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Emerson Electric -- Application and Results of an Electric Energy Audit

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EMERSON ELECTRIC - APPLICATION AND RESULTS
OF AN ELECTRIC ENERGY AUDIT

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ABSTRACT

The objective of the study was to examine the electrical usage of an Emerson division located in the Northeast, provide a method of managing the usage and make recommendations for conservation. Both past and present usage were examined in an attempt to determine if potential savings might be realized by a reduction in energy and peak demand. Discussion will include an electrical energy tracking mechanism, ratios and indicators, use of rate consultants, state sales tax exemption clauses, and sample calculations of cost improvements on demand charges.

1. INTRODUCTION

In recent years, energy conservation has risen high in priority on management's list of problems. The priority has risen at such a rate that "energy management" is the label directed at energy conservation and control efforts. In order to measure the results of conservation efforts and achieve control, it is necessary to establish an understanding about the environment in which the efforts and control are to be applied. Herein lies the objective of an energy audit. Before conservation efforts can become maximized, a point of origin must be established. In short, "How do you know where you're going, if you don't know where you are?" The purpose of this paper is to define an actual energy audit performed for an Emerson division, establish a point of origin about energy usage, define the method developed, and establish a tracking mechanism for management control. In addition explanation of ratios and indicators, the effects of a rate consultant, discussion of state sales tax exemption clauses and savings in demand charges are covered.

2. PRESENT CONDITION

Concerned with the rising cost of electrical power, a request by the division was made to investigate the use of electrical energy and provide recommendations for conservation measures. The facility is composed of approximately 100,000 sq. ft., 68,000 sq. ft. of which is manufacturing space and 32,000 sq. ft. is office facilities. The entire facility is air conditioned.

The division employs approximately 350 people, 240 of which are hourly. The facility is primarily a job shop, made-to-order manufacturer of flow measurement devices. Manufacturing consists of machining, assembly, calibration and testing. The shop operates two shifts per day, the second shift being approximately one-third the size of the first shift.

A review and documentation of the electrical usage, peak demand and total energy billing from January 1972 thru April 1977 was developed. The average annual electrical usage during this period was 3,970,000 KWH with an average monthly demand of 1021 KW.

The facility is supplied power from two incoming service entrances at a voltage of 13.8 KV. The transformers are rented from the utility and metering is performed on the primary side. At the request of the division, conjunctive billing is utilized by the utility when determining the monthly energy bill. On the average the facility operates such that only one of the service entrances is at less than 85% power factor resulting in a minimal penalty charge.

The division has employed the services of a rate consultant since 1963. The function of the rate consultant is to guard against improper rate application and notify the power company when they have overbilled the division, and verify that the division is purchasing power at the most economical rate. In addition, the consultant brings attention to the state sales tax exemption clause applicable to manufacturing operations. The rate consultant is payed quarterly on a set monthly rate plus 50 percent of the savings. The contract is for five years and continues unless cancelled by written notice at least sixty (60) days prior to any renewal date.

Observation of the plant operations on both first and second shift revealed potential for energy savings. It was observed that most of the air conditioning filters were extremely dirty as were the returns. The glass molding department utilizes electric drying ovens that have no exterior insulation. Because of the air conditioning, increased heat loss and reduced operating efficiency result from both the drying ovens and the glass forming machines.

The second shift was operating with approximately sixty (60) hourly employees compared to 180 on the first shift. The shop was lighted on the second shift just as it was on the first. It was observed that there was unnecessary lighting being used in areas that assembly work was not being performed. Discussion with the employees revealed that, in most instances they did not work in these areas except on occasion to operate a small hand press or assemble light short-run items. The coil drying oven was operated only rarely on the second shift resulting in its operation during peak demand hours.

It was observed that the entire office facility was lighted during the second shift as it was during the first shift. Discussion with the janitors revealed they shut down the office lighting at 12:30 a.m., the end of the shift. No attempt was made to shut off lighting in an area as it was completed being cleaned. Further investigation revealed that the thermostat setting was not adjusted for night use or weekend use.

3. ANALYSIS

A graphic representation of the monthly energy usage and demand data was prepared (Exhibit I). This data was provided to establish a point of origin for usage and peak demand in order to make observations and comparisons. The significance of the graphs illustrates when a billing does not look normal compared to the same periods in preceding years. Analysis revealed that electrical energy usage and demand were approximately 25 percent greater during the summer months than during the winter months, an increase that can be attributed to the use of air conditioning during those months.

