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Sample Electrical ENERGY AUDIT REPORT

Prepared by:

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Scope Of work for Complete Electrical Energy Audit

Power Supply Optimization & Control

1) Power Factor
2) Distribution Loss
3) Integrity check of KESC meters

Electric Motor & Drive System

1) Motor Sizing
2) Motor Selection
3) Motor Controller
4) Transmission Devices
5) Power analysis of critical motors/ Feeders
6) Maintenance Techniques
7) Harmonic Analysis

Lighting System

1) Lighting Level V/S needs
2) Efficient Lamp & Ballast
3) Cost benefits
4) Efficient Lighting fixtures
5) Maintenance Techniques
6) Lighting Control

Recommendations

1) Short Term Recommendations
2) Long Term Recommendations
3) Economic Feasibility

INTRODUCTION

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Energy Audit is the translation of energy conservation ideas into realities by blending technically feasible solutions with economic and other organizational constraints within a specified time frame. It attempts to balance the total input of energy with its use. The type of Energy Audit to be performed depends on:

- The function and type of the Industry
- The depth of final Energy Audit needed
- The potential and magnitude of cost reduction desired

The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product or to lower the operating costs. Electrical Energy Audit is a subtask of the General Energy Auditing. The aim of an exclusive Electrical Energy Audit is to reduce the Specific Electric Energy Consumption per unit of the product output without increasing the specific energy (other than electrical energy) consumption per unit product output.

Minor or major modifications in the design of the plant will often result in dramatic improvements in the plant energy efficiency. The need for such modifications will be brought out by a comparison of Specific Energy Consumption of the plant with standard values pertaining to that particular product.

Thus Electrical Energy Audit (EEA) assumes that the process design, material flow etc. of a plant cannot be significantly altered. It focuses almost exclusively on the Electrical System of the plant. Issues regarding process design will be examined in an EEA in so far as to their implication on reducing the load levels on electrical equipment and reducing losses in the Electrical System.

The intensity and the depth of the planned Electrical Energy Audit will depend on a comparison between the best Specific Energy Consumption figures of the product (using the same process design) achieved in the Industry on a worldwide scale and the figure for the plant in question. Also, the Statutory/non-statutory bodies on energy conservation in the country may have laid down reference values for Specific Energy Consumption.

Reduction of Actual Use of Electrical Energy

The actual use of electrical energy is calculated/measured at the output of electrical equipment in the preliminary audit, but the final value of electrical energy content in unit output will be less than this value due to losses in energy conversion process i.e. in the mechanical and chemical systems in general. Improving the efficiency of energy conversion process will result in lower loading levels in electrical equipment and lower use of electrical energy. Reducing the pipe resistance by proper maintenance and correct sizing, implementing automatic level control in pumping systems, replacing throttling valve in pumping systems by variable speed drives, replacing mechanical damper control and vane control in blower systems by adjustable speed drives, using Smart Motor Controllers (SMC) on part loaded Induction Motors, reducing the leakage from compressed air systems, reducing air infiltration into air-conditioned spaces, providing false ceilings/window glazing/window curtains/automatic door closers/air curtains etc. in air-conditioned spaces ,revamping by CFLs and HID lamps etc. are some examples involving this concept.

In fact, this is the only context in which the audit team pays attention to systems other than the Electrical System in the plant. Energy Audit team has to examine the major low efficiency energy conversion processes and arrive at ways to reduce the energy consumption in those processes. The possibility of using automatic controls in order to switch off electrical equipment when the process does not really need the energy and to adjust the efficient operation of electrical equipment against varying process load levels should be critically examined.

The plant lighting system will also come under the scrutiny of audit team with a view towards finding out whether the existing illumination levels at various places are really needed for the task or purpose involved.

As far as electrical energy conservation is concerned, reducing the use of electrical energy is the primary action phase in the hierarchy of conservation strategies. At this point, audit team should identify the steps to be taken to reduce the use of electrical energy and draw up proposals for the financially viable projects aimed at this. The Company will have to allot top priority to these projects in general since they will have a direct impact on electrical energy consumption. The audit team proceeds to the next aspect of energy conservation and management with the figure for actual electrical energy use updated assuming that the projects aimed at reducing the energy use will be implemented.

Load Management

Examination of daily active and reactive load curves for a typical day at the incomer will reveal the need for load management in the system. Load Management at primary level as envisaged here involves techniques aimed at improving the daily active power load factor and bringing it close to unity and techniques aimed at bringing down the daily average reactive load and improving the daily reactive load factor near to unity. These measures will directly affect the maximum VA demand of the plant and thereby effect savings in demand related cost of energy. Also, these measures effect a reduction in system losses too. But the extent of loss reduction achieved will depend on the exact method used to achieve active and reactive load curve smoothing. Reactive load reduction and smoothing is usually achieved by the use of switched capacitors and exact loss reduction achieved will depend on how the capacitor compensation is distributed in the system. This is where load management at the secondary level (i.e. at a deeper level into the system) becomes necessary.

Reduction of Losses in Electrical Motors

Minimization of losses in all the electrical equipment except the process end equipment would have been taken into account in the load management strategies arrived at by audit team so far. What remains is the reduction of losses in the equipment that form the loads on the Electrical System.

