by the number of terminals (q/M). For example, for Bergen Division, (q/M) is equal to 1.6. If (q/M) is multiplied by M , mean queue (q) is found to be 3.2. This means that on the average, each terminal will be in use with 1.2 persons waiting in line to use a terminal.

The second graph shown in Figure 4.9 is used to calculate the mean time spent divided by the mean service time (\overline{tq}/\bar{s}). For Bergen Division, (\overline{tq}/\bar{s}) is equal to 2.2. If (\overline{tq}/\bar{s}) is multiplied by \bar{s} (8.76 minutes), \overline{tq} is obtained. For Bergen \overline{tq} is equal to 19.3 minutes. This value is the mean total system response time for the system in Bergen Division. In other words, it will take a person (on the average) 19.3 minutes from the time he gets on the line until the time he leaves the terminal.



(Source- Public Service Statistical Manual)

Figure 4.9 - Graph of mean time in queue/mean service time



(source- Public Service Statistical Manual)

Figure 4.10 - Graph of probability all terminals are busy

TABLE OF COMPUTE VS. I/O

System Name	COMPUTE BOUND			I/O BOUND		
	Connect Min.	CPU Sec.	Cost \$	Connect Min.	CPU Sec.	Cost \$
GE Mark I	1.17	39.33	1.72	3	4.17	.54
GE Mark III	.15	3.61	1.22	3	.19	.61
AI/Comp	.30	10.7	1.37	3	.48	.61
GC-10	1.10	16.1	1.72	3	.91	.64

Figure 4.11 - Table of Vendor Statistics.

The last graph shown in Figure 4.10 is used to calculate B, the probability that all terminals will be busy. For example, at Bergen Division, a person arriving at the terminals will find both of them occupied 64 percent of the time.

The present terminal placement scheme had as its sole criterion that waiting time be less than 20 minutes for each division. This criterion is satisfied in all divisions at present even with the additional load of the estimating system. No additional terminals are necessary.

Summary

It was the purpose of this chapter to layout the basic framework of the proposed cost estimating system. The use of simplified input was discussed. The selection of a time sharing computer system was made using economic criteria. A computer language, BASIC, was selected and based on the design needs of the system. Finally, the file design, and the general system layout, was flow-charted and discussed.

In total, this chapter has laid the framework to delve into the detailed program design to be examined in the next chapter.

CHAPTER V
DETAILED DESCRIPTION OF THE
OPERATION OF THE OVERHEAD MODULE

Introduction

The purpose of this chapter is to explain to the reader, in detail, the operation of the overhead module of the construction cost estimating system. The overhead module is representative of the other calculation modules of the system, and an understanding of it will give the reader an understanding of the entire system.

Before the discussion of the program module, the reader should refer to a brief introduction to some BASIC language elements given in Appendix I to aid him in the work to follow. The explanation of the overhead module will commence with the reading of a test run of user information from the file D365. The reader will be shown the structure and contents of all pertinent data files used by the module. The methods used to calculate the estimated costs will be explained in detail. The work files created by the module using the test data will be illustrated using actual dumps of file contents during the execution of the test run. Finally the reports derived from the test run will be shown.

Functions of the Overhead Program Module

The functions of the overhead program module (E365W\$) are enumerated below. The enumeration serves as a topic summary for the remainder of the chapter.

- (1) Read information from the user data file D365.
- (2) Read in the data stored in the overhead data files:
 - (a) COMINFO - Contains general estimate costs and percentages.
 - (b) OHCABLE - Contains overhead cable costs and labor hours.
 - (c) BRPTOP - Contains pole top construction costs and labor hours
 - (d) GYANSW - Contains material and labor costs for guys, anchors, and switch installations.
 - (e) NAMES3 - Contains the string descriptors for overhead cables.
- (3) Produce a cost estimate and material requirement for guys, anchors, and switches.
- (4) Produce a cost estimate and material requirement for overhead primary and secondary cable.
- (5) The interaction of the program with simplified user input and the random binary file BRPTOP

to produce pole top hardware material costs and material requirements.

- (6) The appending of the work files for material and costs.
- (7) The selection of a chaining point for the rest of the system.
- (8) The production of the cost estimate printout, the estimate summary, and the material list.

The report will follow a set of test data through the system from its entry in the data file INPUT to the production of the final reports. Actual listings of all pertinent data files will be used to illustrate the functions of the system in progress.

Creation of the File INPUT

The user of the cost estimating system must complete his map and field surveys as in the manual system. At this point, he must fill out a set of data sheets as shown in Figures 4.1 to 4.5. The computer system is accessed and the data is entered from the terminal or through a pre-punched paper tape. The input for the test case is shown on Figure 5.1.

The user runs a check of the data by executing the

```

( OLD INPUT
  READY
  LIS

( INPUT      14:13EDT    02/21/74

100 "TEST DATA"
110 "SPECIAL RUN"
120 2
130 100
140 R
150 0,0,0,0
160 YES
170 "1/9/74","WC"
180 "1/9/74","74-2","VT","CAMDEN","EC","DA22-16.1095"
190 1,74,4,74,6,74
200 0,0
210 0,0
220 YES
230 YES
300 3
301 352,10,4
302 402,5,4
303 402,5,5
330 10
340 1
350 10,10,5,5,0,0,0,.5
360 2
361 130384,3,1
362 135755,1,1
400 2
401 31254,20,100,0
402 31256,10,150,0
500 5
501 31760,10000,3,3.1,80,8,2,10,2,10,2,10,1,1,1,1,.02
502 31854,2000,3,5.1,16,1,0,2,1,3,1,4,1,1,1,1,.03
503 31760,1505,3,4.1,11,0,0,0,1,1,0,2,1,1,1,1,.04
504 31835,15520,1,3.1,115,5,2,20,0,15,20,10,1,1,1,1,.01
505 31256,7500,1,7,50,0,0,0,0,0,0,0,0,1,1,1,1,0
600 0
610 0
620 0
640 0
650 0
660 0
670 0
700 0

( READY

(

(

( RUN

```

Figure 5.1- A listing of user input
for the test case.

the program ESTCK\$. If the data is correct, the program ESTRE\$ will be executed next. This program will write the user input to several work files. The data for the program module E365W\$ is written to the file D365. The contents of D365 after the execution of ESTRE\$ is shown in Figure 5.2.

The coded program module is illustrated in Figures 5.3 through 5.8. Flow charts can be seen in Figures 5.21 through 5.25. Line 1000 on Figure 5.3 sets up the file D365 as file number one. On line 1100 the first access to the file is made. The value of X2 is read. X2 is the amount of user guy and anchor data stored in subsequent entries in the file. Line 1120 tests the value of X2, if it is zero, the program branches to line 1190. If it has a value, the program reads in the data up to the limit of reads as denoted by the value of X2.

Line 1190 will be read to find a value for X1, the number of lines of user switch data to follow in the data file D365. If the value of X1 is zero value, the program reads in the values of Z(1), Z(2), Z\$(1), and Z(3). These are respectively, the number of months for which excalation is to take place, the estimate type, the estimate format code, and the cost rounding factor. After reading

LIS

D365

14:10EDT

02/21/74

111.

```
100 1 ,
110 4 , 2 , R, 100 ,
120 10 , 10 , 5 , 5 , 0 , 0 , 0 , 0.5 , 2 ,
130 4 , 2 , R, 100 ,
140 130384 , 3 , 1 , 135755 , 1 , 1 , 5 ,
150 4 , 2 , R, 100 ,
160 31760 , 10000 , 3 , 3.1 , 80 , 8 , 2 , 10 , 2 , 10 , 2 , 10 , 1 , 1 , 1 ,
170 1 , 0.02 , 31854 , 2000 , 3 , 5.1 , 16 , 1 , 0 , 2 , 1 , 3 , 1 , 4 , 1 ,
180 1 , 1.1 , 1 , 0.03 , 31760 , 1505 , 3 , 4.1 , 11 , 0 , 0 , 1 , 1 , 0 ,
190 2 , 1 , 1 , 1.2 , 1 , 0.04 , 31835 , 15520 , 1 , 3.1 , 115 , 5 , 12 , 20 ,
200 0 , 15 , 20 , 10 , 1 , 1 , 1 , 1 , 0.01 , 31256 , 7500 , 1 , 7 , 50 , 0 ,
210 0 , 0 , 0 , 0 , 0 , 0 , 1 , 1 , 1 , 1 , 0 ,
```

READY

OLD DMISC

READY

LIS

DMISC

14:12EDT

02/21/74

```
100 0 , 0 , 0 , 0 ,
110 DA22-16.1095,
120 YES, YES,
130 4 , 2 , R, 100 ,
140 2 ,
150 4 , 2 , R, 100 ,
160 130384 , 3 , 1 , 135755 , 1 , 1 , 2 ,
170 4 , 2 , R, 100 ,
180 31254 , 20 , 100 , 0 , 31256 , 10 , 150 , 0 , 0 ,
190 1,E364.2,0,GUYS-ANCHORS-XARMS & BRKTS, 3700 , 5400 ,
200 1,E365, 10000 ,4/13KV 397.5K 3/C AL PIONA, 6900 , 6000 ,
210 1,E365, 2000 ,13KV 397K AL.3/C C.L.P.SP, 2200 , 2500 ,
220 1,E365, 1505 ,4/13KV 397.5K 3/C AL PION, 1200 , 900 ,
230 1,E365, 15520 ,4/13KV 1/0AAAC 1/C ALPI*OWA, 5500 , 1600 ,
240 1,E365, 7500 ,SER. 2/0-3/C AL..., 3500 , 1600 ,
250 1,E365,0,POLE TOP HARDWARE, 2800 , 2300 ,
260 1,E365,0,TREE TRIMMING,0, 1400 ,
```

READY

Figure 5.2- User data resorted into D365
& Estimate output in file DMISC

E365W\$ 02/21/74

```

999 OPTION QSUB
1000 FILES D365;OHCABLE;BRPTOP;COMINFO;DMISC;GYANSW;NAMES3;MATFILE
1001 READ :8,I6
1002 IF END :8,THEN 1006
1003 RESTORE :8
1004 APPEND :8
1005 GO TO 1010
1006 SCRATCH :8
1010 READ #4,D(1),C(1),F(2),F(3),F(4),F(5),F(6),F(7),F(8)
1011 FOR I= 1 TO 21
1012 READ #4,D(0)
1013 NEXT I
1015 APPEND #5
1020 DIM U(20,20),H(50,8),Ns(20),Ms(50),P(100)
1030 DIM H(30),L(30),M(30),Ts(30),Y(50,3),S(10,3),Q(30)
1040 DIM A(30)
1110 READ #1,X2
1120 IF X2=0 THEN 1190
1130 READ #1, Z(1),Z(2),Z$(1),Z(3)
1140 FOR I=1 TO X2
1150 FOR J=1 TO 8
1160 READ #1,B(J) 'READS IN USER GUY & ANCH. DATA'
1170 NEXT J
1180 NEXT I
1190 READ #1,X1 'NUMBER OF LINES OF SWITCH DATA'
1200 IF X1=0 THEN 1270
1210 READ #1, Z(1),Z(2),Z$(1),Z(3)
1220 FOR I=1 TO X1
1230 FOR J=1 TO 3
1240 READ #1,S(I,J) 'READS IN USER SWITCH DATA'
1250 NEXT J
1255 WRITE :8,S(I,1);S(I,2);
1260 NEXT I
1270 READ #1,X
1275 IF X+X1+X2<1 THEN 3850
1280 IF X=0 THEN 1575
1290 READ #1, Z(1),Z(2),Z$(1),Z(3)
1300 FOR I=1 TO X
1310 FOR J=1 TO 17
1320 READ #1,U(I,J) 'READS IN USER CABLE DATA'
1330 NEXT J
1340 LET Q(I)=((U(I,3)*100)+(U(I,4)))
1350 NEXT I
1360 IF X2+X1+X>0 THEN 1380
1370 STOP
1380 IF Z$(1)<>"B" THEN 1385
1382 LET D(1)=D(0)
1384 DEF FNA(Y)=INT(((Y)/Z(3))+.5)*Z(3) 'ROUNDS TO $10 or $100'
1385 FOR I=1 TO X-1
1390 FOR I5=I+1 TO X

```

Figure 5.3- Line 999-1390 of E365W\$ module.

E365ws

02/21/74

```

1400 REM THIS ROUTINE CHECKS FOR LIKE CABLE INSTALLATIONS & ADDS THEM
1410 IF U(I,13)>1 THEN 1570
1420 IF U(I5,13)>1 THEN 1560
1430 IF U(I5,1)=0 THEN 1560
1440 IF U(I,1)<>U(I5,1) THEN 1560
1450 IF Q(I)<>Q(I5) THEN 1560
1460 LET K5=U(I,2)/(U(I5,2)+U(I,2))
1470 LET U(I5,1)=0
1480 LET U(I,2)=U(I,2)+U(I5,2)
1490 FOR J=5 TO 12
1500 LET U(I,J)=U(I,J)+U(I5,J)
1510 NEXT J
1520 FOR J=14 TO 16
1530 LET U(I,J)=K5*U(I,J)+(1-K5)*U(I5,J)
1540 NEXT J
1550 LET U(I,17)=K5*U(I,17)+(1-K5)*U(I5,17)
1560 NEXT I5
1570 NEXT I
1575 REM THIS LINE HOLDS POSITION FOR INTERNAL LINE REFERENCE
1580 DEF FNB(X,Y)=Z(1)*(.007*X+.007*Y) 'LABOR ESCALATION'
1590 DEF FNC(X,Y)=Z(1)*(.003*X+.007*Y) 'MATERIAL ESCALATION'
1600 FOR I=1 TO 50
1610 IF END #2 THEN 1680
1620 READ #7,M$(I) 'READS IN OH CABLE NAME'
1630 LET N=N+1
1640 FOR J=1 TO 8
1650 READ #2,N(I,J) 'READS IN OHCABLE TABLE'
1660 NEXT J
1670 NEXT I
1680 FOR I=1 TO 50
1690 IF END #6 THEN 1750
1700 LET N1=N1+1
1710 FOR J=1 TO 3
1720 READ #6,Y(I,J) 'READS IN GUY ANCHOR AND SWITCH DATA'
1730 NEXT J
1740 NEXT I
1745 IF X2=0 THEN 1840
1750 LET H(25)=(B(3)*Y(6,3)+B(4)*Y(7,3)+B(5)*Y(8,3)+(B(6)+B(7))*Y(9,3))
1760 LET H(25)=(H(25)*(2*(1-B(8))))+(H(25)*B(8))
1770 LET H(25)=H(25)+B(1)*Y(2,3)+B(2)*Y(2,3)
1780 LET L(25)=H(25)*D(1) 'LAB HRS GUYS ANCHORS E364.2'
1790 LET H=H(25)
1800 LET M(25)=B(1)*120*Y(2,2)+B(2)*45*Y(2,2)+B(2)*Y(3,2)*.6
1810 LET M(25)=M(25)+B(2)*Y(3,2)*.4+(B(1)+B(2))*Y(5,2)+B(3)*Y(6,2)
1820 LET M(25)=M(25)+B(4)*Y(7,2)+B(5)*Y(8,2)+(B(6)+B(7))*Y(9,2)
1830 REM M(25)=MAT'L COST GUYS ANCHORS E364.2
1834 WRITE #8,Y(1,1);B(1)*120*.85;
1835 WRITE #8,Y(2,1);B(1)*120*.15;Y(2,1);B(2)*45;Y(3,1);B(2)*.6;
1836 WRITE #8,Y(3,1);B(2)*.4;Y(5,1);B(1)+B(2);Y(6,1);B(3);Y(7,1);B(4);
1837 WRITE #8,Y(8,1);B(5);70101;B(7);Y(9,1);B(6);

```

Figure 5.4- Lines 1400-1837 of
E365ws module.

E365W\$ 02/21/74

```

1838 WRITE :8,76633;B(3);76634;B(4);76636;B(5)+B(6);
1840 FOR I=1 TO X
1850 FOR J=1 TO N+1
1860 IF U(I,1)=0 THEN 2680
1870 IF U(I,1)<>N(J,1) THEN 2670'MATCHES USER STK CD & TABLE STK CD'
1880 RESTORE:3
1881 LET H2=H4=0 'INITIALIZES LABOR HRS FOR CABLE INST TO ZERO'
1890 LET N$(I)=N$(J) 'NAMES THE CABLE'
1895 REM THE ROUTINE BELOW TESTS FOR CABLES PURCHASED ON 1 PHASE REELS
1896 REM AND ADJUSTS THESE FOR AMOUNT OF PHASES TO BE INSTALLED...
1898 LET D1=U(I,2)
1900 IF U(I,1)=31835 THEN 1910
1901 IF U(I,1)=31825 THEN 1910
1902 IF U(I,1)=30356 THEN 1910
1904 IF U(I,1)=30363 THEN 1910
1906 IF U(I,1)=30367 THEN 1910
1908 GO TO 1930
1910 IF U(I,4)=7 THEN 1930
1920 LET U(I,2)=U(I,2)*U(I,3) 'FOOTAGE ADJ FOR THOSE CABLES ON 1 PH REELS'
1930 LET H1=INT(U(I,4)) 'TAKES THE INTEGER OF CONSTRUCTION TYPE'
1935 IF U(I,13)>1 THEN 1940
1936 WRITE :8,W(J,1);U(I,2); 'SENDS CABLE INFO TO MATERIAL LIST'
1940 ON (H1-2) GO TO 1950,1970,1990,2010,2010,2010'NAMES CONST TP'
1950 LET T$(I)="OnA"
1960 GO TO 2020
1970 LET T$(I)="On"
1980 GO TO 2020
1990 LET T$(I)="SP"
2000 GO TO 2020
2010 LET T$(I)=".."
2020 LET F(I)=U(I,14)*U(I,15)*U(I,16) 'TOT INS FACT.=GAIN F*REP F*INS F'
2030 IF F(I)<>0 THEN 2050
2040 LET F(I)=1
2050 IF H1=7 THEN 2120
2060 LET P(0)=((U(I,3)+1)/4) 'PHASE FACTOR USED TO ADJ INS HRS'
2070 REM H4 IS THE LAB HRS NEEDED PER CABLE TO BUILD D.E.'S, VERT TRNS ET
2080 LET H4=(U(I,7)*F(6)+U(I,9)*F(7)+U(I,10)*F(5)+U(I,11)*F(8))*P(0)*F(1)
2089 REM TESTS FOR REINSTALLATION CODE
2090 IF U(I,13)>1 THEN 2123
2100 LET H2=((D1*N(J,H1)*F(1)*1E-3)*P(0)) 'PULLING HRS PER CABLE'
2110 GO TO 2130
2120 LET H2=(U(I,2)*1E-3*N(J,H1)*F(1)) 'SECONDARY PULLING HRS PER CAB'
2122 GO TO 2130
2123 LET H2=0 'SETS PULLING HOURS TO ZERO FOR REINSTALLATION'
2130 LET L(I)=(H2+H4)*D(1)
2140 LET L(I)=FNA(L(I))
2150 LET H=H+H2+H4 'ACCUMULATES LABOR HRS FOR ALL CABLE INSTALLATIONS'
2160 IF U(I,13)>1 THEN 2220
2170 LET M(I)=U(I,2)*N(J,2) 'MATERIAL COST PER CABLE E365'
2180 LET M(I)=FNA(M(I))

```

Figure 5.5- Lines 1838-2180 of
E365W\$ module.

E365W\$ 02/21/74

```

2190 IF H1<>5 THEN 2220 'TESTS FOR SPACER CABLE'
2200 LET M(1)=A(1)+(D1*.15+U(1,5)*40*.15+U(1,5)*3) 'CJST MESS.GRDS,RDS'
2205 WRITE :8,35115;D1; 'WRITES MESSENGER TO MATFILE'
2206 WRITE :8,31124;U(1,5)*40;76652;U(1,5) 'GRD WIRE GRD RODS'
2210 LET M(1)=FNA(M(1))
2220 LET T(1)=T(1)+L(1) 'TOT LAB $ ALL CABLES E365'
2230 LET A(1)=A(1)+L(1) 'ADDS LAB $ FOR SCRPAD'
2240 LET T(2)=T(2)+M(1) 'TOT MAT $ ALL CABLES E365'
2250 LET A(2)=A(2)+M(1) 'ADDS MAT $ FOR SCRPAD'
2260 LET H3=((U(1,3)*100)+U(1,4)) 'CALC OF PHASE CONST. CODE FROM USER'
2270 LET E(9)=E(9)+(U(1,2)*U(1,17)*3) 'TREE TRIMMING'
2280 REM ALL V( ) VALUES BELOW REFER TO AMOUNT OF DIFF POLE TOPS IN USER
2290 REM DATA. THESE VALUES ARE REFERENCED IN THE POLE TOP CONS ROUTINE
2300 LET V(1)=U(1,5)-(U(1,6)+U(1,7)+U(1,8)+U(1,10)) 'NORMAL POLES'
2310 LET V(0)=(U(1,5)-1) 'SPANS FOR SPACER CABLE'
2320 LET V(2)=U(1,6) 'EXT BRKT POLES'
2330 LET V(3)=U(1,7) 'VERT TURN POLES'
2340 LET V(4)=U(1,8) 'TURN BRKT POLES'
2350 LET V(5)=U(1,9) 'RISER POLES'
2360 LET V(6)=U(1,10) 'DEAD END POLES'
2370 LET V(7)=U(1,11) 'JUNCTION POLES'
2380 LET V(8)=U(1,12) 'ARRESTOR LOCATIONS'
2390 LET V(9)=0 'ZERO QUANTITY POLE TOP'
2391 IF H1=5 THEN 2400
2392 WRITE :8,31124;V(8)*40;76652;V(8) 'GRDS FOR ARRESTER POLES'
2400 RESTORE
2405 IF U(1,4)=7 THEN 2680 'TESTS FOR SEC CABLE INST'
2410 LET I1=0
2420 READ:3,P(1) 'READS IN PTOP FILE UNTIL MATCH IS FOUND IN 1ST LINE'
2430 LET I1=I1+1
2450 IF END:3 THEN 2660 'TEST FOR END OF FILE CONDITION'
2460 IF INT(P(1)*10+.5)<>INT(H3*10+.5) THEN 2420
2465 SETW 3 TO I1*81+1
2466 FOR I1=1 TO 81
2467 READ:3,P(I1)
2468 NEXT I1
2469 SETW 3 TO 1
2470 FOR K=3 TO 81 STEP 4
2480 IF K>3 THEN 2550
2490 IF U(1,13)=1 THEN 2550 'TESTS FOR REINS. CODE'
2500 REM THE ABS QUANTITY BELOW TESTS FOR REINS OR RECONS REQUIRED
2510 IF ABS(U(1,4)-U(1,13))>.15 THEN 2550
2520 FOR I2=1 TO 20
2530 READ 0 'DUMMIES OUT FIRST LINE OF POLE SEQ DATA TO ALLOW FOR REINS'
2540 NEXT I2
2550 READ J1
2560 DATA 1,1,6,6,5,5,8,8,4,3,3,1,1,4,2,1,0,6,3,8 'NORM POLE SEQ'
2570 DATA 9,9,9,9,5,5,8,8,4,9,9,9,9,4,2,1,0,6,3,8 'REINS POLE SEQ'
2573 IF P(K)*V(J1)<1 THEN 2580
2574 IF P(K-1)<1 THEN 2580

```

Figure 5.6- Lines 2190-2574 of
E365W\$ module

E365W\$ 02/21/74

```

2575 WRITE #8,P(K-1);P(K)*V(J1);
2580 IF K>=63 THEN 2640 'ABOVE COL 63 ALL CHARGED TO E365'
2590 IF K<47 THEN 2610 'BELOW COL 47 ALL CHARGED TO E364.2'
2600 IF H1=5 THEN 2640 'TESTS FOR SPACER CABLE, ABOVE COL 47 ALL E365'
2610 LET H(21)=(P(K)*P(K+2)*V(J1))+H(21) 'LABOR HRS E364.2'
2620 LET M(21)=(P(K)*P(K+1)*V(J1))+M(21) 'MATERIAL COST E364.2'
2630 GO TO 2660
2640 LET H(22)=(P(K)*P(K+2)*V(J1))+H(22) 'LABOR HRS E365'
2650 LET M(22)=(P(K)*P(K+1)*V(J1))+M(22) 'MATERIAL COST E365'
2660 NEXT K
2670 NEXT J
2680 NEXT I
2700 LET L(21)=H(21)*D(1)+L(25) 'LAB $ POLE TOP HDW CHARGED TO E364.2'
2710 LET L(21)=FNA(L(21))
2730 LET M(21)=M(21)+M(25) 'MATERIAL COST POLE TOP HDW CHRD TO E364.2'
2740 LET M(21)=FNA(M(21))
2800 LET E(9)=FNA(E(9)) 'TREE TRIMMING'
2860 REM THE ROUTINE BELOW DOES SWITCH & REC COSTS FOR E365 & 369.1
2870 FOR I=1 TO X1
2880 FOR J=9 TO N1
2890 IF S(I,1)<>Y(J,1) THEN 2960
2900 IF S(I,3)>1 THEN 2940
2910 LET H(23)=S(I,2)*Y(J,3)+H(23) 'LAB HRS E365'
2920 LET M(23)=S(I,2)*Y(J,2)+M(23) 'MAT COST E365'
2930 GO TO 2970
2940 LET H(24)=S(I,2)*Y(J,2)+H(24) 'LAB HRS E369.1'
2950 LET M(24)=S(I,2)*Y(J,2)+M(24) 'MAT COST E369.1'
2960 NEXT J
2970 NEXT I
2980 LET L(22)=(H(22)+H(23))*D(1) 'ADDS TOT LAB$ FOR P TOP HDW FOR E365'
2990 LET M(22)=M(22)+M(23) 'ADDS TOT MAT COST FOR P TOP HDW FOR E365'
3000 LET L(22)=FNA(L(22))
3020 LET M(22)=FNA(M(22))
3240 DEF FNR(Y)=(11-INT(LOG(Y+1)/2.30259))
3250 DEF FNS(Y)=(52-INT(LOG(Y+1)/2.30259))
3260 DEF FNT(Y)=(61-INT(LOG(Y+1)/2.30259))
3270 DEF FNU(Y)=(70-INT(LOG(Y+1)/2.30259))
3280 IF L(21)+M(21)<1 THEN 3450
3290 WRITE #5,"1";"E364.2";"0";"GUYS-ANCHORS-XARMS & BRKTS";L(21);M(21)
3450 IF T(1)+I(2)<1 THEN 3650
3460 IF X<1 THEN 3650
3470 FOR I=1 TO X
3472 IF N$(I)>"0" THEN 3480
3474 LET N$(I)="CODE NOT IN OHCABLE FILE"
3480 IF U(I,1)=0 THEN 3550
3490 IF U(I,13)>1.1 THEN 3550
3520 WRITE #5,"1";"E365";U(I,2);N$(I)+T$(I);L(I);M(I)
3550 NEXT I
3560 FOR I=1 TO X
3570 IF U(I,13)<1.1 THEN 3640

```

Figure 5.7- Lines 2575-3570 of
E365W\$ module.

E365W\$ 02/21/74

```
3580 LET I3=I3+1
3590 IF I3>1 THEN 3610
3600 WRITE #5,"I";"E365";"0";" WIRE TO BE REINSULATED";"0","0"
3610 WRITE #5,"I";"E365";U(I,2);NS(I)+TS(I);L(I);M(I)
3640 NEXT I
3650 IF L(22)+M(22)<1 THEN 3690
3660 WRITE #5,"I";"E365";"0";"POLE TOP HARDWARE";L(22);M(22)
3690 IF E(9)<1 THEN 3720
3700 WRITE #5,"I";"E365";"0";"TREE TRIMMING";"0";E(9)
3720 REM
3840 REM
3850 RESTORE :8
3851 FILE :8,"*"
3852 IF Z(2)=2 THEN 3880
3860 CHAIN "E367,1*"
3870 STOP
3880 CHAIN "MISCP*"
3890 STOP
3900 END
```

Figure 5.8- Lines 3580-END of
E365W\$ module.

in these values, the program will read in the amount of user input for switches as denoted by the value stored in X1.

Line 1270 will be read by the program to find the value for X, the number of lines of cable data to follow in the data file D365. If X equals zero, line 1280 will branch the program execution to line 1575. Note the last item in line 140 in file D365 holds the value of five to be stored in X. Cable data is read into the program by the iterative routine contained in lines 1300 through 1350. This data is read from lines 160 through 200 in file D365 as shown in Figure 5.2.

Reading the Cost Estimating Data Files

Each division has stored in its catalogue, files of material costs and labor productivity. These files are accessed by the cost estimating system in order to produce an estimate adjusted for operating conditions in each division. The files accessed by the program module E365W\$ are: (1) COMINFO, (2) OHCABLE, (3) BRPTOP, (4) GYANSW, and (5) NAMES3. These files are illustrated in formatted form in Figures 5.9 through 5.17.

The file COMINFO shown in Figure 5.9 is sequential

TABLE OF COMINFO ESTIMATING VALUES

NO.	DESCRIPTION	QUANTITY/AMOUNT
1.	LABOR RATE	11.5
2	TELCO TRANSFERS	80
3	MAT'L LOADING %	0.5
4	LABOR LOADING %	1.2
5	POLES MATERIAL LOADING	0.15
6	D.E. LABOR HRS (WIRE ONLY)	6
7	VERT TURN (WIRE ONLY)	6
8	RISERS O.H.	8
9	JUNCTIONS	8
10	BLASTING COST PER HOLE	200
11	MAT'L LOADING U.G.	0.25
12	MH TO MH PULLING HRS	25
13	RISER PULLING HRS	37
14	RACKING HRS/CABLE	2
15	STANCHION INST.LAB. HRS.	2
16	1 PH. PIECEOUT HRS.	10
17	3 PH. 4KV PIECEOUT	24
18	3 PH. 13KV & 26 KV PIECEOUT HRS	36
19	RETAG HRS P/LOCATION	2
20	LABOR HRS P/CUTOVER/LOCATION	4
21	SECONDARY CABLE PULLING HRS	8
22	LABOR HRS P/TRENCH FT	2
23	MANHOLE BREAK-IN	48
24	5' RISER PIPE	2.25
25	HANDHOLE INSTALL. HRS	24
26	MAT'L COST PER H.HOLE	125
27	4-12 STANCHION COST	4.5
28	6-12 STANCHION COST	9.5
29	6-9 STANCHION COST	8.9
30	BILLING LABOR RATE/HR.	14.33

Figure 5.9- Table of Common Estimating Values and Percentages.