A summary of the average monthly usage for the past five years illustrated an average decrease in energy usage from 1972 of 1.6 percent per year and a minimal increase in demand of 0.3 percent per year. However, the average monthly energy and demand cost for that period increased 70.1 percent. Therefore, despite a general trend to use less electrical energy, the cost to use it has risen significantly (Exhibit II). In addition, there appears to have been no effort made to control peak demand as there was very little change from one year to the next. This would indicate an area of potential savings as the peak demand charge was approximately 55 percent of the energy charge annually.

Since energy costs were split almost equally between demand and actual usage, it was necessary to determine that area where conservation efforts would be most productive. In order to make the determination, the "hours use of demand" was calculated by dividing the total energy consumed (KWH) by the peak demand (KW). This measure represents the total hours required to consume the energy billed (KWH) at a constant rate (peak demand). A low number of "hours use of demand" compared to the hours the shop operated during the month would indicate a relatively high peak demand and efforts should be directed at reducing demand. Conversely a high number of hours compared to the shop operating hours would indicate a relatively low demand and efforts should be directed at reducing energy. In the case of this operation, "hours use of demand" for 1976 was 314 per month compared to 400 actual operating hours for the shop. This result suggested that efforts be made to reduce demand as the greatest potential for savings exists in this area.

An additional calculation to determine the load factor was made. Load factor is the ratio of average usage to peak demand. Based on the operating conditions at the facility, the load factor should be approximately 0.55. The average load factor for 1976 was 0.44.

Further investigation and analysis indicates there had been a decline in the amount of electrical energy required per equivalent unit of production and the number of hourly employees (Exhibit III). The general decline in energy usage per hourly employee had been 14.5 percent, and a 6.2 percent reduction in energy per equivalent unit produced from January 1975 to January 1976. (Productivity data was not available before 1975.) This data verified that some effort was being made to become more energy efficient. However, an addition of assembly workers would result in a downward trend of both, without energy conservation actions. The validity of the data can be verified provided the variance in the number of employees is tracked. This data was provided to establish a possible means of control and review of trends.

An analysis of the service rendered by the rate consultant revealed they had provided directive for documenting the percentage of electrical power used for production and raised the percentage from 60 percent to 91.6 percent, resulting in sales tax being paid on 8.4 percent of the billing. That is to say that 8.4 percent of the total energy consumed does not contribute directly to producing the product. The validity of the calculation to determine the percentage of energy used for non-production purposes was proven to be in error by definition in the state sales tax exemption clause. Further analysis of the monthly energy usage and demand data revealed exceptionally high usage during periods that normally had low usage, indicating failure on the consultants part to act accordingly.

Based on the fact that the peak demand charge was approximately 55 percent of the energy charge annually, evaluation of the use of a demand controller and an analysis of possible savings was generated. By calculating an average monthly energy usage and peak demand for each month in the year, the total annual cost for energy was $131,492. The cost was calculated by applying the present rate structure to the average monthly energy usage and peak demand. As a result of the observations made in the shop and discussion with the plant electrician, it was determined that approximately 1072 KW demand could be controlled. Based on the operating characteristics of the facility and the environmental conditions, it was determined that 500 KW was the maximum controllable load during the air conditioning months. For the remaining non-air conditioning months, it was determined that 400 KW demand could be controlled during March and November, and 300 KW demand during January, February and December. A conservative reduction of 5 percent energy usage was applied to each monthly average of energy usage. By calculating the total monthly billing ba based on the reduction in demand and energy, the total annual electric charge would be reduced to $106,828 (includes savings in fuel adjustment charges and taxes). The annual energy savings would be 197,835 KWH or $6,021, resulting in an 8.8 percent reduction in the total energy charges. The annual savings in demand charge would be $13,750 resulting in 36.5 percent reduction in the total demand charges. The annual savings in energy, demand, fuel adjustment charges and taxes, would total $24,664, or an 18.8 percent reduction in total electrical energy charges.

4. RECOMMENDATIONS

In view of the data already presented, the following recommendations were presented in order to conserve electrical energy, increase the efficience of its usage and reduce the cost of using electrical energy.

(1) It was recommended that a demand controller be purchased and installed in order to reduce the total energy charge. Result - selection of a demand controller.

(2) I t was recommended that a full effort be made to provide a preventive maintenance type of program concerning the changing or cleaning of the air conditioning filters and returns. Result - P.M. program stepped-up.

(3) In view of the data presented on the lighting arrangements, it was recommended that a sound lighting-energy reduction program be developed. Result - investigation of feasibility and cost to install additional switches is being conducted, janitors reduce lighting when areas are complete.

(4) It was recommended that additional insulation be installed around the drying ovens and an investigation of increasing the efficiency of the glass formers

through heat loss reduction be made. Result - investigation pending.

