R.P. DELIO & CO.

Strategic Energy Planning

SCOPE OF DESIRED INVESTMENT GRADE ENERGY AUDIT

SECTION 1: INTRODUCTION

Energy assessment/audit has become an accepted first step in identification and implementation of various energy efficiency opportunities in residential, commercial, institutional and industrial facilities. The objective of an energy audit is to identify economical energy/cost saving measures that do not adversely affect the quality of work/product and the environmental consequences of the equipment and processes. Energy audit is a needed step in implementation of any detailed and sizable energy efficiency project. Often there will be the need for engineering design before implementation/ construction of the project.

The major impetus behind an energy audit is that the analysis of energy consumption and identification of potential conservation measures in facilities relate to various disciplines of engineering, that are often beyond the expertise of one person or small engineering firms. For example, on the less complex end of energy consumers, in the residential facilities, energy consumption depends on the structure, windows and doors, lighting, HVAC and refrigeration systems as well as cooking equipment. On the other end of the spectrum, in manufacturing facilities, the energy consumption is very process-dependent and greatly varies from facility to facility. Industrial facilities do not often lend themselves to standard prescriptive energy efficiency measures customarily used in residential, commercial and institutional facilities.

There are two basic types of audits, walk-through audit and detailed audit, the latter considered investment grade audit. Investment grade audit is also called feasibility study by CEC (2000). An investment grade audit may be a comprehensive audit that is intended to identify all energy efficiency opportunities in a facility, or a more targeted audit which focuses on a specific piece of equipment or process, e.g. lighting, a boiler, a drying process, compressed air system.

Walk-through audits – Walk-through audits are usually done by utility representatives or equipment vendors. In an ideal case a person or a team knowledgeable in energy efficiency issues walks through the facility along with facility personnel and identifies simple and standard energy efficiency measures such as lighting replacement, light and occupancy sensors, and high efficiency motors. The measures may be reported to the facility management with little substantiation and back-up information. Milan (2002) has prepared a guidebook for walk-through audits. Although the guide is for industrial facilities, it equally applies to commercial and institutional facilities.

Investment Grade Audits – According to CEC (2000), a detailed or investment grade audit (whether comprehensive or targeted) is a technical and economic analysis of potential energy saving projects in a facility that:

- Provides information on current energy-consuming equipment operations
- Identifies technically and economically feasible energy efficiency improvements for existing equipment, and
- Provides the customer with sufficient information to judge the technical and economic feasibility of the recommended projects.

Detailed or investment grade audits are the basis for further engineering analysis and design, and investment in energy efficiency improvements by facility owners or third parties. They can be also the basis for performance contract agreements. An accurate investment grade audit can result in identification of highly cost effective projects, and result in substantial cost/time savings in realization of the projects, while a low quality audit will result in unrealistic savings analysis, duplicate work in the engineering design process, and potential problems in performance contract agreements. More importantly, because some of these energy audits may become a basis for investment in, and establishment of distributed generation facilities in the present energy market, energy audit work may have significant economic repercussions.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved.

1) COMMON ISSUES WITH COMPREHENSIVE ENERGY AUDITS

SUMMARY OF ISSUES RELATED TO 10 REVIEWED COMPREHENSIVE ENERGY AUDIT REPORTS		
Audit	**Measures Recommended**	**Issues Raised**
Office Building Southern California Firm A	> Retrofit part of the lighting system > HVAC system upgrade	> Type of lamps and fixtures not identified, energy savings overestimated by about 40% > HVAC system energy savings overestimated by about 50% (methodology problem) > Various measures not identified: – VFD* for chilled water and condenser pumps – VFD for cooling tower fans – VFD for return fans – Proper control of supply fan VFD – Various control issues
Office Building Central Valley, CA Firm B	> Installation of a New 400 Ton Variable Speed Chiller > Upgrade Existing Partial Thermal Energy Storage System > Install VSD* on Pumps and Fans > Energy Management Hardware and Software > Retrofit Lighting	> No energy or demand balance presented > Utility rate schedules were not identified > DOE-2 simulation had been used but no input/output data were presented > No equipment cut sheets presented, so performance data used in DOE-2 not clear > It is not clear how cooling tower fans are controlled
Office Building San Francisco Bay Area, CA Firm A	> Installation of VFDs on the Supply and return Fans. > Installation of CO2 Controls on the Return Air Fans. > Installation of Damper Control.	> Measured power of the motors is based on current measurement, lacks power factor measurement > Fan curves have been used for VFD justification, not clear if flow and pressure were measured or assumed, fan curves are sensitive to both > Numerical errors in power savings calculations resulted in overestimation of savings by 50% > It is not clear why installations of CO2 sensors are recommended and how it will result in any energy savings, maintenance cost savings, etc. > Automating the on/off of the HVAC system not identified, while it is done manually now
Office Building Sacramento, CA Firm C	> Lighting Retrofit > Installation of a 100 kW photo voltaic Solar System	> Rate schedules not identified > Operating hours of equipment not identified > Monthly utility data not included > No equipment listing > No energy balance has been done > Inconsistent demand values has been used to size PVC system > DOE-2 simulation done, but no conclusions were drawn
Prison Central Valley, CA Firm D	> Lighting Retrofit > Energy Management System > Variable Air Volume HVAC > Boiler Economizers and Fan VSDs > Transformer Substation > Cogeneration Replacement	> Assumed plug load without justification > No details of the HVAC system to be controlled by the EMS has been presented > Measurement data for boiler not presented, but various measures recommended > The basis for choosing the kW rating of the cogen is not clear > FERC's criterion for cogen not clarified
Vocational Institution Central Valley, CA Firm D	> Lighting Retrofit > Thermal Energy Storage > Programmable Timeclocks and Thermostats > Boiler Economizer and Fan VSDs > Dairy Chiller Heat Recovery > New Water Booster Pump > Cogeneration	> Rate schedules not identified > Boiler measurements not included > Boilers optimization not taken into consideration > Cogen calculations do not include actual plant data
Office Building Southern California Firm D	> Lighting Retrofit > EMS Controls Modifications > VSD's for Pumps and Chillers > Window Film > Thermal Energy Storage	> The schedule of operation of HVAC system and building temperature control (chillers included) are not clear. > The specs for the HVAC system are not provided. > The DOE-2 simulation has not been properly calibrated. There is a discrepancy of up to 50% in demand estimation