TABLE OF O.H. CABLE MATERIAL COST AND INSTALLATION HOURS

CABLE NAME	STOCK CODE	UNIT COST	LABOR OWA	HOURS OW	PER SP	THOUSAND LASH	FEET SEC	AER
27KV 500M 3/C CMPF AER CABLE	20509	7.00	0	0	0	0	0	100
27KV 500M ALUM 3-1/C POLY AER	29552	4.50	0	0	0	0	0	100
27KV 500M 3-1/C POLY AERIAL	29752	8.30	0	0	0	0	0	100
27KV 750M AL 3-1/C POLY AER	29572	5.10	0	0	0	0	0	100
27KV 750M 3-1/C POLY AERIAL	29772	10.00	0	0	0	0	0	100
15KV 500M 3-1/C POLY AERIAL	29452	7.55	0	0	0	0	0	100
15KV 750M 3-1/C POLY AERIAL	29472	9.50	0	0	0	0	0	100
SEC 2/0 CU 600V 1/C	26113	.34	0	0	0	0	0	0
SEC 500K 1/C 600V	26151	1.76	0	0	0	0	0	0
1/0 AAAC 1/C AL BARE*	30356	.05	45	45	0	0	15	0
397.5K 1/C AL BARE*	30363	.13	55	55	0	0	0	0
800K 1/C AL BARE*	30367	.25	60	60	0	0	0	0
397.5K 3/C AL BARE	30370	.46	50	50	0	0	0	0
800K 3/C AL BARE	30371	.70	55	55	0	0	0	0
#4 CU PI GROUND WIRE	31124	.12	2	0	0	0	0	0
SER.#4-3/C AL.	31251	.08	0	0	0	0	20	0
SER.#2-3/C AL.	31254	.11	0	0	0	0	20	0
SER.#2-4/C AL.	31255	.15	0	0	0	0	20	0
SER. 2/0-3/C AL.	31256	.21	0	0	0	0	40	0
SER 2/0-4/C AL.	31257	.27	0	0	0	0	60	0
SEC 1/0 AAAC & #4 AL.	31268	.09	0	0	0	0	25	0
4KV 2/0 AL.3/C LASHED	31571	.95	0	0	0	95	0	0
4KV 397K AL.3/C LASHED	31572	1.79	0	0	0	100	0	0
4KV 2/0 AL.3/C SAC	31586	.37	0	0	60	0	0	0
SEC 2/0-2C LAC AWAC	31750	.24	0	0	0	0	40	0
SEC 2/0-3C LAC AWAC	31752	.34	0	0	0	0	60	0
SEC 397.5 3/C LAC AWAC	31753	.74	0	0	0	0	80	0
4/13KV 397.5K 3/C AL PI	31760	.60	50	50	70	0	0	0
4/13KV 1/0AAAC 1/C ALPI*	31835	.10	45	45	65	0	0	0
13KV 397K AL.3/C C.L.P.	31854	1.04	0	0	70	0	0	0
#2-2/5 AWAC MESS.	35115	.13	25	0	0	0	20	0
9/16" GALV MESS.	35007	.21	0	0	0	0	20	0
9/16" CH MESS.	35108	.47	0	0	0	0	20	0

Figure 5.10- Table of Overhead Cable
Material and Labor Costs
Including NAMES3 and
OHCABLE files

ITEM OF MATERIAL	STOCK CODE	UNIT COST	LABOR HOURS
3/8 INCH GUY WIRE	35004	.07	2.00
7/16 INCH GUY WIRE	35005	.10	2.00
GUY GUARD-GREY	76442	2.00	.00
GUY GUARD-YELLOW	76443	2.00	.00
78 INCH FIBER-GLASS ROD	94301	8.00	.00
8 IN TWIN HELIX ANCHOR	70108	14.00	2.00
10 IN TWIN HELIX ANCHOR	70109	15.00	2.00
EX.HEAVY DUTY ANCHOR	70125	17.00	5.00
SWAMP ANCHOR	70116	35.00	5.00
37KV LIGHTNING ARRESTER	130147	51.52	3.00
3KV LIGHTNING ARRESTER	130153	7.75	.00
10KV LIGHTNING ARRESTER	130160	13.60	.00
60KV INT ARRESTER	130150	338.58	10.00
4KV 50 AMP BAYONET C.O.	130361	13.39	3.00
4KV 100 AMP BAYONET C.O.	130364	27.59	3.00
4KV 100 AMP BAY/BL C.O.	130366	27.13	3.00
4KV 200 AMP IND. C.O.	130367	44.00	3.00
13KV 100 AMP F/BL C.O.	130382	25.51	3.00
13KV 200 AMP C.O.	130384	21.34	3.00
13KV 600 AMP SWITCHES	136175	38.00	5.00
13KV 400 AMP OIL SWITCH(ES)	136152	164.00	5.00
15KV SECT 3PH 200A.	135755	546.75	30.00
13KV FEEDER RECLOSER(S)	338	.00	30.00
13KV TIE RECLOSER(S)	339	.00	30.00
13KV OPEN C.O.	130380	32.31	5.00

Figure 5.11- Table Of GYANSW file
labor and material
costs and hours.

PHASE CODE	NORM POLE TOP				NORM POLE TOP				122.
	STOCK CODE 2	UNIT QUANT 3	UNIT COST 4	UNIT LAB/HR 5	STOCK CODE 6	UNIT QUANT 7	UNIT COST 8	UNIT LAB/HR 9	
104.0	70203	1.0	2.45	.5	70720	1.0	2.17	.5	
204.0	70203	1.0	2.45	.5	70720	1.0	2.17	.5	
304.0	70222	1.0	6.93	.5	70722	1.0	2.59	.5	
104.1	70203	1.0	2.45	.5	70720	1.0	2.17	.5	
204.1	70203	1.0	2.45	.5	70720	1.0	2.17	.5	
304.1	70222	1.0	6.93	.5	70722	1.0	2.59	.5	
304.2	70214	1.0	6.34	.5	70722	1.0	2.59	.5	
604.2	70214	2.0	6.34	.5	70722	3.0	2.59	.5	
104.3	70205	1.0	3.43	.5	70722	1.0	2.59	.5	
204.3	70214	1.0	6.34	.5	70722	1.0	2.59	.5	
304.3	70214	1.0	6.34	.5	70722	1.0	2.59	.5	
103.0	0	.0	.00	.0	0	.0	.00	.0	
203.0	0	.0	.00	.0	0	.0	.00	.0	
303.0	0	.0	.00	.0	0	.0	.00	.0	
103.1	0	.0	.00	.0	0	.0	.00	.0	
203.1	0	.0	.00	.0	0	.0	.00	.0	
303.1	0	.0	.00	.0	0	.0	.00	.0	
303.2	0	.0	.00	.0	0	.0	.00	.0	
603.2	0	.0	.00	.0	0	.0	.00	.0	
103.3	0	.0	.00	.0	0	.0	.00	.0	
203.3	0	.0	.00	.0	0	.0	.00	.0	
303.3	0	.0	.00	.0	0	.0	.00	.0	
303.4	0	.0	.00	.0	0	.0	.00	.0	
305.0	0	.0	.00	.0	0	.0	.00	.0	
305.1	0	.0	.00	.0	0	.0	.00	.0	
306.0	0	.0	.00	.0	0	.0	.00	.0	
308.1	0	.0	.00	.0	0	.0	.00	.0	
308.2	70203	1.0	2.45	.5	0	.0	.00	.0	
308.3	70203	1.0	2.45	.5	0	.0	.00	.0	
107.0	0	.0	.00	.0	0	.0	.00	.0	

PHASE CODE	D.E. POLE TOP				D.E. POLE TOP			
	STOCK CODE 10	UNIT QUANT 11	UNIT COST 12	UNIT LAB/HR 13	STOCK CODE 14	UNIT QUANT 15	UNIT COST 16	UNIT LAB/HR 17
104.0	0	.0	.00	.0	0	.0	.00	.0
204.0	70203	2.0	2.45	.5	70720	1.0	2.17	.5
304.0	70222	3.0	6.93	.5	70722	2.0	2.59	.5
104.1	0	.0	.00	.0	0	.0	.00	.0
204.1	70203	2.0	2.45	.5	70720	2.0	2.17	.5
304.1	70222	3.0	6.93	.5	70722	2.0	2.59	.5
304.2	70214	2.0	6.34	.5	70722	2.0	2.59	.5
604.2	70214	6.0	6.34	.5	70722	6.0	2.59	.5
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	70222	2.0	6.93	.5	70722	2.0	2.59	.5
304.3	70214	2.0	6.34	.5	70722	2.0	2.59	.5
103.0	0	.0	.00	.0	0	.0	.00	.0
203.0	70203	2.0	2.45	.5	70720	2.0	2.17	.5
303.0	70222	3.0	6.93	.5	70722	2.0	2.59	.5
103.1	0	.0	.00	.0	0	.0	.00	.0
203.1	70203	2.0	2.45	.5	70720	2.0	2.17	.5
303.1	70222	3.0	6.93	.5	70722	2.0	2.59	.5
303.2	70214	2.0	6.34	.5	70722	2.0	2.59	.5
603.2	70214	4.0	6.34	.5	70722	2.0	2.59	.5
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	70222	2.0	6.93	.5	70722	2.0	2.59	.5
303.3	70214	2.0	6.34	.5	70722	2.0	2.59	.5
303.4	70214	3.0	6.34	.5	70722	2.0	2.59	.5
305.0	70222	2.0	6.93	.5	70722	2.0	2.59	.5
305.1	70222	2.0	6.93	.5	70722	2.0	2.59	.5
306.0	0	.0	.00	.0	0	.0	.00	.0
308.1	0	.0	.00	.0	0	.0	.00	.0
308.2	0	.0	.00	.0	0	.0	.00	.0
308.3	0	.0	.00	.0	0	.0	.00	.0
107.0	0	.0	.00	.0	0	.0	.00	.0

Figure 5.12- BRPTOP file part 1

PHASE CODE	RISER POLE TOP				RISER POLE TOP			
	STOCK CODE 18	UNIT QUANT 19	UNIT COST 20	UNIT LAB/HR 21	STOCK CODE 22	UNIT QUANT 23	UNIT COST 24	UNIT LAB/HR 25
104.0	0	.0	.00	.0	0	.0	.00	.0
204.0	70203	2.0	2.45	.5	70720	1.0	2.17	.5
304.0	70222	2.0	6.93	.5	70722	2.0	2.59	.5
104.1	0	.0	.00	.0	0	.0	.00	.0
204.1	70203	2.0	2.45	.5	70720	2.0	2.17	.5
304.1	70222	2.0	6.93	.5	70722	2.0	2.59	.5
304.2	70214	2.0	6.34	.5	70722	2.0	2.59	.5
604.2	70214	6.0	6.34	.5	70722	6.0	2.59	.5
104.3	70222	2.0	6.93	.5	70722	2.0	2.59	.5
204.3	70222	2.0	6.93	.5	70722	2.0	2.59	.5
304.3	70214	2.0	6.34	.5	70722	2.0	2.59	.5
103.0	0	.0	.00	.0	0	.0	.00	.0
203.0	70203	2.0	2.45	.5	70720	2.0	2.17	.5
303.0	70222	2.0	6.93	.5	70722	2.0	2.59	.5
103.1	0	.0	.00	.0	0	.0	.00	.0
203.1	70203	2.0	2.45	.5	70720	2.0	2.17	.5
303.1	70222	2.0	6.93	.5	70722	2.0	2.59	.5
303.2	70214	2.0	6.34	.5	70722	2.0	2.59	.5
603.2	70214	6.0	6.34	.5	70722	6.0	2.59	.5
103.3	70222	2.0	6.93	.5	70722	2.0	2.59	.5
203.3	70222	2.0	6.93	.5	70722	2.0	2.59	.5
303.3	70214	2.0	6.34	.5	70722	2.0	2.59	.5
303.4	0	.0	.00	.0	0	.0	.00	.0
305.0	70222	2.0	6.93	.5	70722	2.0	2.59	.5
305.1	70222	2.0	6.93	.5	70722	2.0	2.59	.5
306.0	70222	2.0	6.93	.5	70722	2.0	2.59	.5
308.1	70222	2.0	6.93	.5	70722	2.0	2.59	.5
308.2	70214	2.0	6.34	.5	70722	2.0	2.59	.5
308.3	70214	2.0	6.34	.5	70722	2.0	2.59	.5
107.0	0	.0	.00	.0	0	.0	.00	.0

PHASE CODE	L.A. POLE TOP				L.A. POLE TOP			
	STOCK CODE 26	UNIT QUANT 27	UNIT COST 28	UNIT LAB/HR 29	STOCK CODE 30	UNIT QUANT 31	UNIT COST 32	UNIT LAB/HR 33
104.0	0	.0	.00	.0	0	.0	.00	.0
204.0	0	.0	.00	.0	0	.0	.00	.0
304.0	0	.0	.00	.0	0	.0	.00	.0
104.1	0	.0	.00	.0	0	.0	.00	.0
204.1	0	.0	.00	.0	0	.0	.00	.0
304.1	0	.0	.00	.0	0	.0	.00	.0
304.2	0	.0	.00	.0	0	.0	.00	.0
604.2	0	.0	.00	.0	0	.0	.00	.0
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	0	.0	.00	.0	0	.0	.00	.0
304.3	0	.0	.00	.0	0	.0	.00	.0
103.0	0	.0	.00	.0	0	.0	.00	.0
203.0	0	.0	.00	.0	0	.0	.00	.0
303.0	0	.0	.00	.0	0	.0	.00	.0
103.1	0	.0	.00	.0	0	.0	.00	.0
203.1	0	.0	.00	.0	0	.0	.00	.0
303.1	0	.0	.00	.0	0	.0	.00	.0
303.2	0	.0	.00	.0	0	.0	.00	.0
603.2	0	.0	.00	.0	0	.0	.00	.0
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	0	.0	.00	.0	0	.0	.00	.0
303.3	0	.0	.00	.0	0	.0	.00	.0
303.4	0	.0	.00	.0	70850	3.0	40.00	3.0
305.0	70203	1.0	2.45	.5	70720	1.0	2.17	.5
305.1	70203	1.0	2.45	.5	70720	1.0	2.17	.5
306.0	70222	1.0	6.93	.5	70722	1.0	2.59	.5
308.1	70222	1.0	6.93	.5	70722	1.0	2.59	.5
308.2	70222	1.0	6.93	.5	70722	1.0	2.59	.5
308.3	70222	1.0	6.93	.5	70722	1.0	2.59	.5
107.0	0	.0	.00	.0	0	.0	.00	.0

Figure 5.13- BRPTOP file part 2

PHASE CODE	TURNBRKT POLE TOP				VERT TURN POLE TOP				124.
	STOCK	UNIT	UNIT	UNIT	STOCK	UNIT	UNIT	UNIT	
	CODE	QUANT	COST	LAB/HR	CODE	QUANT	COST	LAB/HR	
	34	35	36	37	38	39	40	41	
104.0	0	.0	.00	.0	0	.0	.00	.0	
204.0	0	.0	.00	.0	0	.0	.00	.0	
304.0	0	.0	.00	.0	0	.0	.00	.0	
104.1	0	.0	.00	.0	0	.0	.00	.0	
204.1	0	.0	.00	.0	0	.0	.00	.0	
304.1	0	.0	.00	.0	0	.0	.00	.0	
304.2	0	.0	.00	.0	0	.0	.00	.0	
604.2	0	.0	.00	.0	0	.0	.00	.0	
104.3	0	.0	.00	.0	0	.0	.00	.0	
204.3	0	.0	.00	.0	0	.0	.00	.0	
304.3	0	.0	.00	.0	0	.0	.00	.0	
103.0	70830	1.0	10.84	.5	0	.0	.00	.0	
203.0	70880	2.0	104.07	3.0	0	.0	.00	.0	
303.0	70880	2.0	104.07	3.0	0	.0	.00	.0	
103.1	70830	1.0	10.84	.5	0	.0	.00	.0	
203.1	70880	1.0	104.07	3.0	0	.0	.00	.0	
303.1	70880	1.0	104.07	3.0	0	.0	.00	.0	
303.2	70880	1.0	104.07	3.0	0	.0	.00	.0	
603.2	70880	3.0	104.07	3.0	0	.0	.00	.0	
103.3	0	.0	.00	.0	0	.0	.00	.0	
203.3	70880	1.0	104.07	3.0	0	.0	.00	.0	
303.3	70880	1.0	104.07	3.0	0	.0	.00	.0	
303.4	70810	1.0	159.54	6.0	0	.0	.00	.0	
305.0	70819	1.0	22.98	4.0	0	.0	.00	.0	
305.1	70819	1.0	22.98	4.0	0	.0	.00	.0	
306.0	71210	1.0	3.44	.5	0	.0	.00	.0	
308.1	71210	1.0	3.44	.5	0	.0	.00	.0	
308.2	71210	1.0	3.44	.5	0	.0	.00	.0	
308.3	71210	1.0	3.44	.5	0	.0	.00	.0	
107.0	71210	1.0	3.44	.5	0	.0	.00	.0	

PHASE CODE	VERT TURN POLE TOP				NORMAL POLE TOP			
	STOCK	UNIT	UNIT	UNIT	STOCK	UNIT	UNIT	UNIT
	CODE	QUANT	COST	LAB/HR	CODE	QUANT	COST	LAB/HR
	42	43	44	45	46	47	48	49
104.0	0	.0	.00	.0	0	.0	.00	.0
204.0	0	.0	.00	.0	0	.0	.00	.0
304.0	0	.0	.00	.0	0	.0	.00	.0
104.1	0	.0	.00	.0	0	.0	.00	.0
204.1	0	.0	.00	.0	0	.0	.00	.0
304.1	0	.0	.00	.0	0	.0	.00	.0
304.2	0	.0	.00	.0	70861	1.0	5.55	1.0
604.2	0	.0	.00	.0	70205	1.0	3.43	.5
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	0	.0	.00	.0	0	.0	.00	.0
304.3	0	.0	.00	.0	0	.0	.00	.0
103.0	0	.0	.00	.0	70837	1.0	9.82	.5
203.0	0	.0	.00	.0	0	.0	.00	.0
303.0	0	.0	.00	.0	70837	1.0	9.82	.5
103.1	0	.0	.00	.0	70857	1.0	8.06	.5
203.1	0	.0	.00	.0	0	.0	.00	.0
303.1	0	.0	.00	.0	70857	1.0	8.06	.5
303.2	0	.0	.00	.0	70875	1.0	15.62	.5
603.2	0	.0	.00	.0	0	.0	.00	.0
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	0	.0	.00	.0	0	.0	.00	.0
303.3	0	.0	.00	.0	0	.0	.00	.0
303.4	0	.0	.00	.0	70861	1.0	5.55	1.0
305.0	0	.0	.00	.0	70820	1.0	15.54	1.0
305.1	0	.0	.00	.0	70820	1.0	15.54	1.0
306.0	0	.0	.00	.0	0	.0	.00	.0
308.1	0	.0	.00	.0	0	.0	.00	.0
308.2	0	.0	.00	.0	0	.0	.00	.0
308.3	0	.0	.00	.0	0	.0	.00	.0
107.0	0	.0	.00	.0	0	.0	.00	.0

Figure 5.14- BRPTOP file part 3.

PHASE CODE	NORMAL POLE TOP				TURN BRKT POLE TOP			
	STOCK	UNIT	UNIT	UNIT	STOCK	UNIT	UNIT	UNIT
	CODE	QUANT	COST	LAB/HR	CODE	QUANT	COST	LAB/HR
	50	51	52	53	54	55	56	57
104.0	0	.0	.00	.0	0	.0	.00	.0
204.0	0	.0	.00	.0	0	.0	.00	.0
304.0	0	.0	.00	.0	0	.0	.00	.0
104.1	0	.0	.00	.0	0	.0	.00	.0
204.1	0	.0	.00	.0	0	.0	.00	.0
304.1	0	.0	.00	.0	0	.0	.00	.0
304.2	0	.0	.00	.0	0	.0	.00	.0
604.2	0	.0	.00	.0	0	.0	.00	.0
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	0	.0	.00	.0	0	.0	.00	.0
304.3	0	.0	.00	.0	0	.0	.00	.0
103.0	0	.0	.00	.0	94038	1.0	1.95	.2
203.0	70833	1.0	15.05	.5	94008	8.0	2.07	.2
303.0	70833	1.0	15.05	.5	94008	16.0	2.07	.2
103.1	0	.0	.00	.0	94038	1.0	1.95	.2
203.1	70833	1.0	15.05	.5	94008	8.0	2.07	.2
303.1	70833	1.0	15.05	.5	94008	8.0	2.07	.2
303.2	70876	1.0	29.78	.5	94050	18.0	2.82	.5
603.2	70876	3.0	29.78	.5	94050	54.0	2.82	.5
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	0	.0	.00	.0	94050	18.0	2.82	.5
303.3	0	.0	.00	.0	94050	18.0	2.82	.5
303.4	70881	2.0	7.27	.7	94050	24.0	2.82	.5
305.0	0	.0	.00	.0	94038	3.0	1.95	.2
305.1	0	.0	.00	.0	94038	3.0	1.95	.2
306.0	0	.0	.00	.0	0	.0	.00	.0
308.1	0	.0	.00	.0	0	.0	.00	.0
308.2	0	.0	.00	.0	0	.0	.00	.0
308.3	0	.0	.00	.0	0	.0	.00	.0
107.0	0	.0	.00	.0	0	.0	.00	.0

PHASE CODE	P.T.E. POLE TOP				NORMAL POLE SPACER OR TOP			
	STOCK	UNIT	UNIT	UNIT	STOCK	UNIT	UNIT	UNIT
	CODE	QUANT	COST	LAB/HR	CODE	QUANT	COST	LAB/HR
	58	59	60	61	62	63	64	65
104.0	0	.0	.00	.0	94061	1.0	.85	.2
204.0	0	.0	.00	.0	94061	2.0	.85	.2
304.0	0	.0	.00	.0	94061	3.0	.85	.2
104.1	0	.0	.00	.0	94061	1.0	.85	.2
204.1	0	.0	.00	.0	94061	2.0	.85	.2
304.1	0	.0	.00	.0	94061	3.0	.85	.2
304.2	0	.0	.00	.0	94051	3.0	6.73	.2
604.2	0	.0	.00	.0	94051	6.0	6.73	.2
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	0	.0	.00	.0	0	.0	.00	.0
304.3	0	.0	.00	.0	0	.0	.00	.0
103.0	70826	1.0	88.74	3.0	94061	1.0	.85	.2
203.0	70826	1.0	88.74	3.0	94061	2.0	.85	.2
303.0	70826	1.0	88.74	3.0	94061	2.0	.85	.2
103.1	70826	1.0	88.74	3.0	94061	1.0	.85	.2
203.1	70826	1.0	88.74	3.0	94061	2.0	.85	.2
303.1	70826	1.0	88.74	3.0	94061	3.0	.85	.2
303.2	0	.0	.00	.0	94085	1.0	8.89	.2
603.2	0	.0	.00	.0	94086	6.0	10.96	.2
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	0	.0	.00	.0	0	.0	.00	.0
303.3	0	.0	.00	.0	0	.0	.00	.0
303.4	0	.0	.00	.0	94090	1.0	34.34	1.0
305.0	70802	1.0	63.26	1.5	77320	1.0	6.02	.5
305.1	70802	1.0	63.26	1.5	77320	1.0	6.02	.5
306.0	0	.0	.00	.0	71209	1.0	2.98	.5
308.1	0	.0	.00	.0	71209	1.0	2.98	.5
308.2	0	.0	.00	.0	71209	1.0	2.98	.5
308.3	0	.0	.00	.0	71209	1.0	2.98	.5
107.0	0	.0	.00	.0	71207	1.0	.92	.5

Figure 5.15- BRPTOP file part 4

PHASE CODE	IN SPAN SPACERS				D.E. POLE TOP			
	STOCK	UNIT	UNIT	UNIT	STOCK	UNIT	UNIT	UNIT
	CODE	QUANT	CUST	LAB/HR	CODE	QUANT	COST	LAB/HR
	66	67	68	69	70	71	72	73
104.0	0	.0	.00	.0	94008	2.0	2.07	.2
204.0	0	.0	.00	.0	94008	4.0	2.07	.2
304.0	0	.0	.00	.0	94008	6.0	2.07	.2
104.1	0	.0	.00	.0	94008	2.0	2.07	.2
204.1	0	.0	.00	.0	94008	4.0	2.07	.2
304.1	0	.0	.00	.0	94008	6.0	2.07	.2
304.2	0	.0	.00	.0	94050	9.0	2.82	.5
604.2	0	.0	.00	.0	94050	18.0	2.82	.5
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	0	.0	.00	.0	0	.0	.00	.0
304.3	0	.0	.00	.0	0	.0	.00	.0
103.0	0	.0	.00	.0	94008	2.0	2.07	.2
203.0	0	.0	.00	.0	94008	4.0	2.07	.2
303.0	0	.0	.00	.0	94008	6.0	2.07	.2
103.1	0	.0	.00	.0	94008	2.0	2.07	.2
203.1	0	.0	.00	.0	94008	4.0	2.07	.2
303.1	0	.0	.00	.0	94008	6.0	2.07	.2
303.2	94086	2.0	10.96	.2	94050	9.0	2.82	.5
603.2	0	.0	.00	.0	94050	18.0	2.82	.5
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	0	.0	.00	.0	94050	9.0	2.82	.5
303.3	0	.0	.00	.0	94050	9.0	2.82	.5
303.4	94095	2.0	34.00	.7	94050	24.0	2.82	.5
305.0	77308	3.0	2.47	.5	94008	6.0	2.07	.2
305.1	77308	3.0	2.47	.5	94008	6.0	2.07	.2
306.0	0	.0	.00	.0	0	.0	.00	.0
308.1	0	.0	.00	.0	0	.0	.00	.0
308.2	0	.0	.00	.0	0	.0	.00	.0
308.3	0	.0	.00	.0	0	.0	.00	.0
107.0	0	.0	.00	.0	0	.0	.00	.0

PHASE CODE	VERT TURN POLE TOP				L.A. POLE			
	STOCK	UNIT	UNIT	UNIT	STOCK	UNIT	UNIT	UNIT
	CODE	QUANT	CUST	LAB/HR	CODE	QUANT	COST	LAB/HR
	74	75	76	77	78	79	80	81
104.0	94008	4.0	2.07	.2	130153	1.0	7.76	1.5
204.0	94008	8.0	2.07	.2	130153	2.0	7.76	1.5
304.0	94008	12.0	2.07	.2	130153	3.0	7.76	1.5
104.1	94008	4.0	2.07	.2	130160	1.0	13.61	1.5
204.1	94008	8.0	2.07	.2	130160	2.0	13.61	1.5
304.1	94008	12.0	2.07	.2	130160	3.0	13.61	1.5
304.2	94050	26.0	2.82	.5	130147	1.0	51.52	1.5
604.2	94050	52.0	2.82	.5	130147	2.0	51.52	1.5
104.3	0	.0	.00	.0	0	.0	.00	.0
204.3	0	.0	.00	.0	0	.0	.00	.0
304.3	0	.0	.00	.0	0	.0	.00	.0
103.0	94008	4.0	2.07	.2	130160	1.0	13.61	1.5
203.0	94008	8.0	2.07	.2	130160	2.0	13.61	1.5
303.0	94008	12.0	2.07	.2	130160	3.0	13.61	1.5
103.1	94008	4.0	2.07	.2	130160	1.0	13.61	1.5
203.1	94008	8.0	2.07	.2	130160	2.0	13.61	1.5
303.1	94008	12.0	2.07	.2	130160	3.0	13.61	1.5
303.2	94050	26.0	2.82	.5	130147	1.0	51.52	1.5
603.2	94050	52.0	2.82	.5	130147	2.0	51.52	1.5
103.3	0	.0	.00	.0	0	.0	.00	.0
203.3	0	.0	.00	.0	0	.0	.00	.0
303.3	0	.0	.00	.0	0	.0	.00	.0
303.4	94050	24.0	2.82	.5	130150	3.0	338.58	2.0
305.0	94008	12.0	2.07	.2	130153	3.0	7.76	1.5
305.1	94008	12.0	2.07	.2	130160	3.0	13.61	1.5
306.0	0	.0	.00	.0	130153	3.0	7.76	1.5
308.1	0	.0	.00	.0	130160	3.0	13.61	1.5
308.2	0	.0	.00	.0	130147	3.0	51.52	1.5
308.3	0	.0	.00	.0	0	.0	.00	.0
107.0	0	.0	.00	.0	0	.0	.00	.0

Figure 5.16- BRPTOP file part 5

ASCII in structure. The file contains labor rates and loadings as well as miscellaneous items not feasible for storage in other files. COMINFO data is read into the E365W\$ program module as illustrated in Figure 5.3, line 1010.

The files OHCABLE and NAMES3 are shown in report form in Figure 5.10. Both files are sequential ASCII in structure. The OHCABLE file contains material costs and productivity hours for each cable indicated. The cost shown is per linear foot for the number of conductors normally wound on a reel. The labor hours shown are based on six different types of construction.

- (1) OWA is open wire armless construction and is in column 3 of the OHCABLE file.
- (2) OW is open wire construction. This value is stored in the fourth column of the OHCABLE file.
- (3) SP is spacer cable construction. This value is stored in the fifth column of the OHCABLE file.
- (4) LASH is lashed cable construction. This value is stored in the sixth column of the OHCABLE file.

(5) SEC is secondary construction. This value is stored in the seventh column of the OHCABLE file.

(6) AER is aerial cable construction. This value is stored in the eighth column of the OHCABLE file.

The column position used in this table is also the number used to describe construction type on the data sheet. This enables the program to select the proper labor value from the file when needed for the estimate. If it is possible for a cable to be installed in more than one construction type, labor values are provided in all appropriate columns. For example, cable code 31760 on Figure 5.10 shows values in three columns, indicating that this cable can be installed in three different ways.

The cable name shown in the table in Figure 5.10 is stored in the NAMES3 file. This file stores the string information necessary to label the cables in the same sequence as the OHCABLE file. Consequently, when cables are added or deleted from the OHCABLE file the corresponding name must be added or deleted from the NAMES3 file.

The OHCABLE file and the NAMES3 file are read into the E365W\$ program module shown in Figure 5.4 in lines 1600 through 1670.

The file GYANSW is shown in report form in Figure 5.11. The file is sequential ASCII in structure. The file contains material cost and labor hours for guy, anchor, and switch installations. This file is read into the program module in lines 1680 through 1740 as shown in Figure 5.4.

The large file BRPTOP is shown in report form in Figures 5.12 through 5.16. This file is stored in random binary structure. The file contains information structured in such a way as to relieve the estimator of the burden of entering, in the input data, detailed information on required pole top material items. The file is organized in an N by 81 word structure. N can be any number of 81 word records needed by a particular division. The first record in the file is a directory of the rest of the file. This is done by sequencing the phase code key in the same order as they are found in the rest of the file. The phase code key is formed by multiplying the number of phases to be installed by 100 and adding the construction code to it. For example,

three phase spacer cable would have a phase code of $3 \times 100 + 5$. The resulting code is 305. This code uniquely identifies every type of overhead construction used by Public Service. The user does not generate this code. The program takes the user input data and constructs the code necessary to access the file.

Each record of the BRPTOP file is begun with the phase code key. The rest of the record is divided into 20 four-word groups. The four-word groups are organized in the same way. The first word contains the stock code of the item. The second word contains the quantity of the item identified in the first word needed for the construction required by the estimate. The third item is the cost of one unit of material described by the first item. The fourth item is the amount of labor hours required to install one item of material as identified in item one.

The twenty groups of four items are further organized so that each describes a particular pole top configuration. If the configuration does not exist for a particular phase code key, zeroes are entered in the file instead of the required values. The file is further organized so that it can charge material to the proper estimate account. All

entries below column 47 are automatically charged to account E364.2. All entries above column 63 are automatically charged to account E365. The program module E365W\$ tests for spacer cable installations to determine to which account material from columns 44 through 62 is charged.

The BRPTOP file is read into the program module a line at a time so as not to use too much core space. Lines 2405 through 2468 in Figure 5.6 are used to read this file.

The organization of this file by phase code key, by pole top construction unit, and by account to be charged, was developed by the author in order to simplify user input. He believes that it is a unique approach to the estimating problem. Research into the literature available on computer cost estimating techniques have not changed this belief.

Producing the Cost Estimate for Guys, Anchors, and Switches

The routine used to calculate the costs of guys and anchors is located in Figures 5.4 and 5.5 in lines 1745 to 1838. Line 1745 tests to see if there is guy and anchor data in the user input, if so the program execution branches to line 1750. Lines 1750 to 1770 calculate the

required labor hours to install guys and anchors, and stores the result in a variable named H(25). It can be seen that user data stored in the B array is being multiplied by values stored in the Y array which is the data read in from the file GYANSW. The third column of the Y array contains the labor hours to install guys and anchors. The B array tells the computer how many of each type are to be installed. No search is necessary, since the type of installation is pre-specified on the data sheet. After the labor hours are accumulated in H(25), they are multiplied by the labor rate D(1), in line 1780. Material costs are similarly calculated in lines 1800-1820 of Figure 5.4.

