BREAKER-EQUIPMENT DATABASE SYSTEM

GRADUATE PROJECT

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ABSTRACT

This project is the design, test, and implementation of the breaker equipment portion of the relational database system for CPL's Relay & Operations Department for the purpose of facility management. The system allows the user to integrate manufacturer, relay, accounting, and historical data about all high-voltage breakers in CPL's electrical system. Also, the system is designed so that relay, and other high-voltage equipment databases can be added for future applications. Access is provided through a network using a simple menu-driven interface.
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1. INTRODUCTION

1.1. ENGINEERING BACKGROUND

Central Power & Light Company (CPL) is an electric utility company providing electric service to a 44,000 square mile area of South Texas. To provide this service, electricity must be generated at a power plant, carried over transmission lines to substations, and then delivered to the customer over distribution lines.

Transmission lines are used to carry bulk electric power over long distances. In general, any line that has a voltage greater than or equal to 69,000 volts (69 Kv) is considered a transmission line. CPL has transmission lines rated at 69 Kv, 138 Kv, and 345 Kv in its system. Transmission lines start and end at substations.

The electric lines carrying the lower voltages are called distribution lines. In general, any voltage below 34.5 Kv is considered distribution. CPL uses 12.47 Kv for its distribution lines. Once the distribution lines leave the substation, the voltage is transformed to 120/240 volts for light industrial or residential use. Distribution lines start at a substation and terminate at the customer's electric meter.

Substations are used throughout an electrical system. They are used to isolate (deenergize) sections of transmission or distribution lines during a fault condition or for maintenance. In addition, substations can be used to transform (raise or lower) the voltage from an incoming transmission line. The voltage is normally raised to ship bulk power over long distances, and lowered to distribute power to customers.

Transmission and distribution lines require protection against faults to maintain the stability of the electric power system. A fault is a disturbance that interrupts electric service. These disturbances can be caused by a variety of things such as somebody throwing a chain over an electric line, or lightning striking a transmission tower.

CPL uses protection schemes to protect its electric lines. These schemes require the use of relays. Relays are devices that can sense the voltage and/or current of an electric line to determine whether a fault condition exists. If a fault condition
exists, the relays will isolate the fault by deenergizing only the affected portion of electric line. In other words, by isolating the fault to one section of an electric line, fewer customers are without electric service.

The relays are normally housed in an air-conditioned control building in the substation. Two types of relays exist: the electromagnetic relay and the microprocessor-based relay. The electromagnetic relay is becoming obsolete and is being replaced by the microprocessor-based relay.

CPL’s Relay & Operations engineers design the protection schemes for the transmission and distribution lines. In addition, they calculate the relay settings that will isolate an electric line at a specific voltage and/or current level. Each relay has its own relay setting-sheet(s).

The relay setting-sheets contain information determining the source of the voltage and/or current sample. The voltage sample comes from potential transformers (PT). PTs are usually high-voltage stand-alone equipment. The current sample comes from current transformers (CT). CTs can be high-voltage stand-alone equipment, or can be housed within the bushing (porcelain insulated jacket) of a high-voltage circuit breaker or high-voltage transformer.

High-voltage circuit breakers are used in distribution and transmission lines. They are used to interrupt (or deenergize) a segment or the complete line for a fault condition or for maintenance. A high-voltage circuit breaker works identical to the circuit breaker in the AC panel of a residence. Both of them interrupt electric service to an electrical circuit. However, the circuit breaker in a residential house operates at a much lower voltage. All high-voltage circuit breakers are located in substations. For this paper, high-voltage circuit breakers are referred to simply as breakers.

The high-voltage transformer is the largest and most expensive single piece of equipment located in a substation. Therefore, it is also the best relay protected piece of equipment in a substation. It takes approximately one year to receive a new transformer from the time of bid requests. There are two types of high-voltage transformers, the distribution transformer and the autotransformer. The distribution transformer is used to lower the voltage from a transmission line voltage to a distribution line voltage. The autotransformer raises or lowers a transmission line voltage to another transmission line voltage. For the remainder of this paper, high-voltage transformers will be simply referred to as transformers.
1.2. PROCEDURAL BACKGROUND

Once the relay engineer calculates the relay setting-sheets, the relay setting-sheets are sent to the field by the relay engineer using the company mail. CPL has its own internal mailing system. On the average it takes two working days to receive mail.

CPL's relay technicians set and test the relays as specified in the relay setting-sheets. The relay setting-sheets, which also contain the test results are returned to the Relay & Operations engineers by company mail for the engineers to evaluate the test results. If the test results are satisfactory, the relay setting-sheets are manually filed in a file cabinet. If not, each questionable relay must be retested, repaired, or replaced until its tests are satisfactory.

The Substation Department of CPL maintains an equipment database of all breakers and transformers. The facility tracking system consists of issuing a breaker or transformer card for each corresponding piece of equipment. The creation or editing of a breaker or transformer card is initiated by field personnel. The breaker and transformer cards contain an historical account of where the equipment has been and where it is today, the quantity and type of current transformers in the equipment, and accounting information. These cards are stored manually in a filing cabinet. Some of the information on these cards is duplicated on the relay setting-sheets.

1.3. PROJECT RATIONALE

Since the project proposal was written, CPL has undergone a reorganization in July 1994. CPL is a subsidiary company of Central South West (CSW) Corporation based in Dallas, Texas. CSW owns three other electric utility companies located in Texas, Oklahoma, and Louisiana. The reorganization combined the engineering, accounting, and other departments from the four electric utility companies into one.

A new company was created called Central South West Services (CSWS) which contains these departments and is located in Tulsa, Oklahoma. My present job is still in Substation Design. However, now I work for CSWS instead of CPL.
Before the reorganization, my graduate project was going to be tested, implemented, and utilized by CPL. However, CSWS has bought a relay database package from Aspen Engineering. Aspen Engineering's relay database package was written in Paradox for Windows. This software has had many bugs. Presently, Aspen Engineering is rewriting their software package using C++. My graduate project will not be implemented for CPL or CSW. Therefore, my graduate project will only be done for educational purposes. For simplicity, the project assumes that the customer is still CPL and that the reorganization never occurred.

In my proposal, the project established a PC-based relational database system that automates the management of relay equipment for CPL's Relay & Operations Department. The system was to allow the user to edit and query the database, which would help in locating and eventually replacing obsolete relays. The system would allow the engineer to input the relay settings directly into the database. Since the system would be on a region-wide network, relay test sheets would be sent and retrieved through the network by the engineers and relay technicians, thus reducing time and paper consumption.

My first task for this graduate project was to reduce the duplication of information found in the existing relay setting-sheet database, breaker database, and transformer database. By combining the three databases, a very powerful and useful database system emerged. The next step was to create the database fields, relationships, and indexes necessary to fulfill the task.

In analyzing the results with Mr. William Allen Bush (my previous committee chairman), the relay database had grown into a much larger project then presented in the proposal. Therefore, Mr. William Allen Bush advised me to concentrate on a subsystem of the original project that utilized only one of the sub-databases within the relay-equipment database. The relay-equipment database is composed of several sub-databases. Each sub-database in essence determines a self-supporting sub-system. By proving the capability to program, test, and implement the software related to one of the sub-databases, the other sub-databases that compose the rest of the Relay-Equipment database system could easily be implemented following the same guidelines as the initial sub-database.

The breaker database sub-system, which is a sub-system of the Relay-Equipment database system was selected to be programmed, tested, and implemented for my graduate project. The graduate computer program was written to allow for the other sub-systems. However, the breaker database and related supporting
scope of the project has been narrowed, the overall purpose of the project is the same.