Reference: INVESTMENT GRADE ENERGY AUDIT Ahmad R. Ganji, Ph.D., P.E. BASE Energy, Inc. San Francisco, CA 94103 Bruce Gilleland Energy Management Division California Department of General Services Sacramento, CA 95814 25th World Energy Engineering Congress Atlanta Georgia October 9-11, 2002

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

2) PROPOSED CHECKLIST BASED ON LESSON LEARNED FROM PRIOR ENERGY AUDIT REPORTS

The following can serve as a checklist for preliminary screening of a detailed/investment grade energy audit:

a. Are the energy rates based on historical (or projected) energy consumption and current (or projected) energy rates?

b. Has energy usage (and demand in the case of large electricity users) been balanced for at least one full year of energy data, separately for different fuels and preferably per meter? The preferred forms of presentation is graphical (e.g. pie chart) or tabular.

c. Are operating hours for different areas in the facility clearly identified and taken into consideration?

d. Are major energy consumer's clearly identified and taken into considerations in the energy balance?

e. Are the bases for implementation costs clearly identified?

f. If modeling software has been used, are the inputs and outputs clearly identified, so that another expert can repeat the work?

g. For the proposed measures, is it clear why energy will be saved?

h. Is it clear what form of retrofit is proposed and what are the advantages?

i. Is it clear where the retrofit should take place?

j. Have all potential energy efficiency measures been addressed?

3) MAJOR SHORTCOMINGS IN PRIOR ENERGY AUDIT REPORTS

The following have been the major issues with the audit reports we have reviewed:

- Lack of consistency in energy cost, demand cost, operating hours of various area of the facilities; often the basis for the considered demand cost is not clear
- Lack of energy balance, which often results in overestimation of the cost savings
- Lack of a clear description of the energy rate schedules, annual energy analysis, so that the customer is not really provided with a clear picture of how they are charged.
- Lack of equipment inventory and their ratings
- Lack of clear description and identification of retrofit scheme
- Overestimation of savings due to lack of consistency
- Lack of consideration of the latest retrofit technology
- Lack of pointing out the measures that may exist in similar facilities but do not exist in the surveyed facility

Overall, while the comprehensive detailed energy audit reports are supposed to provide a clear picture of the energy supply and consumption in the facility, and act as a roadmap for improvement of the energy utilization and cost reduction, they lacked some key components to serve the ultimate purpose.

4) PERCEIVED CAUSES

Some of the perceived causes of deficiencies in the audit reports seem to stem from:

- Lack of expertise of people who do the surveys, and more importantly those who prepare the report. Although taking inventory of equipment is fairly straightforward (filling out a site sheet), it often takes a clear understanding of complicated systems (e.g. a multiple-chiller system) to offer any meaningful energy efficiency improvements.
- Lack of basic knowledge of the fundamental engineering principles. Energy efficiency work is multidisciplinary, which necessitates a strong knowledge of fundamentals of mechanical and electrical engineering. It is always advisable to have a professional engineer oversee comprehensive energy audit projects.
- Lack of training in application of sophisticated simulation software such as DOE-2 and its various derivatives. Very sophisticated computer programs can produce incorrect results if they are not fed with the proper data (e.g. operating hours, load factors, etc.}, and properly applied to the specific situation.
- Conflict of interest – Often the firm that conducts the survey and prepares the audit report, is the same or affiliated with the firm that will do the engineering design and implementation (such as full energy service companies). There may be cases that are not directly leading into a profitable project and get omitted, or some required steps and information are overlooked in the interest of "green lighting" a project. An example is when a firm is hired to do a comprehensive energy audit, but fails to take inventory of all equipment and evaluate them, in the interest of an attractive lighting retrofit project. Other examples are consideration of unrealistic operating hours, utility factors, and load factors of the equipment. An oversized 50 hp fan motor may operate at 50% of its load, but it will not be known in the plant audit if its power draw is not measured!

5) MORE COMPLICATED ENERGY AUDIT CASES

Comprehensive energy audit of manufacturing facilities requires significantly higher expertise than commercial and institutional facilities. Energy consuming devices are highly varied and process/product-dependent and many remote users may dictate the operation of major energy consuming devices, e.g. boilers and compressors. In such cases understanding the process is as important as understanding the equipment. An auditor of commercial buildings will not necessarily have the expertise of auditing industrial facilities. While there are tens of energy saving opportunities in commercial facilities (refer to CEC 2000}, there are hundreds of energy efficiency opportunities in industrial facilities. It is not uncommon to identify 10-30% energy efficiency opportunities with simple paybacks of zero to a few years in industrial facilities. Major guidelines for performing comprehensive energy audit of manufacturing facilities are the same as those for commercial facilities. Some specific issues in audit of manufacturing facilities are:

- A much wider scope of measures and advanced technologies (inclusive of those for commercial facilities) can be identified in industrial facilities.
- While there are significant commonalties between industrial facilities with different processes, most facilities may have their unique energy efficiency measures that can be identified and analyzed based on fundamental engineering principles.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

- Load measurements are required for major energy consuming devices. Some equipment may go through significant load variations.
- Energy usage in most industrial facilities is highly product and production dependent, and much less dependent on ambient conditions.
- Taking a detailed inventory (which includes the rating, usage pattern, loading) of energy consuming equipment is an essential component of a comprehensive energy audit of industrial facilities.

6) EXPECTATIONS FROM AN INVESTMENT GRADE AUDIT

Objective: To carryout Investment Grade Electrical Energy Audit of the Facility and other industrial operation, so that various Options for Energy Saving measures can be straight away implemented on Performance – Contracting basis. As such, in addition to Energy Audit, "Base Line" for Energy Consumption as well as "Protocol for Measuring and Verification" must be worked out so that after the necessary implementation, actual quantum of Energy Saved can be quantified in very well acceptable level by the Client. (Any audit area as mentioned above is termed as "facility")

CEC (2000) elaborates on the details of an investment grade audit. Although it may sometime be costly to follow the details of the process as outlined by CEC (2000), the final product of an investment grade audit (the audit report) needs to at least address the following issues:

a. Clear operating hours per department (and equipment in the case of major energy users)

b. Clear inventory of energy consuming equipment including their nominal ratings and capacities

c. Energy rate/cost per unit of energy usage and for different types of energy (electricity, natural gas, etc.). In the case of electricity the customer may be paying for electrical demand too. In such a case, the demand cost and its basis should be clearly identified.