After the costs are calculated, the material requirement is written to MATFILE in lines 1834-1838 in Figures 5.4 and 5.5.

The cost calculation for switches and reclosers is done in the routine of Figure 5.7 in lines 2860-2970. The user data is stored in the S array. The switch data from the GYANSW file is stored in the Y array. A search is performed by the program to find a match between user input code numbers and those stored in the Y array. When a match is found in line 2890, the calculation is performed in line 2910 for labor and material. This will be

done if these costs will be charged to account E365. If the costs are to be charged to account E369.1, the program branches to line 2940.

Producing the Cost Estimate for Overhead Cables

The largest cost portion of an overhead construction cost estimate is that due to the installation of overhead primary and secondary cables. This cost is made up of the material cost of the cable, the cost of pulling the cable into position on the pole, and the cost of building the pole top construction. This part of the estimate is done by the E365W\$ module in lines 1840 through 2800 of Figures 5.5 through 5.7.

Matching the cable code. The desired cable needed for the estimate is input by the user and stored in the U array in the first position of every line. This value is checked against the OHCABLE data stored in the W array. The checking procedure is accomplished using a doubly nested iteration loop for I and J contained in lines 1840 and 1850. The user cable is indexed on the outer I loop while the OHCABLE data is indexed on the inner J loop. The IF statement of line 1870 serves as a gate, and will step through the J loop until a match is found in the W array. If a match is not found an error code is generated

in line 3474. When a match is found, the execution of the program falls through the IF statement of line 1870, and proceeds to initialization the H2 and H4 variables. The cable is named in line 1890 using information stored in the M\$ string array from the NAMES3 file.

The cable stock code is then checked against several codes of cables known to be supplied on single conductor reels. If a match is found in line 1900-1906, the footage is adjusted to three times the quantity input by the user in line 1920 of the E365W\$ module. This is done because all cables are considered to be supplied on three conductor reels by the user, the program must recalculate the special cases. This was done to further simplify the input requirements for the user.

Naming the construction type. Line 1930 takes the integer of the construction code input by the user. It will be remembered that this code is a single digit number followed by a single digit decimal (ex. 3.1). In order to use this code to access the proper column of the W array, the decimal must be chopped off and the number stored in integer form in the variable H1. Line 1935 tests for reinsulation code, if it is greater than 1, the program branches to line 1940 in order to avoid appending

the material file MATFILE as would be done if the program had executed line 1936.

The large computed GO TO statement found in line 1940 of Figure 5.5 selects the proper string to be concatenated with the cable name to further describe the installation on the final report.

Computing the total installation factor. Line 2020 computes the final installation factor to be used in determining the amount of extra labor needed for the line of cable being processed. If this factor equates to zero, a mistake has been made on the user's part. The program tests this value in line 2030. If the factor as stored in the variable f(1) is equal to zero, the program sets the value to one in line 2040. The reader should note that the final installation factor is made up of the multiplication of the user input replacement factor, installation factor, and the gain factor.

Calculating the Labor and Material Costs. The calculation of the costs of pulling the cable, and the wire work associated with the building of special pole tops is done in the program section bounded by lines 2080 and 2200 of Figures 5.5 and 5.6. The variable H4 is used to store

the result of the equation on line 2080. User input data for the amount of special pole tops including: vertical turns (U(I,7)), risers (U(I,9)), deadends (U(I,10)), and junctions (U(I,11)), is multiplied by the corresponding normal labor hours to do each from the COMINFO file stored in the variables F(5) through F(8). The total is multiplied by the total installation factor calculated in line 2020 and explained above. The total is further multiplied by the phase factor P(0) calculated in line 2060 and used to adjust three phase labor figures stored in the OHCABLE file for single or double phase installations. The variable H2 is calculated in one of two places depending on whether the cable being installed is a primary or secondary cable. If it is a primary installation, the calculation will be done in line 2100 of Figure 5.5. The OHCABLE data stored in the W array is referenced at the Jth line position determined by the IF statement of line 1870, and the H1th column number determined by the integer of the construction code as calculated in line 1930. This item as stored in the W array will be the proper pulling labor hours required for the cable in question. For example, the first line of the user cable data found in Figure 5.1, line 501, would reference the W array in the following way. The stock code 31760 would have found a match in the 28th

line of the OHCABLE file, the construction code of 3.1 would result in an integer value of 3 stored in H1. The resultant reference would be made at the 28th line, third column of the W array. This position is held by the value of 50 hours, the normal labor requirement to install 1000 feet of the cable. This value is multiplied by the total installation factor $F(1)$ to arrive at the adjusted labor hours for the job in question. This value is then multiplied by $P(0)$ to adjust for the number of phases. In our test case, the value of $F(1)$ is 1, and the value of $P(0)$ is also 1.

The last thing to be done in finding the labor cost is to multiply the labor hours $H2 + H4$ times the labor rate $D(1)$. This is done in line 3130 of Figure 5.5. Finally, the figure is rounded to the nearest 10 or 100 dollars using the rounding function FNA in line 2140. The function is defined in line 1384 of Figure 5.3.

The material cost for the cable is arrived at in line 2170 of Figure 5.5. It is simply the number of feet of cable as shown in the user data times the cost per foot as stored in the W array. This cost is then rounded using the FNA function in line 2180.

A test is made for spacer cable installation in line

2190 of Figure 5.6. If the test shows that the installation is spacer cable, lines 220-2206 are executed to provide for supporting messenger cable and ground rods. If the installation is not spacer cable, the program will branch to the equations contained in lines 2210-2250. These equations are used to subtotal the material and labor for all cable installations.

Calculation of Pole Top Material and Labor Costs

The calculation of pole top labor and material costs is accomplished by the routine bounded by lines 2260 and 2680 of Figures 5.6 and 5.7 of the E365W\$ program module. In general terms, the purpose of the routine is to substitute user data into the V array for easier handling, to search the BRPTOP file for the proper data, and to calculate labor and material costs for pole top construction.

Lines 2300 through 2390 of Figure 5.6 load each line of user overhead cable data stored in the U array into the singly dimensioned V array. This is done to simplify the iteration needed to step through this data in a subsequent calculation. The phase code key is calculated in line 2260 of Figure 5.6 and is stored in the variable H3. It is derived as described above, by multiplying the number

of phases (U(I,3)), times 100 and adding the result to the construction type (U(I,4)).

The routine bounded by the lines 2410 and 2460 reads in the directory of the BRPTOP file. The routine reads through the directory one item at a time, and checks the phase code stored in P(1) with the phase code generated by the program and stored in the variable H3. This test is made in line 2460 of Figure 5.6. If a match is found the program branches to line 2465 and begins the cost calculation. If not match is found, the program steps through to the next cable entry.

Setting to the proper record. Line 2465 is a binary set function which moves the next file access to the proper file record. The file need never be read into core entirely, the pertinent record alone is read. This saves core space and makes it possible to handle a large volume of data economically. The set function as shown in line 2465 will direct the reading of the BRPTOP file to the matched directory location sotred in the variable I1 multiplied by 81, which is the record length in words.

Initiating the proper pole top sequence. The cost calculation is begun in the K iteration loop commencing on line 2480. The loop is structured to step through the

twenty, four-word sub-records at the cost per unit storage location. Line 2480 through 2570 set the sequence with which the V array will be accessed during the cost calculation to follow. The reader will note that there are two possible ways to sequence this array; for the normal installation sequence and for the reinsulation sequence. The former is contained in the data stored in line 2560, and the latter in the data stored in line 2570. Each line contains 20 data items which correspond to the subscript numbers of the desired value stored in the V array. For example, the first value stored in line 2560 is the integer 1. Substituting this number as the subscript for the V array produces the amount of normal pole tops stored in the V(1) variable. If this were a re-insulation data line, the first value would be read from the data stored in line 2570. The value read would be the integer 9. Substituting this value as the index for the V array yields the zero quantity pole top. In other words, a re-insulated pole requires no material in this position.

Cost calculation equations. The program checks for zero cost and/or zero stock code values in lines 2573 and 2574. If a zero case exists, line 2575 is skipped and the material is not written to the file MATFILE. Line 2580 and 2590 check the K loop value to determine the

account to which the material cost and labor cost should be charged. As explained earlier, all charges under a K value of 47 will be charged to account E364.2. All K values above 63 will be charged to account E365. Labor hours for labor charged to account E364.2 will be stored in the variable H(21). Material costs will be stored in the variable M(21). The variable H(22) and M(22) will store the costs for account E365. In either case the calculation will be done in the following manner. The P(k) variable holds the quantity of the item of pole top material. The P(K+2) variable holds the labor hours required to install a unit of material. The V(J1) variable holds the amount of the particular pole top in question. The multiplication of the above three variables yields the total cost for the pole top material required in the user data. The costs developed in the above calculations are rounded and totaled using the equations contained in lines 2700 through 2740.

Summary of the pole top calculation section. The use of the simplification techniques incorporated in the structure and handling of the random binary pole top construction file BRPTOP make the assembly of input data an easy matter. Other systems the author has reviewed require a catalog of construction packages in order for

the user to fill out the data sheets. Several hundred packages of pole top hardware are listed according to number of phases, voltage class, and construction type. The input of data is more burdensome with this type of system. However, the system developed by the author requires only the input of the amount of various special pole tops. The computer generates the material package.

Appending of the Work Files DMISC and MATFILE

Throughout the execution of the E365WS program module, the work files DMISC and MATFILE are appended. The DMISC file is appended to contain the material and labor costs calculated during the execution. The format of the output to the file contains the following:

- (1) Account type (1 means overhead, 2 means underground)
- (2) Account title (E365, E364.2, etc.)
- (3) Item description (Cable name, pole top hardware)
- (4) Labor cost (Cost is rounded inside the program)
- (5) Material cost (Cost is rounded inside the program)

The DMISC file appended during the execution of the E365WS module is shown in Figure 5.2.

The file entitled MATFILE is appended to contain the stock code of the material required and the quantity needed.

The contents of this file created during the run of the sample data is shown in Figure 5.17.

Chaining Out of the E365W\$ Module

Upon completion of the E365W\$ module, the selection of a chaining point must be made in the program. The program section bounded by lines 3852 and 3880 provides this function. If the estimate is an overhead only type, the program will chain to the MISCP program to produce the cost estimate printout. If the estimate contains underground data, the program will chain to the underground module E367W\$.

Printing of The Estimate, The Estimate Summary, and The Material List

After the completion of the calculating modules of the estimate system, the MISCP*, SUMRY*, and MATLS* program modules are called in, sequentially, to produce the necessary reports. The functions of these programs were discussed in Chapter IV. The cost estimate for the sample data is shown in Figure 5.18. The estimate summary is illustrated in Figure 5.19. Finally, the material list is shown in Figure 5.20. The reader will note that these computer reports are similar to the manually produced reports. They are a direct replacement for these reports, consequently, no retyping is necessary. After the necessary

CODE	QUANT		
40112	10	70722	2
40122	5	70203	4
40122	5	70720	4
130384	3	70819	2
135755	1	70820	10
35004	1020	94038	6
35005	180	70802	1
35005	450	77320	10
76442	6	77308	45
76442	4	94008	18
94301	20	130160	12
70108	5	31760	1505
70109	5	31124	80
70125	0	76652	2
70101	0	70222	10
70116	0	70722	10
76633	5	70222	3
76634	5	70722	2
76636	0	70222	2
31760	10000	70722	2
31124	400	94061	30
76652	10	94008	6
70222	30	130160	6
70722	20	31835	15520
70222	4	31124	400
70722	4	76652	10
70880	10	70830	20
70857	50	70857	73
70833	50	94038	20
94008	80	70826	5
70826	8	94061	73
94061	150	94008	30
94008	60	94008	8
94008	24	130160	10
130160	30	31256	7500
31854	2000	31124	0
35115	2000	76652	0
31124	640	31254	2000
76652	16	31256	1500
70222	6		
70722	6		
70222	2		

Figure 5.17- Contents of Matfile
for sample run

EST. NO.74-2 DIVISION: CAMDEN

ACCT. NO.	QUANT.	ITEM	LABOR	MAT'L. &EXP.	TOTAL
E364.1	20	WOOD POLES	1200	1600	
		TELCO TRANSFER CHARGES		800	
		LOADING (L@ 120. %--M@ 15. %)	1400	200	
		ESCALATION	100	0	
		SUB TOTAL	2700	2600	5300
E364.2		GUYS-ANCHORS-XARMS & BRKTS	3700	5400	
		LOADING (L@ 120. %--M@ 50 %)	4400	2700	
		ESCALATION	200	100	
		SUB TOTAL	8300	8200	16500
E365	10000	4/13KV 397.5K 3/C AL PLOW	6900	6000	
	2000	13KV 397K AL.3/C C.L.P.SP	2200	2500	
	1505	4/13KV 397.5K 3/C AL PLOW	1200	900	
	15520	4/13KV 1/0AAAC 1/C ALPI*OWA	5500	1600	
	7500	SER. 2/0-3/C AL...	3500	1600	
		POLE TOP HARDWARE	2800	2300	
		TREE TRIMMING	0	1400	
		LOADING (L@ 120. %--M@ 50 %)	26500	8200	
		ESCALATION	1400	400	
		SUB TOTAL	50000	24900	74900
E369.1		O.H. SERVICES	1400	500	
		LOADING (L@ 120. %--M@ 50 %)	1700	300	
		ESCALATION	100	0	
		SUB TOTAL	3200	800	4000
		ESTIMATE TOTAL	64200	36500	100700

Figure 5.18- The Estimate Report using Test data.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
ELECTRIC DEPARTMENT
ESTIMATE-GENERAL

146.

TO: THE GENERAL MANAGER - TRANSMISSION & DISTRIBUTION

REQUESTED VERBALLY BY 1/9/74 FROM NC

TEST DATA
SPECIAL RUN

SUMMARY

	LABOR	MAT'L. &EXP.	TOTAL
OVERHEAD CONSTRUCTION	28400	24600	53000
OVERHEADS (L@ 120. %--M@ 46. %)	34000	11400	45400
ESCALATION	1800	500	2300
TOTAL OVERHEAD COST	64200	36500	100700
AUTH. JOBSITE MANHOURS	2469		
OPERATING JOBSITE M.H.	0		
REMOVAL JOBSITE M.H.	0		
TOTAL JOBSITE MANHOURS	2469		
TOTAL PROJECT	28400	24600	53000
OVERHEADS (L@ 120. %--M@ 46. %)	34000	11400	45400
ESCALATION	1800	500	2300
TOTAL PROJECT	64200	36500	100700
TOTAL JOBSITE MANHOURS	2469		
LABOR RATE USED	11.50 PER HOUR		

DATE 1/9/74 ESTIMATE NUMBER 74-2
SKETCH NUMBER DA22-16.1095
CAMDEN DIVISION
MUNICIPALITY - VT
ESTIMATED TIME TO COMPLETE - 12 MONTHS
PREPARED BY - EC
ELECTRIC DISTRIBUTION DEPARTMENT

CHECKED BY -

APPROVED BY -

Figure 5.19- The Estimate Summary using
Test data.

JOB TITLE: TEST DATA
SPECIAL RUN

ESTIMATE NO: 74-2 DATE: 1/9/74

JOB START DATE: 4 / 74

147.

MATERIAL LIST

NAME OF ITEM	STOCK CODE	QUANTITY
(OVERHEAD MATERIAL)		
#4 CU NTN- GROUND WIRE	31124	1520
SER.#2-3/C AL.	31254	2000
SER. 2/0-3/C AL.	31256	9000
4-13KV 397KCMIL AL.3/C H.D.P.	31760	11505
4-13KV 1/0AAAC-1/C H.D.P.	31835	15520
13KV 397KCMIL AL.3/C C.L.P.	31854	2000
3/8 INCH GUY WIRE	35004	1020
7/16 INCH GUY WIRE	35005	630
#2-2/5 AWAC MESS.	35115	2000
35 FT.-CL.2	40112	10
40 FT.-CL.2	40122	10
8 IN TWIN HELIX ANCHOR	70108	5
10 IN TWIN HELIX ANCHOR	70109	5
4 FT X ARM	70203	4
8 FT X ARM	70222	57
4 FT BRACE	70720	4
5 FT BRACE	70722	46
13KV POLE TOP EXTENTION BRKT	70802	1
3 PHASE CORNER BRACKET	70819	2
TANGENT BRACKET L.D.	70820	10
BRKT. EXT. INS O.W.A.	70826	13
1 PHASE CORNER BRKT	70830	20
TWO PHASE VERT BRKT.	70833	50
4-13KV INSULATING RIDGE PIN (30 IN.)	70857	123
26KV D.E. CORNER BRKT	70880	10
GUY GUARD-GREY	76442	10
MEDIUM DUTY ANCHOR ROD	76633	5
HEAVY DUTY ANCHOR ROD	76634	5
8 FT. GROUND ROD	76652	38
9 INCH HENDRIX SPACER	77308	45
15 INCH PLASTIC SPACER	77320	10
4-13KV DISC INSULATOR	94008	226
13KV SPOOL INSULATOR	94038	26
13KV RIDGE PIN INSULATOR	94061	253
78 INCH FIBER-GLASS ROD	94301	20
10KV LIGHTNING ARRESTER	130160	58
13KV 200 AMP C.O.	130384	3
15KV SECT 3PH 200A.	135755	1

USED. 7.89 UNITS

Figure 5.20- The Estimate Material List.
using test data,

signatures are entered on the reports, they are sent out to the general office sponsor.

Summary

This chapter has attempted to explain in detail the operation of the E365W\$ module of the construction cost estimating system designed by the author. The explanation of the program was augmented with a discussion of all data files used by the program. Listings of all files were provided to aid the explanation. The cost calculation section was divided into three parts, including; guys, cables, and pole top hardware. The use of a test run was included to help implement the discussion.

The intent of the chapter was to give the reader an insight into the operation of a program module of the cost estimating system in order to aid him in understanding the entire system. Listings of all program modules are available in the appendix to this paper.

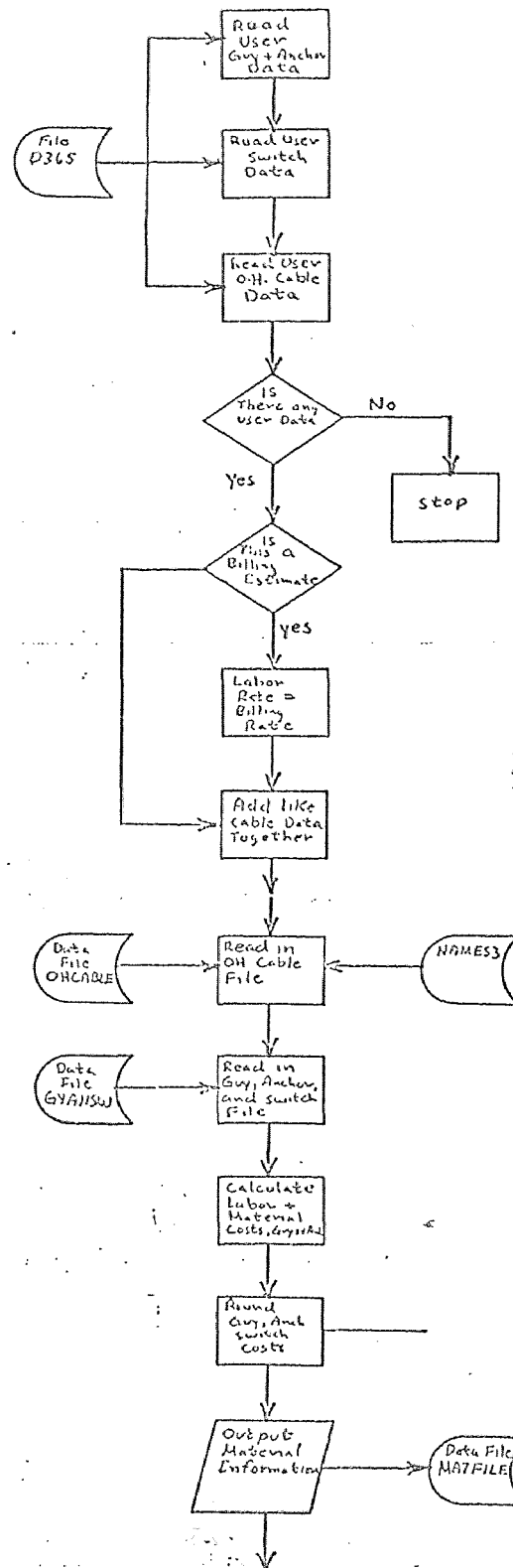


Figure 5.21 - Flowchart of Overhead Module part 1.

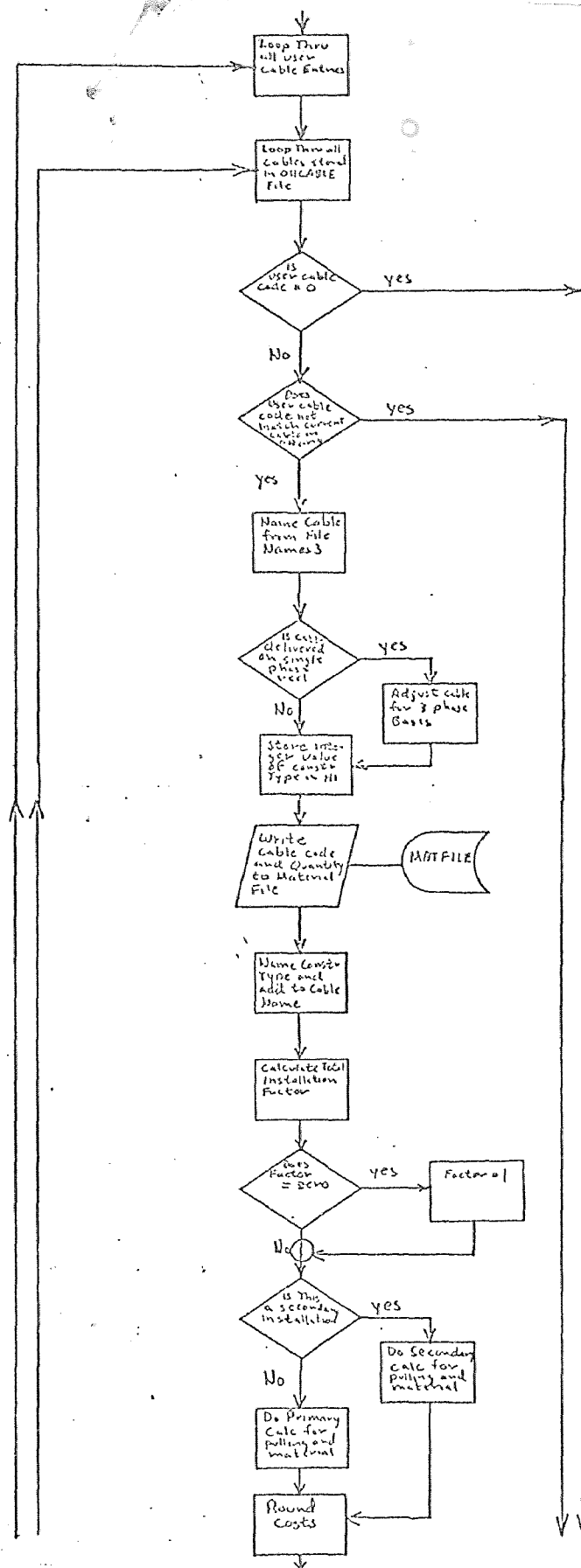


Figure 5.21 - continued

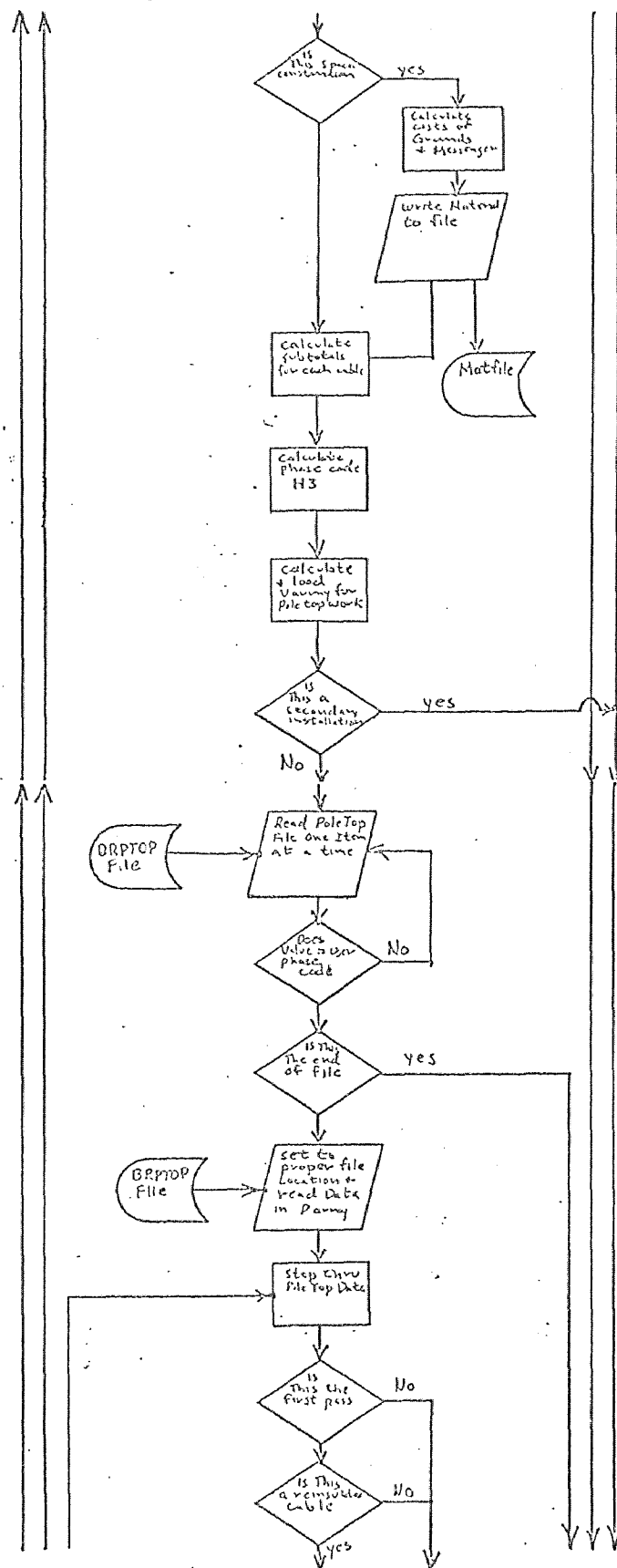


Figure 5.21 - Continued

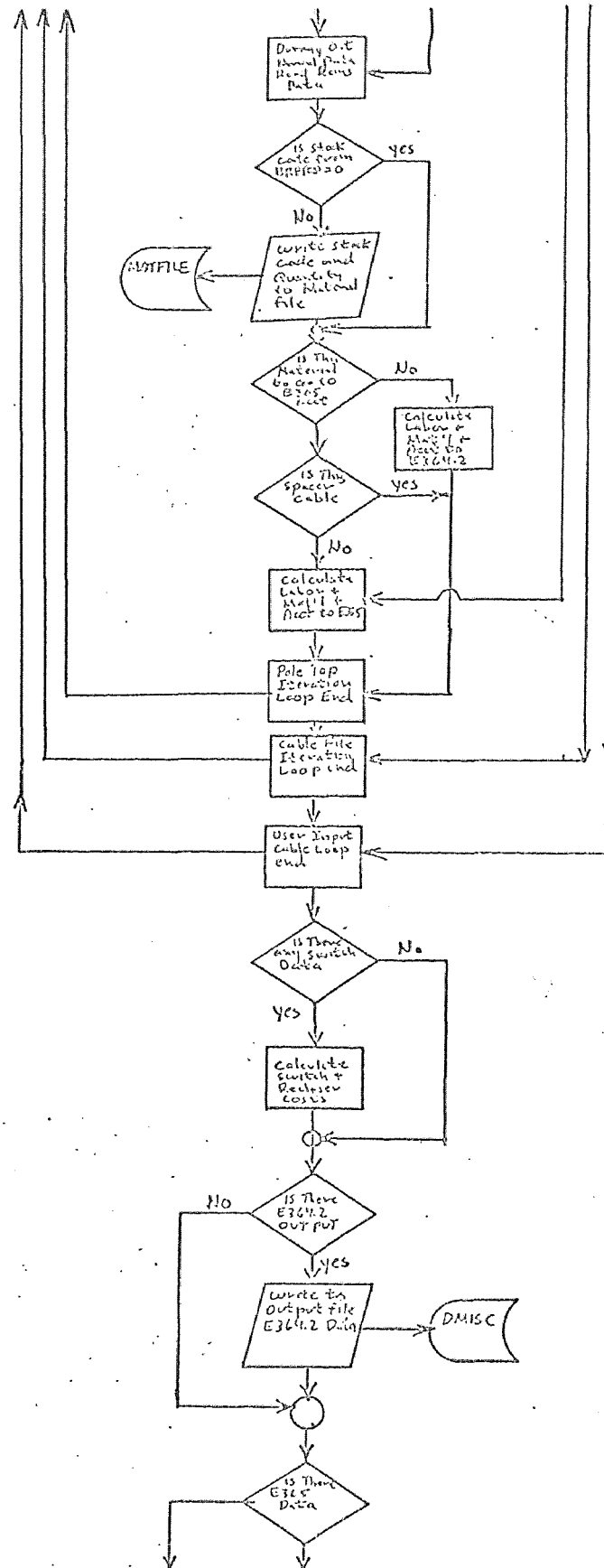


Figure 5.21 - continued

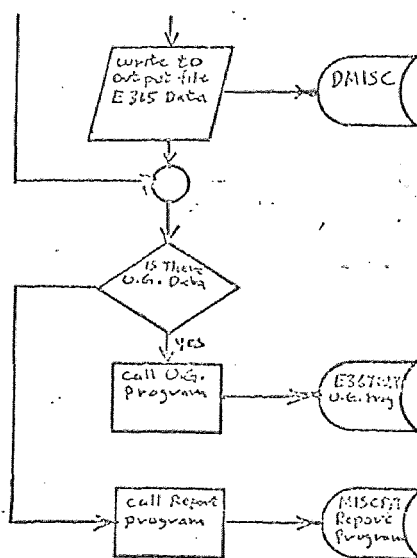


Figure 5.21 - concluded

CHAPTER VI
IMPLEMENTATION OF THE COMPUTERIZED
CONSTRUCTION COST ESTIMATING SYSTEM

Introduction

The implementation of any new computer system requires careful preparation to insure success. Considerable skepticism existed among field engineers that so complicated a function as cost estimating could be done on a computer. The problem had to be overcome using discussions and classes concerning the use of the system in each field location. Complete user documentation had to be prepared and distributed. Test cases had to be run in each division comparing manual versus computer solutions to estimates.

Organizational changes had to be made to incorporate the new estimating system. The office unions had to be convinced that the use of lower classification personnel to do cost estimates using the new system did not violate the contract. The following discussion shows how this was accomplished in order to implement the new system.

Steps Used To Implement the New System

The implementation of any new computer system requires careful planning. The finest system can meet with disaster

if implementation is hastily done. A new computer system will always disrupt the informal inter-relationships between the individual people and the groups it is being imposed on. If the human factor is neglected, implementation will be difficult at best.

With the above in mind, the following steps were taken in order to implement the computerized cost estimating system in the eight field locations of the Electric Distribution Department of the Public Service Electric and Gas Company.

- (1) Meet with the Distribution Engineer's Association.
- (2) Prepare complete user documentation. (10 Days)
- (3) Schedule meetings in each division. (5 Days)
- (4) Conduct classes in each division. (5 Days)
- (5) Organize field personnel for the new system. (16 Days)
- (6) Run test cases in each division. (20 Days)
- (7) Clear the new system with the office union. (5 Days)
- (8) Parallel the new and old system. (30 Days)
- (9) Replace the old system - switch over to the new system. (5 Days)
- (10) Feedback from the field offices. (Continuing)
- (11) Adjust the new system as needed. (Continuing)
- (12) Audit the system periodically.