(5) It was recommended that thermostat settings be established for work periods and non-work periods for both day and night. Result - complete.

(6) It was recommended that a continuing in-house auditing of the electrical energy usage be performed. This should include accounting for the energy being used and verifying the billing calculations. Result - auditing has been assigned. The determination of billing error, calculation of the load factor and hours use has been automated.

(7) It was recommended that the division request to be put on the utility mailing list to receive copies of future rate increases and rate application. Result - complete.

(8) It became apparent that the rate consultant had outlived its usefulness to the division. Therefore, it was recommended their services be terminated provided arrangements were made to perform the service in-house. Result - termination is forthcoming.

(9) It was recommended that an additional investigation of energy reduction be established. Result - development pending.

5. BIOGRAPHIES

Bruce E. Jacobs received his B.S degree from Washington University. He is a Senior Project Engineer in Corporate Manufacturing Department of Emerson Electric Company. His current responsibilities include productivity improvement assignments throughout the Emerson Divisions of Emerson Electric Company.

Dr. Yildirim Omurtag is an Associate Professor in the Department of Engineering Management at the University of Missouri, Rolla. He received his B.S. and Ph.D. degrees from Iowa State University in Mechanical and Industrial Engineering respectively. He holds an M.S. degree from the Middle East Tech University in Mechanical Engineering. He is a registered professional engineer with significant industrial and consluting experience both in the U.S. and abroad.