d. Analysis of at least one year (as the base year) of energy consumption by type of energy/fuel

e. Energy balance of the plant per type of fuel and preferably per meter based on rating, operating hour, utility factor and load factor of equipment. Utility factor is the ratio of the operating hours of a piece or group of equipment to the total operating hours of facility or department. Load factor is the ratio of the actual draw of equipment to the nominal rating of equipment, usually determined from measurement.

f. Clear identification of major energy consuming processes and equipment in the whole facility

g. Analysis of major energy efficiency measures identified in the audit process, which at least includes source of energy saving, amount and type of energy saved, cost savings, implementation cost and a pay-back analysis, as well as any major assumptions made in the analysis. In the case of computer simulation, a clear and succinct input/output for computer programs needs to be included.

h. Clear identification of the retrofit or control scheme/technology, and inclusion of cut sheets of the proposed equipment

i. Clear identification of the measures that may have potential in similar facilities that do not exist or are not economical in the audited facility

j. It is expected that investment grade energy audits include realistic assumptions on the conservative side; be complete, self-sufficient, and a clear guide to implementation, and serve as a roadmap to any future energy efficiency retrofit work in the facility. Assuming that an identified measure is chosen, and the detailed design is done, no more detailed energy consumption analysis should be needed to design and construct the measures.

SECTION 2:
SCOPE OF DESIRED INVESTMENT GRADE ENERGY AUDIT

The up-front cost of an energy audit can vary depending on the size and complexity of the design of the facility. A level 2 energy audit with data collection using sub metering of gas, water and electric, as well as occupancy, cycle count and other spot monitoring has a price tag that ranges 30 to 50 cents per square foot for facilities with less than 50,000 square feet of conditioned area, to about 20 to 30 cents per square foot for larger facilities (e.g., greater than 250,000 square feet), to 15 to 20 cents per square foot for very large facilities (e.g., greater than one million square feet).

Additional costs include performance specifications and design/engineering scope of work, financial analysis to create investment grade economics and record drawings and exploratory inspections to minimize construction change orders and various other risks.

RP Delio & Co charges per square foot on a sliding scale based on build environment and use. Engineering scope of work and performance specifications add several cents per square foot to the cost of a single purpose or comprehensive energy audit.

Under certain circumstances, where RP Delio & Co is selected to be the performance contractor or EPC, there is an opportunity to consider crediting the preparation of a portion of the costs for engineering scope of work, performance specifications and as-built towards the total costs of implementing the energy savings measure.

1) ENERGY AUDIT SCOPE

a. Energy Audit activities, in general will include:

   i. The activity starts at the utility meters, locating all energy sources coming into a facility.

   ii. Identification of energy streams for each fuel as well as electricity including own electricity generation facility.

   iii. Quantification of energy streams into discrete functions (Systems I equipment I appliances etc.)

   iv. Evaluation of the efficiency of each of those functions

   v. (Systems I equipment I appliances etc.)

   vi. Identification of Energy and cost savings opportunities and analyze the impact of improvements.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

b. Preparation of 'Energy Audit Report' that documents the use and occupancy of the facility and facility systems equipment.

c. The report also recommends ways to improve and implement on performance contracting basis the efficiency improvements in operation of maintenance/ housekeeping measures, and through installation of Energy Conservation Measures (ECM).

2) FACILITY DETAILS

a. To develop the key details of facility with specific reference
   - i. Facility structural details
   - ii. Use & Occupancy of the facility
   - iii. Energy supply features
   - iv. Details of Systems I Equipment I Appliances etc.

b. Methodology adopted for the Facility Energy Audit

c. The 'Energy Audit Structure' for developing energy efficiency projects to be implemented under performance contracting is given below. The facility energy system data collection and analysis can be conducted in modular way.
   - i. Facility Energy bills analysis
   - ii. Electrical Audit
     1. Electrical supply and distribution system analysis
     2. Harmonic Study
     3. Thermography
     4. Electrical Motors and Drives
     5. CPP & DG Sets
     6. Pumping Systems including performance evaluation of distribution networks
     7. Fan & Blowers
     8. Compressed Air Systems
     9. Cooling Towers
     10. Air Conditioning Systems (HVAC)
     11. Refrigeration Systems (Process Operations and Distribution)
     12. Lighting system analysis

3) FACILITY ENERGY BILLS ANALYSIS

a. Objective:
   - i. Tariff audit – to estimate the opportunities for peak load savings as well opportunities for Power Saving during the Evening Peak Load hours.
   - ii. Base line for Energy Consumption – Energy Consumption trends for developing baseline for gross metering (whole facility) for implementing multifaceted energy efficiency projects in a facility.

b. Methodology I Data Collection:
   - i. Energy bills (KWH, KVAr, KVA, and KW) on monthly basis for last 3 years.
   - ii. Peak load on daily basis for last 1-2 years.
   - iii. Weather Bins: dry bulb and wet bulb temperature for last 3 years
   - iv. Occupancy data: attendance and visitors record on monthly basis for last 5 years.
   - v. Energy system maintenance expenses on monthly basis for last 3 years.

c. Analysis
   - i. Identification of variables affecting energy consumption
   - ii. Regression analysis of energy consumption and development of correlations with identified variables.
   - iii. Databank management for regular energy bill analysis.
   - iv. Savings are determined by measuring energy use at the whole facility level. Short term or continuous measurements are taken throughout the post-retrofit period. If felt necessary, Energy Meters can be provided on certain Load Centers also.

4) ELECTRICAL SUPPLY AND DISTRIBUTION SYSTEM

a. Objective:
   - i. Transformer loss reduction projects by optimum transformer loading.
   - ii. Distribution loss reduction.

b. Methodology/ Data Collection:
   - i. Peak load on daily basis for last 1-2 years.
   - ii. Single line diagram (SLD) of the electrical supply and distribution
   - iii. To develop Load Curve of the facility (Voltage, Power in kW. and P.F.) with 2 – 5 minutes intervals.
   - iv. Maintenance expenses on monthly basis for last 3 years.

c. Analysis:
   - i. Transformer loading profile for optimizing the loading for transformer loss reduction
   - ii. Variable capacitor application
   - iii. Distribution loss reduction
   - iv. Savings are determined by field measurements of the energy use of the systems to which the ECM was applied. Separate from the energy use of the facility. Short term or continuous measurements are taken throughout the post retrofit period.