Introducing the New System to the Distribution Engineers' Association

The department most concerned with construction cost estimating is the Distribution Engineering Department in each field division. The author met with the association early in January 1974. The purpose of the meeting was to introduce the new computer estimating system. The system was discussed in general terms, and the subject of data files was introduced. Each division was requested to submit their labor productivities. Sample data files were distributed to facilitate the gathering of this data.

Preparation of User Documentation

In order for anyone to use even the simplest of computer systems, the input of required data must be precisely delineated. A complete set of user documentation was prepared by the author and distributed to the field prior to local discussions. A set of the documentation can be found in the appendix of this thesis.

Discussing the System in Each Field Location

The next step in implementing the estimating system was to meet with the engineering personnel of each division. The meetings were held in January 1974 with all eight divisions. The purpose of the meetings was to discuss the use of the new system. The author led these

meetings, which revolved around the discussion of the user documentation. The engineering personnel were informed of the structure of the data files, and how the programs used these files in order to produce an estimate. Some engineers expressed skepticism that a computer system would be flexible enough to properly handle all of the situations that arise in the preparation of a cost estimate. The author assured them that the system was capable of handling 95% of the possible cases. Arrangements were made to perform tests of the system in each division before the scheduled implementation.

Use of Classes

Before implementation of the system, the author and his assistants conducted classes for those personnel directly involved with the implementation in each division. Again, the user documentation was discussed. Special emphasis was placed on accessing the General Electric Mark III foreground system. Interpretation of system and program error diagnostics was stressed.

Organizing for Computerized Cost Estimating

Since the new system greatly simplified the cost estimating function, the exclusive use of management and higher level union personnel was no longer needed. It was recommended that Engineering Plant personnel be used to fill

out the data sheets. It was further recommended that data be input to the system by a clerk. The clerk would run the system and produce the reports. The reports would then be rough checked by the Engineering Plant Assistant and re-submitted to the clerk if errors were found. If the reports appeared to be correct, the completed estimate would be given to an Assistant Engineer for further checking. If approved, the reports would be submitted to the appropriate Group Head for signature. Following that, the reports would be submitted to the Distribution Engineer for approval and signature. The reports would then be sent to the Division Superintendent for final approval and for forwarding to the General Office.

Clearing the New System and Use of Personnel with the Union

In order to preclude any union problems, the subject of computerized cost estimating was discussed with union officers in each field division. The union was shown that the simplicity of the new system fit within the job specifications of Clerk and Engineering Plant Assistant. The union was given a demonstration of the system to reinforce this contention. In all cases the union agreed that the estimating system did not appear to violate the contract.

Running Test Cases in Each Division

In order to convince engineers in each division that

the new system could accurately calculate construction cost estimates, test cases were devised and run. The test cases consisted of estimating one thousand foot lengths of various types of cables and installations by manual methods and by computer. In most cases these tests were very satisfactory. They showed that the computer estimate system could duplicate answers arrived at by careful hand calculation. Where they were not satisfactory, the cause of the problem was often found to be data file errors. In a few cases the program was found to be in error, and changes were made to correct it. At the conclusion of the test runs, all divisions agreed to proceed with a parallel run of the new and old system.

Parallel Run of the New and Old System

The next step in the implementation of the computerized cost estimating system was to run a parallel operation with the old manual system. This is the stage the implementation has reached at the writing of this thesis. Results have shown that the new system is performing very well. Few problems have cropped up, and the author feels that the remainder of the trial should go smoothly.

Replacing the Old System

After the successful completion of the parallel run

of the two systems, the old system will be phased out if the computer estimate can produce accurate estimates and handle at least 95% of all estimates desired. The new system will be spot-checked during this stage, but all new estimates will be produced by the computer system.

Feedback From the Field Divisions

After the old system is phased out and the computer system is in operation in all divisions, provision must be made for feedback of user problems. The feedback mechanism will be provided through the Time Sharing Computer Coordination Committee. The committee was originally set up with the author as chairman and a representative from each division. The purpose of the committee was to disseminate information about time sharing systems and programming techniques. Feedback concerning the cost estimating system will be introduced during the regular meetings of this committee.

Adjusting the System

Based on the feedback from the field divisions reviewed during the regular committee meetings discussed above, changes will be made to the estimating system. When the program is changed, the committee will also serve as a method to inform the field users of the change.

Auditing the System

The estimating system will be audited for accuracy and timeliness once every six months by the time sharing coordinator in each division. Test cases will be prepared using unit lengths of cable and unit packages of construction hardware. Current costs from the division stock ledger will be used in a manual check of a computer run estimate. Division data files will be checked and updated by the local division coordinator.

Results of estimates will be checked against actual field construction costs in order to audit the results of the estimating system. The check will be performed by each local division coordinator. The estimate system will then be adjusted by the coordinator by revising the loading and estimating percentages in the COMINFO file.

Summary

It was the purpose of this chapter to inform the reader of the implementation of the computerized construction cost estimating system in the Electric Distribution Department of the Public Service Electric and Gas Company. A plan for the implementation was presented and followed through its several stages. The implementation is progressing smoothly at the writing of this thesis.

CHAPTER VII
ECONOMIC JUSTIFICATION OF THE
COMPUTERIZED ESTIMATING SYSTEM

Introduction

The replacement of the manual method of cost estimating used in the Electric Distribution Department of the Public Service Electric and Gas Company was done to simplify the function and to achieve standardization. Thus far, the system has proven successful in accomplishing these goals. It is also apparent that significant cost savings will accrue due to the implementation of the computerized system.

It is the purpose of this chapter to analyze and compare the costs associated with the manual system and the new system. The costs will be compared on the basis of expected usage in all divisions. First, a break-even analysis will be made to find the minimum amount of estimates required to justify the new system. Secondly, the total cost savings derived from doing all estimates on the new system will be calculated.

Identification of Cost Items

The calculations to follow will be made on the assumption that the costs are equal for preparing the

preliminary data for either the manual or the computerized systems. This is a valid assumption because both systems require that surveys of map and field conditions be made. Neither will require a change in the normal pre-estimate work. Hence, the cost of the preliminary work will be dropped from the calculation.

Manual system cost factors. The manual system required that the estimate be prepared by management personnel or by a Senior Engineering Plant Assistant. The average cost per hour for this work is \$15.50. The amount of time required to do an estimate manually is six hours. This figure is an average based on a consensus of the Time Share Committee members. After an estimate is calculated by hand, it must be typed. The cost of a typist is \$9.50 per hour. The above constants will be identified by the following list.

- (1) $E\$$ is the cost per engineering labor hours.
(\$15.50)
- (2) $T\$$ is the cost per typing hours. (\$9.50)
- (3) E_m is the engineering time necessary to calculate an estimate manually. (6 hours)
- (4) T_m is the required time to type an estimate.
(1 hour)

(5) X is amount of estimates to break even.

The cost of one estimate calculated manually is therefore:

$$X * (E\$ (Em) + T\$ (Tm)) = 1 * (15.50(6) + 9.50(1)) = 102.50$$

The result of the above equation shows that it costs \$102.50 to calculate and type a construction cost estimate manually.

Computer system cost factors. The computer system has simplified the estimate function so that an Engineering Plant Assistant is able to prepare the estimate data sheet. The average hourly wage for this job category is \$12.00 per hour. The amount of time required to fill out a data sheet is .5 hours. The data is entered via terminal by a clerk. The wage for a clerk is \$9.50 per hour. The amount of time required to enter data and receive the reports is .5 hours. The figures used above were arrived at by the members of the Time Sharing Computer Coordination Committee.

In addition to the costs described above, there are cost factors associated with the computer. The charges are as follows:

- (1) Terminal connect hours @ \$14 per hour.
- (2) Computer Resource Units charges @ \$.40 per unit of processing time. (Includes C.P.U. and Disk access charges.)

- (3) I/O kilo-character charges at \$.10 per 1000 characters.
- (4) Storage charges @ \$.80 per 1.28 k of ASCII storage, and \$.20 per link of binary storage.

The computer cost per estimate execution is made up of two costs: the execution cost and the storage cost of the programs. The execution cost per estimate is calculated with the above cost factors and the average run time and expected report size in kilo-characters.

- (1) The average estimate will be run in .5 hours.
- (2) The average estimate used 7.5 computer resource units.
- (3) The average estimate generates 8 kilo-characters of I/O.

The total cost per computer execution is shown below:

$$\text{Total cost} = (14)(.5) + (7.5)(.40) + (8)(.10) = \$10.80$$

The cost of storing the computer system must be spread over all divisions and then over all expected runs. The program modules are stored in the author's user number and are used by all the divisions through an execute permission. The total storage of the programs is 40 ASCII units. The data files are stored in each of the eight division

user numbers. The total storage is made up of 23 units of ASCII units and 8 units of binary storage. The above quantity must be multiplied by 8 to arrive at total storage. The cost of storage must then be divided by 170, the expected number of estimate runs per month. The cost of storage per estimate run is calculated below:

$$\text{Storage Cost/Run} = (.80)(40) + 8(23) + (.20)(8)(8)/170 = \$1.13$$

The total computer cost per estimate is, therefore, \$10.80 plus \$1.13 or \$11.93. The cost of storage along is \$192 per month.

The total cost of the computer estimating system per estimate is made up of the above computer cost and the labor cost. The labor cost is calculated below:

$$\text{Total Labor Cost} = (\$12)(.5) + (\$9.50)(.5) = \$10.75$$

The total cost for an estimate using the computerized estimating system is, therefore, \$11.93 plus \$10.75 or \$22.68.

Break Even Analysis

The break even analysis is the result of comparing fixed and variable cost elements for alternate economic plans. In the case being investigated; variable costs

include labor plus execution costs; fixed costs are file storage costs.

$$X(\text{Manual Cost}) = X(\text{Computer System Cost}) + \text{Storage}$$

where X is the number of estimates required to break even.

$$\text{Break Even} = (22.68 + 192.) / 102.50 = 2 \text{ estimates/mo.}$$

The computer system will pay for itself if only 2.0 estimates are done per month.

Total Cost Savings

The total cost savings amount to \$79.82 per estimate. The average amount of estimates done per year by the Electric Distribution Department of Public Service Electric and Gas Company is approximately 2,000. The total savings to be expected from the implementation of the computerized cost estimating system is, therefore, $(\$79.82) \times (2000) = \$159,640.00$ per year.

Conclusion

The implementation of the computerized construction cost estimating system apart from standardizing and simplifying the estimating function, provides a considerable cost benefit to the company. The cost for an estimate done manually, averaged \$102.50; the cost for the same estimate

using the computer is \$22.68. The cost saving per estimate is, therefore, \$79.82. Based on the average use of 2000 estimates annually, the computerized system will save \$159,640.00 per year.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

General

The purpose of this Thesis is the design and implementation of a real time computer based construction cost estimating system for the Electric Distribution Department of the Public Service Electric and Gas Company of New Jersey. While the system was specifically designed for electric utility construction cost estimating, the techniques employed are applicable to other industries.

Conclusions

The preparation of this Thesis has led the author to the following conclusions:

1. There is a vital need for a cost estimating system in the Distribution Department of Public Service Electric and Gas Company of New Jersey.
2. Cost estimating is an excellent application for digital computers.
3. The use of time-shared computers is a real advantage for a decentralized distribution department.

4. The General Electric Mark III foreground system is the most cost effective for the cost estimating application of those systems available and tested.
5. The use of the BASIC computer language is preferable to FORTRAN IV for the estimating application.
6. The existing terminal facilities available in the field divisions are adequate to handle the new system without excessive waiting.
7. The use of disk stored random binary and sequential file structures are preferable for the cost estimating system.
8. Multi structured file organization has simplified input and make it possible to use less technically skilled personnel.
9. Carefully organized implementation is insuring the acceptance and success of the system.
10. A considerable economic benefit should accrue when the system is fully implemented.

A vital need for a cost estimating system - Prior to the system design work, it was apparent to management that the manual cost estimating system was not consistent among the eight field divisions. Estimates were often inaccurate and were often submitted late. The need for accuracy, consistency and timeliness was necessary to the smooth economic functioning of the department, therefore, a new system capable of meeting the above criteria was of vital importance.

Cost estimating is an excellent application for digital computers - The large volume of labor and material data can be conveniently stored on magnetic storage devices. The multitudinous calculations and file look ups can be rapidly handled under program control. Decision criteria and circuit design variation can be successfully transferred to program logic. A great deal of manual effort can be saved using digital computers. In fact, other electric utilities have developed systems in past years to handle the function.

Use of time-shared computers - The use of time shared computers is an excellent medium for the estimating application. Flexibility was built into the system allowing each of the eight field divisions to

have their own data files. The immediacy of the data input and return of the final estimate is important for the calculation of variations on a proposed construction project. In practice, many more variations are being tried with the new system, resulting in better cost/benefit optimization. Also, the feeling of control over the computer has helped sell the system to field personnel.

The General Electric Mark III system - The selection of a time-shared computer service was conducted among four vendors. The General Electric Mark III system was found to be most cost effective for a system which is a blend of input-output and computation. The system also offered the advantage of local dial-up for our geographically spread field divisions. A considerable savings in telephone costs has been gained by using the General Electric telephone network. Finally, the General Electric Mark III system offered a user oriented executive system and diagnostic package. The ease of use proved to be important in gaining Union acceptance in field locations.

BASIC is the preferred computer language - The selection of the BASIC language was based on its ability to handle the necessary system logic, its ability to

handle data files, and its ability to handle alphanumeric string input. FORTRAN was able to handle four character alphas while BASIC could handle the 30 character strings necessary in the estimating system. The BASIC compiler was able to generate efficient code resulting in fast program execution.

Existing terminal facilities are adequate - An investigation of existing load on field terminal facilities using queueing techniques showed that current facilities are adequate. The criteria of waiting times of no longer than 20 minutes was not violated in any field location.

The use of disk stored files is preferred - The use of disk stored files for rapid access is a great benefit in reducing execution times. Sequential ANSCII structure was used for shorter files. These files are directly listable on local field terminals and are open to modification by responsible field personnel. The random-binary structural files cut processing times on the large files access by the system. These files are listable and modifiable under program control.

Multi-structured file organization simplifies input - The goal of input simplification was met by using multi-

structured random binary file organization. The file which generates pole top material was organized such that the program can select packages of required materials. The user is not burdened with knowing the exact items required for pole top construction. The use of personnel of lesser technical skills was facilitated by this method. Management personnel were freed of the exclusive duty of estimate preparation.

Carefully organized implementation is essential - The success of any system, no matter how fantastic that system is, can be jeopardized by poor implementation. Care was taken to document the system, to meet with field personnel, and to ease the new system into effect. This program has paid off and the new cost estimating system has met with excellent response from the field.

Economic Justification - The implementation of the computerized construction cost estimating system in addition to standardizing and simplifying the estimating function, provides a considerable cost benefit to the company. The cost of an estimate done manually averaged \$102.50; the cost for the same estimate using the computer system was \$22.68. The cost saving per estimate is, therefore, \$79.82. Based on the average use of 2000 estimates annually, the computerized system should save

\$159,640 per year.

Recommendations

The following is series of recommendations based on the conclusions reached by the author during his work on the construction cost estimating system.

Department wide implementation - If the parallel run in all field divisions proves as successful as the early results indicate, then the computer based estimating system should be adopted as the only acceptable means for producing a cost estimate in the Electric Distribution Department. This recommendation is based on the improved estimate technique and the cost savings provided by the computer based system.

Company wide implementation - If the estimating system proves successful and anticipated savings are realized in the Electric Distribution Department of Public Service, then it is recommended that a similar system be designed for each of the other operating departments of the company. Construction work done by the Electric Engineering Department includes: installation of conduit, construction of substations and switching stations, and the construction of generating stations. Projects must be estimated by the Electric

Engineering Department in a similar manner as that used by the Electric Distribution Department. Therefore, a similar computer based estimating system can be designed for this department. In the same way, the Gas Department, and the Generation Department could benefit from a computerized cost estimating system.

Implementation in other electric utilities - Electric distribution construction is fairly similar throughout the country. Utility accounting methods are virtually identical in all American electric utilities. With the above facts in mind, it is not difficult to see that the system designed by the author could be put to use by other utilities. Data files and report structures could be easily modified to fit local requirements. Smaller utilities without the necessary capital to invest in a computer system would find such a system particularly beneficial because they would pay only for operating expense on a time-shared computer.

Other industries - Many of the concepts used in the design of the computer based estimating system discussed in the course of this thesis are applicable to the general solution of the estimating problem. The use and structure of data files would be similar in other industries.

The design of the program modules for the time sharing environment could serve as examples for other industries desiring such an estimating system. The concept of input simplification would well be used by other estimate system designers.

Further system development - The following is a list of suggested expansion of the computer based estimating system.

1. Creation of a random binary file containing authorized estimate money to serve as a directory of active jobs.
2. Generating C.P.M. reports from the labor output data from the estimating system.
3. Interfacing the estimate system and the material ordering system.
4. Feedback of actual dollars spent versus estimated dollars to serve as control mechanism.

The creation of a random binary file to contain the account and cost information output from the estimate program could serve as a rapid directory for management

for all authorized jobs. Such a file could be created as a function of the report producing program (MISCP\$). Video terminals could be provided for management to access cost information as needed. The file could also serve as a data base to produce cost reports on work in progress.

C.P.M. Scheduling - It is current practice to schedule line work crews manually in each division through the means of a modified Gantt Chart. Enough data is available in the estimate files to provide the necessary input data for a critical path method (C.P.M.) scheduling program. The author envisions that a direct interface could be designed between the estimate system and the General Electric Mark III package C.P.M. program, entitled CPMX1\$***. The output of the program could be a C.P.M. report or a graphical representation of the C.P.M. solution. The author believes that a significantly improved schedule of line crews could be made if this recommendation is implemented.

Interface with material system - The output of the estimating system includes a material list as illustrated in Figure 5.20. The material list must be submitted for keypunching in order to serve as input to the current

material ordering system resident on a company owned Univac 1106 computer system. The Univac system is capable of accepting eight level ASCII code on paper tape. Each field division has a General Electric Terminet 300 terminal capable of punching eight level ASCII code on paper tape directly from computer output. With the addition of some extra programming in both systems, it would be possible to enter input from one system to the other through the means of paper tape. This would save the cost of repunching data and eliminate resulting error.

Cost Feedback - A final recommendation concerns the control of expended money. The author recommends that a study be made to determine the feasibility of interfacing the current Univac 1106 based work order system and the output of the estimating program. As costs accrue to the various accounts of an authorization through work done in the field as reported on work order forms, a check could be made against estimated dollars for that account. A monthly report could be generated which would review the charges to authorizations and flag those in danger of being overspent.

A Final Word

The author would like to state that this thesis

offers a real solution to a real problem as it existed in the Electric Distribution Department of the Public Service Electric and Gas Company of New Jersey. It is not intended to be a text book solution, but rather an honest effort to attain a workable estimating system in a reasonable time frame.

CHAPTER IX
CRITICAL EVALUATIONS

The letters presented on the following pages reflect the opinions of two men highly qualified to write on the subject of construction cost estimating. The first letter was written by my supervisor, Mr. H. S. Blauvelt, Manager of Methods of the Electric Distribution Department of the Public Service Electric and Gas Company of New Jersey. Mr. Blauvelt has had over thirty years of experience in the Distribution Department. Most of his career was spent in field supervisory positions, including the top management position of superintendent in several divisions.

The second letter of critical evaluation was submitted by Mr. R. F. Dauer, Assistant Manager of Electric Distribution of the Orange and Rockland Utilities Company. Mr. Dauer is also highly qualified to write on the subject of construction cost estimating. He has had extensive experience as project engineer for field construction jobs, and has had a good deal of experience with computer applications.



Public Service Electric and Gas Company 80 Park Place Newark, N.J. 07101 Phone 201/622-7000

March 19, 1974

Professor I. R. Goldstein
Industrial Engineering Department
Newark College of Engineering

EVALUATION OF THE THESIS ENTITLED
"COMPUTER BASED CONSTRUCTION COST ESTIMATING"
BY T. A. WESTPHAL

I have reviewed the thesis entitled "Computer Based Construction Cost Estimating", by T. A. Westphal. I find it to be an accurate representation of the work he has done in this area while working for my office in the Electric Distribution Department of Public Service Electric and Gas Company.

The design concepts are original and well thought out. The programs were written by Mr. Westphal in an exceptionally short period of time. The entire programming effort was accomplished in three months. At present, field trials of the new system are being run in all eight of our field operating divisions. The results obtained have been extremely satisfactory.

Mr. Westphal has succeeded in simplifying the effort and skill necessary to prepare a construction cost estimate. We will be able to use Union personnel of lower classification for estimating with the new system. In addition, we will obtain a considerable saving in manpower and a resulting cost saving when the system is fully implemented.

Speaking from my experience as a former Division Superintendent and my current position as Manager of Methods, I find Mr. Westphal's effort to be of high merit. He has found an excellent solution to the problem of cost estimating. The thesis he has written about the topic is of similar high merit. Certain portion of the thesis will be used to document and explain the system to field personnel.

In conclusion, I find the work to be in good form, accurate, and of high merit.

Very truly yours,

H. S. Blauvelt
Manager of Methods
Electric Distribution Department



ORANGE AND ROCKLAND UTILITIES, INC.

&



75 WEST ROUTE 59, SPRING VALLEY, NEW YORK 10977

April 10, 1974

914-352-6000

Mr. Thomas Westphal
Public Service Electric & Gas Company
80 Park Place - Room 7360
Newark, New Jersey

I received a copy of your Thesis "Computer Based Construction Cost Estimating" and have read it with interest. As you may know, Orange and Rockland Utilities is a combination Electric and Gas utility serving Orange and Rockland Counties and a portion of Sullivan County in New York State. Our wholly owned subsidiary Rockland Electric Company provides electric to communities in northern Bergen, Passaic and Sussex Counties in New Jersey, while our other subsidiary Pike County Power and Light provides electric to portions of Pike County, Pa.. At present we do not have a computerized estimating system, though we are interested in developing one for Electric Distribution Construction Projects.

It would appear that you have a sound basic knowledge of electric distribution construction. Chapter II serves as a demonstration of this fact. The estimating system as a whole, was written with input simplicity as a guideline and yet with sufficient flexibility to allow the user coverage of a wide range of construction conditions.

The manual systems like the one you described in Chapter III do present problems. It was interesting to see your technique for simplifying the estimating function. We, too, are interested in using non-management union personnel for estimating and I have found your work in this area to be well thought out.

I have some background in the computer systems area and found Chapter IV and V to be well constructed and executed. Chapter IV explained in what I thought was a very straight forward manner how a relatively large system can be written for the small core space generally available on a time shared computer. Chapter V was unique in that it takes the reader inside a program and explains in detail how it works. The flow charts and documented program listing were a great assistance in understanding the text.

Mr. Thomas Westphal
Page 2
April 10, 1974

Your Chapter on implementation (this is always a difficult area) impressed me with how rapidly a well constructed computer system could be brought into effect and in selling a system this is an important factor.

I was also interested in the cost savings PSE&G will experience with the computerized system.

In conclusion, I found your Thesis to be an accurate representation of construction cost estimating as it pertains to the Electric Utility Industry. It offers an excellent computer design.

Sincerely,

ORANGE AND ROCKLAND UTILITIES, INC.

R. F. Dauer
Ass't. Manager
Electric Distribution

RFD/alb

APPENDIX A

An Introduction to the
BASIC Computer Language

Source

General Electric
Information Services

Section 1. Introduction

Before we talk about programming in BASIC we should understand what programming is. To do that, we must know something about how a computer works.

Let us begin by using a simple analogy to explain what a computer does. Suppose that you have just been on a shopping spree, and you would like to determine how much you have spent. Since it was a rather extensive affair, it would be convenient to use a desk calculator. Fortunately, you have a friend who owns one and knows how to operate it. You visit your friend and you tell him what you have bought. The conversation might go something like this:

"Multiply 6 pairs of shoes by the price of \$15.00 and jot down the answer. Multiply 2 hats by the price of \$10.00 and jot down the answer. Multiply 3 six-packs of soda by 50¢ and jot down the answer. Multiply 12 returned bottles by minus two cents and jot down the answer----and so on. Now add all the items and tell me what the answer is."

In this simple analogy we have outlined the elements of a simple computer such as that shown in the block diagram of Figure 1.

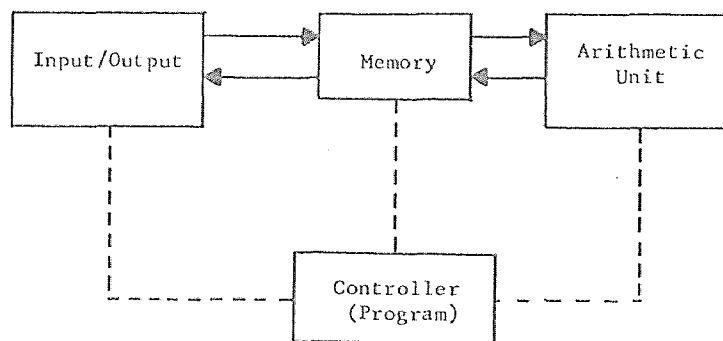


Figure 1. A Simple Computer Configuration

In our analogy, your friend's ears and his voice are the "input/output device." The scratch pad on which he jotted down your "instructions," sub-totals, and total was the memory. His

desk calculator was the "arithmetic unit." His ability to understand and interpret your instructions, and to operate the desk calculator and jot down items on the scratch pad represent the "program" built into the "controller"----which is, of course, your friend.

In an actual computer these functions are all performed by electronic components. In the BASIC 1 Time-Sharing Service, the processor is a GE computer, and the input/output device for our purpose is a terminal. In fact, there are many terminals, all connected to the same computer. The computer operates so much more quickly than you can type in or print out information that it can "time share" many input/output devices. This is done in much the same way that a good waitress in a restaurant can wait on several tables without causing any inconvenience to her other patrons. While one is drinking his cocktail, she can be serving the main course to another. While he is eating the main course, she can serve dessert to a third patron. Then she can deliver the check to a fourth in time to return to the first just as he is finishing his cocktail and is ready to order another. If the patrons were not able to see one another, each might think that the waitress was serving only him.

In the same way, GE Time-Sharing Service can accept an "order" from one terminal, then service many others, and still return to the first one in time to accept the next "order" without delay. Thus, it appears to each user, sitting at his terminal, that he has exclusive use of the computer.

The fact that a terminal is used as an input/output device means that it can be located some distance from the computer. To go back to our analogy, it is as if you decided to call your friend on the telephone rather than drive over to his house. This is, of course, much more convenient. Since computers have not yet been designed to respond to the spoken word, we don't call up the computer by telephone, but by a terminal. The computer can readily interpret the electrical signals put out by the terminal, and the human operator has little difficulty operating a terminal keyboard. It is almost identical to that of a standard typewriter. By the same token, the computer can readily generate electrical signals which cause a terminal to print out a message which the operator can read.

Thus, we now have all the elements of a "time-shared" computer system serving many remote locations. There remains one problem however--computers have a "language" all their own, so far as program instructions are concerned. They don't do arithmetic the way humans do, either. It is as if, in our analogy, the friend were Japanese, spoke no English, and used an abacus rather than a desk calculator. What we need is a translator. Maybe your friend's wife speaks English. We talk to her on the phone, so that she can translate into Japanese for her husband and translate his answers back into English for us. Meanwhile, he can use the abacus to do what we would have done on a calculator.

If time-sharing brings every man his own computer, the BASIC language makes every man his own programmer.

A BASIC program will employ several different instructions, both English language and mathematical. In time you may learn to use them all. Let's begin by seeing how BASIC, the language used in BASIC 1 would have solved the problem of our analogy:

<u>Our Human Method</u>	<u>The Computer Program</u>
Multiply 6 by \$15.00 and jot down answer.	100 LET X1 = 6*15
Multiply 2 by \$10.00 and jot down answer.	110 LET X2 = 2*10
Multiply 3 by \$00.50 and jot down answer.	120 LET X3 = 3*0.5
Multiply 12 by minus \$.02 and jot down answer.	130 LET X4 = 12*(-.02)
Add all items and jot down answer.	140 LET T = X1+X2+X3+X4
Tell me what the answer is.	150 PRINT T
That's all, thank you.	999 END

While the above example is quite workable in BASIC 1 time sharing, we have left out a few essentials, such as calling up your friend, identifying ourselves, telling him what language we would like to speak (his wife is by now multilingual), and telling him goodbye. Let's use the comparison method again to see how this works.

<u>Human</u>	<u>Computer</u>
1. Pick up phone.	1. Push the ORIG button on teletypewriter.*
2. Listen for dial tone.	2. Listen for dial tone on speaker.
3. Dial friend's number.	3. Dial the Time-Sharing computer's number.
4. Friend answers.	4. Computer answers (beep).
5. Friend says, "Who is this?"	5. Computer types USER NUMBER.
6. Tell him your name.	6. Type in your user number.
7. Friend says, "What language?"	7. Computer types SYSTEM.
8. Tell him: "English."	8. Type in BBASIC.
9. Friend says, "Is this a new problem or the same as before?"	9. Computer types NEW OR OLD
10. Tell him, "A new problem."	10. Type in NEW.
11. Friend says, "What kind?"	11. Computer types NEW FILE NAME.
12. Tell him, "Sales spree."	12. Type in SPREE.
13. Friend says, "O.K. let's go."	13. Computer types READY.

Now we are ready to enter the program as previously described. Once we have entered the program, including the END statement, we simply type in RUN, and depress the RETURN key. The computer will perform the requested operations and type the answer. We perform the goodbye sequence as follows:

Say "Thank you, goodbye."	Type in BYE.
Friend hangs up.	Computer advances paper to where it can be torn off, and automatically disconnects the teletypewriter.

The following chart lists the instructions for teletypewriter operation and illustrates the keyboard.

* - A teletypewriter type of terminal has been and continues to be one of the most-used terminal devices for time-sharing purposes. For that reason, its use is illustrated in this text. If you have any questions about time-sharing terminals, please contact your GE Representative.

Instructions for Teletypewriter Operation

1. Push the ORIG button. This corresponds to lifting the telephone off the hook.
2. Listen for the dial tone that emanates from the teletypewriter speaker.
3. Dial the number of the computer. If it is busy, push the CLR button. Wait a while and try again.
4. When a computer answers with a beep, the teletypewriter will automatically type out its own identification number.
5. Type your user number and other information requested, then enter a new program or call up an old one and use it.
6. When you have finished, type BYE, followed by a carriage return. The teletypewriter will shut off automatically.

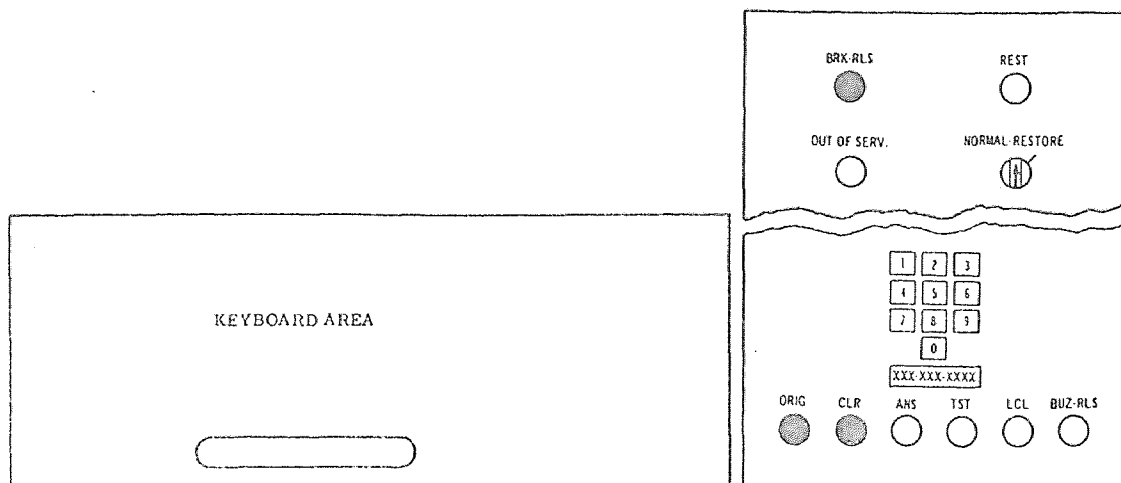


Figure 2. Teletype Unit Control Panel

Note: Controls shown as a solid black color (●) are the only controls needed for BASIC I operations.

