International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 09 , September 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

"Role of Energy Audit for Indian Railway"

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ABSTRACT

This paper shall help in the development of a long-term vision, internal policies, directives, regulations, procedures on energy efficiency in railway non traction system. It also helps for identifying specific energy efficiency technologies and measures, standards, performance criteria, material standards and specifications, etc., and promoting and monitoring the implementation of EE measures; preparation of annual plans for energy efficiency with specific targets and allocated budget; development and institutionalization of a monitoring and verification and audit system; the institutionalization of energy efficiency and conservation awareness programs within the organization.

Keywords: Government Entities, Bureau of Energy Efficiency (BEE), Need of Energy Audit, Promotion of Renewable Sources of Energy ,Energy audit procedure

I. INTRODUCTION

The purpose of the energy audit is to develop long term energy efficiency and adopt the newest energy efficient technologies to conserve maximum energy for the non-traction area over Indian Railways. To maximize the efficient usages of the present system it is required to collect, monitor, analyse the energy consumption pattern for various energy intensive areas such as production units, workshops and sheds, washing lines, railway stations, offices and residential colonies. For analysis and energy audit all basic parameters we should know.

II. GOVERNMENT ENTITIES

A) Planning Commission, Government of India

The Planning Commission has the responsibility of making assessment of all resources of the country, augmenting deficient resources, formulating plans for the most effective and balanced utilization of resources and determining priorities. Five Year Plans are formulated by Planning Commission.

Inclusion of appropriate outcome of the project in the policy formulation such as Five Year Plans, etc. may be best affected through the Planning Commission. Therefore Planning Commission is one of the most important stakeholders for achieving the goal of energy efficiency in India Railway in terms of fund allocation in the plan of Indian Railway.

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ISSN (O) 2319 - 8354
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III. BUREAU OF ENERGY EFFICIENCY (BEE)

BEE is the coordinator of umbrella programme on "Programmatic Framework Project for EE" under which the Improving EE in Indian Railways System is one of the projects. BEE is one of the project steering committee (PSC) member and play a key role in risk mitigation, particularly in mitigating the risks to project implementation due to lack of manufacturers' interest in investing in EE products BEE will also play a key facilitation role among partners.

IV. RDSO (RESEARCH, DESIGNS AND STANDARDS ORGANISATION)

RDSO is the organization of Indian Railways (IR) responsible for research and design. It serves as the technical advisor to the Railway Board, Zonal Railways and Production Units. It is responsible for the development of new and improved designs, adoption, absorption of new technologies, development of standards and specifications for materials and equipment, technical investigation, statutory clearances, testing and providing consultancy services. IR procurement is based on the specifications that are released by RDSO. RDSO would assist in framing/updating the technical requirements and specifications of the equipment.

V. NEED OF ENERGY AUDIT

Energy Audit is an effective energy management tool. By identifying and implementing the means to achieve energy efficiency and conservation, not only can energy savings be achieved, but also equipment/system services life can be extended. All these mean savings in money. Based on the principle of "The less energy is consumed, the less fossil fuels will be burnt", the power supply companies will generate relatively less pollutants and by-products. Therefore, all stakeholders contribute to conserve the environment and to enhance sustainable development.

In Indian Railway, there are three top operating expenses which include energy, labour and machinery. In one were to relate to the manageability of the cost or potential cost saving in each of the above components, energy would invariably emerge as a top ranker. As discussed in earlier section, energy cost in Indian Railway represents about 24% of the ordinary working expenses of Indian Railways. Thus, the possibility of savings on electricity would have a positive effect on the operating margins of Indian Railways. Energy audit will help in ensure that energy is being used efficiently in different types of equipment/system.

The energy audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programme which will be vital for operation for India Railway. Such an audit programme will help to keep focus on variations which occur in the energy cost, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.

In general Energy Audit is the translation of conservation ideas into realties, by lending techno-commercially feasible solution within a specific time frame. The primary objective of the energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. The energy audit provides a benchmark, or reference point, for managing and assessing energy use across the organization and provides the basis for ensuring more effective use of energy

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VI. BROAD AREAS OF ENERGY CONSERVATION IN NON TRACTION

Timer & Sensor:

Illumination is not required at uniform level throughout the night time at different locations. Timer and Sensors has been provided. Sensor helps in switching on and off the lamp depending on natural light. Timer is required to switch off part of the mast tower lights after 22 hrs or as per actual survey of train/passenger movement.