5) HARMONIC STUDY

a. Objective:
   - i. Identification of losses caused by Harmonic Distortion.
   - ii. Analysis of Electric Power Quality

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved.

b. Methodology/Data Collection:

   i. Preparation of Measurement plan based on single line diagram and operating load at facility.

   ii. Evaluation of measurement time at each point of measurement based on operating load.

   iii. Measurement of Voltage, Current Harmonics up to 51st Harmonic.

   iv. Estimation of Total Harmonic Distortion (THD)

   v. Maintenance Expenses due to failure of equipment because of poor power quality.

c. Analysis:

   i. THD, Voltage & Current Harmonics Profiles

   ii. Identification of area of high harmonic distortion and suggestion to improve power quality.

   iii. Identification of Voltage Sags, Swells, Imbalance and its effect to operating systems.

6) THERMOGRAPHY (NON DESTRUCTIVE TEST)

a. Objective:

   i. Identification of early warnings on equipment I component failure and to avoid excessive preventive maintenance.

   ii. Optimization of maintenance cost and minimization of break downs.

b. Applicable Areas:

   i. Electrical Appliances:

      1. High Voltage Aerial electrical inspection for transmission lines.
      2. Power generation generator inspections
      3. Fuse boxes
      4. Cables and relays
      5. Switches
      6. Insulators
      7. Circuit breakers
      8. Motors
      9. Battery banks
      10. Power connections and controllers and many more applications.

   ii. Process Applications

      1. Boiler flue gas leak detection
      2. Storage tanks sludge level inspections
      3. Flame propagation explosion analysis
      4. Heat exchanger quality and efficiency analysis
      5. Flow of products, fluids, steam, chemicals, hot gases, or solids through any system typically display a particular thermal signature.
      6. Process evolution like distillation column, reaction vessel, drying operation etc.
      7. Many more process applications.

   iii. Mechanical Applications

      1. Motor racing suspension and tire contact diagnostics.
      2. Brake and engine system evaluation of performance and cooling efficiency.
      3. HVAC system evaluation.
      4. Pipe inspection, leak detections, stress corrosion cracking areas.
      5. Measurement of pressures and vibrations
      6. Pumps, compressors, Fans, Hydraulics, Drives, Conveyors, couplings, gears, pulleys, shafts, turbines etc.
      7. Shutoff, throttling, and relief Valves

   iv. Building Inspection applications

      1. Thermal heat loss inspection
      2. Moisture contamination evaluations.
      3. Concrete Integrity Inspections
      4. Flat roof leak detection
      5. Solar loading (Solar heat gain)
      6. Air leakages
      7. Pipe leakages
      8. Cold storage cooling loss
      9. Mold growth, Facade delamination
      10. Crack diagnosis

   v. Miscellaneous applications.

      1. Design proto type evaluation
      2. Fire mapping
      3. Airborne application
      4. Covert surveillance
      5. Environmental inspection, pollution dumping, thermal dumping of waste water.
      6. Medical injury examinations
      7. Many more applications.

7) ELECTRICAL MOTORS AND DRIVES

a. Objective:

   i. Identification overloading and under loading of motors.

   ii. Saving Evaluation w.r.t. Motor operation criterion.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

b. Methodology/Data Collection:

i. Measurement of various parameters like V, A, PF, kVA, kW, RPM and frequency during normal operation of motors

ii. Rewind motors use details and No's of rewinding for same motors.

iii. Motor burning incidences of last 2 years.

iv. Maintenance Expenses on monthly basis for last 3 years.

c. Analysis

i. Motor Loading Analysis

ii. Drive Matching

iii. Regression Analysis for use of rewind motors

iv. Saving evaluation from motor management analysis

8) CPP & DG SETS

a. Objective:

i. CPP or DG set efficiency evaluation

ii. Identification of specific energy consumption.

b. Methodology/Data Collection:

i. Measurement of fuel consumption for specified period

ii. Measurement of Units generation for same period.

iii. Measurement of auxiliary drives consumption

iv. Measurement of other losses like flue gas etc.

v. Study of Operational criterion.

vi. Maintenance Expenses on monthly basis for last 3 years.

c. Analysis

i. Calculation of specific output in terms of power based on specific input based on fuel used.

ii. Comparison of same with design values.

iii. Identification of opportunity to reuse or recycle various loses for other purpose.

9) PUMPING SYSTEM

a. Objective:

i. Pumping system efficiency improvement

ii. Piping layout

b. Methodology I Data Collection:

i. Parameters Measures and Observed

ii. Pump pipeline layout (for pressure drop estimation)

iii. Pump discharge flow and Suction head

iv. Discharge head

v. Operating hour on year basis

vi. Maintenance expenses on monthly basis for last 3 years

c. c. Analysis:

i. Pumping efficiency

ii. Pumping power consumption

iii. Piping pressure drop estimation

10) FANS AND BLOWERS

a. Objective:

i. Fan and Blower System Efficiency improvement

ii. Ducting layout and air flow distribution assessment

b. Methodology/Data Collection:

i. Parameters Measures and Observed

ii. Fan/Blower Ducting layout (for pressure drop estimation)

iii. Fan/Blower discharge flow and Static and Velocity head

iv. Operating hour on year basis

v. Maintenance expenses on monthly basis for last 3 years

c. Analysis:

i. Fan/Blower efficiency

ii. Fan/Blower power consumption

iii. Ducting pressure drop estimation

iv. Saving evaluation based on reducing efficiency gaps as well as supply demand characteristics.

11) COMPRESSED AIR SYSTEMS

a. Objective:

i. Estimation of specific energy consumption

ii. Quantification of compressed air leakages

b. Methodology/Data Collection:

i. Assessment of free air delivery

ii. Distribution network analysis for pressure drop analysis.

iii. Compressor Loading Pattern and capacity control mechanism

iv. End-use application study

v. Maintenance expenses on monthly basis for last 3 years

c. Analysis

i. Air compressor volumetric efficiency evaluation

ii. Elimination of poor application of compressed air. iii. Optimization of operating pressure.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

12) COOLING TOWERS

a. Objective:

   i. Exploring suitable measures to improve approach and reduce power as well as water consumption.

b. Methodology/Data Collection:

   i. Measurement of Cooling Water Flow

   ii. Inlet Outlet temperatures

   iii. Dry bulb and Wet bulb temperatures at Cooling tower inlet and outlet.

   iv. Measurement of electrical energy for all cooling tower drives

   v. Measurements of cooling water blow down and make up rates.

   vi. Estimation of quality (TDS level) of cooling water.

   vii. Maintenance expenses on monthly basis for last 3 years

c. Analysis

   i. Cooling tower effectiveness.

   ii. Estimation of evaporation and drift losses.

   iii. Suitable measures to improve the effectiveness of cooling tower.