Here is how the entire "conversation" would actually appear on a teletypewriter:

USER NUMBER--B12345
SYSTEM--BBASIC
NEW OR OLD--NEW
NEW FILE NAME--SPREE
READY.

100 LET X1=6*15
110 LET X2=2*10
120 LET X3=3*0.5
130 LET X4=12*(-0.02)
140 LET T=X1+X2+X3+X4
150 PRINT T
999 ENL
RUN

SPREE 11:08

111.26

USED XX.XX UNITS
BYE

For the purpose of illustration only, those parts of the conversation typed by the user have been underlined. In actual practice this underlining does not exist.

Section 2. Preparing a BASIC Program

Now we've carried our analogy far enough. It's time we entered the world of BASIC and time-sharing. Let's discuss the BASIC program.

Each program instruction must be entered on a separate line and must be followed by a carriage return. Notice that each BASIC program instruction to the computer is assigned a number---in the example we used 100, 110, 120 and so on. The computer executes the instructions in numerical order, thus the program must be written so that the instructions, when taken in numerical order, follow a logical sequence. For example, it would do no good to ask for PRINT T before the other instructions had been executed, because the computer wouldn't know the value of T and could not print it. Notice that we said "taken in numerical order." The instructions can be typed in any order because the computer will automatically resequence them into numerical order. This is a great convenience and is one of the reasons for numbering the instructions in the first place.

If we realized after the program was all written that we had forgotten one line, we would just type it in: 141 LET X5 = 3*17. All instructions would automatically be put into sequential order by the computer. We don't have to retype the whole program. For this reason, most programmers leave a few spare numbers between instructions. This makes it easier to correct or modify the program later.

Every program must have an END statement so that the computer will know when it has processed all the program instructions. The END statement must be the highest numbered instruction in the program. Most users designate a sufficiently large number (for example: 999 in the example), to ensure that all other instructions will have lower line numbers. Because line numbers are limited to five digits, the largest permissible line number is 99999.

Notice that each instruction is in simple algebraic form, rather than in English or arithmetic. That is we don't say, multiply 6 x 15. Instead we say, LET X = 6*15. Any arbitrary alphabetic letter may be used instead of X as long as it is a letter or a letter followed by a single digit number (i.e., 0,1,2,3,4,5,6,7,8, or 9).

Be sure to distinguish between "zero" and the letter "oh", and between the digit "one" and the lower case "ell". There are no lower case letters on a teletypewriter, but if you are accustomed to using lower case "ell" on a typewriter for the digit "one"--be careful! Also, since there is no lower case X, or a multiplication sign on a teletypewriter, we use the asterisk for this purpose.

Section 3. Providing Data

Most programs can be reduced to three simple steps:

1. Providing data
2. Performing desired calculations
3. Printing out answers

Because Steps 1 and 3 are the easiest to understand, let's start with them. Assume some kind of calculation is needed, for example:

```
LET X = -3.14159 * Y
```

There are three ways in which step 1 can be performed. First, we can simply say: READ Y. Then we can include a statement: DATA 3, 7, 23, 71. An illustration of a BASIC program using these statements is:

```
10 READ Y
20 LET X = -3.14159 * Y
30 PRINT X
40 GOTO 10
50 DATA 3,7,23,71
60 END
```

Whenever the computer encounters a READ statement in the program, it will read the next value of Y. The first time it will read 3, the next time 7, the next time 23, and so on until no more data is left to be read. Then it will stop. If our program had said: LET X = A*B, we would have had to say: READ A, B. The computer would then take the numbers two at a time from our DATA statement regarding the first number as A and the second as B, the third as A and the fourth as B and so on.

The second way of providing data is the FOR...NEXT method. For example, we could say: FOR Y = 1 TO 10. Notice the use of "Ø" for the letter "O" to distinguish it from the numeric zero. At the appropriate point, where the next variable is required in the program we would give a NEXT Y instruction. The computer would then perform the desired calculation for all integral values of Y from 1 to 10. If we want larger or smaller steps, we simply specify the size of step required. For example: FOR Y = 1 TO 10 STEP 0.1 would cause the machine to use: 1, 1.1, 1.2, 1.3,... This method of input is very useful for computing tables of squares, cubes, square roots, cube roots, etc.

The third way of providing data is to have the computer ask for it. For example, assume we have a program which needs the values of A, B, and C, which we would like to provide each time we run the program. To do this, we use two instructions: PRINT "ENTER A, B, C"; followed on the next line by INPUT A, B, C. The computer will now ask for the values of A, B and C by typing: ENTER A,B,C? Then you enter any values, for example 2,8, -10, by typing them in and depressing the RETURN key. The computer will perform the calculations with the values you provided and print out the answer. If you have programmed a loop (which we will discuss later) it will ask you to ENTER A,B,C again.

Section 4. Printing Answers

So much for providing data. Now let's see how we get information out of the computer. Again, there are three ways in which we can get the computer to print out information, using program instructions. The first two use the PRINT command. Anything included in quotes following a PRINT command will be printed as is. For example, the command PRINT "T", would cause T to be printed, perhaps as a column heading. The command PRINT T, however, without the quotes around T, would cause the computer to print the value of T. In our very first example (SPREE), for instance, we could have written 149 PRINT "T=" before the 150 PRINT T instruction. The teletypewriter would then have printed out T= on one line, and the value of T (111.26) immediately below it on the next line. To save paper, we could have written: 150 PRINT "T="; T in which case we would receive the printout: T= 111.26.

Thus by using quotation marks, we can get the computer to print out what we specify, for column headings, line titles, and so on. By omitting the quotation marks we can get it to print the actual value of the quantity called for.

Now let's discuss where the computer is going to print. Each PRINT instruction causes the computer to begin a new line. A PRINT instruction with nothing after it won't print anything, but it will advance the paper one line. This is a useful technique for improving the appearance of your printout.

A page is divided into five zones of fifteen spaces each across each line. Anything in quotes is printed just as it appears. For anything not in quotes, however, a comma is the signal for the computer to move to the next zone. For example, if we used the instruction PRINT A,B,C, (note that we used no quotation marks around the letters) the computer would start at the left edge of the page and print the value of A. Then it would skip over to column 15 and print the value of B. It would skip the necessary spaces to bring it to column 30, and print the value of C. We could thus get as many as five printouts across the page, beginning at columns 0, 15, 30, 45, and 60. This operation is just like tabulating on a typewriter.

If we want to get more than five columns, we can compress the printouts by using a semicolon instead of a comma between the letters. Then the spacing between printouts will depend on how many characters are printed. When each value is printed, one space appears in front of the number for the sign, and as many as four spaces after the number. The sign is printed only if it is minus. The following table shows the field widths for the different numbers of characters.

<u>Number of Characters</u>	<u>Field Width</u>
1	3
2, 3, or 4	6
5, 6, or 7	9
8, 9, or 10	12
11, 12, or 13	15

How are numbers printed out? Here are the rules which the BASIC language uses:

1. No more than six significant digits are printed (except for integers---see rule 4 below).
2. Any trailing zeros after the decimal point are not printed.
3. For numbers less than 0.1, the form X.XXXXXX E-Y is used, unless the entire significant part of the number can be printed as a six digit number. For example, 0.0000376 is the same as 3.76×10^{-5} , and will be printed as 3.76E-5.
4. If the number is an integer (in other words a whole number), a decimal point will not be printed and as many as nine digits will be printed in full.

The third method of printing out information involves the use of the LIST system command which instructs the computer to type out your entire program just as it is stored in the computer. This is very useful for obtaining the current version of a program which has undergone many corrections, additions and deletions as it was being typed in.

There is another BASIC command that is useful when listing programs. This is the REM (Remarks) command. It is useful for documenting comments in a program and can be used by the programmer to make remarks throughout the program logic. Following a REM statement the computer will type out exactly what is stated. For example:

```
100 REM THIS IS A LIST OF CONSTANTS.
```

The difference between PRINT and REM is that, in the first case, the words to be printed out should be in quotation marks; and they are printed when the program is RUN. In the second case, the words to be printed out are not in quotation marks; and they are printed when the program is listed, but not when it is RUN.

Section 5. Performing Calculations

Now that we know various ways of providing data, and printing answers, headings and remarks, we should turn our attention to the problem of how we get the input data computed into answers.

We have already said that program instructions should be in simple algebraic form, such as: LET X = 6*15. We can actually say: LET X = almost anything in mathematical terms. Some of the symbols used for mathematical operations may be unfamiliar to you, but they result from limitations of the teletypewriter keyboard. These basic symbols are as follows:

+	plus
-	minus
*	times
/	divided by, (for example A/B means A divided by B)
↑	raise to the power of, (for example $2 \uparrow 3 = 2^3 = 2 \times 2 \times 2$)

Because each expression must be written on a single line, parentheses are often required where they might not be needed in ordinary mathematical notation. For example:

$$\frac{A-B}{C} \text{ must be written: } (A-B)/C$$

Omitting the parentheses would cause the expression to be interpreted as $A - (B/C)$, which is not what was intended.

In addition to arithmetic operation, the following standard mathematical functions are available:

SIN (X)	Sine of X	} X must be in radians
COS (X)	Cosine of X	
TAN (X)	Tangent of X	
ATN (X)	Arctangent of X	
EXP (X)	Natural exponential of X, e^X	
ABS (X)	Absolute value of X, X	
LOG (X)	Natural logarithm of X	
SQR (X)	Square root of X	
RND (X)	Generates a random number between zero and one	
INT (X)	Integer part of X	

In any of the above expressions, X may be any quantity or expression.

Section 6. Writing a Program

One of the things which sometimes confuses people who are familiar with algebra but unfamiliar with programming is the use of an expression such as: `LET X = X+7`. Mathematically, such an expression reduces to: $X - X = 7$ or $0 = 7$ which is meaningless. In the programming sense, however, the meaning is: Let the new value of X equal the old value of X, plus 7.

Going back to our original example of SPREE, for instance, instead of:

```
140 LET T=X1+X2+X3+X4
```

we could have written:

```
140 LET I=X1
141 LET T=I+X2
142 LET T=T+X3
143 LET T=T+X4
150 PRINT T
```

This wouldn't be a very efficient way to write the program, but it does serve to illustrate the point. To show a useful purpose for such instructions, let's take a look at a program "loop."

Where the same operation is to be performed many times in the course of a program, looping greatly reduces the length of the program. For example, in a program to find the squares of numbers from 1 to 10 we might write:

```
100 PRINT "X","X^2"
110 LET X=1
120 LET X1=X^2
130 PRINT X,X1
140 LET X=X+1
150 GO TO 120
999 END
```

In this case, the program sets the initial value of X to 1, squares X, and prints X and X squared. It then adds 1 to X (making $X = 2$) and goes back to program step 120 to repeat the process. X is increased by 1 each time the program goes through the loop. This program would continue indefinitely, of course. We can stop it in one of two ways--either by interrupting it at the appropriate time, or by inserting another instruction as follows:

```
141 IF X=11 THEN 999
```

or

```
141 IF X>10 THEN 999
```

Where the ">" symbol is the mathematical 'greater than' symbol. This statement means "if X is greater than 10, then go to the statement numbered 999".

In this case, when the loop has been traversed enough times so that $X = 11$, the program will branch to 999 (jumping over instruction 150) and stop.

Anytime we use a program loop, we must plan on a way for getting out of the loop. Otherwise, the computer will continue to run around the loop indefinitely. When printing is not taking place, we can interrupt the program by typing STOP. When printing is occurring, depress the Break key to interrupt the program. But no program should rely on user manual intervention to get out of a loop. There are two customary methods for this purpose:

1. Include a READ instruction as part of the loop. The computer will use successive values from the DATA instruction lines until all values are used up, at which time it will stop, and print: `OUT OF DATA IN XYZ` (where XYZ is the line number of the READ instruction).
2. Include in the loop a "conditional branch" instruction (IF THEN PQR). In this case, when the given condition is satisfied, the computer will branch to the instruction whose line number is PQR. PQR may be the line number of an END statement, a STOP statement, or simply another instruction in the program, outside of the loop.

The condition for branching can be in the form of a test. For example: IF $X = 0$, IF $X < 0$ (if X is negative), IF $X > 10$, or some similar condition. We can also test to see whether X is positive by writing: IF $X > 0$.

The GOTO and IF .. THEN instructions may be used for other purposes besides forming and getting out of loops. The instruction line number specified in the GOTO and IF...THEN statements may cause the program to transfer to either an earlier or a later instruction. For example, if a program requires taking the square root of a negative number, the computer will perform the computation as if it were a positive number, but will automatically print out a "warning" and terminate execution. For example: `SQUARE ROOT OF NEGATIVE NUMBER IN 50`. If we don't want that warning printed out, we can avoid it in this manner:

```
140 IF P<0 THEN 152
150 LET Q=SQR(P)
151 GOTO 160
152 LET Q=SQR(-P)
153 GOTO 160
```

In this example, if P is a positive number or zero the computer ignores statement 140, computes $\text{SQR}(P)$ in 150, and goes to 160 as a result of instruction 151. If P is less than zero the program "jumps over" instructions 150 and 151 and computes $\text{SQR}(-P)$ in step 152. Since P is negative, $-P$ is positive, and we won't get the warning printed out. Step 153 causes us to go to 160 as before, so we end up at 160 by either route.

Section 7. Correcting a Program

"To err is human"----and we all make an occasional error. Here is how typing and program errors may be corrected.

To correct a line, retype it correctly using the original line number and end it with a carriage return.

To delete a line, retype the line number only, and follow it with a carriage return.

If you type an incorrect character and notice it right away, type the "backwards arrow" (\leftarrow). Then type in the correct character. This will not, of course, erase the character from the page, but it will delete the character from computer memory. For example: 120 LEX \leftarrow T X=3 will come out as "LET X=3". If you have mistyped several incorrect characters, type \leftarrow once for each incorrect character (including spaces) then type in the correct characters. If you have typed many characters incorrectly, you may delete the entire line by pressing the control and X keys simultaneously. The line will then be ignored by the computer.

If you find you have forgotten an instruction several lines back, just retype it with the correct line number. The computer will automatically rearrange the instructions into the proper numerical sequence.

If you are a poor typist, the program may look messy by the time you get through, with re-typed and deleted lines and backwards arrows. Don't worry about it. Just type LIST, followed by a carriage return, and the computer will print a nice clean copy of your program.

Once you are sure your program is correct, type RUN followed by a carriage return. The computer will then run your program. It may type out one or more error messages, for example:

NØ DATA (You have put in a READ statement but forgotten to type a DATA statement.)

ILLEGAL FØRMULA IN 190 (Maybe you put LET X = 5R, instead of LET X = 5*R.)

Careful examination of the error messages and checking your instructions will enable you to quickly correct your program to the point where it will run correctly. Don't spend long periods of time at the terminal just thinking or making wild guesses as to what the trouble might be. SAVE your program, type in BYE and depress the RETURN key. Then go back to your desk and analyze the situation. Once you have determined the answer to the problem, go back to the terminal, recall your program, and make corrections.

Unless you SAVE your program, the computer will "forget" it as soon as you "sign off." If you want to have the computer "remember" your program, you must type SAVE, depress RETURN, and wait for the computer to answer READY before you say BYE.

To recall a saved program, ask for an OLD program and type in the file name in response to the computer instruction OLD FILE NAME. When the computer has found your program it will type READY. If you subsequently wish to UNSAVE the program, type UNSAVE and depress the RETURN key.

If you forget which program you have saved, type CATALOG, followed by a carriage return. The computer will list the names of all the programs saved under your user number.

If you want to start a new program, simply type NEW, followed by a carriage return. This may be done at any time. The computer will then ask: NEW FILE NAME--type in your new program name and the new program.

RENAME is another command that may be useful when you wish to slightly modify an existing program, but still retain the old program. First SAVE the existing program; then type RENAME, and depress the RETURN key. The computer will ask for NEW FILE NAME. You may then type in the new name and modify your program, since the original program has been saved under the old name. Your modified program may be saved under the new name.

By now you should be able to do two things: write simple programs in BASIC and understand most of the material in the more advanced BASIC Language Chapter. To increase your understanding, try to understand the program logic of the sample problems in the next section.

APPENDIX B

Construction Cost Estimating
Program Listings

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```

999 OPTION QSUB
1000 FILES INPUT;D3641;D365;D367;DMISC;SCRPAD;USAGE*
1001 FILES MATFILE
1010 SCRATCH #2
1020 SCRATCH #3
1030 SCRATCH #4
1040 SCRATCH #5
1050 SCRATCH #6
1060 APPEND #7
1065 SCRATCH #8
1066 FILE #8,"*"
1070 DIM ES(20),P(20,3),G(10,5),X(15),S(20,3),N$(20),L(20),M(20)
1080 DIM W(20,4),C(20,17),U(20,11),M$(20),N(10,3)
1090 DIM Q(20),H(10,8),K(10,5),R(10,2),B(10,3),V(100)
1100 READ #1,A$(1) 'READS IN FIRST LINE OF ESTIMATE TITLE'
1110 READ #1,B$(1) 'READS IN SECOND LINE OF ESTIMATE TITLE'
1120 READ #1,E(1) 'READS IN EST TYPE, COMBINED=1, OH=2, UG=3'
1130 READ #1,E(5) 'READS IN ROUNDING FACTOR'
1140 READ #1,ES(1) 'READS IN FORMAT TYPE; R&E OR BILLING'
1150 READ #1,E(6),E(7),E(8),E(9) 'READS IN COSTS'
1160 WRITE #5,E(6),E(7),E(8),E(9) 'WRITES COSTS'
1170 READ #1,ES(2) 'REQUESTED VERBALLY (YES/NO)'
1180 READ #1,ES(3),ES(4) 'EITHER REQ BY & LOC OR DATE & DICTATOR'
1190 READ #1,ES(5),ES(6),ES(7),ES(8),ES(9),ES(10)
1200 WRITE #5,ES(10)
1210 REM DATE, EST NO., TOWN, DIV., PREP BY, SK NO.
1220 READ #1,M(1),Y(1),M(2),Y(2),M(3),Y(3)
1230 REM CUR MO, CUR YR, JOB ST MO, JOB ST YR, JOB END MO, JOB END YR
1240 READ #1,E(3),E(4) 'O.H., U.G. WITHDRAWAL HOURS'
1250 READ #1,E(2),E(10) '% OF OPERATING MANHOURS'
1260 READ #1,ES(11) 'DO YOU WANT A MATERIAL LIST(YES/NO)'
1270 READ #1,ES(12) 'DO YOU WANT A SUMMARY(YES/NO)'
1280 WRITE #5,ES(11),ES(12)
1290 LET A$(2)=UNUS
1300 LET A$(3)=DAT$
1310 LET A$(4)=CLK$
1320 WRITE #7,A$(2),A$(3),A$(4),E$(8),E$(6)
1330 LET Z(2)=((Y(3)*12+M(3))-(Y(2)*12+M(2))) 'EST TIME TO COMPLETE'
1340 LET Z(1)=(((Y(2)*12+M(2))-(Y(1)*12+M(1)))+Z(2)/2) 'ESC FACTOR'
1350 WRITE #5,Z(1);E(1);ES(1);E(5)
1355 IF E(1)=3 THEN 1890
1360 READ #1,X(1) 'NUMBER OF LINES OF POLE DATA'
1370 WRITE #2,X(1)
1380 IF X(1)=0 THEN 1460
1390 WRITE #2,Z(1);E(1);ES(1);E(5)
1400 FOR I=1 TO X(1)
1410 FOR J=1 TO 3
1420 READ #1,P(I,J) 'READS IN POLE DATA'
1430 WRITE #2,P(I,J);
1440 NEXT J

```


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```
1450 NEXT I
1460 READ #1,T(1) 'JOINT POLES FOR TELCO TRANSFER CHARGES'
1470 WRITE #2,T(1)
1480 READ #1,X(2) 'NUMBER OF LINES OF GUY & ANCHOR DATA'
1490 WRITE #3,X(2)
1500 IF X(2)=0 THEN 1560
1510 WRITE #3, Z(1),E(1),E$(1),E(5)
1520 FOR J=1 TO 8
1530 READ #1, V(J) 'READS IN GUY AND ANCHOR DATA'
1540 WRITE #3,V(J); 'WRITES GUY & ANCHOR DATA TO D365'
1550 NEXT J
1560 READ #1,X(3) 'NUMBER OF LINES OF SWITCH & RECLOSER DATA'
1570 WRITE #3,X(3)
1580 WRITE #5,X(3)
1590 IF X(3)=0 THEN 1690
1600 WRITE #3, Z(1);E(1);E$(1);E(5)
1610 WRITE #5, Z(1);E(1);E$(1);E(5)
1620 FOR I=1 TO X(3)
1630 FOR J=1 TO 3
1640 READ #1,S(I,J) 'READS IN SWITCH & RECLOSER DATA'
1650 WRITE #3,S(I,J);
1660 WRITE #5,S(I,J);
1670 NEXT J
1680 NEXT I
1690 READ #1,X(4) 'NUMBER OF LINES OF SERVICE WIRE DATA'
1700 WRITE #5,X(4)
1710 IF X(4)=0 THEN 1790
1720 WRITE #5, Z(1);E(1);E$(1);E(5)
1730 FOR I=1 TO X(4)
1740 FOR J=1 TO 4
1750 READ #1,W(I,J) 'READS IN SERVICE WIRE DATA'
1760 WRITE #5,W(I,J); 'WRITES SERVICE WIRE DATA TO DMISC'
1770 NEXT J
1780 NEXT I
1790 READ #1,X(5) 'NUMBER OF LINES OF PRI & SEC CABLE DATA'
1800 WRITE #3,X(5)
1810 IF X(5)=0 THEN 1885
1820 WRITE #3, Z(1),E(1),E$(1),E(5)
1830 FOR I=1 TO X(5)
1840 FOR J=1 TO 17
1850 READ #1,C(I,J) 'READS IN PRI & SEC CABLE DATA'
1860 WRITE #3,C(I,J); 'WRITES PRI & SEC CABLE DATA TO D365'
1870 NEXT J
1880 NEXT I
1885 IF E(1)=2 THEN 2470
1890 READ #1,X(6) 'NUMBER OF CONDUIT & TRENCH LINE DATA'
1900 WRITE #4,X(6)
1910 IF X(6)=0 THEN 1980
1915 WRITE #4,Z(1),E(1),E$(1),E(5)
1920 FOR I=1 TO X(6)
```

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```
1930 for j=1 to 5
1940 READ #1,G(I,J) 'READS IN CONDUIT & TRENCH DATA'
1950 WRITE #4,G(I,J) 'WRITES CONDUIT & TRENCH DATA TO D367'
1960 NEXT J
1970 NEXT I
1980 READ #1,X(7) 'READS NUMBER OF LINES-ST.LIGHTING'
1981 WRITE #4,X(7) 'WRITES ST. LIGHT DATA TO D367'
1990 IF X(7)=0 THEN 2060
1995 WRITE #4,Z(1),E(1),E$(1),E(5)
2000 FOR I=1 TO X(7)
2010 FOR J=1 TO 8
2020 READ #1,H(I,J) 'READS IN ST. LIGHT DATA'
2030 WRITE #4,H(I,J) 'WRITES ST.LIGHT DATA TO D367'
2040 NEXT J
2050 NEXT I
2060 READ #1,X(8) 'NUMBER OF LINES OF UG CABLE DATA'
2061 WRITE #4,X(8) 'WRITES U.G. CABLE TO D367'
2075 IF X(8)=0 THEN 2150
2080 WRITE #4, Z(1);E(1);E$(1);E(5)
2090 FOR I=1 TO X(8)
2100 FOR J=1 TO 11
2110 READ #1,U(I,J) 'READS IN UG CABLE DATA'
2120 WRITE #4,U(I,J); 'WRITES UG CABLE DATA TO D367'
2130 NEXT J
2140 NEXT I
2150 READ #1,X(10) 'READS NUMBER OF MANHOLES'
2151 WRITE #4,X(10) 'WRITES MANHOLE DATA TO D367'
2160 IF X(10)=0 THEN 2230
2165 WRITE #4,Z(1),E(1),E$(1),E(5)
2170 FOR I=1 TO X(10)
2180 FOR J=1 TO 5
2190 READ #1,K(I,J) 'READS IN MANHOLE DATA'
2200 WRITE #4,K(I,J) 'WRITES MANHOLE DATA TO D367'
2210 NEXT J
2220 NEXT I
2230 READ #1,X(11) 'READS NUMBER OF STANCHION ITEMS'
2231 WRITE #4,X(11) 'WRITES STANCHION DATA TO D367'
2240 IF X(11)=0 THEN 2310
2245 WRITE #4,Z(1),E(1),E$(1),E(5)
2250 FOR I=1 TO X(11)
2260 FOR J=1 TO 2
2270 READ #1,R(I,J) 'READS IN STANCHION DATA'
2280 WRITE #4,R(I,J) 'WRITES STANCHION DATA TO D367'
2290 NEXT J
2300 NEXT I
2310 READ #1,X(12) 'READS NUMBER OF PIECE-OUT ITEMS'
2311 WRITE #4,X(12) 'WRITES PIECE-OUT DATA TO D367'
2320 IF X(12)=0 THEN 2390
2325 WRITE #4,Z(1),E(1),E$(1),E(5)
2330 FOR I=1 TO X(12)
```

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```
2340 FOR J=1 TO 3
2350 READ #1,B(I,J) 'READS IN PIECE-OUT DATA'
2360 WRITE #4,B(I,J) 'WRITES PIECE-OUT DATA TO D367'
2370 NEXT J
2380 NEXT I
2390 READ #1,X(13) 'READS NUMBER OF U.G. DEVICES'
2395 WRITE #4,X(13) 'WRITES U.G. DEVICES TO D367'
2400 IF X(13)=0 THEN 2470
2405 WRITE #4,Z(1),E(1),E$(1),E(5)
2410 FOR I=1 TO X(13)
2415 FOR J=1 TO 3
2420 READ #1,N(I,J) 'READS IN U.G. DEVICES EXCEPT TITLES'
2424 WRITE #4,N(I,J) 'WRITES U.G. DEVICES TO D367'
2425 NEXT J
2430 READ #1,S$(1),T$(1) 'READS IN U.G. DEVICE TITLES'
2435 WRITE #4,S$(1),T$(1) 'WRITES U.G. DEVICE TITLES TO D367'
2440 NEXT I
2470 READ #1, X(9) 'READS IN MISC. ACCTS.'
2480 WRITE #5, X(9) 'WRITES MISC. ACCTS.'
2490 IF X(9)=0 THEN 2560
2500 WRITE #5, Z(1);E(1);E$(1);E(5)
2510 FOR J=1 TO X(9)
2520 READ #1,Q(J),N$(J),M$(J),L(J),M(J)
2530 REM THE ABOVE READS IN ACCT NO.,DESCRIPTION,LABOR,MATERIAL...
2540 WRITE #5,Q(J);N$(J);M$(J);L(J);M(J)
2550 NEXT J
2560 PRINT "-----";
2570 PRINT "-----"
2580 PRINT
2590 PRINT
2600 IF E$(1)="R" THEN 2720
2610 PRINT "NAME: ";A$(1)
2620 PRINT
2630 PRINT "LOCATION: ";B$(1)
2640 PRINT
2650 PRINT "NATURE OF WORK: RELOCATION OF DISTRIBUTION FACILITIES TO"
2660 PRINT " MAINTAIN ELECTRIC SERVICE."
2670 PRINT
2680 PRINT "TYPE OF WORK:"
2690 PRINT
2700 PRINT TAB(25);"DETAIL OF ESTIMATE"
2710 GO TO 2730
2720 PRINT"EST. NO. ";E$(6);" DIVISION: ";E$(8)
2730 PRINT
2740 PRINT
2750 PRINT
2760 IF E$(1)="B" THEN 2780
2770 PRINT TAB(2);"ACCT.";
2780 PRINT TAB(9);"QUANT.";TAB(25);"ITEM";
2790 PRINT TAB(50);"LABOR";TAB(58);"MAT'L.";TAB(67);"TOTAL"
```

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```
2800 IF E$(1)="B" THEN 2820
2810 PRINT TAB(3);"NO.";
2820 PRINT TAB(58);"&EXP."
2830 PRINT
2840 ON E(1) GOTO 2850,2850,2890
2850 CHAIN "E364W*"
2860 STOP
2890 CHAIN "E367W*"
2900 STOP
2920 END
```

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```
999 OPTION QSUB
1000 FILES POLES;D3641;COMINFO;SCRPAD;MATFILE
1005 DIM U(20,3)
1010 SCRATCH #4
1015 SCRATCH :5
1020 REM POLES CONTAINS DATA ABOUT COST AND SETTING TIMES FOR WOOD POLE
1030 REM D3641 CONTAINS USER DATA FOR POLE ACCOUNT E364.1
1040 REM COMINFO CONTAINS DATA USED BY ALL THE ESTIMATE PROGRAMS
1050 REM SCRPAD CARRIES INFO FROM PROGRAM TO PROGRAM
1060 READ #3,D,C(1),M(1),L(1),M(2),X5,X5,X5,X5,X5
1061 FOR I=1 TO 19
1062 READ #3,I0
1063 NEXT I
1064 READ #3,D1
1070 REM D=LABOR RATE, C(1)=TELCO TRANSFER CHARGE, L(1)=LABOR LOADING
1080 REM RATE, M(1)=MATERIAL LOADING RATE, B=COST OF BLASTING PER HOLE
1090 REM M(2)=POLE MAT LOADING
1100 READ #2,X 'X=NUMBER OF LINE OF USER POLE DATA'
1110 IF X<1 THEN 1740
1120 READ #2, Z(1),Z(2),Z$(1),Z(3)
1121 IF Z$(1)<>"B" THEN 1130
1122 LET D=D1
1130 DEF FNA(Z)=INT(((Z)/Z(3))+.5)*Z(3) 'ROUNDS TO $10 OR $100'
1140 FOR I=1 TO X 'POLE SETTING & MAT'L COSTS ARE CALC'D INSIDE LOOP'
1150 RESTORE #1 'SET FILE POLES TO FIRST DATA ENTRY'
1160 READ #2,U(I,1),U(I,2),U(I,3) 'READS IN USER DATA, WHERE
1170 REM U(I,1)=POLE CODE, U(I,2)=AMOUNT SET, U(I,3)=TYPE OF SET
1180 LET K=U(I,3) 'K=TYPE OF SET WHICH CORRESPONDS TO COL.4&5 IN POLES
1190 READ #1,P(1),P(2),P(3),P(4),P(5)
1200 REM P(1)=POLE CODE,P(2)=COST,P(3)=REAL STOCK CODE,P(4)= MACHINE
1205 IF END #1 THEN 1280
1210 REM SET LABOR HRS., P(5)=HAND DIG LABOR HRS.
1220 IF P(1)<>U(I,1) THEN 1190 'FILE SEARCH TO FIND PROPER DATA IN POLES'
```