Automatic Platform Lighting:

100% light works at Railway Station when train comes to the station and only 30% during rest of the time. This is achieved automatically by taking a feed from signalling system by which 100% lights switches on when the signal is lowered for the train. Railway may adopt other methodology for automatic switches of PF lighting.

Pumping

Pumping installation consumes considerable amount of electric energy. With increase in passenger services, demand is continuously increasing. Actions taken to contain energy consumption are as follows:

o Selection of pump depending on the head and yield test. Over capacity pump is energy inefficient and shall be avoided.

o Use of energy efficient motors and pump

o Provision of capacitor bank at load centre to improved power factor

o Provision of timer to control the pumping hours

o Provision of electrical controlled water level sensor

o To make best use of overhead tank capacity to work the pump with electric power instead diesel. The situation arises due to load shedding by Electricity Board.

o To stop water leakage through pipe line and water tap

Air Conditioning

Air Conditioning load is having a rising trend. This is mainly for the fact that air conditioning is now being considered as an efficiency multiplier instead a luxury. Hospitals, Office Buildings, Upper Class waiting Hall, Reservation Office, Control office, etc. are being provided with air conditioned comfort. Actions taken to contain energy consumption in these areas are:

Use of energy efficient BEE standard star rated air conditioning machine

- Air sealing
- Temperature setting at a comfort level of 23-25°C and its remote control. 3% increase in energy consumption for every 1 degree reduction in temperature.
- Directing cool air flow towards the occupant when there are only few user
- Use of occupancy sensor
- Training of office peons to switch off the air conditioners when Boss is away.
- Switching off supply for air conditioner load of the office building just after 15 minutes of schedule office hours.
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Air Compressor

Air compressor is used in carriage and wagon repair center for testing of the rake at 5kg/cm2 pressure. Energy conservation scope exists in the following area:

- To control air leakage and to increase time taken for cut in of the compressor.
- To reduce the setting for cut out. Optimum setting is 7kg/cm2

Fan

- Extensive service duty with working for almost 24 hours during summer in 24×7 buildings.
- Selection of fan size shall be decided based on plinth area
- Blade pitch or the angle with the horizontal shall be between 120-150
- BEE has defined service value of more than 4 for best result. 1200mm sweep fan delivers 210cum/min air.
- Mounting of fan shall be such to maintain a gap of 24″ between ceiling and fan blade. Using ceiling fans at slow speed along with air-conditioner will help in increasing the thermostat setting to a comfortable value of 260C.
- Electronic regulator is commonly used now-a-days. Energy consumption at step 1 is almost half as compared to full step.
- Ceiling fans are suitable for the enclosed area. Heavy duty air circulators are more suitable for covered platform. Heavy wind damages the blade angle and deforms the mounting, sometime even making it unsafe.
- Fans are provided with fixed and running capacitor. The speed drops if the value deteriorates with time.

Timely replacement of capacitor is necessary. This should be done as a must change item along with some cleaning/painting schedule as this is a low value item. One can find many fans rotating at slow speed during a visit to a Railway Station.

VII. PROMOTION OF RENEWABLE SOURCES OF ENERGY

Indian Railway has gone for use of solar power energy at manned level crossing gates, way side stations etc. It is difficult to extend power supply at these locations; therefore, solar power at these remote locations is an attractive proposition. This application being in remote area therefore, anti-theft measures have been built in the design of the solar panel at way side stations

LED lamp is preferred with solar panel for reasons that LEDs are available in lower power ratings and battery supply can directly feed to LED lamp thus saving on inverter. LED lamp is normally justified on life costing therefore decided to design with antitheft measures and IP65 protection

VIII. TYPE OF ENERGY AUDIT

The type of Energy Audit to be performed depends on:

Function and type of utility

- Depth to which final audit is needed and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types:

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- Preliminary Audit
- Detailed Audit

Preliminary Audit

The preliminary energy audit uses existing or easily obtained data through walk survey, study of available historical data, consultation etc. Preliminary energy audit is a relatively quick excise to:

- Establish energy consumption
- Identify and estimate the scope of saving
- dentify immediate (especially no/low cost) improvement/saving
- Set reference point
- Identify areas for more detailed study/measurement

Detailed Energy Audit Methodology

A detailed energy audit provides a comprehensive energy project implementation plan for a facility, since it evaluates all major energy-using systems.