13) AIR CONDITIONING SYSTEM (REFRIGERATION)

a. Localized System: Window/Split AC's

   i. Objective:

      1. Energy Savings by optimum use of air conditioners (central or zone wise package).

      2. Providing optimum comfort level to the occupants.

   ii. Methodology/ Data Collection:

      1. Inventory of Air Conditioners type, numbers and age)

      2. Sample size selection for Testing for power consumption and also output delivered in TR under the existing weather conditions (kW, Air Flow, Inside Air Temperature & Humidity, Outside Air Temperature and Humidity)

      3. Typical temperatures maintained in the rooms.

      4. Air conditioner control operation – Time Cycle bases Control or Temperature Control

      5. Hours of operation

      6. Air conditioned floor area

      7. AC ventilation floor area

      8. Weather bins for last 2-3 years

      9. Maintenance expenses on monthly basis for last 4 years.

   iii. Analysis

      1. Calculation of zone wise tons/sq. meters.

      2. Calculation of individual AC power consumption kW/TR.

      3. Application of zone wise package air conditioners or central air conditioning systems

      4. Projected air conditioners consumptions for the year in kWh.

b. Central Air Conditioning System

   i. Objective:

      1. Energy savings by retrofits/replacement of chilling plants/system components for reduction in specific power (kW /TR) consumption.

      2. Energy savings by retrofit / replacement chilling plant Auxiliaries such as condenser pumps, chiller pumps, cooling towers, Air Handling units.

   ii. Methodology/Data Collection:

      1. Inventory of chilling plant & auxiliaries

      2. Performance evaluation of VAM and other compressor Machines.

      3. Performance evaluation of chilled water distribution.

      4. Performance testing of chillers for power consumption and Output TR delivered to derive specific power consumption (KW /TR).

      5. Size selection and testing for power consumption, CFM delivered and efficiency of Air Handling Units.

      6. Typical temperatures maintained in the rooms.

      7. Chiller capacity control mechanism loading/unloading or vane control

      8. Hours of operations for chilling plant, AHU's and other auxiliaries

      9. Performance testing of condenser/chiller pumps to derive operating efficiency.

      10. Air conditioned floor area

      11. Weather bins for last 2-3 years

      12. Maintenance expenses on monthly basis for last 4 years.

   iii. Analysis

      1. Calculation of zone wise TR/sq. meters.

      2. Calculation of individual chiller specific power consumption kW /TR.

      3. Calculation of operating efficiency for

      4. Condenser/Chiller pumps, AHU's etc.

      5. Optimization of end use of chilling requirements.

      6. Projected consumption of chilling plants and auxiliaries for year in KWH.

14) LIGHTING SYSTEM ANALYSIS

a. Objectives:

   i. Lighting system

   ii. Providing optimum comfort level lighting to the occupants.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

b. Methodology/ Data Collection:

   i. Inventory of lighting fixtures (type and number of fixtures)

   ii. Zone or space or room wise Lux measurement (day time and evening time) and type of activity

   iii. Hours of operation

   iv. Isolation the lighting circuits and measure power consumption for lighting

   v. Floor plan

   vi. Maintenance expenses on monthly basis for last 3 years.

c. Analysis:

   i. Calculation of zone wise lux

   ii. Lighting power consumption in terms of Watt /Fixture and watt /M 2 (Lighted Space)

   iii. Projected lighting consumption for the year in kWh.

   iv. IV. Retrofit Isolation: Savings are determined by field measurement of the energy use of the system to which the ECM was applied. Separate from the energy use of the rest of the facility short-termed or continuous measurements are taken throughout the post-retrofit period.

   v. Partially Measured Retrofit Isolation: Savings are determined by partial field measurement of the energy use of the system (s) to which an EMC was supplied. Separate from the Energy use of the facility. Measurements may be either short term or continuous.

15) SAFETY AUDIT

a. Safety Policy

   i. The audit shall ascertain whether the installation has a written safety policy endorsed by top management in which safe management of hazardous chemicals are adequately covered.

b. Safety Information

   i. The audit shall ascertain whether the management of the company has set up and maintained a comprehensive set of written safety information to enable its entire staff to handle and store chemicals safely.

   ii. The information shall cover those items normally reflected in the material safety data sheets of the chemicals, which include identification and understanding the potential hazards of chemicals, safe working procedures and emergency actions to take in case of emergency.

c. Safe Work Practices

   i. The audit shall ascertain whether safe work procedures have been established to ensure the safe handling, including transportation, loading and unloading, storage and use of hazardous chemicals by plant employees as well as contract workers.

   ii. Identification of all hazardous chemicals and their hazards used in the plant, a work authorization system and compliance of standards and regulatory requirements should be part of the safe work procedures.

d. Hazmat Change Management

   i. The audit shall ascertain whether the installation has developed and instituted a system including use of proper written procedures to manage changes to handling of hazardous chemicals.

   ii. It shall also ascertain whether the plant staff have been informed of and adequately trained to safely manage such changes.

e. Material Handling and Storage

   i. The audit shall ascertain whether a maintenance system to ensure that all facilities used for the handling and storage of hazardous chemicals, including storage containers, are maintained in sound and good working order at all times.

f. Safety Training

   i. The audit shall ascertain whether training provided to staff responsible for the handling and storage of hazardous chemicals is effective and that such training adequately covers the safety information and safe work practices.

   ii. The training shall ensure staff are kept up to date on changes to the types and work procedures in the handling of the hazardous chemicals.

g. Incident Investigation

   i. The audit shall ascertain whether the installation has established a system to investigate every incident in the workplace involving the handling and storage of hazardous chemicals, and to promptly address the investigation's findings and to implement the recommendations.

h. General Plant Inspection / Reviews

   i. The audit shall ascertain whether regular inspections and reviews on handling and storage of hazardous substances have been conducted, and procedures for reporting potential hazardous conditions and monitoring the remedial actions established.