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```
1230 REM WHICH CORRESPONDS TO SIZE & CLASS OF POLE USER WANTS TO SET
1235 WRITE :5,P(3);U(I,2);
1240 LET A=A+U(I,2) 'KEEPS SUM OF TOTAL AMT. OF ALL POLES USED'
1241 IF U(I,3)<>6 THEN 1250
1242 LET M=M+U(I,2)*X5+U(I,2)*P(2) 'POLE COST + BLASTING CHARGE'
1243 LET H=H+U(I,2)*P(4)
1244 GO TO 1270
1250 LET M=M+P(2)*U(I,2) 'TOT MAT'L COST =UNIT COST * NUM OF UNITS'
1251 IF U(I,3)<>7 THEN 1260
1252 LET H=H+U(I,2)*P(5)+U(I,2)*5
1253 GO TO 1270
1260 LET H=H+U(I,2)*P(K) 'LABOR HRS=NUM OF SETS TIMES LABOR HOURS'
1270 REM FOR K THE DESIRED INSTALLATION METHOD
1278 NEXT I
1279 GO TO 1290
1280 PRINT "NO MATCH IN FILE POLES FOR CODE";U(I,1)
1281 STOP
1290 LET M=FNA(M) 'ROUNDS MAT'L COST TO NEAREST TEN DOLLARS'
1300 LET L=H*D 'LABOR COST=LABOR HRS TIMES LABOR RATE'
1310 LET L=FNA(L) 'ROUNDS LABOR COST TO NEAREST TEN DOLLARS'
1320 READ #2,I(1) 'NUMBER OF JOINT POLES FOR TELCO TRANSFER CHARGES'
1325 IF Z$(1)="B" THEN 1350
1330 LET T=T(1)*C(1) 'TRANSFER CARGE = # POLES * CHARGE PER POLE'
1340 LET T=FNA(T) 'ROUNDS TELCO TRANSFER CHARGE TO NEAREST TEN'
1350 DEF FNR(Y)=(11-INT(LOG(Y+1)/2.30259))
1360 DEF FNS(Y)=(52-INT(LOG(Y+1)/2.30259))
1370 DEF FNT(Y)=(61-INT(LOG(Y+1)/2.30259))
1380 DEF FNU(Y)=(70-INT(LOG(Y+1)/2.30259))
1390 DEF FNB(X,Y)=Z(1)*(X*.007+Y*.007) 'LABOR ESCALATION'
1400 DEF FNC(X,Y)=Z(1)*(X*.003+Y*.007) 'MATERIAL ESCALATION'
1410 LET M(3)=M+T 'ADDS TELCO TRANSFER CHARGES INTO TOTAL MAT'
1420 LET E(1)=L*L(1) 'LABOR LOADING E364.1'
1430 LET E(2)=M*M(2) 'MATERIAL LOADING 364.1'
1440 LET E(3)=FNB(L,E(1)) 'LABOR ESCALATION E364.1'
1450 LET E(4)=FNC(M,E(2)) 'MATERIAL LOADING 364.1'
1460 FOR I=1 TO 4
1470 LET E(I)=FNA(E(I))
1480 NEXT I
1490 LET T(1)=L+E(1)+E(3) 'TOTAL LABOR COST+ESC+LOADING'
1500 LET T(2)=M(3)+E(2)+E(4) 'TOTAL MATERIAL COST E364.1'
1510 IF L+M+T<1 THEN 1740
1520 LET Q=3
1525 IF Z$(1)="B" THEN 1721
1530 PRINT "E364.1";
1540 IF L+M<1 THEN 1580
1550 PRINT TAB(FNR(A));A;TAB(18);"WOOD POLES";
1560 PRINT TAB(FNS(L));L;TAB(FNT(M));M
1570 LET Q=Q+1
1580 IF T=0 THEN 1610
1590 PRINT TAB(18);"TELCO TRANSFER CHARGES";TAB(FNT(T));T
```

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```
1600 LET Q=Q+1
1610 PRINT TAB(18);"LOADING (L@":L(1)*100.;"%--M@":M(2)*100.;"%)" ;
1620 PRINT TAB(FNS(E(1)));E(1);TAB(FNT(E(2)));E(2)
1630 LET Q=Q+1
1640 PRINT TAB(18);"ESCALATION";TAB(FNS(E(3)));E(3);TAB(FNT(E(4)));E(4)
1650 LET Q=Q+1
1660 PRINT TAB(44);"-----"
1670 LET Q=Q+1
1680 PRINT TAB(18);"SUB TOTAL";TAB(FNS(T(1)));T(1);
1690 PRINT TAB(FNT(T(2)));T(2);TAB(FNU(T(1)+T(2)));T(1)+T(2)
1700 LET Q=Q+1
1710 PRINT
1718 LET Q=Q+1
1719 GO TO 1730
1720 IF L+M<1 THEN 1730
1721 PRINT TAB(FNR(A));A;TAB(18);"WOOD POLES";
1722 PRINT TAB(FNS(L));L;TAB(FNT(M));M
1730 WRITE #4,L;M(3);E(1);E(2);E(3);E(4);T(1);T(2);H;Q
1740 CHAIN "E365W*"
1750 STOP
1760 END
```

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```
999 OPTION QSUB
1000 FILES D365;OHCABLE;BRPTOP;COMINFO;DMISC;GYANSW;NAMES3;MATFILE
1001 READ :8,I6
1002 IF END :8,THEN 1006
1003 RESTORE :8
1004 APPEND :8
1005 GO TO 1010
1006 SCRATCH :8
1010 READ #4,D(1),C(1),F(2),F(3),F(4),F(5),F(6),F(7),F(8)
1011 FOR I= 1 TO 21
1012 READ #4,D(0)
1013 NEXT I
1015 APPEND #5
1020 DIM U(20,20),W(50,8),N$(20),M$(50),P(100)
1030 DIM H(30),L(30),M(30),T$(30),Y(50,3),S(10,3),Q(30)
1040 DIM A(30)
1110 READ #1,X2
1120 IF X2=0 THEN 1190
1130 READ #1,Z(1),Z(2),Z$(1),Z(3)
1140 FOR I=1 TO X2
1150 FOR J=1 TO 8
1160 READ #1,B(J) 'READS IN USER GUY & ANCH. DATA'
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1170 NEXT J
1180 NEXT I
1190 READ #1,X1 'NUMBER OF LINES OF SWITCH DATA'
1200 IF X1=0 THEN 1270
1210 READ #1, Z(1),Z(2),Z$(1),Z(3)
1220 FOR I=1 TO X1
1230 FOR J=1 TO 3
1240 READ #1,S(I,J) 'READS IN USER SWITCH DATA'
1250 NEXT J
1255 WRITE :8,S(I,1);S(I,2);
1260 NEXT I
1270 READ #1,X
1275 IF X+X1+X2<1 THEN 3850
1280 IF X=0 THEN 1575
1290 READ #1, Z(1),Z(2),Z$(1),Z(3)
1300 FOR I=1 TO X
1310 FOR J=1 TO 17
1320 READ #1,U(I,J) 'READS IN USER CABLE DATA'
1330 NEXT J
1340 LET Q(I)=((U(I,3)*100)+(U(I,4)))
1350 NEXT I
1360 IF X2+X1+X>0 THEN 1380
1370 STOP
1380 IF Z$(1)<>"B" THEN 1385
1382 LET D(1)=D(0)
1384 DEF FNA(Y)=INT(((Y)/Z(3))+.5)*Z(3) 'ROUNDS TO $10 or $100'
1385 FOR I=1 TO X-1
1390 FOR I5=I+1 TO X
1400 REM THIS ROUTINE CHECKS FOR LIKE CABLE INSTALLATIONS & ADDS THEM
1410 IF U(I,13)>1 THEN 1570
1420 IF U(I5,13)>1 THEN 1560
1430 IF U(I5,1)=0 THEN 1560
1440 IF U(I,1)<>U(I5,1) THEN 1560
1450 IF Q(I)<>Q(I5) THEN 1560
1460 LET K5=U(I,2)/(U(I5,2)+U(I,2))
1470 LET U(I5,1)=0
1480 LET U(I,2)=U(I,2)+U(I5,2)
1490 FOR J=5 TO 12
1500 LET U(I,J)=U(I,J)+U(I5,J)
1510 NEXT J
1520 FOR J=14 TO 16
1530 LET U(I,J)=K5*U(I,J)+(1-K5)*U(I5,J)
1540 NEXT J
1550 LET U(I,17)=K5*U(I,17)+(1-K5)*U(I5,17)
1560 NEXT I5
1570 NEXT I
1575 REM THIS LINE HOLDS POSITION FOR INTERNAL LINE REFERENCE
1580 DEF FNB(X,Y)=Z(1)*(.007*X+.007*Y) 'LABOR ESCALATION'
1590 DEF FNC(X,Y)=Z(1)*(.003*X+.007*Y) 'MATERIAL ESCALATION'
1600 FOR I=1 TO 50

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1610 IF END #2 THEN 1680
1620 READ #7,M$(I) 'READS IN OH CABLE NAME'
1630 LET N=N+1
1640 FOR J=1 TO 8
1650 READ #2,W(I,J) 'READS IN OHCABLE TABLE'
1660 NEXT J
1670 NEXT I
1680 FOR I=1 TO 50
1690 IF END #6 THEN 1750
1700 LET NI=NI+1
1710 FOR J=1 TO 3
1720 READ #6,Y(I,J) 'READS IN GUY ANCHOR AND SWITCH DATA'
1730 NEXT J
1740 NEXT I
1745 IF X2=0 THEN 1840
1750 LET H(25)=(B(3)*Y(6,3)+B(4)*Y(7,3)+B(5)*Y(8,3)+(B(6)+B(7))*Y(9,3))
1760 LET H(25)=(H(25)*(2*(1-B(8))))+(H(25)*B(8))
1770 LET H(25)=H(25)+B(1)*Y(2,3)+B(2)*Y(2,3)
1780 LET L(25)=H(25)*D(1) 'LAB HRS GUYS ANCHORS E364.2'
1790 LET H=H(25)
1800 LET M(25)=B(1)*120*Y(2,2)+B(2)*45*Y(2,2)+B(2)*Y(3,2)*.6
1810 LET M(25)=M(25)+B(2)*Y(3,2)*.4+(B(1)+B(2))*Y(5,2)+B(3)*Y(6,2)
1820 LET M(25)=M(25)+B(4)*Y(7,2)+B(5)*Y(8,2)+(B(6)+B(7))*Y(9,2)
1830 REM M(25)=MAT'L COST GUYS ANCHORS E364.2
1834 WRITE :8,Y(1,1);B(1)*120*.85;
1835 WRITE :8,Y(2,1);B(1)*120*.15;Y(2,1);B(2)*45;Y(3,1);B(2)*.6;
1836 WRITE :8,Y(3,1);B(2)*.4;Y(5,1);B(1)+B(2);Y(6,1);B(3);Y(7,1);B(4);
1837 WRITE :8,Y(8,1);B(5);70101;B(7);Y(9,1);B(6);
1838 WRITE :8,76633;B(3);76634;B(4);76636;B(5)+B(6);
1840 FOR I=1 TO X
1850 FOR J=1 TO N+1
1860 IF U(I,1)=0 THEN 2680
1870 IF U(I,1)<>W(J,1) THEN 2670 'MATCHES USER STK CD & TABLE STK CD'
1880 RESTORE:3
1881 LET H2=H4=0 'INITIALIZES LABOR HRS FOR CABLE INST TO ZERO'
1890 LET NS(I)=M$(J) 'NAMES THE CABLE'
1895 REM THE ROUTINE BELOW TESTS FOR CABLES PURCHASED ON 1 PHASE REELS
1896 REM AND ADJUSTS THESE FOR AMOUNT OF PHASES TO BE INSTALLED...
1898 LET DI=U(I,2)
1900 IF U(I,1)=31835 THEN 1910
1901 IF U(I,1)=31825 THEN 1910
1902 IF U(I,1)=30356 THEN 1910
1904 IF U(I,1)=30363 THEN 1910
1906 IF U(I,1)=30367 THEN 1910
1908 GO TO 1930
1910 IF U(I,4)=7 THEN 1930
1920 LET U(I,2)=U(I,2)*U(I,3) 'FOOTAGE ADJ FOR THOSE CABLES ON 1 PH REEL
1930 LET HI=INT(U(I,4)) 'TAKES THE INTEGER OF CONSTRUCTION TYPE'
1935 IF U(I,13)>1 THEN 1940
1936 WRITE :8,W(J,1);U(I,2); 'SENDS CABLE INFO TO MATERIAL LIST'

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1940 ON (H1-2) GO TO 1950,1970,1990,2010,2010,2010,2010,NAMES CONST TH
1950 LET T$(I)="OWA"
1960 GO TO 2020
1970 LET T$(I)="OW"
1980 GO TO 2020
1990 LET T$(I)="SP"
2000 GO TO 2020
2010 LET T$(I)=".."
2020 LET F(I)=U(I,14)*U(I,15)*U(I,16) 'TOT INS FACT.=GAIN F*REP F*INS
2030 IF F(I)<>0 THEN 2050
2040 LET F(I)=1
2050 IF H1=7 THEN 2120
2060 LET P(0)=((U(I,3)+1)/4) 'PHASE FACTOR USED TO ADJ INS HRS'
2070 REM H4 IS THE LAB HRS NEEDED PER CABLE TO BUILD D.E.'S, VERT TRNS
2080 LET H4=(U(I,7)*F(6)+U(I,9)*F(7)+U(I,10)*F(5)+U(I,11)*F(8))*P(0)*F
2089 REM TESTS FOR REINSTALLATION CODE
2090 IF U(I,13)>1 THEN 2123
2100 LET H2=((D1*n(J,H1)*F(1)*1E-3)*P(0)) 'PULLING HRS PER CABLE'
2110 GO TO 2130
2120 LET H2=(U(I,2)*1E-3*n(J,H1)*F(1)) 'SECONDARY PULLING HRS PER CAB
2122 GO TO 2130
2123 LET H2=0 'SETS PULLING HOURS TO ZERO FOR REINSTALLATION'
2130 LET L(I)=(H2+H4)*D(1)
2140 LET L(I)=FNA(L(I))
2150 LET H=H+H2+H4 'ACCUMULATES LABOR HRS FOR ALL CABLE INSTALLATIONS
2160 IF U(I,13)>1 THEN 2220
2170 LET M(I)=U(I,2)*n(J,2) 'MATERIAL COST PER CABLE E365'
2180 LET M(I)=FNA(M(I))
2190 IF H1<>5 THEN 2220 'TESTS FOR SPACER CABLE'
2200 LET M(I)=M(I)+(D1*.15+U(I,5)*40*.15+U(I,5)*3) 'COST MESS.GRDS,RDS
2205 WRITE :8,35115;D1; 'WRITES MESSENGER TO MATFILE(
2206 WRITE :8,31124;U(I,5)*40;76652;U(I,5) 'GRD WIRE GRD RODS'
2210 LET M(I)=FNA(M(I))
2220 LET T(1)=T(1)+L(I) 'TOT LAB $ ALL CABLES E365'
2230 LET A(1)=A(1)+L(I) 'ADDS LAB $ FOR SCRPAD'
2240 LET T(2)=T(2)+M(I) 'TOT MAT $ ALL CABLES E365'
2250 LET A(2)=A(2)+M(I) 'ADDS MAT $ FOR SCRPAD'
2260 LET H3=((U(I,3)*100)+U(I,4)) 'CALC OF PHASE CONST. CODE FROM USE
2270 LET E(9)=E(9)+(U(I,2)*U(I,17)*3) 'TREE TRIMMING'
2280 REM ALL V( ) VALUES BELOW REFER TO AMOUNT OF DIFF POLE TOPS IN US
2290 REM DATA. THESE VALUES ARE REFERENCED IN THE POLE TOP CONS ROUTI
2300 LET V(1)=U(I,5)-(U(I,6)+U(I,7)+U(I,8)+U(I,10)) 'NORMAL POLES'
2310 LET V(0)=(U(I,5)-1) 'SPANS FOR SPACER CABLE'
2320 LET V(2)=U(I,6) 'EXT BRKT POLES'
2330 LET V(3)=U(I,7) 'VERT TURN POLES'
2340 LET V(4)=U(I,8) 'TURN BRKT POLES'
2350 LET V(5)=U(I,9) 'RISER POLES'
2360 LET V(6)=U(I,10) 'DEAD END POLES'
2370 LET V(7)=U(I,11) 'JUNCTION POLES'
2380 LET V(8)=U(I,12) 'ARRESTOR LOCATIONS'

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2390 LET V(9)=0 'ZERO QUANTITY POLE TOP'
2391 IF H1=5 THEN 2400
2392 WRITE :8,31124;V(8)*40;76652;V(8) 'GRDS FOR ARRESTER POLES'
2400 RESTORE
2405 IF U(1,4)=7 THEN 2680 'TESTS FOR SEC CABLE INST'
2410 LET I1=0
2420 READ:3,P(1) 'READS IN PTOP FILE UNTIL MATCH IS FOUND IN 1ST LINE'
2430 LET I1=I1+1
2450 IF END:3 THEN 2660 'TEST FOR END OF FILE CONDITION'
2460 IF INT(P(1)*10+.5)<>INT(H3*10+.5) THEN 2420
2465 SETW 3 TO I1*81+1
2466 FOR I1=1 TO 81
2467 READ:3,P(I1)
2468 NEXT I1
2469 SETW 3 TO 1
2470 FOR K=3 TO 81 STEP 4
2480 IF K>3 THEN 2550
2490 IF U(I,13)=1 THEN 2550 'TESTS FOR REINS. CODE'
2500 REM THE ABS QUANTITY BELOW TESTS FOR REINS OR RECONS REQUIRED
2510 IF ABS(U(I,4)-U(I,13))>.15 THEN 2550
2520 FOR I2=1 TO 20
2530 READ D 'DUMMIES OUT FIRST LINE OF POLE SEQ DATA TO ALLOW FOR REINS'
2540 NEXT I2
2550 READ J1
2560 DATA 1,1,6,6,5,5,8,8,4,3,3,1,1,4,2,1,0,6,3,8 'NORM POLE SEQ'
2570 DATA 9,9,9,9,5,5,8,8,4,9,9,9,9,4,2,1,0,6,3,8 'REINS POLE SEQ'
2573 IF P(K)*V(J1)<1 THEN 2580
2574 IF P(K-1)<1 THEN 2580
2575 WRITE :8,P(K-1);P(K)*V(J1);
2580 IF K>=63 THEN 2640 'ABOVE COL 63 ALL CHARGED TO E365'
2590 IF K<47 THEN 2610 'BELOW COL 47 ALL CHARGED TO E364.2'
2600 IF H1=5 THEN 2640 'TESTS FOR SPACER CABLE, ABOVE COL 47 ALL E365'
2610 LET H(21)=(P(K)*P(K+2)*V(J1))+H(21) 'LABOR HRS E364.2'
2620 LET M(21)=(P(K)*P(K+1)*V(J1))+M(21) 'MATERIAL COST E364.2'
2630 GO TO 2660
2640 LET H(22)=(P(K)*P(K+2)*V(J1))+H(22) 'LABOR HRS E365'
2650 LET M(22)=(P(K)*P(K+1)*V(J1))+M(22) 'MATERIAL COST E365'
2660 NEXT K
2670 NEXT J
2680 NEXT I
2700 LET L(21)=H(21)*D(1)+L(25) 'LAB $ POLE TOP HDW CHARGED TO E364.2'
2710 LET L(21)=FNA(L(21))
2730 LET M(21)=M(21)+M(25) 'MATERIAL COST POLE TOP HDW CHRD TO E364.2'
2740 LET M(21)=FNA(M(21))
2800 LET E(9)=FNA(E(9)) 'TREE TRIMMING'
2860 REM THE ROUTINE BELOW DOES SWITCH & REC COSTS FOR E365 & 369.1
2870 FOR I=1 TO X1
2880 FOR J=9 TO N1
2890 IF S(I,1)<>Y(J,1) THEN 2960
2900 IF S(I,3)>1 THEN 2940

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2910 LET H(23)=S(I,2)*Y(J,3)+H(23) 'LAB HRS E365'
2920 LET M(23)=S(I,2)*Y(J,2)+M(23) 'MAT COST E365'
2930 GO TO 2970
2940 LET H(24)=S(I,2)*Y(J,2)+H(24) 'LAB HRS E369.1'
2950 LET M(24)=S(I,2)*Y(J,2)+M(24) 'MAT COST E369.1'
2960 NEXT J
2970 NEXT I
2980 LET L(22)=(H(22)+H(23))*D(1) 'ADDS TOT LAB$ FOR P. TOP HDW FOR E365'
2990 LET M(22)=M(22)+M(23) 'ADDS TOT MAT COST FOR P TOP HDW FOR E365'
3000 LET L(22)=FNA(L(22))
3020 LET M(22)=FNA(M(22))
3240 DEF FNR(Y)=(11-INT(LOG(Y+1)/2.30259))
3250 DEF FNS(Y)=(52-INT(LOG(Y+1)/2.30259))
3260 DEF FNT(Y)=(61-INT(LOG(Y+1)/2.30259))
3270 DEF FNU(Y)=(70-INT(LOG(Y+1)/2.30259))
3280 IF L(21)+M(21)<1 THEN 3450
3290 WRITE #5,"1";"E364.2";"0";"GUYS-ANCHORS-XARMS & BRKTS";L(21);M(21)
3450 IF T(1)+T(2)<1 THEN 3650
3460 IF X<1 THEN 3650
3470 FOR I=1 TO X
3472 IF N$(I)>"0" THEN 3480
3474 LET N$(I)="CODE NOT IN OHCABLE FILE"
3480 IF U(I,1)=0 THEN 3550
3490 IF U(I,13)>1.1 THEN 3550
3520 WRITE #5,"1";"E365";U(I,2);N$(I)+T$(I);L(I);M(I)
3550 NEXT I
3560 FOR I=1 TO X
3570 IF U(I,13)<1.1 THEN 3640
3580 LET I3=I3+1
3590 IF I3>1 THEN 3610
3600 WRITE #5,"1";"E365";"0";" WIRE TO BE REINSULATED";"0","0"
3610 WRITE #5,"1";"E365";U(I,2);N$(I)+T$(I);L(I);M(I)
3640 NEXT I
3650 IF L(22)+M(22)<1 THEN 3690
3660 WRITE #5,"1";"E365";"0";"POLE TOP HARDWARE";L(22);M(22)
3690 IF E(9)<1 THEN 3720
3700 WRITE #5,"1";"E365";"0";"TREE TRIMMING";"0";E(9)
3720 REM
3840 REM
3850 RESTORE :8
3851 FILE :8,"*"
3852 IF Z(2)=2 THEN 3880
3860 CHAIN "E367W*"
3870 STOP
3880 CHAIN "MISCP*"
3890 STOP
3900 END

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999 OPTION QSUB
1000 FILES D367;COMINFO;STLIGHT;UGCABLE;NAMES1;DMISC;UGMAT;CONMAN
1010 APPEND #6
1015 GO TO 1070
1020 READ#7,A
1030 IF END :7,THEN 1070
1040 RESTORE:7
1050 APPEND :7
1060 GOTO 1080
1070 SCRATCH :7
1080 DIM B(10,3),A(30),M(30),L(30),H(10,8),U(20,11),C(100,10),Cs(100),
1081 DIM Bs(40),E(40,4),P(100,3),D(100,3),X(15),G(10,5),K(10,5),R(10,2)
1082 DIM F(30),O(25),N(10,3)
1090 READ#2,F(1),P,P,F(2),P,P,P,P,P,P,F(3) 'READS IN DATA FROM COMINF
1100 READ#2,F(4),F(5),F(6),F(7),F(8),F(9),F(10)
1110 READ#2,F(11),F(12),F(13),F(14),F(15),F(16)
1120 READ#2,F(17),F(18),F(19),F(20),F(21)
1130 READ#2,F(0)
1140 FOR I=1 TO 40
1150 READ#8,Bs(I)
1160 FOR J=1 TO 4
1170 READ#8,E(I,J) 'READS IN CONMAN FILE'
1180 NEXT J
1190 NEXT I
1191 FILE #8,"*"
1192 FILE #8,"UGMISC"
1195 FOR I=1 TO 100
1196 FOR J=1 TO 3
1197 READ#8,P(I,J) 'READS IN UGMISC FILE'
1198 NEXT J
1199 IF END #8 THEN 1209
1200 N9=N9+1
1201 NEXT I
1209 FOR I=1 TO 100
1210 FOR J=1 TO 3
1220 READ#3,D(I,J) 'READS IN STLIGHT FILE'
1230 NEXT J
1240 IF END #3 THEN 1260
1250 NEXT I
1260 FOR I=1 TO 100
1270 IF END #4 THEN 1350
1280 LET N=N+1
1290 READ#5,Cs(I) 'READS IN UG CABLE NAME'
1300 FOR J=1 TO 10
1310 READ#4,C(I,J) 'READS IN UG CABLE FILE'
1320 NEXT J
1330 NEXT I
1350 READ#1,X(6) 'NUMBER OF CONDUIT & TRENCH LINE DATA'
1360 IF X(6)=0 THEN 1420
1365 READ#1,Z(1),Z(2),Zs(1),Z(3)
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1370 FOR I=1 TO X(6)
1380 FOR J=1 TO 5
1390 READ#1,G(I,J) 'READS IN CONDUIT & TRENCH DATA'
1400 NEXT J
1410 NEXT I
1420 READ#1,X(7) 'READS NUMBER OF LINES-ST.LIGHTING'
1430 IF X(7)=0 THEN 1490
1435 READ#1,Z(1),Z(2),Z$ (1),Z(3)
1440 FOR I=1 TO X(7)
1450 FOR J=1 TO 8
1460 READ#1,H(I,J) 'READS IN ST. LIGHT DATA'
1470 NEXT J
1480 NEXT I
1490 READ#1,X(8) 'NUMBER OF LINES OF UG CABLE DATA'
1500 IF X(8)=0 THEN 1560
1505 READ#1,Z(1),Z(2),Z$ (1),Z(3)
1510 FOR I=1 TO X(8)
1520 FOR J=1 TO 11
1530 READ#1,U(I,J) 'READS IN UG CABLE DATA'
1540 NEXT J
1550 NEXT I
1560 READ#1,X(10) 'READS NUMBER OF MANHOLES'
1570 IF X(10)=0 THEN 1630
1575 READ#1,Z(1),Z(2),Z$ (1),Z(3)
1580 FOR I=1 TO X(10)
1590 FOR J=1 TO 5
1600 READ#1,K(I,J) 'READS IN MANHOLE DATA'
1610 NEXT J
1620 NEXT I
1630 READ#1,X(11) 'READS NUMBER OF STANCHION ITEMS'
1640 IF X(11)=0 THEN 1700
1645 READ#1,Z(1),Z(2),Z$ (1),Z(3)
1650 FOR I=1 TO X(11)
1660 FOR J=1 TO 2
1670 READ#1,R(I,J) 'READS IN STANCHION DATA'
1680 NEXT J
1690 NEXT I
1700 READ#1,X(12) 'READS NUMBER OF PIECE-OUT ITEMS'
1710 IF X(12)=0 THEN 1770
1715 READ#1,Z(1),Z(2),Z$ (1),Z(3)
1720 FOR I=1 TO X(12)
1730 FOR J=1 TO 3
1740 READ#1,B(I,J) 'READS IN PIECE-OUT DATA'
1750 NEXT J
1760 NEXT I
1770 READ#1,X(13) 'READS IN U.G. DEVICES'
1775 IF X(13)=0 THEN 1840
1780 READ#1,Z(1),Z(2),Z$ (1),Z(3)
1785 FOR I=1 TO X(13)
1790 FOR J=1 TO 3

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1795 READ#1,N(I,J)          'READS IN U.G. DEVICES'
1800 NEXT J
1805 READ#1,S$(I),T$(I)     'READS IN U.G. DEVICE TITLES'
1810 NEXT I
1840 DEF FNA(Y)=INT(((Y)/Z(3))+.5)*Z(3) 'ROUNDS TO $10 OR $100'
1845 REM*****THE ROUTINE BELOW DOES CONDUIT & TRENCH LINE DATA*****
1849 IF X(6)=0 THEN 2030
1850 FOR I=1 TO X(6)
1860 FOR J=21 TO 40
1870 IF G(I,1)<>J THEN 1910
1880 G1=G(I,5)
1890 L1=G(I,2)*E(J,G1)*G(I,3) 'LAB $ OF CON&TRENCH'
1900 M1=G(I,2)*E(J,4)         'MATERIAL $ FOR CONDUIT & TRENCH'
1901 GOTO 1920
1910 NEXT J
1911 WRITE "NO SUCH CODE AVAILABLE FOR CONDUIT AND TRENCHING."
1912 STOP
1920 ON G(I,4) GOTO 1930,1950,1970,1972
1930 A$="E366"               'REGULAR'
1940 GOTO 1980
1950 A$="E362.1"             'SUBSTATIONS'
1960 GOTO 1980
1970 A$="E373.21"           'ST. LIGHTING'
1971 GOTO 1980
1972 A$="E367.2"             'B.U.D.'
1980 L1=FNA(L1)
1990 M1=FNA(M1)
2000 WRITE#6,"2",A$,G(I,2),B$(J),L1,M1
2010 NEXT I
2020 REM *****THE FOLLOWING ROUTINE DOES ST. LIGHTING'
2030 IF X(7)=0 THEN 2490
2040 FOR I=1 TO X(7)
2050 FOR J=1 TO 100
2055 IF H(I,1)=0 THEN 2140
2060 IF H(I,1)<>C(J,1) THEN 2130
2070 LET M2=H(I,2)*C(J,2)+M2
2080 L2=(H(I,2)*(F(13)/300))*F(1)+L2 'LABOR HRS ST. LIGHTING'
2090 WRITE#7,H(I,1);H(I,2) 'WRITES CABLE TO MATFILE'
2100 M2=FNA(M2)
2110 L2=FNA(L2)
2120 GOTO 2140
2130 NEXT J
2140 FOR J=1 TO 100
2145 IF H(I,3)=0 THEN 2230
2150 IF H(I,3)<>D(J,1) THEN 2220
2160 LET L3=H(I,4)*D(J,2)*F(1)+L3 'POLE LABOR'
2170 LET M3=H(I,4)*D(J,3)+M3 'POLE MATERIAL $'
2180 WRITE#7,H(I,3);H(I,4) 'WRITES POLES TO MATFILE'
2190 L3=FNA(L3)
2200 M3=FNA(M3)

