ELEMCO's "ENERGY EXECUTIVE III"®

Building Automation System
Specification

INTRODUCTION

A successful building automation system is one that provides and maintains predetermined environments around the clock, for varying states of building operation, at a minimum expense. It must be able to evaluate and react to changes in inside and outside climatic conditions as well as fluctuations in facility utilization. As one might expect, this involves much more than simple time cycling of HVAC equipment.

The integrity of system design is based on operational harmony between the control system and the actual HVAC machinery. Long term functionality relies upon system flexibility and expandability. Cost effectiveness depends upon inexpensive installation and operation.

Elemco Building Controls, Inc. (EBC) has developed a system to meet these stringent specifications. Combining experience and expertise in the fields of computer science and HVAC maintenance with state-of-the-art data acquisition, control and transmission equipment has produced the "ENERGY/TENANT EXECUTIVE III"®.

OVERVIEW

The EBC computerized building automation system provides automatic control of heating, ventilation, air conditioning and lighting by evaluating environmental conditions along with preprogrammed operating parameters and consequently operating all energy consuming apparatus for optimum comfort and conservation.

The EBC System can handle thousands of remote points of on/off control, analog input, pulse counters, analog outputs, switch closure type inputs and special alarm inputs.

The central PC workstation conducts two-way data communications with each remote area by transmitting an addressable, low voltage signal. The system can utilize various types of multiplexed wired circuitry and even power line carrier (PLC) or radio frequency (RF) data transmission where appropriate. Interfaces are available to many off-the-shelf distributed process or local controller networks.

The following sections detail the specific system capabilities of the EBC System:

CAPABILITIES

Remote Panels: Each of the remote panels has resident electronic intelligence capable of gathering information and/or controlling equipment activity. For example:

Temperature (analog input)
Pressure (analog input)
Amperage (analog input)
Electrical/Flow consumption (pulse counting)
Equipment status (running or not)
Alarm conditions
Analog output (for modulation)
Equipment control (on/off)

This information is gathered by monitoring temperature sensors, temperature insertion probes, auxiliary contacts, transducers, switches and electric/flow consumption and demand meters located in the remote areas. Environmental sensing equipment is pre-calibrated and non-adjustable to prevent tampering.

Central Workstation: The central workstation continuously scans all remote points and stores pertinent information for evaluation and data logging. After analyzing these remote environmental conditions, the workstation will send the appropriate instructions back to the local control apparatus. Screen and printed reports are available to the operator through the Graphical User Interface (GUI). In addition, the workstation:

Registers and displays alarms.
Provides password protection from unauthorized tampering.
Allows for manual override of automated procedures for emergency and/or unusual circumstances (see Software Specifications).
Shows real time status of the equipment and the system command being sent.
Shows real time analog data such as temperatures, pressures, amperages and voltages.
Displays the daily and month to date consumption for each metered area. If demand limiting is implemented, the current electrical demand is also displayed, as well as the peak values and times.

The system also keeps track of the operations of its own data acquisition hardware. The central control continuously monitors the number of "no answers" from the remote units. When an excess count is recorded, the system enters an alarm state, displaying the event on the screen and recording it to disk. The workstation also monitors the number of successful communications and the number of attempts necessary for the communication to be established.

This data is kept in "hardware performance logs" which are updated hourly. These records assist in system start up and maintenance.

Remote Communications: The "ENERGY EXECUTIVE III"® has extensive remote communications (internet and modem) capabilities. It is possible to contact the central computer from an off-site location with a remote computer using a broadband internet connection or a standard modem. The remote user can access all screen displays as well as generate printed reports. However, password protection is included to prevent an unauthorized party from logging

onto the system. The password protection is user selectable and may be enabled or disabled at any time.

HARDWARE SPECIFICATIONS

All hardware used in the ELEMCO System is standard off-the-shelf equipment from major manufacturers. When desired the system can be easily expanded without complicated customization.

PC Workstation: The central computer is an standard PC. Minimum system specifications are:

Intel Pentium 4 CPU (NOTE: PC must be able to reboot unattended after power outage)
512 Mbytes RAM
20+ Gbyte Hard Disk
CD Read/Write Drive
3.5” Floppy Disk
Printer Port
4 USB ports
Keyboard
USB Mouse
Network Interface Card
16 Bit Sound Card
1024 X 768 Minimum Video Resolution
56 Kb Modem (internal or external as needed to comply with other serial communications / IRQ requirements)

These are **MINIMUM** specifications applying to standard systems with no requirements for additional I/O ports. Some systems may require more than the minimum in terms of I/O ports, hard disk storage and processing speed!