i. Hazard Analysis

   i. The audit shall check on whether the company has an established program to carry out hazard analysis on the handling of hazardous chemicals so as to identify, assess and evaluate potential hazards, especially when new hazardous chemicals or a significant increase in the quantities of hazardous chemicals are handled.

   ii. The audit shall also ascertained whether the company has an established procedure to record these hazards and develop and implement means to eliminate the hazards or reduce the hazards to an acceptable level of risk.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

j. Emergency Planning and Response

   i. The audit shall ascertain whether the on-site emergency action plan established by the installation can deal with all accidental releases and/or fires of hazardous chemicals and whether there are adequate emergency equipment stored on standby and maintained in good working order.

   ii. The audit shall also ascertain whether regular rehearsals of all or part of the emergency action plan were carried out and documented.

   iii. It shall also ascertain whether the lessons learnt from these rehearsals were recorded and used during updates of the plan.

k. Contractor Safety

   i. The audit shall ascertain whether contractors engaged to handle hazardous chemicals, including transportation, have been carefully selected, informed of their safety responsibilities and adequately trained to handle hazardous chemicals safely and to respond to emergency.

l. Additional Items

   i. The audit shall ascertain if the site conforms generally to guidelines pertaining to the safe management of hazardous chemicals stated in the Semiconductor Equipment and Materials International (SEMI) international standards/specifications or Factory Mutual (FM) loss prevention engineering guidelines or equivalent (only for wafer fabrication plants)

   ii. The audit shall ascertain if the maintenance of fire alarm and protection systems and other fire safety works conform to the requirements stated in the National Fire Protection Association (NFPA) code or Uniform Fire Code (UFC) or Uniform Building Code (UBC) or any code of practice established by PSB and FSB. (For sites storing or handling flammable or combustible substances)

16) RENEWABLE ENERGY

a. The audit shall also cover the study on feasibility of incorporating renewable energy systems such as solar water heater, solar PV, wind energy etc.

17) RESOURCE ACCOUNTING & RESOURCE USE OPTIMIZATION (WASTE)

a. [insert description of the objective]

b. Process & Resource mapping:

   i. Analysis of Resource Consumption patterns vis-a-vis design parameters

   ii. Loss Analysis at Resource Sourcing, Pre-processing / Pre Treatment, Storage and Distribution stages

   iii. Analysis of resource wastages through re-processing and losses at intermediate stages of conversion.

   iv. Resource flow pattern analysis – Quantity and Quality wise across the process

   v. Identification of Resource Conservation & Optimization opportunities

   vi. Review of existing Environment Management Infrastructure for improvements.

   vii. Classification & Prioritization of the Resource Saving opportunities as No-Cost, Low Cost and Investment based ones.

c. Optional:

   i. Provide assistance to clients in implementation (Identification and selection of technology providers)

   ii. Post Implementation monitoring

   iii. Environment Management Services

   iv. Identify sources of waste generation

   v. Cause and variance in the waste generation pattern

   vi. Identify means to reduce waste generation at source

   vii. Identify potential areas of reuse, recycle of the wastes – Onsite / Offsite applications Identify potential recovery of resources.

   viii. Auditing of existing Environment Management Infrastructure.

   ix. Technical advice for solid & hazardous waste management

   x. Develop alternate /optimum treatment schemes.

   xi. Identify potential reuse of the treated resources.

   xii. Environment Risk Analysis & Development of Onsite & Offsite

   xiii. Emergency Preparedness Plans for Disaster Management. Optional:

   xiv. Provide assistance to clients in implementation (Identification and selection of technology providers)

   xv. Post Implementation monitoring

18) RESOURCE CONSERVATION AUDIT (WATER AUDIT)

a. One of the core elements of Water Management is “Water Audit”.

b. A Water Audit is a “Systematic approach of Identifying, Measuring, Monitoring and Reducing the Water Consumption by various activities in an Industry”

c. Water Audit study is a qualitative and quantitative analysis of water consumption to identify means of reuse and recycling of water. Water Audits encourage social responsibility by identifying wasteful use, enables estimation of the saving potential. They not only promote water conservation but also deliver cost savings. In addition they help companies safeguarding public health and property, improve external relations and reduce legal liability.

d. Objective

   i. Estimation of water consumption in overall facility

   ii. Identification of opportunity to reduce, reuse and recycle of water based on quality at various points of requirements.

   iii. Estimation of water pumping energy at each stage & Identify

   iv. Energy Saving Potential in Pumps and Pumping Systems

   v. Identify the sources of water consumption and Wastewater

   vi. Generation through Field Studies

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

vii. Quantification and Characterization of Water and Wastewater by way appropriate sampling and measurements
viii. Establishment of Specific water Consumption and Wastewater
ix. Specific Water Consumption/Ton of Product Produced
x. Benchmarking of Specific Water Consumption and Wastewater
xi. Evolve Techno-Economic feasible solutions for recommended measures for implementation

e. Scope of Work
i. Analyze historic water use in the plant
ii. Identify water flow and quality for each applications
iii. Identify the areas for water conservation
iv. Identify the sources of wastewater Generation
v. In-depth Process studies for waste quantification and characterization
vi. Identify for Flow Monitoring, Measurement, Sampling and Analysis
vii. Identify areas for water conservation and waste minimization measures
viii. Identify energy saving potential for pumps and pumping systems
ix. Analyze for Compliance & Legal Requirements
x.) On-the spot recommendations of General House Keeping measures
xi. Recommendations of short term measures
xii. Evolving Options for Medium and Long-Term measures
xiii. Evolving Techno-Economic feasible measures for the options identified
xiv. Recommend the feasible options for recommendations
xv. Submission of Detailed Audit Report

f. Methodology/Data Collection:
i. Design details of all facilities related to water like Raw water plant, DM plants, Soft water plants, RO Plants, Cooling towers, Chilled water systems, pretreated water plants, waste water treatment plants. Fire water, potable water, bore well water etc.
ii. Piping layout of each streams.
iii. Connected and operating load of each stream.
iv. Design and operating details of various plants in each streams.
v. Design and operating details of various pumps used in each streams.
vi. Operation timing of each stream.
vii. Quality details at each stream (last 3 years records)
viii. Last 3 years breakdown details with reasons.
ix. Last 3 years various optimization details with benefits I losses achieved.
x. Last 3 years weather details on hourly basis (for cooling tower calculations)

g. Analysis & Deliverables
i. Flow Chart of Water Supply Distribution System
ii. Preparations of water balance overall and stream wise.
iii. Check List for self-assessment for determining the water efficiency for facility managers
iv. Estimation of water pumps actual efficiency and comparison with design efficiency.
v. Energy Conservation Measures in Pumps and Pumping Systems
vi. Estimation of pressure drops at selected locations (piping).
vii. Identification of opportunities to reuse, recycle and reduce the water consumption.
viii. Estimation of water pumping cost and suggestion to reduce the same.
ix. Detailed Water Audit and Wastewater Audit Report.