This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

In a detailed audit, one of the key elements is the energy balance. This is based on an inventory of energy-using systems, assumptions of current operating conditions, and calculations of energy use. This estimated use is then compared to utility bill charges.

Detailed energy auditing is carried out in three phases:

- Phase I – Pre-Audit
- Phase II – Audit
- Phase III – Post-Audit

IX. GUIDELINES FOR ENERGY AUDITS OF NON-TRACTION FACILITIES OF IR

The first exercise towards energy audit railway station, offices, hospital, workshops, production units and residential colony is to formulate the energy audit team. The energy audit team will include the representatives from each department where energy audit will be performed. The energy audit team will collect, analyse and document data for energy consumption of each utility, equipment and appliances etc.

Responsibility of energy efficiency team:

- Obtain copies of monthly utility bills and invoices for delivered fuel
- Classify utility bills either by meter or by building and put them together into 12-month blocks using the meter-read dates
- Pinpoint location of all meters and sub-meters
- Identify which facility, building or space is served by which meter

The energy team will develop simple recording forms each department, production unit etc. The following should be recorded:

- Energy usage in appropriate units (kWh, Litre, etc.);

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

- Electric demand (kW); and
- Cost/ rate schedule.

Conduct a brief meeting/awareness programme with all divisional heads and persons concerned to building up cooperation between each department. The forms developed by energy audit team will be circulated to head of each department. Discussion will be held on establishing a methodology on accurately calculate the specific energy consumption of various products/services or activity etc.

- An improved data recording, collection and analysis system to keep track of energy consumption is to be developed.
- Identify key locations for Installation of energy meters at all feeders to monitor electricity consumption
- Separate monitoring and recording of electricity consumed by ATM, canteen, and other establishments at railway station. Prepaid meters can be installed.
- Maintaining and cleaning of all lighting fixtures on a regular basis. Maintain record of cleaning of all lighting fixtures against each location.
- Regular services are to be done for air conditions, fans, motors etc.
- Monitoring of load variations trends in pump, fans and compressors etc.
- Regular monitoring of transformer core loss reduction in distribution system
- Regular checking of leakage and pressure reduction in compressor system
- Seasonal reset of timers for street light and platform light where automation has been done
- Promotion of using natural light wherever feasible. This will allow putting off all the lamps during sunny days.
- Replace 40 watt conventional TFL and Incandescent lamp with 28 watt energy efficient TFL (T5)
- Promote efficient lamps for lighting purpose
- Promote variable frequency drives for traversors and cranes
- Promotion of Renewable Energy for non-traction railway sites
- Ensure proper functioning, operation & maintenance and calibration of meters to avoid any in-consistency in monitoring of energy consumption
- Monitoring and recording of electricity generated from diesel generators and monitoring of diesel consumption of generators
- Regular energy awareness training programmes are to be conducted within the each department

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- Identification of energy conservation opportunities in fuel substitution, energy generation, energy distribution and energy usage by process.
- Recording of maximum demand (MD) over the period of time and compare it with contract demand. If the MD is less than the contract demand for a long time then reduce the contract demand.
- Identify motors with less than 50% loading, 50-75% loading, 75-100% loading and over 100% loading. Motor loading above than 70% can be avoided by properly sizing the motor and by optimising the load on the motor.

To find out possibilities of replacement of old motors and pump with energy efficient motors and pump for pumping system

- Regular overhauling and maintenance of DG sets with special consideration to fuel injection and discharge system; removal of hot spots; and reduction of blow – by.
- The log book should be properly maintained so that the performance of the DG sets can be assessed in – house by monitoring the parameters such as specific power generation as lube oil consumption with respect to fuel oil consumption.

Post Audit Activities-Implementing Energy Efficiency

The process of key importance – an energy audit – has been concluded. As soon as possible after audit, the management team in consultation with the implementing agency should review the result and decide on the course of action to be taken. At this point in the process, the facility is ready to act on ESOs and develop new operating scenarios.