Induction Motors constitute 70 to 80% of electrical load and hence reduction of losses in these motors assumes special significance. Audit team can take note of the various ways in which the loading levels of these motors can be minimized by better utilization of energy in the energy conversion process. This includes identification of motors that require automatic control for avoiding idling, motors which need to be fitted with Motor controllers etc.

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Data Needed for Loss Reduction in Motors

- Rating of Motors and Nature of Load

- Loading Data over a typical day; preferably in the form of load curve in the case of large motors.

- Type and details of the controller provided for the motor.

Data Collection

- The torque output of an Induction Motor is proportional to slip for a torque variation of 10% to 110% of rated value. Since the speed does not change much in this region the power output itself may be taken as proportional to slip in the range of 10% to 110% of rated HP output. Thus accurate measurement of speed of the Induction Motor and the System Frequency will permit determination of power output of the motor.

- It is also possible to estimate the power output of the motor by measuring the KW and KVA input to the motor by highly sophisticated analyzer, if certain assumptions regarding the full load efficiency of the motor can be permitted.

- Losses can be estimated using these readings.

Factors Affecting the Induction Motor Performance

- Voltage and Frequency – Operating the motor at other than rated voltage and frequency can result in reduced motor efficiency and adverse effects on power factor, breakaway torque, starting current, running speed etc.

- Unbalanced Voltage – Even a small degree of unbalance at the motor terminal voltages can result in large negative sequence currents in the motor. and the resistance of the rotor to negative sequence currents will be greater due to skin effect and deep bar effect. Thus small unbalance in voltage will cause large increase in motor losses

and heating. Careful balancing of voltages everywhere is imperative from this point of view.

- Loading Level– Motors are designed to operate with maximum efficiency at full load. At part load efficiency and power factor come down. Thus, for same power output, using an oversized motor will result in higher active power input and higher reactive power input into the motor compared to a properly sized one. Thus, part loading of Induction Motors (especially on a continuous duty basis) will increase the losses and the Maximum KVA demand of the plant. Motors maintain good efficiency in the range of 60%-100% of rated output. However, loading below 50% of rated load results in serious active and reactive losses. Replacing the oversized motor with a properly rated one or installing variable voltage controllers on the oversized motor will have to be resorted when part loading of motors is observed.

- Speed – For same HP rating motors with higher speed have higher efficiency at rated loads.

- Duty Cycle – The losses in the Induction Motors depend on the type of duty on the motor. The duty cycle of the motor has to be obtained and suitability of the motor for the duty must be examined. For example, a continuous duty rated motor, if applied for an intermittent duty with frequent starting will have more losses than a high starting torque intermittent duty type motor.

- High Efficiency Design - High Efficiency Design versions of Induction Motors with 20 to 30% higher costs are available in the market now. These motors use specially processed low loss steel core, longer stator and rotor and optimized precision air gap to minimize the magnetizing current and core losses and they use more copper/aluminum for reducing copper losses. The higher initial investment is often paid back in one to two years through loss reduction.

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Motor Loading Analysis in Electrical Energy Audit

1. Classify the motors into various categories depending on type of loading viz. Continuous constant load duty, Continuous variable load duty, intermittent duty with or without starting/electrical braking, short time duty etc. In each category, classify the motors into low HP, medium HP and high HP classes.
2. Short time duty motors of all ratings may not offer much in terms of possible loss reduction.
3. Low HP motors, if exist, may need only a cursory evaluation since the loss reduction achievable from them may not be enough to justify the effort and expense. However, the final decision in this matter will depend on the number of such motors in the plant, their HP distribution, loading levels, the extent of loss reduction desired by the firm etc.
4. The adequacy of rating (under rating or over rating or wrong type of motor etc.) of the motors has to be paid close attention in the case of motors on intermittent duty with frequent starting/reversing/plugging etc. The starting/stopping control of these motors will have to be looked into from energy loss point of view.
5. Continuous constant load motors and continuous variable load motors offer possibilities of loss reduction. Their loading levels must be determined. If part loaded, audit team should come up with suggestions for loading them fully by transferring load from similar under loaded motors or for replacing the motor by one of suitable rating on an 'interchange' basis i.e. various under loaded motors in the plant must be relocated and reused with only a minimum number of motors being relegated to store room and only a minimum number of motors drawn from store room or for replacing the motor with a new high efficiency motor of suitable rating. The audit team also must examine financial viability of the suggestions.

Reduce Motor Speed, pumps and Compressors:

There are certain machines where power used is proportional to the speed. With fans, blowers and centrifugal pumps, the power used is proportional to the cube of speed. Oversized motors and resultant effects of speed have their most wasteful effect. If the speed of the device could be reduced by a ratio of 6:5, about 42 % of the power could be saved. For such applications a variable speed drive would solve the purpose.

Total Energy Consumption and Costs

Statistical data will reveal the loopholes in the energy consumption and how to calculate the cost. Complete data for the energy consumption is collected from the bills provided and the analysis carried out during the electrical audit of the site.