SCOPE OF DESIRED INVESTMENT GRADE THERMAL ENERGY AUDIT

19) FACILITY ENERGY BILLS ANALYSIS

a. Thermal Audits
i. Compressed Air System
ii. Cooling Tower System
iii. Air Conditioning and Refrigeration System
iv. Steam Generation (Boilers)
v. Steam Distribution
vi. Furnaces
vii. Thermic Fluid Heaters
viii. Insulation Study
ix. Hot Water/Oil Systems
x. Drying Operations
xi. Process and Other Energy Consuming equipment

20) FACILITY ENERGY BILLS ANALYSIS

a. Objective:
i. Tariff audit to estimate the impact of savings as well opportunities for fuel saving during the particular time frame as well as contribution of energy cost to the products.
ii. Base line for Energy Consumption: Energy Consumption trends for developing baseline for gross metering (whole facility) for implementing multifaceted energy efficiency projects in a facility.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

b. Methodology/ Data Collection:

   i. Energy bills (Liter, kg, lb., Rs/kg, MT, KL etc.) on monthly basis for last 3 years.

   ii. Peak load on daily basis for last 1-2 years.

   iii. Weather Bins: dry bulb and wet bulb temperature for last 3 years

   iv. Occupancy data: attendance and visitors record on monthly basis for last 5 years.

   v. Energy system maintenance expenses on monthly basis for last 3 years.

c. Analysis

   i. Identification of variables affecting energy consumption

   ii. Regression analysis of energy consumption and development of correlations with identified variables.

   iii. Databank management for regular energy bill analysis.

   iv. IV. Savings are determined by measuring energy use at the whole facility level. Short term or continuous measurements shall be taken throughout the post retrofit period. If felt necessary, Energy Meters can be provided on certain Load Centers also.

21) COMPRESSED AIR SYSTEMS

a. Objective:

   i. Estimation of specific energy consumption

   ii. Quantification of compressed air leakages

b. Methodology/Data Collection:

   i. Assessment of free air delivery

   ii. Distribution network details for pressure drop analysis.

   iii. Compressor Loading Pattern and capacity control mechanism

   iv. End-use application study

   v. Maintenance expenses on monthly basis for last 3 years

c. Analysis

   i. Air compressor volumetric efficiency evaluation

   ii. Elimination of poor application of compressed air.

   iii. Optimization of operating pressure.

22) COOLING TOWERS

a. Objective:

   i. Exploring suitable measures to improve approach and reduce power as well as water consumption.

b. Methodology/Data Collection:

   i. Measurement of Cooling Water Flow

   ii. Cooling Water – Inlet & Outlet temperatures

   iii. Dry bulb and Wet bulb temperatures at Cooling tower inlet and outlet.

   iv. Measurement of electrical energy for all cooling tower drives

   v. Measurements of cooling water blow down and make up rates.

   vi. Estimation of quality (TDS level) of cooling water.

   vii. Maintenance expenses on monthly basis for last 3 years

   viii. Disinfection process for cooling water

c. Analysis

   i. Cooling tower effectiveness.

   ii. Estimation of evaporation and drift losses.

   iii. Suitable measures to improve effectiveness of cooling tower

   iv. Identification of disinfection as per new technology which eliminates microbiological & scaling problems and improves heat transfer.

23) AIR CONDITIONING SYSTEM (REFRIGERATION)

a. Localized System: Window/Split AC's

   i. Objective:

      1. Energy Savings by optimum use of air conditioners (central or zone wise package).

      2. Providing optimum comfort level to the occupants.

   ii. Methodology/ Data Collection:

      1. Inventory of Air Conditioners (type, numbers and age)

      2. Sample size selection for Testing for power consumption and also output delivered in TR under the existing weather conditions (kW, Air Flow, Inside Air Temperature & Humidity, Outside Air Temperature and Humidity)

      3. Typical temperatures maintained in the rooms.

      4. Air conditioner control operation – Time Cycle bases Control or Temperature Control

      5. Hours of operation

      6. Air conditioned floor area

      7. AC ventilation floor area

      8. Weather bins for last 2-3 years

      9. Maintenance expenses on monthly basis for last 4 years.

   iii. Analysis

      1. Calculation of zone wise tons/sq. Meters.

      2. Calculation of individual AC power consumption kW/TR.

      3. Application of zone wise package air conditioners or central air conditioning systems

      4. Projected air conditioners consumptions for the year in kWh.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

b. Central Air Conditioning System

i. Objective:

1. Energy savings by retrofits/replacement of chilling plants/system components for reduction in specific power (kW /TR) consumption.
2. Energy savings by retrofits/replacement of chilling plant auxiliaries such as condenser pumps, chiller pumps, cooling towers, Air Handling units.

ii. Methodology/Data Collection:

1. Inventory of chilling plant & auxiliaries
2. Performance evaluation of VAM and other compressor Machines.
3. Performance evaluation of chilled water distribution.
4. Performance testing of chillers for power consumption and Output TR delivered to derive specific power consumption (KW /TR).
5. Size selection and testing for power consumption, CFM delivered and efficiency of Air Handling Units.
6. Typical temperatures maintained in the rooms. Chiller capacity control mechanism loading/unloading or vane control
7. Hours of operation for chilling plant, AHU's and other auxiliaries
8. Performance testing of condenser/chiller pumps to derive operating efficiency.
9. Air conditioned floor area
10. Weather bins for last 2-3 years
11. Maintenance expenses on monthly basis for last 4 years.

iii. Analysis

1. Calculation of zone wise TR/sq. meters.
2. Calculation of individual chiller specific power consumption kW /TR.
3. Calculation of operating efficiency for Condenser/Chiller pumps, AHU's etc.
4. Optimization of end use of chilling requirements.
5. Projected consumption of chilling plants and auxiliaries for year (KWH).