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2210 GOTO 2230
2220 NEXT J
2230 FOR J=1 TO 100
2235 IF H(I,5)=0 THEN 2320
2240 IF H(I,5)<>D(J,1) THEN 2310
2250 LET L4=H(I,6)*D(J,2)*F(1)+L4 'BRACKET LABOR'
2260 LET M4=H(I,6)*D(J,3)+M4 'BRACKET MATERIAL $'
2270 WRITE:7,H(I,5);H(I,6) 'WRITES BRACKETS TO MATFILE'
2280 L4=FNA(L4)
2290 M4=FNA(M4)
2300 GOTO 2320
2310 NEXT J
2320 FOR J=1 TO 100
2325 IF H(I,7)=0 THEN 2460
2330 IF H(I,7)<>D(J,1) THEN 2400
2340 LET L5=H(I,8)*D(J,2)*F(1)+L5 'LUMINAIRE LABOR'
2350 LET M5=H(I,8)*D(J,3)+M5 'LUMINAIRE MATERIAL $'
2360 WRITE:7,H(I,7);H(I,8) 'WRITES LUMINAIRES TO MATFILE'
2370 L5=FNA(L5)
2380 M5=FNA(M5)
2390 GOTO 2460
2400 NEXT J
2460 NEXT I
2465 IF L2<1 THEN 2475
2470 WRITE#6,"2";"E373.22";0;"U.G. ST LIGHT CONDUCTORS";L2;M2
2475 IF L3+L4+L5<1 THEN 2490
2480 WRITE#6,"2";"E373.42";0;"STREET LIGHT UNITS"; L3+L4+L5; M3+M4+M5
2490 IF Z$(1)<>"B" THEN 2510
2500 LET F(1)=F(0)
2510 IF X(8)=0 THEN 2970
2520 FOR I=1 TO X(8)
2530 FOR J=1 TO N+1
2540 IF U(I,1)<>C(J,1) THEN 2800
2550 WRITE:7,U(I,1);U(I,2); 'WRITES CABLE TO MATFILE'
2560 LET U$(I)=C$(J) 'NAMES CABLE'
2570 IF U(I,1)>25999 THEN 2590
2580 GO TO 2600
2590 IF U(I,1)<28000 THEN 2710
2600 LET U(I)=(U(I,3)*F(4)+U(I,4)*F(5))*U(I,8) 'CABLE PULLING HRS'
2610 LET U(I)=U(I)+(U(I,5)*C(J,3)+U(I,6)*C(J,4)+U(I,7)*C(J,5))
2615 IF C(J,9)=0 THEN 2625
2620 WRITE:7,C(J,9);U(I,5); 'WRITES SPLICE KITS TO MATFILE'
2625 IF C(J,10)=0 THEN 2650
2630 WRITE:7,C(J,10);U(I,7)*3; 'WRITES POTHEADS TO MATFILE'
2640 REM SPLICING HOURS'
2650 LET L(I)=U(I)*F(1) 'CABLE PULLING+SPLICING LABOR $'
2660 LET L(I)=FNA(L(I))
2670 LET M(I)=U(I,2)*C(J,2)+U(I,5)*C(J,6)+U(I,6)*C(J,7)+U(I,7)*C(J,8)*3
2680 LET M(I)=FNA(M(I))
2690 REM MATERIAL COST OF CABLE,ST SPLICE KITS,BR SPLICE KITS,POTHEADS'
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2700 GO TO 2730
2710 LET U(1)=(U(1,3)*F(13)*U(1,8)) 'SECONDARY CABLE PULLING HRS'
2720 GO TO 2610
2730 LET H3=U(1,9)*F(11) 'RETAG HRS'
2740 LET H3=U(1,10)*F(12)+H3 'CUTOVER HRS'
2750 LET L9=H3*F(1) 'LABOR $ RETAG & CUTOVER'
2760 LET T(1)=T(1)+L(1) 'TOTAL LABOR $ CABLE'
2770 LET T(2)=T(2)+M(1) 'TOTAL MATERIAL $ CABLE'
2780 LET H=H+O(1) 'TOTAL LABOR HOURS CABLE'
2790 GO TO 2810
2800 NEXT J
2810 IF J<=N THEN 2840
2820 WRITE"NO U.G. CABLE STOCK CODE";U(1,1);"IN UGCABL FILE, CORRECT DATA"
2830 WRITE"THIS CODE IS FOUND IN THE";I;"LINE OF YOUR JG CABLE READ DATA"
2840 NEXT I
2850 LET L9=FNA(L9)
2910 FOR I=1 TO X(8)
2911 ON U(1,11) GOTO 2912,2914,2916
2912 A$="E367.1" 'REGULAR'
2913 GOTO 2920
2914 A$="E362.1" 'SUBSTATION'
2915 GOTO 2920
2916 A$="E367.2" 'B.U.D.'
2920 WRITE#6,"2";A$;U(1,2);U$(I);L(1)+L9;M(1)
2930 NEXT I
2970 IF X(10)=0 THEN 3140
2980 FOR I=1 TO X(10)
2990 FOR J=1 TO 20
3000 IF K(I,1)<>J THEN 3120
3010 IF K(I,2)=2 THEN 3070
3020 L6=(E(J,1)*K(I,4))*K(I,3) 'ST. MANHOLE LABOR
3030 M6=E(J,2)*K(I,4) 'STREET MANHOLE MATERIAL $'
3040 L6=FNA(L6)
3050 M6=FNA(M6)
3060 GOTO 3110
3070 L6=(E(J,3)*K(I,4))*K(I,3) 'S.W. MANHOLE LABOR
3080 M6=E(J,4)*K(I,4) 'SIDEWALK M.H. MATERIAL $'
3090 L6=FNA(L6)
3100 M6=FNA(M6)
3110 WRITE#6,"2";"E366";K(I,4);B$(J);L6;M6
3120 NEXT J
3130 NEXT I
3140 IF X(11)=0 THEN 3250
3150 FOR I=1 TO X(11)
3160 FOR J=1 TO N9
3170 IF R(I,1)<>P(J,1) THEN 3200
3180 LET L7=(P(J,2)*F(1))*R(I,2)+L7 'STANCHION LABOR'
3190 LET M7=R(I,2)*P(J,3)+M7 'STANCHION MATERIAL $'
3191 WRITE:7,R(I,1);R(I,2) 'WRITES STANCHIONS TO MATFILE'
3200 NEXT J

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3205 R9=R9+R(I,2)
3210 NEXT I
3220 LET L7=FNA(L7)
3230 LET M7=FNA(M7)
3240 WRITE#6,"2";"E366";R9;"STANCHIONS";L7;M7
3250 IF X(12)=0 THEN 3370
3260 FOR I=1 TO X(12)
3265 FOR J=1 TO N
3270 IF B(I,1)<>C(J,1) THEN 3320
3275 L8=(B(I,2)*(C(J,3)*2))*F(1)+L8 'PIECEOUT LABOR'
3280 Z8=(B(I,3)*F(6))*F(1)+Z8 'RACKING LABOR'
3285 IF B(I,2)=0 THEN 3320
3290 M8=((C(J,2)*10)+C(J,6)*2)+M8 'PIECEOUT MATERIAL'
3305 IF C(J,9)=0 THEN 3315
3310 WRITE#7,C(J,9);2 'ADDL SPLICE KITS TO MATFILE'
3315 WRITE#7,B(I,1),B(I,2)*10 'WRITES SPLICE CABLE TO MATFILE'
3320 NEXT J
3325 B9=B9+B(I,2) 'TOTAL PEICEOUTS'
3330 C9=C9+B(I,3) 'TOTAL RE-RACKS'
3335 NEXT I
3340 L8=FNA(L8)
3345 Z8=FNA(Z8)
3350 M8=FNA(M8)
3355 IF B9=0 THEN 3362
3360 WRITE#6,"2";"E366";B9;"PIECEOUTS";L8;M8
3362 IF C9=0 THEN 3370
3364 WRITE#6,"2";"E367.1";C9;"RE-RACKS";Z8;0
3370 IF X(13)=0 THEN 9998
3380 FOR I=1 TO X(13)
3390 FOR J=1 TO N9
3400 IF N(I,1)<>P(J,1) THEN 3450
3410 LET L9=((P(J,2)*F(1))*N(I,2))*N(I,3) 'DEVICE LABOR'
3420 LET M9=(P(J,3)*N(I,2)) 'DEVICE MATERIAL'
3430 WRITE#7,N(I,1);N(I,2) 'WRITES DEVICES TO MATFILE'
3440 WRITE#6,"2";S$(I);0;T$(I);L9;M9
3450 NEXT J
3460 NEXT I
9998 CHAIN "MISCP*"
9999 END

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999 OPTION QSUB
1000 FILES DMISC;COMINFO;SCRPAD;OHCABLE;GYANSW;MATFILE
1010: 'LLLLLLL ##### 'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL ##### #####
1020: ##### 'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL ##### #####
1030: 'LLLLLLL 'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL ##### #####
1040: 'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL ##### #####
1050 READ #1,D7,D8,D9,U0
1060 READ #1,Z$(2),Z$(3),Z$(4) 'SKETCH #,MAT LIS& SUMMARY(YES/NO)'
1070 READ #1,Z(1),Z(2),Z$(1),Z(3)
1080: 'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL ##### #####
1090 DIM A(30),P(15),n(20,4),N$(100),M$(100),L(100),M(100),B(100)
1100 DIM X(100)
1110 DIM Q(100),C(100),D(100),E(100),U(100),S(100)
1120 READ :6,I7
1130 IF END :6 THEN 1170
1140 RESTORE :6
1150 APPEND :6
1160 GO TO 1180
1170 SCRATCH :6
1180 READ #2,P(1),P(2),F(1),P(3),P(4),P(5),P(6),P(7),P(8),P(9),F(2)
1190 FOR I=1 TO 19
1200 READ #2,P(0)
1210 NEXT I
1220 FOR I=1 TO 20
1230 READ #3,A(I)
1240 NEXT I
1245 IF Z(2)=3 THEN 1750
1250 READ #1,X1
1260 IF X1=0 THEN 1490
1270 READ #1,Z(1),Z(2),Z$(1),Z(3)
1280 DEF FNA(X)=INT(((X)/Z(3))+.5)*Z(3) 'ROUNDS TO $10 OR $100'
1290 LET P(1)=P(0)
1300 FOR I=1 TO X1
1310 FOR J=1 TO 3
1320 READ #1,V(I,J) 'READS IN SWITCH DATA'
1330 NEXT J
1340 NEXT I
1350 FOR I=1 TO X1
1360 RESTORE #5
1370 READ #5,Y(1),Y(2),Y(3) 'READS IN GYANSW TABLE'
1380 IF END #5 THEN 1480
1390 IF V(I,3)<1.9 THEN 1480
1400 IF V(I,1)<>Y(1) THEN 1370
1410 LET X3=1
1420 LET A(9)=A(9)+Y(3)*V(I,2) 'TOTAL LABOR HRS SWITCHES FOR SUMMARY'
1430 LET L(X3)=Y(3)*V(I,2)*P(1)+L(X3) 'TOT LAB $ SWITCHES'
1440 LET M(X3)=M(X3)+Y(2)*V(I,2) 'MAT'L $ SWITCHES'
1450 LET Q(1)=1
1460 LET N$(X3)="E368.21" 'NAMES ACCT'
1470 LET m$(X3)="LINE TRANSF. DEVICES" 'GIVES DESCRIPTION'

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1480 NEXT I
1490 READ #1,X 'NUMBER OF LINES OF SERV WIRE DATA'
1500 IF X=0 THEN 1750
1510 READ #1,Z(1),Z(2),Z$(1),Z(3)
1530 LET P(1)=P(0)
1540 FOR I=1 TO X
1550 FOR J=1 TO 4
1560 READ #1,W(I,J) 'READS IN SERVICE WIRE DATA'
1570 NEXT J
1580 WRITE :6,W(I,1);W(I,2)*W(I,3);
1590 NEXT I
1600 FOR I=1 TO X
1610 RESTORE #4
1620 READ #4,G(1),G(2),G(3),G(4),G(5),G(6),G(7),G(8)
1630 IF END #4 THEN 1740
1640 IF W(I,1)<>G(1) THEN 1620
1650 IF I>1 THEN 1670
1660 LET X3=X3+1
1670 LET H=W(I,2)*W(I,3)*1E-3*G(7)*(1+W(I,4))+H 'SEC INS LAB HRS'
1680 LET A(9)=H
1690 LET L(X3)=H*P(1) 'SEC INST LAB $'
1700 LET M(X3)=W(I,2)*W(I,3)*G(2)+M(X3) 'MAT $ SEC INST'
1710 LET N$(X3)="E369.1" 'NAMES ACCT'
1720 LET Q(X3)=1
1730 LET M$(X3)="U.H. SERVICES"
1740 NEXT I
1750 READ #1,X2
1760 IF X2=0 THEN 1850
1770 READ #1,Z(1),Z(2),Z$(1),Z(3)
1790 LET P(1)=P(0)
1800 FOR I=X3+1 TO X2+X3
1810 READ #1,Q(I),N$(I),M$(I),L(I),M(I) 'TYPE ACCT OH=1 UG=2,'
1820 LET X(I)=0
1830 REM ACCT. NO.,DESCRIPTION,LABORS,MATERIALS
1840 NEXT I
1850 FOR I=X2+X3+1 TO 100
1860 READ #1,Q(I),N$(I),X(I),M$(I),L(I),M(I)
1870 IF END #1, THEN 1900
1880 LET N1=N1+1
1890 NEXT I
1900 REM ROUTINE ABOVE READS IN UG DATA
1910 DEF FNB(X,Y)=Z(1)*(X*.007+Y*.007) 'LABOR ESCALATION'
1920 DEF FNC(X,Y)=Z(1)*(X*.003+Y*.007) 'MATERIAL ESCALATION'
1930 REM THE ROUTINE BELOW SORTS THE MISC ACCTS INTO ASCENDING ORDER
1940 FOR I=1 TO X2+X3+N1-1
1950 FOR J=I+1 TO X2+X3+N1
1960 IF N$(I)<=N$(J) THEN 2150
1970 LET T$=N$(I)
1980 LET X4=L(I)
1990 LET S$=M$(I)

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2000 LET X5=M(I)
2010 LET X6=Q(I)
2020 LET X7=X(I)
2030 LET N$(I)=N$(J)
2040 LET L(I)=L(J)
2050 LET M$(I)=M$(J)
2060 LET M(I)=M(J)
2070 LET Q(I)=Q(J)
2080 LET X(I)=X(J)
2090 LET N$(J)=T$
2100 LET L(J)=X4
2110 LET M$(J)=S$
2120 LET M(J)=X5
2130 LET Q(J)=X6
2140 LET X(J)=X7
2150 NEXT J
2160 NEXT I
2170 FOR I=1 TO X2+X3+N1
2180 LET M(I)=FNA(M(I))
2190 LET L(I)=FNA(L(I))
2200 IF Q(I)>2.1 THEN 2960
2210 IF Z$(I)="B" THEN 2380
2220 IF N$(I)<>N$(I-1) THEN 2260
2230 IF N$(I)<>N$(I+1) THEN 2290
2240 GO SUB 4120
2250 GO TO 2980
2260 IF N$(I)<>N$(I+1) THEN 2310
2270 GO SUB 4050
2280 GO TO 2980
2290 GO SUB 4120
2300 GO TO 2430
2310 IF Z$(I)="B" THEN 2380
2320 IF X(I) < .5 THEN 2360
2330 PRINT USING 1010,N$(I),X(I),M$(I),L(I),M(I)
2340 LET A(10)=A(10)+1
2350 GO TO 2430
2360 PRINT USING 1030,N$(I),M$(I),L(I),M(I)
2370 GO TO 2420
2380 IF X(I)<.5 THEN 2410
2390 PRINT USING 1020,X(I),M$(I),L(I),M(I)
2400 GO TO 2420
2410 PRINT USING 1040,M$(I),L(I),M(I)
2420 LET A(10)=A(10)+1
2430 LET B(I)=L(I)*P(3) 'LABOR LOADING'
2440 LET B(I)=FNA(B(I))
2450 LET C(I)=M(I)*F(Q(I)) 'MATERIAL LOADING'
2460 LET C(I)=FNA(C(I))
2470 LET D(I)=FNB(L(I),B(I)) 'LABOR ESC'
2480 LET D(I)=FNA(D(I))
2490 LET E(I)=FNC(M(I),C(I)) 'MATERIAL ESC'

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2500 LET E(I)=FNA(E(I))
2510 LET U(I)=L(I)+B(I)+D(I) 'LABOR+LOADING+ESCALATION'
2520 LET S(I)=M(I)+C(I)+E(I) 'MATERIAL+LOADING+ESCALATION'
2530 IF Q(I)>1.1 THEN 2660
2540 LET T(1)=T(1)+U(I) 'TOTALS LABOR+LOADING+ESC FOR O.H.'
2550 LET A(1)=A(1)+L(I) 'TOTALS O.H. LABOR'
2560 LET A(2)=A(2)+M(I) 'TOTALS O.H. MATERIAL $'
2570 LET A(3)=A(3)+B(I) 'TOTALS O.H. LABOR LOADING'
2580 LET A(4)=A(4)+C(I) 'TOTALS O.H. MATERIAL LOADING'
2590 LET A(7)=A(7)+U(I) 'TOTAL LAB+LDING+ESC FOR SUMMARY'
2600 LET A(5)=A(5)+D(I) 'TOTALS O.H. LABOR ESCALATION'
2610 LET A(6)=A(6)+E(I) 'TOTALS O.H. MATERIAL ESCALATION'
2620 LET T(2)=T(2)+S(I) 'TOTALS MATERIAL+LOADING+ESC FOR O.H.'
2630 LET A(8)=A(8)+S(I) 'TOTAL MAT+LDING+ESC FOR SUMMARY'
2640 LET A(9)=A(9)+(T(1)/P(1)) 'ADDS TOTAL O.H. MANHOURS FOR SUMMARY'
2650 GO TO 2800
2660 IF Q(I)>2.1 THEN 2960
2670 LET T(3)=T(3)+U(I) 'TOTALS LABOR+LOADING+ESC FOR U.G.'
2680 LET A(11)=A(11)+L(I) 'TOTALS U.G. LAB $ FOR SUMMARY'
2690 LET A(12)=A(12)+M(I) 'TOTALS MAT $ U.G. FOR SUMMARY'
2700 LET A(13)=A(13)+B(I) 'TOTALS U.G. LABOR LOADING FOR SUMMARY'
2710 LET A(14)=A(14)+C(I) 'TOTALS U.G. MAT LOADING FOR SUMMARY'
2720 LET A(15)=A(15)+D(I) 'TOTALS U.G. LAB ESC FOR SUMMARY'
2730 LET A(16)=A(16)+E(I) 'TOTALS U.G. MAT ESC FOR SUMMARY'
2740 LET A(17)=A(17)+U(I) 'TOTALS U.G. LAB$+LAB LDING +ESC FOR SUMMARY'
2750 LET A(18)=A(18)+S(I) 'TOTALS U.G. MAT+MAT LDING+ESC FOR SUMMARY'
2760 LET T(4)=T(4)+S(I) 'TOTALS MATERIAL+LOADING+ESC FOR U.G.'
2770 LET A(19)=A(19)+(T(3)/P(1)) 'ADDS TOT OH MANHRS FOR SUMMARY'
2780 REM SPACE RES
2790 REM SPACE RESERVED
2800 DEF FNS(Y)=(52-INT(LOG(Y+1)/2.30259))
2810 DEF FNT(Y)=(61-INT(LOG(Y+1)/2.30259))
2820 DEF FNU(Y)=(70-INT(LOG(Y+1)/2.30259))
2830 REM SPACE RES
2840 IF Z$(1)="B" THEN 2980
2850 PRINT TAB(18);"LOADING (L@";P(3)*100.;"%--M@";F(Q(I))*100.;"%)" ;
2860 PRINT TAB(FNS(B(I)));B(I);TAB(FNT(C(I)));C(I)
2870 PRINT TAB(18);"ESCALATION";TAB(FNS(D(I)));D(I);TAB(FNT(E(I)));E(I)
2880 PRINT TAB(44);"-----"
2890 PRINT TAB(18);"SUB TOTAL";TAB(FNS(U(I)));U(I);TAB(FNT(S(I)));S(I)
2900 PRINT TAB(FNU(U(I)+S(I)));U(I)+S(I)
2910 PRINT
2920 LET A(10)=A(10)+5
2930 IF X2+X3+N1=1 THEN 2980
2940 IF A(10)<45 THEN 2980
2950 GO SUB 3010
2960 IF Q(I)<>3 THEN 2980
2970 LET I5=I5+1
2980 NEXT I
2990 IF Z$(1)="B" THEN 3530

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3000 GO TO 3220
3010 PRINT TAB(44);"=====
3020 PRINT TAB(18);"ESTIMATE SUB TOTAL";
3030 PRINT TAB(FNS(A(7)+A(17)+I6));A(7)+A(17)+I6;
3040 PRINT TAB(FNT(A(8)+A(18)));A(8)+A(18);
3050 PRINT TAB(FNU(A(7)+A(8)+A(17)+A(18)+I6));A(7)+A(8)+A(17)+A(18)+I
3060 LET A(10)=A(10)+2
3070 LET Z(4)=60-A(10)
3080 LET A(10)=0
3090 FOR I1=1 TO Z(4)+6
3100 PRINT
3110 NEXT I1
3120 PRINT TAB(2);"ACCT.";TAB(9);"QUANT.";TAB(25);"ITEM";
3130 PRINT TAB(50);"LABOR";TAB(58);"MAT'L.";TAB(67);"TOTAL"
3140 PRINT TAB(3);"NO.";TAB(58);"&EXP."
3150 PRINT
3160 PRINTTAB(18);"CARRIED FORWARD";TAB(FNS(A(7)+A(17)+I6));A(17)+A(7
3170 PRINTTAB(FNT(A(8)+A(18)));A(8)+A(18);TAB(FNU(A(7)+A(8)+A(17)+A(1
3180 PRINT A(7)+A(8)+A(17)+A(18)+I6
3190 PRINT
3200 LET A(10)=A(10)+6
3210 RETURN
3220 PRINT TAB(44);"=====
3230 PRINT TAB(18);"ESTIMATE TOTAL";TAB(FNS(A(7)+A(17)));A(7)+A(17);
3240 PRINT TAB(FNT(A(8)+A(18)));A(8)+A(18);TAB(FNU(A(7)+A(8)+A(17)+A(
3250 PRINT A(7)+A(8)+A(17)+A(18)
3260 IF I5<.9 THEN 3520
3270 FOR I=1 TO X2+X3+N1
3280 IF Q(1)<2.9 THEN 3450
3290 LET I4=I4+1
3300 IF I4>1.1 THEN 3370
3310 PRINT
3320 PRINT
3330 PRINT
3340 PRINT TAB(18);"OPERATING ACCOUNTS"
3350 PRINT
3360 LET A(10)=A(10)+5
3370 PRINT N$(I); TAB(18);M$(I);TAB(FNS(L(I)));L(I)
3380 PRINT
3390 LET I6=I6 + L(I)
3400 LET A(10)=A(10)+2
3410 IF A(10)<45 THEN 3450
3420 LET I2=I2+1
3430 IF I2>1.1 THEN 3450
3440 GOSUB 3010
3450 NEXT I
3460 PRINT TAB(44);"-----"
3470 PRINT TAB(18);"TOTAL OPERATING";TAB(FNS(I6));I6
3480 PRINT TAB(44);"=====
3490 PRINT TAB(18);"TOTAL CAPITAL & OPERATING";TAB(FNS(I6+A(7)+A(17)))

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3500 PRINT I6+A(7)+A(17);TAB(FNT(A(8)+A(18)));A(8)+A(18);
3510 PRINT TAB(FNU(I6+A(7)+A(17)+A(8)+A(18)));I6+A(7)+A(17)+A(8)+A(18)
3520 GO TO 4000
3530 IF 07<1 THEN 3560
3540 PRINT TAB(18);"O.H. MAINTENANCE";TAB(FNS(07));07
3550 LET A(1)=A(1)+07
3560 IF 08<1 THEN 3590
3570 PRINT TAB(18);"U.G. MAINTENANCE";TAB(FNS(08));08
3580 LET A(11)=A(11)+08
3590 PRINT TAB(44);"-----"
3600 PRINT TAB(35);"SUB-TOTAL";TAB(FNS(A(1)+A(11)));
3610 PRINT A(1)+A(11);TAB(FNT(A(2)+A(12)));A(2)+A(12);
3620 PRINT TAB(FNU(A(1)+A(11)+A(2)+A(12)));A(1)+A(11)+A(2)+A(12)
3630 PRINT
3640 PRINT
3650 LET 01=(A(2)*.1)+(A(12)*.04) 'EXEMPT MATERIAL'
3660 LET 01=FNA(01)
3670 LET 02=(A(2)+A(12)+01)*.1 'STOREROOM HANDLING'
3680 LET 02=FNA(02)
3690 LET 03=(A(2)+A(12)+01+02)*.15 'E.A.S.A.'
3700 LET 03=FNA(03)
3710 LET 04=((A(1)+A(11))/P(1))*2*3.8 'TRUCKING & EQUIP'
3720 LET 05=FNA(04)
3730 LET 06=((A(1)+A(11))/100)*4.5+(04/30)*.66
3740 LET 06=FNA(06)
3750 PRINT TAB(11);"(1)";TAB(18);"EXEMPT MATERIAL";TAB(FNU(01));01
3760 PRINT TAB(11);"(2)";TAB(18);"STOREROOM HANDLING";TAB(FNU(02));02
3770 PRINT TAB(11);"(3)";TAB(18);"E.A.S.A.";TAB(FNU(03));03
3780 PRINT TAB(18);"TRUCKING AND EQUIPMENT";TAB(FNU(05));05
3790 PRINT TAB(11);"(4)";TAB(18);"INSURANCE";TAB(FNU(06));06
3800 PRINT TAB(18);"COST OF REMOVAL";TAB(FNU(09));09
3810 LET I8=01+02+03+05+06+09
3820 PRINT TAB(66);"-----"
3830 PRINT TAB(40);"TOTAL";
3840 PRINT TAB(FNU(A(1)+A(11)+A(2)+A(12)+I8));
3850 PRINT A(1)+A(11)+A(2)+A(12)+I8
3860 PRINT TAB(18);"CREDIT FOR SALVAGE";TAB(FNU(00));00
3870 PRINT TAB(66);"-----"
3880 PRINT TAB(40);"NET TOTAL";TAB(FNU(A(1)+A(11)+A(2)+A(12)+I8-00));
3890 PRINT A(1)+A(11)+A(2)+A(12)+I8-00
3900 PRINT
3910 PRINT
3920 PRINT "REFER TO DRAWING ";Z$(2)
3930 PRINT "(1) 10% OF O.H. MATERIAL & 4% U.G. MATERIAL"
3940 PRINT "(2) 10% OF ALL MATERIAL INCLUDING EXEMPT MATERIAL"
3950 PRINT "(3) 15% OF TOTAL MATERIAL INCLUDING STOREROOM HANDLING"
3960 PRINT "(4) INCLUDES TRUCK INSURANCE"
3970 PRINT
3980 PRINT "NOTE: THE WORK COVERED BY THIS ESTIMATE TO BE PERFORMED I
3990 PRINT " PUBLIC SERVICE PERSONNEL."

```

MISCPs 05/08/74

```
4000 SCRATCH #3
4010 FOR I=1 TO 20
4020 WRITE #3,A(I),
4030 NEXT I
4040 GO TO 4210
4050 IF X(I)<.5 THEN 4090
4060 PRINT USING 1010,N$(I),X(I),M$(I),L(I),M(I)
4070 LET A(10)=A(10)+1
4080 GO TO 4200
4090 PRINT USING 1030,N$(I),M$(I),L(I),M(I)
4100 LET A(10)=A(10)+1
4110 GO TO 4200
4120 IF X(I)>.5 THEN 4150
4130 PRINT USING 1040,M$(I),L(I),M(I)
4140 GO TO 4160
4150 PRINT USING 1020,X(I),M$(I),L(I),M(I)
4160 LET A(10)=A(10)+1
4170 IF N$(I)<>N$(I-1) THEN 4200
4180 LET L(I)=L(I)+L(I-1)
4190 LET M(I)=M(I)+M(I-1)
4200 RETURN
4210 IF Z$(1)="B" THEN 4230
4215 IF Z$(4)="NO" THEN 4230
4220 CHAIN "SUMRY*"
4230 IF Z$(3)="NO" THEN 4280
4240 FOR I=1 TO 20
4250 PRINT
4260 NEXT I
4270 CHAIN "MATLS*"
4280 END
```


SUMRY : 05/08/74

```
999 OPTION QSUB
1000 FILES INPUT;SCRPAD;COMINFO
1010 DIM A(30)
1020 FOR I=1 TO 20
1030 READ#2,A(I)
1040 NEXT I
1060 LET P1=60-A(10)
1090 FOR I=1 TO P1
1100 PRINT
1110 NEXT I
1120 READ #3,F(4),P,F(2),F(1),P,P,P,P,P,P,F(3)
1130 DIM E$(20),P(20,3),G(8),X(15),S(20,3),N$(20),L(20),M(20)
1140 DIM W(20,4),C(20,17),M(7),U(20,10),M$(20)
1150 READ #1,A$(1) 'READS IN FIRST LINE OF ESTIMATE TITLE'
1160 READ #1,B$(1) 'READS IN SECOND LINE OF ESTIMATE TITLE'
1170 READ #1,E(1) 'READS IN EST TYPE, COMBINED=1, OH=2, UG=3'
1175 READ #1, E(5) 'READS IN ROUNDING FACTOR'
1180 READ #1,E$(1) 'READS IN FORMAT TYPE; R&E OR BILLING'
1185 READ #1, E(6),E(7),E(8),E(9) 'READS IN COSTS'
1190 READ #1,E$(2) 'REQUESTED VERBALLY (YES/NO)'
1200 READ #1,E$(3),E$(4) 'EITHER REQ BY & LOC OR DATE & DICTATOR'
1210 READ #1,E$(5),E$(6),E$(7),E$(8),E$(9),E$(10)
1220 REM DATE, EST NO., TOWN, DIV., PREP BY, SK NO.
1230 READ #1,M(1),Y(1),M(2),Y(2),M(3),Y(3)
1240 REM CUR MO,CUR YR, JOB ST MO,JOB ST YR, JOB END MO,JOB END YR
1250 READ #1,E(3),E(4) 'O.H., U.G. WITHDRAWAL HOURS'
1260 READ #1, E(2),E(10) '%OF OPERATING MANHOURS'
1270 READ #1,E$(11) 'DO YOU WANT A MATERIAL LIST(YES/NO)'
1280 LET A(9)=INT(A(1)/F(4)) 'TOT AUTH OH LAB HRS'
1290 LET A(21)=INT(A(9)*E(2))
1300 LET A(22)=INT(E(3))
1310 LET A(23)=A(9)+A(21)+A(22)
1320 LET A(19)=INT(A(11)/F(4)) 'TOT AUTH UG LAB HRS'
1330 LET A(24)=INT(A(19)*E(10)) 'UG OPERATING M.H.'
1340 LET A(25)=INT(E(4))
1350 LET A(26)=A(19)+A(24)+A(25) 'TOTAL UG JOBSITE MANHOURS'
1360 LET A(27)=A(26)+A(23) 'TOTAL OH & UG JOBSITE MANHOURS'
1370 LET Z(2)=((Y(3)*12+M(3))-(Y(2)*12+M(2))) 'EST TIME TO COMPLETE'
1380 LET Z(1)=(((Y(2)*12+M(2))-(Y(1)*12+M(1)))+Z(2)/2) 'ESC FACTOR'
1390 PRINT TAB(17);"PUBLIC SERVICE ELECTRIC AND GAS COMPANY"
1400 PRINT TAB(27);"ELECTRIC DEPARTMENT"
1410 PRINT TAB(28);"ESTIMATE-GENERAL"
1420 PRINT
1430 PRINT TAB(13);"TO: THE GENERAL MANAGER - TRANSMISSION & DISTRIBUTI
1440 PRINT
1450 IF E$(2)="YES" THEN 1480
1460 PRINT "REQUESTED BY LETTER "E$(3);" FROM ";E$(4)
1470 GO TO 1490
1480 PRINT "REQUESTED VERBALLY BY ";E$(3);" FROM ";E$(4)
1490 PRINT
```

SUMRY \$

05/08/74

