A PRACTICAL APPROACH TO ELECTRONIC DATA PROCESSING OF HYDROLOGIC RECORDS 1/

By

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The Southern California Edison Company is an investor owned utility serving a population of some 7 million in Southern California and west-central Nevada. During the first 50 years of its operation, Edison obtained most of its power from hydrogeneration sources. The increased energy demands following World War II required rapid expansion which has been met largely by developing thermal energy. However, hydro remains an important part of the integrated system. Therefore, our interest in maintaining accurage hydrologic records is of a practical nature. They serve principally to protect our longstanding water rights, which are the same as real property rights, and are used to back a portion of our bonded indebtedness and to satisfy the license requirements of both the state and federal governments. Additional benefits are derived from these same records as they are available for engineering and operating studies.

Many of our hydrologic records span a period of more than a half a century. Although our files do not reveal any records carved on birch bark or inscribed on sheepskin, we can find carefully hand-lettered sheets of linen tracing cloth recording stream flow and reservoir storage in the late 1800's and early 1900's. Many of these documents are impressive in appearance and we presume that the records were obtained as carefully as they were recorded. In comparison, the printed output of a computer looks sterile and definitely is lacking in character.

Why are we changing to electronic data processing? Our requirements have been satisfied in the past by manual methods. Is the change for the purpose of increasing the accuracy of our records or to expand them beyond some new and hitherto unattainable horizons or for some other great and noble purpose? To be truthful, the purpose of changing is simply economy, which to an investor owned utility is perhaps the greatest and most noble purpose to be found. This economy is being achieved at no loss in accuracy and results in a record in a more versatile form than before.

Edison's first step in the field of electronic data processing of hydrologic records occurred in 1953 with the acquisition of an X - Y chart reader. The chart reader, together with a program unit, feeds a digital record of gage height and discharge on IBM punch cards from Stevens A-35 recorder charts. This is accomplished by bringing the Y axis cross-hair into alignment with the pen trace of gage height and the X axis cross-hair into alignment with the intersection of the Y cross-hair and a discharge curve prepared for the particular station. A single card thus punched contains values of gage height, discharge and the time interval represented by that card as well as other pertinent programmed information such as station number, date, rating curve identification, etc. The cards thus punched are summarized by electronic data processing to print a daily and an annual summary of discharge in cubic feet per second for each station.

This data is also accumulated on magnetic tape and is available for many very practical uses. With these tapes of daily discharge it has been possible to examine in detail long term records by executing relatively simple programs. The ability to examine 50 years of records and determine mean and median daily flows, the number and distribution of days when available flow equaled or exceeded plant capacity, losses in output and the economic effect of various fish water and recreational releases or other studies of a similar nature has been of great value in planning for the future. While some of these operations could be performed manually, in most cases it would be physically impossible to examine the data in great depth and the cost would be prohibitive.

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The base record for our stream flow and reservoir data has for many years been the familiar Leupold & Stevens Type A-35 recorder. Although digital recorders offer a considerable advantage in automatic data processing, we use the A-35. The continuous trace of the A-35 seems to satisfy the requirements of our lawyers and is adaptable to rapid visual interpretation of prevailing conditions. The only advantage we can find in the digital recorder is the automatic processing feature and we would at the present time feel uncomfortable in losing a continuous visual record by replacing our present recorders with digital units. We also believe that such a program would not be economical at this time. When cost is not a governing factor, a digital unit could be operated in conjunction with an A-35 either as a separate instrument or as an attachment whereby the advantages of both are realized, as we are now doing at one cooperative station. Again, the economics of the situation preclude this action at all locations. Should it be found desirable to add or convert to digital recorders in the future, a total capital outlay of over $100,000 would be required for some 135 stations.

The greatest use we are finding for electronic data processing at this time is programming for machine computation and print-out of as many as possible of the routine jobs which have been manually computed and hand lettered in the past. Most of these are very simple from a mathematical standpoint, time consuming from a practical standpoint, and fall into the general category of machine accounting. The manual operation requires careful checking at every step, while machine processing will be largely self-checking and will reduce office time required to a minimum.

Stream flow records, although of primary importance to us, are by no means the only records we process. Climatological records of precipitation, temperature, relative humidity, snow depth, etc. are summarized for some 65 stations. These have been tabulated from field observers sheets and worked up to provide totals and averages or other pertinent information. In the future this work will be done by computer. The operation is quite simple, with daily observations recorded on a form which is sent to our office for a visual check and forwarded to central keypunch for processing. The basic requirement for a successful program is that the field forms be properly filled out in a manner suitable for direct keypunching.

Another example of routine work that is being programmed for electronic data processing is our reservoir storage data. This is required monthly and annually on a daily basis and includes evaporation, storage, and change in storage for each reservoir as well as totals for all reservoirs. When recorded on magnetic tape, this data is available for use in conjunction with taped stream flow records to compute unregulated or natural runoff. In the past , natural daily runoff has been manually computed and tabulated on a monthly or annual basis. With stream flow and reservoir data on tape, a simple computer program will provide natural or unregulated runoff.

Some daily records do not appear to be economically adaptable for machine processing at this time but do require periodic tabulation. These have been hand inked in the past. In the future, as an intermediate step, these records can be typed with optical scanning characters by simply changing the type element on an IBM Selectric typewriter. This will make the records available for direct transfer to magnetic tape and print-out on a standard record form.

The only problems encountered in converting to electronic data processing have been of a very minor nature, centered mostly around the forms used for input and output documents.

We do not expect to find an appreciable change in the volume or complexity of field work or in instrumentation as a result of electronic data processing. However, we do anticipate as an end result; (1) equal or superior records with a material saving in cost; (2) rapid availability of records; and (3) data readily available for programmed studies.

The prinicpal benefit we expect to realize from electronic data processing is the saving in time spent in computing, checking and tabulating records of a routine nature by manual methods. This saving in time represents an effective reduction in manpower requirements and will allow a greater concentration of effort toward special problems and projects of a non-repetitive nature with no increase in personnel.

It appears that the initial programming cost will be recovered in approximately two years of operation and from that time forward, electronic data processing will perform these operations at a fraction of the cost of manual operation.

Our application of electronic data processing to hydrologic records can be regarded as another example of the practical benefits of modern electrical appliances and "Better Living Through the Use of Electricity".