24) STEAM GENERATION (BOILERS)

a. Objective:

i. Evaluation and optimization of combustion efficiency of Boiler

b. Methodology/Data Collection:

i. Quantification of fuel consumption
ii. Quantification of Steam Generation
iii. Operating parameters for boiler operation
iv. Estimation of boiler feed water and blow down quantity and quality.
v. Estimation of various heat losses in the boiler
vi. Preparation of Boiler heat balance and Sankey diagrams.

c. Analysis

i. Estimation of Boiler efficiency by direct and indirect methods.
ii. Estimation of potential heat recovery from boiler heat losses.
iii. Identification of various energy conservation measures to increase the boiler efficiency.

25) STEAM DISTRIBUTION

a. Objective:

i. Identification of unjustified use and various losses of steam and condensate in distribution system.

b. Methodology/Data Collection:

i. Steam and condensate piping layout details
ii. Operating parameters like temperatures, pressures, duration of process etc. of steam consuming equipment
iii. Details of other steam consumption, which can be returned back in terms of condensate.
iv. Details of steam traps (Type, size and quantities) at various locations.
v. Operation status of steam traps.
vi. Estimation of steam distribution quantity
vii. Estimation of Condensate return Quantity
viii. Material balance for condensate returns and steam distribution.
ix. Heat balance for condensate return and steam distribution (If process details are available)

c. Analysis

i. Maximizing the opportunity of condensate recycle.
ii. Identification of faulty steam traps and estimation of losses for same.
iii. Estimation of overall steam balance and optimization of steam requirement. (If process details are available)
iv. Identification of other steam and condensate losses.

26) FURNACES

a. Objective:

i. Evaluation and optimization of combustion efficiency of Furnace

b. Methodology/Data Collection:

i. Quantification of fuel consumption
ii. Quantification of Furnace output
iii. Operating parameters for furnace operation
iv. Estimation of various heat losses in the furnace.
v. Preparation of heat balance and Sankey diagrams.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

c. Analysis

i. Estimation of furnace efficiency by direct and indirect methods.

ii. Estimation of potential heat recovery from furnace heat losses.

iii. Identification of various energy conservation measures to increase the furnace efficiency.

27) THERMIC FLUID HEATERS

a. Objective:

i. Evaluation and optimization of combustion efficiency of Thermic Fluid Heater

b. Methodology/Data Collection:

i. Quantification of fuel consumption

ii. Quantification of TFH output

iii. Operating parameters for TFH operation

iv. Estimation of various heat losses in the TFH.

v. Preparation of heat balance and Sankey diagrams.

c. Analysis

i. Estimation of TFH efficiency by direct and indirect methods.

ii. Estimation of potential heat recovery from TFH heat losses.

iii. Identification of various energy conservation measures to increase the TFH efficiency.

28) INSULATION STUDY

a. Objective:

i. Identification of poor insulation quantification of equivalent fuel loss.

b. Methodology/Data Collection:

i. Piping layout for insulated lines area and

ii. Insulated Equipment layout. Operating parameters. Dimensions and

iii. Operating parameters of insulated lines like temperatures, fluid and pressures.

iv. Type and thickness of insulation used and its physical properties like thermal resistance of conductivity, effect of vanous pickings, bulk density, and temperature range etc.

c. Analysis

i. Estimation of insulated area and corresponding heat loss.

29) HOT WATER/OIL SYSTEMS

a. Objective:

i. Identification of unjustified use and various losses of hot water/oil in distribution system.

b. Methodology/Data Collection:

i. Hot water/oil piping layout details

ii. Operating parameters like temperatures, pressures, duration of process etc. of hot water/oil consume equipment

iii. Details of other Hot water consumption, which cannot be returned back.

iv. Estimation of hot water distribution quantity

v. Material balance for hot water/oil distribution.

vi. Heat balance for hot water/ oil distribution (If process details are available)

c. Analysis

i. Estimation of overall heat balance and optimization of hot water/oil requirement. (If process details are available)

30) DRYING OPERATIONS

a. Objective:

i. Optimization of drying efficiency by reduction of various losses.

b. Methodology/Data Collection:

i. Design details of dryers

ii. Operating parameters of drying.

iii. Drying material properties details

iv. Connected load details of drying.

v. Measurement of various parameters for drying operation (minimum 3 cycles).

c. Analysis

i. Estimation of drying efficiency

ii. Estimation of specific energy consumption for drying of unit mass of product on dry base

iii. Identification of various opportunities to lower the specific energy consumption.

31) PROCESS AND OTHER ENERGY CONSUMING EQUIPMENT

a. Objective:

i. Overall manufacturing Process Study to evaluate theoretical and actual energy consumption.

ii. Preparation of overall as well as process wise mass balance and energy balance.

b. Methodology/Data Collection:

i. Process Flow chart

ii. Process & Instrumentation Diagrams

iii. Plant Layout

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

iv. Operating and design details of all equipment utilized for manufacturing process.

v. Operation timing details

vi. Cost of Raw materials, man power, maintenance, and other overheads as well as energy charges for all types of fuel used including electricity.

vii. Ideal operating hours for year.

viii. Last 3 years breakdown details with reasons.

ix. Last 3 years various optimization details with benefits / losses achieved.

x. x) Last 3 years weather details on hourly basis

c. Analysis

i. Preparation of material balance

ii. Preparation of energy balance

iii. Estimation of specific energy consumption theoretical and actual based on past 3 years data

iv. Suggestion to improve specific energy consumption close to theoretical values based on Bifurcation of specific energy consumption in two parts.

32) FIXED ENERGY CONSUMPTION:

a. Not related with production activity and consumption which will production is zero also terms as base remain constant when Reduction in base consumption can be achieved by energy conservation measures

33) VARIABLE ENERGY CONSUMPTION:

a. It is related to production volume. Reduction in variable consumption can be achieved by energy efficiency measures.

The audit shall also cover the study on feasibility of incorporating renewable energy systems such as solar water heater, solar cookers, solar PV, wind energy etc.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved.

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved.

CONTACT US

Contact.Us@rpdelio.com
855 RPDELIO
(855) 773-3546

SOUTH PACIFIC MAILING ADDRESS

1050 Bishop Street
Suite 351
Honolulu, Hawaii, USA 96813

NORTHEAST USA MAILING ADDRESS

9 Reservoir Street
Bethel, CT 06801

© Copyright 1989-2015 RP Delio & Company, Inc. All Rights Reserved. www.rpdelio.com