```

1500 PRINT A$(1)
1510 IF B$(1)="NONE" THEN 1530
1520 PRINT B$(1)
1530 PRINT
1540 PRINT TAB(N);"SUMMARY"
1550 PRINT
1560 DEF FNB(Y)=(51-INT(LOG(Y+1)/LOG(10)))
1570 DEF FNC(Y)=(60-INT(LOG(Y+1)/LOG(10)))
1580 DEF FND(Y)=(69-INT(LOG(Y+1)/LOG(10)))
1590 PRINT TAB(48);"LABOR";TAB(58);"MAT'L.";TAB(67);"TOTAL"
1600 PRINT TAB(58);"&EXP."
1610 PRINT
1615 IF A(7)+A(8)<1 THEN 1790
1620 LET F(2)=INT(((A(4)/A(2))*100)+.5)/100 'CALC TOT OH MAT LDING'
1640 PRINT "OVERHEAD CONSTRUCTION";TAB(FNB(A(1)));A(1);
1650 PRINT TAB(FNC(A(2)));A(2);TAB(FND(A(2)+A(1)));A(2)+A(1)
1660 PRINT "      OVERHEADS (L@";F(1)*100;"%--M@";F(2)*100;"%)"
1670 PRINT TAB(FNB(A(3)));A(3);TAB(FNC(A(4)));A(4);TAB(FND(A(3)+A(4)));A(
1680 PRINT "      ESCALATION";TAB(FNB(A(5)));A(5);TAB(FNC(A(6)));A(6);
1690 PRINT TAB(FND(A(5)+A(6)));A(5)+A(6)
1700 PRINT TAB(47);"-----"
1710 PRINT "      TOTAL OVERHEAD COST";TAB(FNB(A(7)));A(7);
1720 PRINT TAB(FNC(A(8)));A(8);TAB(FND(A(7)+A(8)));A(7)+A(8)
1730:   AUTH. JOBSITE MANHOURS   #####
1735 PRINT USING 1730,A(9)
1740:   OPERATING JOBSITE M.H.   #####
1745 PRINT USING 1740,A(21)
1750:   REMOVAL JOBSITE M.H.     #####
1755 PRINT USING 1750,A(22)
1760:   TOTAL JOBSITE MANHOURS   #####
1761 PRINT"      -----"
1765 PRINT USING 1760,A(23)
1770 PRINT
1780 PRINT
1790 IF A(17)+A(18)<1 THEN 1950
1800 PRINT "UNDERGROUND CONSTRUCTION";TAB(FNB(A(11)));A(11);
1810 PRINT TAB(FNC(A(12)));A(12);TAB(FND(A(11)+A(12)));A(11)+A(12)
1820 PRINT "      OVERHEADS (L@";F(1)*100;"%--M@";F(3)*100;"%)"
1830 PRINT TAB(FNB(A(13)));A(13);TAB(FNC(A(14)));A(14);TAB(FND(A(13)+A(1
1840 PRINT A(13)+A(14)
1850 PRINT "      ESCALATION";TAB(FNB(A(15)));A(15);TAB(FNC(A(16)));A(16)
1860 PRINT TAB(FND(A(15)+A(16)));A(15)+A(16)
1870 PRINT TAB(47);"-----"
1880 PRINT "      TOTAL UNDERGROUND COST";TAB(FNB(A(17)));A(17);
1890 PRINT TAB(FNC(A(18)));A(18);TAB(FND(A(17)+A(18)));A(17)+A(18)
1900 PRINT USING 1730,A(19)
1910 PRINT USING 1740,A(24)
1920 PRINT USING 1750,A(25)
1925 PRINT"      -----"
1930 PRINT USING 1760,A(26)

```

SUMRY\$ 05/08/74

```
1940 PRINT
1950 PRINT
1960 PRINT "TOTAL PROJECT";TAB(FNB(A(1)+A(11)));A(1)+A(11);
1970 PRINT TAB(FNC(A(2)+A(12)));A(2)+A(12);
1980 PRINT TAB(FND(A(2)+A(1)+A(11)+A(12)));A(1)+A(2)+A(11)+A(12)
1990 LET F(6)=(A(3)+A(13))/(A(1)+A(11)) 'CALC OF TOT PROJ LAB LDING'
2000 LET F(5)=(A(4)+A(14))/(A(2)+A(12)) 'CALC OF TOT PROJ MAT LDING'
2010 LET F(6)=INT(((F(6))*100)+.5)/100
2020 LET F(5)=INT(((F(5))*100)+.5)/100
2030 PRINT " OVERHEADS (L@";F(6)*100;"%--M@";F(5)*100;"%)" ;
2040 PRINT TAB(FNB(A(3)+A(13)));A(3)+A(13);TAB(FNC(A(4)+A(14)));A(4)+A(14)
2050 PRINT TAB(FND(A(3)+A(4)+A(13)+A(14)));A(3)+A(4)+A(13)+A(14)
2060 PRINT " ESCALATION";TAB(FNB(A(5)+A(15)));A(5)+A(15);
2070 PRINT TAB(FNC(A(6)+A(16)));A(6)+A(16);
2080 PRINT TAB(FND(A(5)+A(6)+A(15)+A(16)));A(5)+A(6)+A(15)+A(16)
2090 PRINT TAB(47);"-----"
2100 PRINT " TOTAL PROJECT";TAB(FNB(A(7)+A(17)));A(7)+A(17);TAB(FNC
2110 PRINT A(8)+A(18);TAB(FND(A(7)+A(8)+A(17)+A(18)));A(7)+A(8)+A(17)+
2120 PRINT USING 1760,A(27)
2130: LABOR RATE USED ###.## PER HOUR
2135 PRINT USING 2130,F(4)
2140 PRINT
2150 PRINT
2160 PRINT TAB(15);"DATE ";E$(5);TAB(36);"ESTIMATE NUMBER ";E$(6)
2170 PRINT TAB(25);"SKETCH NUMBER ";E$(10)
2180 PRINT TAB(25);E$(8);" DIVISION"
2190 PRINT TAB(15);"MUNICIPALITY - ";E$(7)
2200 PRINT TAB(15);"ESTIMATED TIME TO COMPLETE - ";Z(2);" MONTHS"
2210 PRINT TAB(25);"PREPARED BY - ";E$(9)
2220 PRINT TAB(15);"ELECTRIC DISTRIBUTION DEPARTMENT"
2230 PRINT
2240 PRINT TAB(25);"CHECKED BY - "
2250 PRINT
2260 PRINT
2270 PRINT
2280 PRINT TAB(25);"APPROVED BY - "
2290 FOR I=1 TO 20
2300 PRINT
2310 NEXT I
2315 IF E$(11)="NO" THEN 2320
2316 CHAIN "MATLS*"
2320 END
```

MATLSS 05/08/74

```
999 OPTION QSUB
1000 FILES MATFILE;MATNM*;INPUT
1010 READ #3,A$,B$
1020 READ #3,A(1),A,Z$,A,A,A,A,Z$,Z$,Z$,E$(1),E$(2),E$(3),E$(4),E$(
1030 READ #3,A,A,E(1),E(2)
1040 PRINT "JOB TITLE: ";A$
1050 IF B$="NONE" THEN 1070
1060 PRINT " ";B$
1070 PRINT"ESTIMATE NO: ";E$(2);" DATE: ";E$(1)
1080 PRINT"JOB START DATE: ";E(1);"/";E(2)
1090 PRINT
1100 PRINT" MATERIAL LIST"
1110 PRINT
1120 PRINT
1130 DIM S(1000),Q(1000),I(1000)
1140 DIM C(500),M$(500),N$(500)
1150: 'EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
1160PRINT" NAME OF ITEM STOCK QUANTIT
1170PRINT" CODE"
1180PRINT
1181 PRINT "(OVERHEAD MATERIAL)"
1190 FOR I=1 TO 1000
1200 IF END :1 THEN 1231
1210 LET N=N+1
1220 READ :1,S(I),Q(I) 'READS IN STOCK CODE AND QUANTITY'
1225 N$(I)=" "
1230 NEXT I
1231 N=N-1
1232 FOR I=1 TO N
1234 I(I)=I
1236 NEXT I
1240 D=8191
1250 FOR K=1 TO 12
1260 D=(D-1)/2
1270 FOR I=D+1 TO N
1280 T=I(I)
1290 FOR J=I-D TO 1 STEP -D
1300 IF S(T)>=S(I(J)) THEN 1350
1310 I(J+D)=I(J)
1320 NEXT J
1330 I(J)=T
1340 GO TO 1360
1350 I(J+D)=T
1360 NEXT I
1370 NEXT K
1460 FOR I=1 TO 500
1470 LET N2=N2+1
1480 READ #2,C(I),M$(I)
1490 IF END #2 THEN 1520
1500 NEXT I
```

MATLS\$ 05/08/74

```
1510 LET N3=1
1520 FOR I=1 TO N
1530 FOR J=N3 TO N2
1540 IF S(I(I))=0 THEN 1590
1550 IF S(I(I))<>C(J) THEN 1580
1560 LET N$(I)=M$(J)
1570 LET N3=J
1575 GO TO 1590
1580 NEXT J
1590 NEXT I
1600 SCRATCH :1
1605 FOR I=1 TO N
1606 T1=I(I)
1607 T2=I(I+1)
1608 IF S(T1)<>S(T2) THEN 1611
1609 Q(T2)=Q(T2)+Q(T1)
1610 GO TO 1630
1611 IF Q(T1)=0 THEN 1630
1620 PRINT USING 1150,N$(I),S(T1),Q(T1)
1625 WRITE :1,S(T1);Q(T1);
1630 NEXT I
1635 IF Z9>0 THEN 1750
1636 Z9=1
1640 IF A(1)=2 THEN 1750
1650 FILE :1,"*"
1660 FILE :1,"UGMAT"
1665 RESTORE #2
1670 PRINT
1680 PRINT
1690 PRINT
1691 PRINT "(UNDERGROUND MATERIAL)"
1695 N=N2=N3=0
1700 GOTO 1190
1750 END
```

RESRV* 05/08/74

```

900 MARGIN #(0),90
1000 FILES MATFILE;RESRV;MATNM*;NUMBR*
1010 DIM C(200),N(200),D$(12),Y(10,12),Z(200,12),U$(200),X$(200,12)
1020 DIM X(200),B$(200),E$(200)
1030 DIM Y$(200)
1040 DIM I(200)
1050 DIM C$(200),A(360),A$(360)
1060 F$=UNQ$
1070 FOR X=1 TO 8
1080 READ #4,G$,H$
1090 IF F$<>G$ THEN 1120
1100 T$=H$
1110 GO TO 1130
1120 NEXT X
1130 P$=DAT$
1140 FOR I2=1 TO 350
1150 READ #3,A(I2),A$(I2)
1160 IF END #3 THEN 1190
1170 N2=N2+1
1180 NEXT I2
1190 N2=N2+1
1200 FOR I=1 TO 8
1210 PRINT
1220 NEXT I
1230 REM C(I)=STOCK CODE,N(I)=QUANT.,Y(I,J)=PERCENTAGE,

1240 REM Z(I,J)=OUTPUT QUANT.,U$(I)=UNIT OF MEASURE,X$(I,J)=UNIT OF
1250 REM MEASURE IN OUTPUT,X(I)=STOCK CODE IN OUTPUT,D$(I)=MONTH
1260 REM *****
1270 REM *****
1280 REM THE FOLLOWING GROUP OF LOOPS READ DATA FROM RESRV AND
1290 REM MATFILE
1300 N7=0
1305 READ #2,Q$
1306 READ #2,I$
1307 READ #2,J$
1310 READ #2,A$,M,C$,G
1320 READ #2,F
1330 REM A$=AUTH NO.,X=CODE,C$=MONTH COMPLETE,N=NO. MONTHS MATERIAL
1340 REM IS TO BE DELIVERED
1350 : 'RRRRRRR ##### 'LLL 'LLLLLLL ## 'LLLLLLLLLLLLLLLLL 'LLLLLL
1360 REM *****
1370 REM THE FOLLOWING IS A LOOP TO READ DELIVERY DATES FROM RESRV
1380 FOR I=1 TO G
1390 READ #2,D$(I)
1400 NEXT I
1410 REM *****
1420 REM THE FOLLOWING IS A LOOP TO READ PERCENT DATA FROM RESRV
1430 FOR I=1 TO 8
1440 FOR J=1 TO G
1450 READ #2,Y(I,J)

```

RESRV* 05/08/74

```
1460 NEXT J
1470 NEXT I
1480 ON F GO TO 1530,1530,3460
1490 REM *****
1500 REM THE FOLLOWING IS A LOOP TO READ STOCK CODE AND QUANT. FROM
1510 REM MATFILE, SORT ACCORDING TO STOCK CODE AND ASSIGN UNIT OF
1520 REM MEASURE (U/M)
1530 REM
1540 PRINT "SORT MATERIAL FILE (YES/NO)"
1550 INPUT R$
1560 FOR I=1 TO 7
1570 PRINT
1580 NEXT I
1590 IF R$="NO" THEN 1910
1600 FOR I=1 TO 1000
1610 READ :I,C(I),N(I)
1620 IF END :I THEN 1660
1630 N=N+1
1640 I(I)=I
1650 NEXT I
1660 D=8191
1670 FOR K=1 TO 12
1680 D=(D-1)/2
1690 FOR I=D+1 TO N
1700 T=I(I)
1710 FOR J=I-D TO 1 STEP -D
1720 IF C(T)>=C(I(J)) THEN 1770
1730 I(J+D)=I(J)
1740 NEXT J
1750 I(J)=T
1760 GO TO 1780
1770 I(J+D)=T
1780 NEXT I
1790 NEXT K
1800 SCRATCH :I
1810 FOR I=1 TO N
1820 T1=I(I)
1830 T2=I(I+1)
1840 IF C(T1)<>C(T2) THEN 1870
1850 N(T2)=N(T2)+N(T1)
1860 GO TO 1880
1870 WRITE :I,C(T1);N(T1);
1880 NEXT I
1890 N=D=K=T=J=T1=T2=0
1900 RESTORE :I
1910 FOR I=1 TO 200
1920 READ :I,C(I),N(I)
1930 IF END :I THEN 1960
1940 N9=N9+1
1950 NEXT I
```

RESRV* 05/08/74

```
1960 W=1
1970 N2=N2+1
1980 FOR I=1 TO N9
1990 FOR J=W TO N2
2000 IF C(I)<>A(J) THEN 2140
2010 LET C$(I)=A$(J)
2020 W=J
2030 IF C(I)<10000 THEN 2090
2040 IF C(I)>39999 THEN 2070
2050 LET U$(I)="FT."
2060 GO TO 2120
2070 IF C(I)=70720 THEN 2110
2080 IF C(I)=70722 THEN 2110
2090 LET U$(I)="EA."
2100 GO TO 2120
2110 LET U$(I)="PR."
2120 LET C(I)=C(I)/10000
2130 GO TO 2170
2140 NEXT J
2150 C(I)=C(I)/10000
2160 C$(I)="MISSING NAME"
2170 NEXT I
2180 W=1
2190 REM *****
2200 REM *****
2210 REM THE FOLLOWING GROUP OF LOOPS SORT ACCORDING TO STOCK CODE
2220 REM AND MONTH, EXCLUDE EXEMPT MATERIAL, AND MULTIPLY BY
2230 REM APPROPRIATE PERCENTAGE VALUES.
2240 REM *****
2250 FOR I=1 TO N9
2260 IF C(I)=9.4008 THEN 2710
2270 IF C(I)=9.4020 THEN 2710
2280 IF C(I)=9.4036 THEN 2710
2290 IF C(I)=9.4038 THEN 2710
2300 IF C(I)=.0338 THEN 2710
2310 IF C(I)=.0339 THEN 2710
2320 IF C(I)=7.6652 THEN 2710
2330 IF C(I)=9.4061 THEN 2710
2340 IF C(I)=13.5750 THEN 2710
2350 IF C(I)=13.6755 THEN 2710
2360 IF C(I)=0 THEN 2710
2370 ON INT(C(I)) GO TO 2430,2380,2380,2380,2380,2430,2400,2400,2400,24
2380 X=1
2390 GO TO 2430
2400 X=2
2410 GO TO 2430
2420 X=5
2430 K=K+1
2440 FOR J=1 TO G
2450 IF INT(C(I))=4 THEN 2500
```


RESRV* 05/08/74

```
2460 IF INT(C(I))=5 THEN 2500
2470 IF INT(C(I))=7 THEN 2500
2480 IF INT(C(I))=9 THEN 2500
2490 GO TO 2540
2500 IF J>1 THEN 2520
2510 GO TO 2540
2520 IF N(I)<=10 THEN 2540
2530 IF N(I)<=10 THEN 2560
2540 Z(K,J)=N(I)*Y(INT(C(I)-X),J)
2550 GO TO 2570
2560 Z(K,J)=N(I)
2570 X$(K,J)=U$(I)
2580 C$(K)=C$(I)
2590 B$(K)=STR$(C(I))
2600 IF INT(C(I))>10 THEN 2670
2610 IF LEN(B$(K))>6 THEN 2690
2620 IF LEN(B$(K))<6 THEN 2640
2630 GO TO 2650
2640 B$(K)=B$(K)+"0"
2650 B$(K)="0"+B$(K)
2660 GO TO 2690
2670 IF LEN(B$(K))<>6 THEN 2690
2680 B$(K)=B$(K)+"0"
2690 B$(K)=REP$(B$(K),".", "-",1,2)
2700 NEXT J
2710 NEXT I
2720 REM *****
2730 REM *****
2740 REM THE FOLLOWING LOOP IS USED TO PRINT STORED INFORMATION
2750 FOR J=1 TO G
2751 O=0
2760 LET N5=1
2761 FOR L=1 TO K
2762 IF Z(L,J)>1 THEN 2770
2763 O=1
2765 NEXT L
2766 IF O=1 THEN 2910
2770 GO SUB 2960
2780 LET N3=15
2790 FOR I=1 TO K
2800 IF Z(I,J)<1 THEN 2860
2810 PRINT USING 1350;B$(I),Z(I,J),X$(I,J),A$,M,C$(I),D$(J),C$,J$
2820 LET N3=N3+1
2830 IF N3>=50 THEN 2850
2840 GO TO 2860
2850 GO SUB 3130
2860 NEXT I
2870 GO SUB 3340
2880 IF J<G THEN 2900
2890 GO TO 2910
```

RESRV* 05/08/74

```
2900 GO SUB 3260
2910 NEXT J
2920 GO TO 3410
2930 REM *****
2940 REM *****
2950 REM SUBROUTINE TO PRINT HEADING
2960 PRINT" AUTHORIZATION MATERIAL RESERVATION"
2970 PRINT" PUBLIC SERVICE ELECTRIC AND GAS COMPANY"
2980 PRINT
2990 PRINT
3000 PRINT"DATE ";P$;" REFERENCE NUMBER"
3010 PRINT
3020 PRINT"STOREROOM NUMBER ";T$;" TITLE-";Q$
3022 IF I$="NONE" THEN 3030
3024 PRINT" ";I$
3030 PRINT
3040 PRINT"TRANSACTION CODE NUMBER 31"
3050 PRINT
3060 PRINT" STOCK QUANT. U/M AUTH'N EX. DESCRIPTION DA
3070 PRINT" CL-CODE NO. CODE RE
3080 PRINT
3090 RETURN
3100 REM *****
3110 REM *****
3120 REM SUBROUTINE TO PRINT PAGE NUMBER AND SUB-HEADING
3130 FOR I1=1 TO 11
3140 PRINT
3150 NEXT I1
3160 LET N5=N5+1
3170 PRINT TAB(30);"PAGE";N5
3180 FOR I1=1 TO 4
3190 PRINT
3200 NEXT I1
3210 PRINT" STOCK QUANT. U/M AUTH'N EX. DESCRIPTION DA
3220 PRINT" CL-CODE NO. CODE RE
3230 PRINT
3240 LET N3=0
3250 RETURN
3260 LET T=66-N3
3270 FOR I=1 TO T
3280 PRINT
3290 NEXT I
3300 RETURN
3310 REM *****
3320 REM *****
3330 REM SUBROUTINE TO PRINT ENDING
3340 PRINT
3350 PRINT
3360 PRINT
3370 PRINT"SPONSOR APPROVED BY STOREKEEPER
```

RESRV* 05/08/74

```
3380 PRINT
3390 PRINT"
3400 RETURN
3410 FOR I=1 TO 20
3420 PRINT
3430 NEXT I
3440 ON F GO TO 3450,3510,3450
3450 IF N7=>1 THEN 3510
3460 FILE :1,"*"
3470 FILE :1,"UGMAT"
3480 N7=1
3490 N1=N9=K=0
3500 GO TO 1540
3510 END
```

COMPUTER PRINTOUT OF FORM 95-3786"

ESTCK\$ 05/08/74

```
1000 FILES INPUT;D3641;D365;D367;DMISC;SCRPAD
1001 PRINT"      THIS PROGRAM WILL HELP YOU ANALYZE DATA FILE INPUT"
1002 PRINT"      FOR ERRORS. IT WILL LIST THE LINE NUMBERS OF INPUT"
1003 PRINT"      AS IT READS IN ESTIMATE DATA AND WILL ENABLE YOU TO"
1004 PRINT"      FIND WHERE DATA ERRORS AND/OR OMISSIONS OCCUR"
1005 PRINT
1006 PRINT
1060 DIM E$(20),P(20,3),G(10,5),X(15),S(20,3),N$(20),L(20),M(20)
1070 DIM A(20,4),C(20,17),U(20,11),M$(20)
1075 DIM Q(20),H(10,8),K(10,5),R(10,2),B(10,3),N(10,3)
1076 PRINT"LINE"
1077 PRINT"NO."
1078 PRINT"INPUT"
1079 PRINT"FILE      VALUE(S) BEING READ IN"
1080 READ #1,A$(1) 'READS IN FIRST LINE OF ESTIMATE TITLE'
1081 PRINT
1085 PRINT LIN(1);A$(1);" 1ST LINE EST TITLE"
1090 READ #1,B$(1) 'READS IN SECOND LINE OF ESTIMATE TITLE'
1095 PRINT LIN(1);B$(1);" 2ND LINE EST TITLE"
1100 READ #1,E(1) 'READS IN EST TYPE, COMBINED=1, OH=2, UG=3'
1104 PRINT LIN(1);" ";E(1);" ESTIMATE TYPE"
1105 READ #1, E(5) 'READS IN ROUNDING FACTOR'
1106 PRINT LIN(1);E(5);"ROUNDING FACTOR"
1110 READ #1,E$(1) 'READS IN FORMAT TYPE; R&E OR BILLING'
1111 PRINT LIN(1);" ";E$(1);" ESTIMATE FORMAT R&E OR BILLING"
1115 READ #1, E(6),E(7),E(8),E(9) 'READS IN COSTS'
1117 PRINT LIN(1);E(6);E(7);E(8);E(9);"BILLING COSTS"
1120 READ #1,E$(2) 'REQUESTED VERBALLY (YES/NO)'
1121 PRINT LIN(1);E$(2);" REQUESTED VERBALLY (YES/NO)"
1130 READ #1,E$(3),E$(4) 'EITHER REQ BY & LOC OR DATE & DICTATOR'
1135 PRINT LIN(1);E$(3);" ";E$(4);" REQUESTED BY INFO"
1140 READ #1,E$(5),E$(6),E$(7),E$(8),E$(9),E$(10)
1144 PRINT LIN(1);E$(5);"= ESTIMATE DATE...";E$(6);"= EST NO..."
1145 PRINT LIN(1);E$(7);"= TOWN....";E$(8);"= DIVISION"
1146 PRINT LIN(1);E$(9);"= PREPARED BY...";E$(10);"= SKETCH NO."
1150 REM DATE, EST NO., TOWN, DIV., PREP BY, SK NO.
1160 READ #1,M(1),Y(1),M(2),Y(2),M(3),Y(3)
1165 PRINT LIN(1);M(1);"= CURRENT MONTH..";Y(1);"= CURRENT YEAR"
1166 PRINT LIN(1);M(2);"= JOB START MONTH";Y(2);"= JOB START YEAR"
1167 PRINT LIN(1);M(3);"= JOB COMPLETE MO.";Y(3);"= JOB COMPLETE YR."
1170 REM CUR MO,CUR YR, JOB ST MO, JOB ST YR, JOB END MO, JOB END YR
1180 READ #1,E(3),E(4) 'O.H., U.G. WITHDRAWAL HOURS'
1185 PRINT LIN(1);E(3);"= O.H. WITHDRAWAL MHRS";E(4);"= UG WDRWL MHRS."
1190 READ #1, E(2),E(10) '% OF OPERATING MANHOURS'
1195 PRINT LIN(1);E(2);"= % OH OP MHRS";E(10);"= % UG OP MHRS"
1200 READ #1,E$(11) 'DO YOU WANT A MATERIAL LIST(YES/NO)'
1205 PRINT LIN(1);E$(11);"= DO YOU WANT A MAT'L LIST"
1210 READ #1,E$(12) 'DO YOU WANT A SUMMARY (YES/NO)'
1215 PRINT LIN(1);E$(12);"= DO YOU WANT A SUMMARY"
1220 LET Z(2)=((Y(3)*12+M(3))-(Y(2)*12+M(2))) 'EST TIME TO COMPLETE'
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1230 LET Z(1)=(((Y(2)*12+M(2))-(Y(1)*12+M(1)))+Z(2)/2) 'ESC FACTOR'
1235 IF E(1)=3 THEN 1770
1240 READ #1,X(1) 'NUMBER OF LINES OF POLE DATA'
1245 PRINT LIN(1);X(1);"LINES OF POLE DATA TO FOLLOW"
1260 IF X(1)=0 THEN 1340
1280 FOR I=1 TO X(1)
1290 FOR J=1 TO 3
1300 READ #1,P(I,J) 'READS IN POLE DATA'
1320 NEXT J
1325 PRINT LIN(1);P(I,1);P(I,2);P(I,3);"LINE";I;"POLE DATA"
1330 NEXT I
1340 READ #1,T(1) 'JOINT POLES FOR TELCO TRANSFER CHARGES'
1345 PRINT LIN(1);T(1);"NO. OF POLES FOR TELCO TRANSFS."
1360 READ #1,X(2) 'NUMBER OF LINES OF GUY & ANCHOR DATA'
1365 PRINT LIN(1);X(2);"NO. OF LINES OF GUY, ANCH, SW. DATA"
1380 IF X(2)=0 THEN 1440
1400 FOR J=1 TO 8
1410 READ #1,V(J) 'READS IN GUY AND ANCHOR DATA'
1430 NEXT J
1435 PRINT LIN(1);V(1);V(2);V(3);V(4);V(5);V(6);V(7);V(8);"GUY, AN, SW. D
1440 READ #1,X(3) 'NUMBER OF LINES OF SWITCH & RECLOSER DATA'
1445 PRINT LIN(1);X(3);"LINES OF SWITCH & RECLR DATA"
1470 IF X(3)=0 THEN 1570
1500 FOR I=1 TO X(3)
1510 FOR J=1 TO 3
1520 READ #1,S(I,J) 'READS IN SWITCH & RECLOSER DATA'
1550 NEXT J
1555 PRINT LIN(1);S(I,1);S(I,2);S(I,3);"LINE";I;"SW & REC DATA"
1560 NEXT I
1570 READ #1,X(4) 'NUMBER OF LINES OF SERVICE WIRE DATA'
1575 PRINT LIN(1);X(4);"LINES OF SERV WIRE DATA"
1590 IF X(4)=0 THEN 1670
1610 FOR I=1 TO X(4)
1620 FOR J=1 TO 4
1630 READ #1,W(I,J) 'READS IN SERVICE WIRE DATA'
1650 NEXT J
1655 PRINT LIN(1);W(I,1);W(I,2);W(I,3);W(I,4);"LINE";I;"SERV WIRE DATA"
1660 NEXT I
1670 READ #1,X(5) 'NUMBER OF LINES OF PRI & SEC CABLE DATA'
1675 PRINT LIN(1);X(5);"LINES OF PRI & SEC CABLE DATA"
1690 IF X(5)=0 THEN 1770
1710 FOR I=1 TO X(5)
1720 FOR J=1 TO 17
1730 READ #1,C(I,J) 'READS IN PRI & SEC CABLE DATA'
1750 NEXT J
1755 PRINT LIN(1);C(I,1);"---";C(I,17);"FIRST & LAST VALUES, LINE";I
1760 NEXT I
1765 IF E(1)=2 THEN 2060
1770 READ #1,X(6) 'NUMBER OF CONDUIT & TRENCH LINE DATA'
1771 PRINT LIN(1);X(6);"LINES OF CONDUIT & TRENCH LINE DATA"
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1772 IF X(6)=0 THEN 1780
1773 FOR I=1 TO X(6)
1774 FOR J=1 TO 5
1775 READ #1,G(I,J)
1776 NEXT J
1777 PRINT LIN(1);G(I,1);G(I,2);G(I,3);G(I,4);G(I,5);"LINE";I;"CON. & T
1778 NEXT I
1780 READ #1,X(7) 'NUMBER OF LINES FOR ST LIGHTS'
1781 PRINT LIN(1);X(7);"LINES OF ST LIGHT DATA"
1782 IF X(7)=0 THEN 1930
1783 FOR I=1 TO X(7)
1784 FOR J=1 TO 8
1785 READ #1,H(I,J)
1786 NEXT J
1787 PRINT LIN(1);H(I,1);H(I,2);H(I,3);H(I,4);H(I,5);H(I,6);H(I,7);H(I,
1788 NEXT I
1930 READ #1,X(8) 'NUMBER OF LINES OF UG CABLE DATA'
1935 PRINT LIN(1);X(8);"LINES OF UG PRI & SEC CABLE DATA"
1970 FOR I=1 TO X(8)
1980 FOR J=1 TO 11
1990 READ #1,U(I,J) 'READS IN UG CABLE DATA'
2010 NEXT J
2015 PRINT LIN(1);U(I,1);"---";U(I,10);"FIRST & LAST VALUES,LINE";I;"UG
2016 NEXT I
2017 READ #1,X(10) 'NUMBER OF MANHOLES'
2018 PRINT LIN(1);X(10);"NUMBER OF MANHOLES"
2019 IF X(10)=0 THEN 2026
2020 FOR I=1 TO X(10)
2021 FOR J=1 TO 5
2022 READ #1,K(I,J)
2023 NEXT J
2024 PRINT LIN(1);K(I,1);K(I,2);K(I,3);K(I,4);K(I,5);"LINE";I;"MANHOLES
2025 NEXT I
2026 READ #1,X(11) 'NUMBER OF STANCHIONS'
2027 PRINT LIN(1);X(11);"NUMBER OF STANCHIONS"
2028 IF X(11)=0 THEN 2035
2029 FOR I=1 TO X(11)
2030 FOR J=1 TO 2
2031 READ #1,R(I,J)
2032 NEXT J
2033 PRINT LIN(1);R(I,1);R(I,2);"LINE";I;"STANCHIONS"
2034 NEXT I
2035 READ #1,X(12) 'NUMBER OF PIECEOUTS'
2036 PRINT LIN(1);X(12);"NUMBER OF PIECEOUTS"
2037 IF X(12)=0 THEN 2044
2038 FOR I=1 TO X(12)
2039 FOR J=1 TO 3
2040 READ #1,B(I,J)
2041 NEXT J
2042 PRINT LIN(1);B(I,1);B(I,2);B(I,3);"LINE";I;"PIECEOUTS"
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2043 NEXT I
2044 READ #1,X(13)      'MISC. U.G. DEVICES'
2045 PRINT LIN(1);X(13);"MISC. U.G. DEVICES"
2046 IF X(13)=0 THEN 2060
2047 FOR I=1 TO X(13)
2048 FOR J=1 TO 3
2049 READ #1,N(I,J)
2050 NEXT J
2051 READ #1,S$(I),T$(I)
2052 PRINT LIN(1);N(I,1);N(I,2);N(I,3);S$(I);T$(I);"LINE";I;"MISC. U.G. I
2053 NEXT I
2060 READ #1, X(9)      'READS IN MISC. ACCTS.'
2070 PRINT LIN(1);X(9);"LINES OF MISC ACCTS DATA"
2080 IF X(9)=0 THEN 2140
2090 FOR J=1 TO X(9)
2100 READ #1,Q(J),N$(J),M$(J),L(J),M(J)
2110 PRINT LIN(1);Q(J);N$(J);" ";M$(J);"--LINE";J;"MISC ACCTS."
2120 REM THE ABOVE READS IN ACCT NO.,DESCRIPTION,LABOR,MATERIAL...
2130 NEXT J
2140 PRINT"-----";
2150 PRINT "-----"
2160 END
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