EMERSON ELECTRIC CO.
ENERGY AND DEMAND USAGE

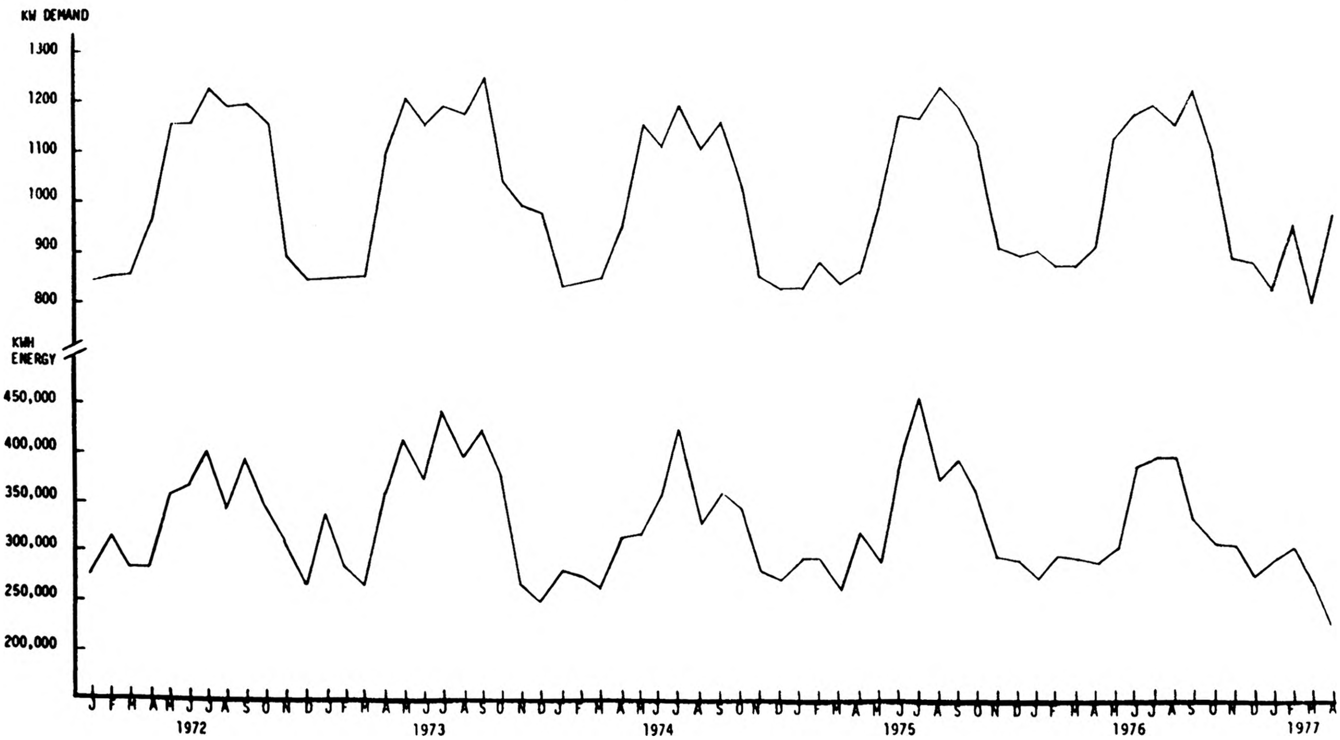

Exhibit I

EMERSON ELECTRIC CO.
SUMMARY OF MONTHLY AVERAGES

MONTHLY AVERAGES	1972	1973	1974	1975	1976
Energy - KWH	327,733	348,767	319,758	335,513	322,367
Demand - KW	1023	1057	992	1009	1026
Cost	$6,498.87	$6,814.50	$7,992.23	$10,369.85	$11,054.69
% Change from 1972 - Energy		6.4%	-2.4%	2.4%	-1.6%
- Demand		3.3%	-3.0%	-1.4%	.3%
- Cost		4.9%	23.0%	59.6%	70.1%

Exhibit II

EMERSON ELECTRIC CO.
COMPARISON OF ENERGY FOR PRODUCTION

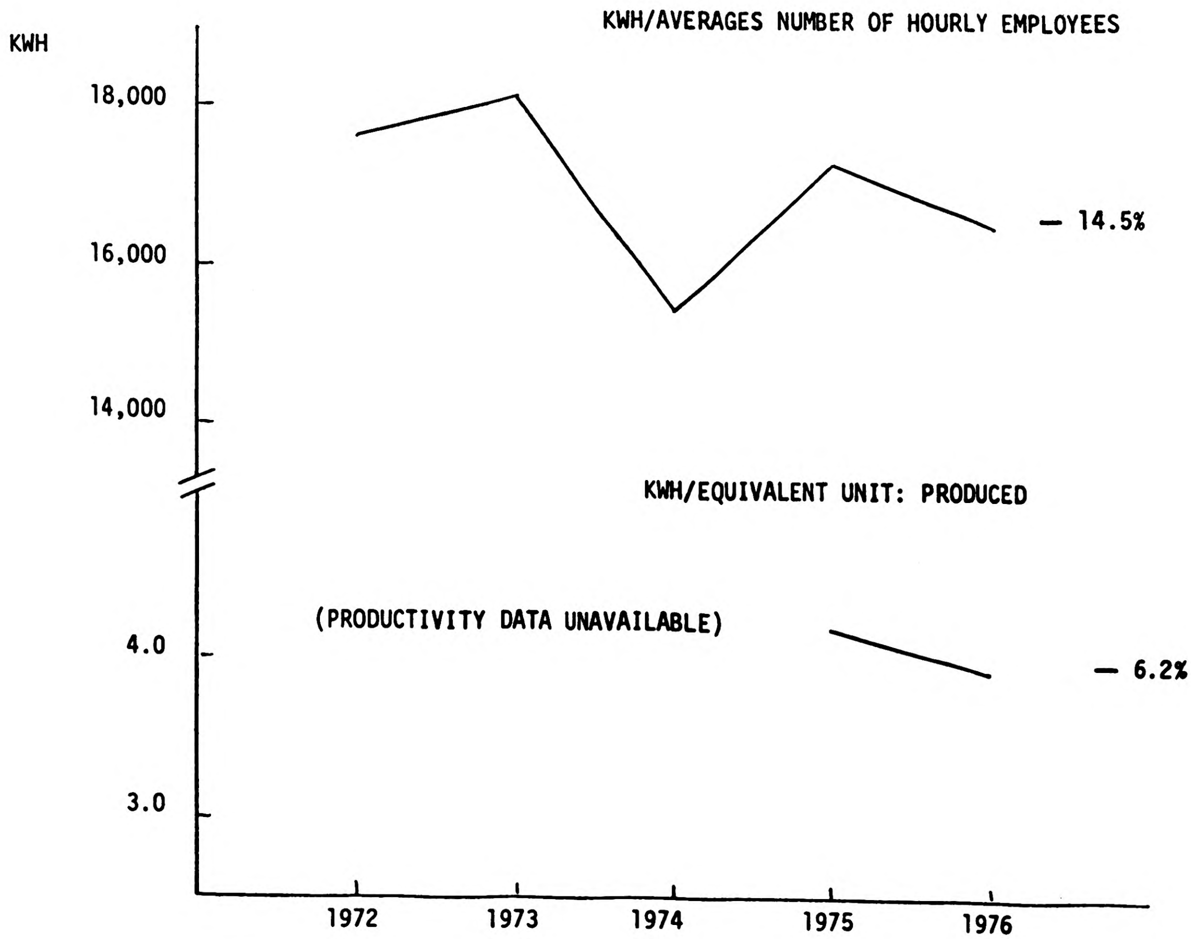

Exhibit III