X. ENERGY AUDIT PROCEDURES

Energy Audit Procedure for Electrical supply (Transformer) and Distribution System

- Record all source of energy for each utility, collect and record contract demand for each utility and prepare single line diagram of the electrical supply and distribution.
- Prepare transformer design detail in the format given in energy audit manual.
- Prepare and Maintain record on periodic testing and schedule maintenance of transformer
- Collect last two year energy bills and record data in specified format for benchmarking purpose.
- Record and measure peak load on daily basis for last 2 years, Maximum Demand , KW, PF, KVAR, etc.
- Prepare inventories of all connected loads including load distribution, peak load, Energy use and power factor pattern for monthly basis.
- Prepare energy consumption breakup of different utilities in Railway Stations, Hospitals, Offices, Workshops, Production Units and Residential Colonies etc.
- Prepare inventory of all energy-using equipment, including the capacity, year of installation and rated consumption data for each.
- Optimize transformer loading by load shifting, proper sizing of transformer and better maintenance practices.
- All the meters installed at each utility should be calibrated at defined interval by manufacturer.

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Energy Audit Procedure for Motors

- Prepare inventory of motors/drives rating, operating hours. Voltage, frequency, line current, power factor, power drawn and the shaft RPM at the operating conditions for the motors rating 20 HP or more.
- Ensure rewinding of motors shall be allow only if the rewinding cost is less than 50% of the motors cost otherwise purchased new energy efficient motors.
- Ensure periodical motor load survey or identify the following
- Motors with less than 50 % loading, 50 – 75 % loading, 75 – 100 % loading, over 100 % loading.
- Motors with low voltage / power factor / voltage imbalance for needed improvement measures.
- Motors with machine side losses / inefficiencies like idle operations, throttling / damper operations for avenues like automatic controls / interlocks, variable speed drives, etc
- Ensure use of Energy-efficient motors in all installations. The energy- efficient motors have lower operating temperatures and noise levels, greater ability to accelerate higher-inertia loads, and are less affected by supply voltage fluctuations.
- Motor load survey is aimed not only as a measure to identify motor efficiency areas but equally importantly, as a means to check combined efficiency of the motor, driven machine and controller if any. The margins in motor efficiency may be less than 10 % of consumption often, but the load survey would help to bring out savings in driven machines / systems, which can give 30 – 40 % energy savings.

Energy Audit Procedure for Pump and Pumping Stations

- Prepare inventory of pumps to record type, rating, and operating hours of individual pumps. Pump discharge flow, Suction head, Discharge head, water distribution pipeline network for calculating the pressure drop across the pipeline.
- Ensure operation of pumps near best efficiency point.
- Modify pumping system and pumps losses to minimize throttling.
- Stop running multiple pumps - add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Repair seals and packing to minimize water loss by dripping.
- Balance the system to minimize flows and reduce pump power requirements.

Avoid pumping head with a free-fall return (gravity); Use siphon effect to advantage:

- Conduct water balance to minimize water consumption
- Replace old pumps by energy efficient pumps
- In the case of over designed pump, provide variable speed drive, or downsize / replace impeller or replace with correct sized pump for efficient operation.
- Optimise number of stages in multi-stage pump in case of head margins
- Reduce system resistance by pressure drop assessment and pipe size optimisation

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Energy Audit Procedure for Lighting

- Prepare inventory of lighting fixtures floor wise– number and type of fixtures.
- Prepare and maintain power consumption of light in kW/fixture (for each type of fitting), Hours of operation etc.
- Ensure cleaning of all lighting fixtures on a regular basis. Maintain record of cleaning of all lighting fixtures against each location.
- Seasonal reset of timers for street light and platform light where automation has been done.
- Lights can be shut off during non-working hours by automatic controls, such as occupancy sensors which turn off lights when a space becomes unoccupied.
- Use natural light wherever feasible. This will allow putting off all the lamps during sunny days.
- Replace obsolete incandescent lighting with CFL and LED
- Change exit signs from incandescent to LED.
- Installation of energy efficient fluorescent lamps in place of "Conventional" fluorescent lamps
- Installation of metal halide lamps in place of mercury / sodium vapour lamps (Metal halide lamps provide high color rendering index when compared with mercury & sodium vapour lamps. These lamps offer efficient white light. Hence, metal halide is the choice for colour critical applications where, higher illumination levels are required)
- Installation of High Pressure Sodium Vapour (HPSV) lamps for applications where colour rendering is not critical (High pressure sodium vapour (HPSV) lamps offer more efficacy. But the colour rendering property of HPSV is very low. Hence, it is recommended to install HPSV lamps for applications such street lighting, yard lighting, etc.)
- Installation of LED panel indicator lamps in place of filament lamps (Panel indicator lamps are used widely in industries for monitoring, fault indication, signalling, etc.)
- Installation of "exclusive" transformer for lighting (Generally, lighting load varies between 2 to 10%. Most of the problems faced by the lighting equipment and the "gears" is due to the "voltage" fluctuations. Hence, the lighting equipment has to be isolated from the power feeders. This provides a better voltage regulation for the lighting)
- Installation of servo stabilizer for lighting feeder
- Installation of high frequency (HF) electronic ballasts in place of conventional ballasts

XI. ENERGY AUDIT TOOLS & INSTRUMENT

For carrying out energy audit activity, team will require some portable measuring devices which can able to observe the actual measurements and monitor parameters (e.g. luminous intensity, Pressure, flow, voltage, current) of the equipment. These instruments must be portable, durable, easy to operate and relatively inexpensive. Basic monitored parameters during the energy audit includes following:

Basic Electrical Paramters in AC & DC system – Voltage (V),Current (I), Power Factor, Active Power (kW), Apparent Power (Demand) (kVA), Reactive Power (kVAr), Energy Consumption (kWh), Frequency (Hz), Harmonics etc.

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Paramters of importance other than electrical parameters such as temperature & heat flow, radiation, air and gas flow, liquid flow, RPM, noise & vibration, dust concentration, TDS, pH, moisture content, RH, Flue gas analysis – CO2, O2, CO, SOx, NOx, Combustion efficiency.

XII. APPLICATION OF NON-CONVENTIONAL & RENEWABLE ENERGY SOURCES

The electricity generation by installing renewable projects such as roof-top solar project or stand alone solar project can reduce Indian Railways dependency on grid as well as reduce GHG emission. The roof-top solar project can be installed on zonal head quarters, divisional offices, railway stations, hospitals and used generated electricity for captive consumption in same building and installation. The excess generation will be feed to the grid. The energy saving can also be achieve by installing solar panels on signals.

XIII. SAVING OPPORTUNITY

Saving opportunities can be achieved by adopting following measures:

Tariff

Analysis of tariffs also needs to be undertaken to identify tariff cost saving opportunities. Energy use pattern need to be analysed and matched with all tariff options (including oil, gas and other fuel) available to determine what tariff will be most cost effective.

Electricity Distribution System

- Optimise the tariff structure with utility supplier
- Schedule your operations to maintain a high load factor
- Shift loads to off-peak times if possible.
- Minimise maximum demand by tripping loads through a demand controller
- Stagger start-up times for equipment with large starting currents to minimize load peaking.
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.90 under rated load conditions.
- Relocate transformers close to main loads.
- Set transformer taps to optimum settings.
- Disconnect primary power to transformers that do not serve any active loads
- Consider on-site electric generation or cogeneration.
- Export power to grid if you have any surplus in your captive generation
- Check utility electric meter with your own meter.

Motors

- Properly size to the load for optimum efficiency. (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Use energy-efficient motors where economical.
- Use synchronous motors to improve power factor.
- Check alignment.
- Provide proper ventilation

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- For every 100C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- An imbalanced voltage can reduce 3 - 5% in motor input power
- Demand efficiency restoration after motor rewinding.
- If rewinding is not done properly, the efficiency can be reduced by 5 - 8%

Drives

- Use variable-speed drives for large variable loads.
- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives to v-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings.
- Shut them off when not needed.

Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimise bends in ductwork

Blowers

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.

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- Minimize blower speed.
- Use low-slip or no-slip belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Eliminate ductwork leaks.
- Turn blowers off when they are not needed.

Pumps

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

DG sets

- Optimise loading
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

Building

- Seal exterior cracks/openings/gaps with caulk, gasketing, weatherstripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.

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ISSN (O) 2319 - 8354
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- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

Miscellaneous

- Meter any unmetered utilities. Know what is normal efficient use. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbors, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

XIX. CONCLUSION

This work helps for identifying specific energy efficiency technologies and measures, standards, performance criteria, material standards and specifications, etc., and promoting and monitoring the implementation of EE measures; monitoring ,v erification and audit system; it also highlight the the institutionalization of energy efficiency and conservation awareness programs .

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