Remote Points: Each remote point (i.e. temperature sensor, auxiliary contact, etc.) is monitored by a remote panel. This unit is equipped with an on-board microprocessor to gather specific environmental data, convert it to digital form and store it for use in local control algorithms and for global system access. It is also capable of receiving digital information from network, controlling an electrical load and/or converting the signal to analog output for modulation purposes (DDC).

Environmental feedback is received from the remote panels and made available to the system workstations. The data acquisition interface software performs all error checking and data verification.

SOFTWARE SPECIFICATIONS

The "ENERGY EXECUTIVE III"® software package is designed to run twenty-four hours a day, three-hundred sixty-five days a year. It is programmed to continually compile and act upon acquired input and to display pertinent information on system operation.

It is user friendly, and provides complete environmental and machine status via mouse driven GUI. It allows the user to change operation parameters through easily understood icons and display prompts.

The software is carefully designed to be flexible and adaptable. All displays are clear and concise, using the actual names of the equipment and areas in question rather than employing a cryptic computer code to identify locations and machinery.

The EBC software is custom tailored for each facility from standard program modules to compensate for each facility's unique environmental demands. It may include the following software features:

Scheduling: This software feature provides for individual start and stop schedule(s) for each piece of machinery, for each day of the week. As standard there are 6 sets of stop/starts per point, but the system can be configured to handle up to 10 stop/starts per day per point.

Holiday Programming: The program provides for unlimited, user selectable number of special holiday schedules which can be configured a year in advance. Each of these holidays can be programmed for complete shutdown where all zones of control are maintained at setback levels, or for special days requiring the partial shut down of the facility. In addition, each of these holidays can be designated as a single date or a range of dates**.**

Yearly Scheduling: Any number of control points can be assigned to special yearly scheduling routines. The operator may enter schedules for these control points for any date during the year. These schedules operate in conjunction with the normal daily or holiday schedule. Once these have passed and the schedules have been implemented, the dates and schedules are erased. Unlike the Holiday Programs, these special schedules do not repeat on the same date next year. This feature allows convenient scheduling of special, one time events in the facility.

Schedule duplication features allow for copying schedules from point to point or from day to day. This eliminates repetitious data entry for multiple days/points with the same schedule.

Demand Shedding: Demand shedding can be based on a single electrical meter or multiple meters. All system loads can be assigned to the appropriate meters and maximum demand limits can be programmed for each of these meters. The operator also has the ability to specify the order in which equipment is to be shed and to identify any given control point as a "round-robin" shed point (first off-first on), a "priority" demand point (first off-last on) or a "temperature" shed point (load closest to setpoint is shed first). Other operator selectable parameters per control point include Rated KW, Minimum Shed Time, Maximum Shed Time and Minimum Time Between Shed.

Minimum ON - Minimum OFF Times: The system has the ability to turn equipment on and off based on temperatures, schedules, duty cycles, demand limits and other environmental parameters. However, mechanical equipment often is specified to run for a minimum amount of time once started and/or remain off for a minimum amount of time once shut down. Therefore, the Elemco system gives the operator the ability to enter these minimum times for each piece of machinery controlled. This can be especially critical in compressor operation.

Duty Cycling: Any given control point can be designated for either temperature compensated or straight time dependent duty cycling. Control parameters for temperature compensated duty cycling include Total Cycle Lengths, Long and Short Off Cycles and Hi and Low Temperatures. There are separate sets of parameters for both heating and cooling. Time dependent duty cycling uses Total Cycle Length and Off Cycle Lengths. Cycles for each load can be programmed in two minute increments and are based on a selectable offset from the top of the hour.

Optimum Start/Stop: For both heating and cooling seasons, the system provides customized optimum start/stop routines which take into account outside temperature and inside zone temperatures when preparing the building climate for the occupant or shutting the facility down at the end of the day. During unoccupied hours (typically at night) the software tracks the rate of heat loss or gain and then utilizes this data when deciding when equipment will be enabled in order to regain desired climatic conditions by the scheduled time of occupation. The same logic is used in reverse for optimum stop. (Note: Some types of loads are not viable candidates for optimum stop.)

Heating Control: Building low temperature limits for nighttime, weekend and holiday hours, as well as parameters and limits for normal occupied operation are user selectable. Night set back is programmable to evaluate outside air temperature in the algorithm.

Air Conditioning Optimization: Air conditioning is balanced and controlled considering the following factors:

Date (user selectable start and stop dates)
Time of day
Temperature (outside and inside zone temperatures)
Electrical load (staggered start ups & cycling)
Short cycle protection (user selectable minimum on and minimum off times)
Free Cooling (based on Enthalpy and/or temperature comparison)

Also, just as the heating mode uses night set back to maintain minimum temperatures during unoccupied times, the cooling algorithms maintain a maximum set up temperature, if desired.

Manual Override: Manual override schedules can be programmed to allow for direct control of building machinery for specific periods of time. Loads are assigned as candidates for manual override via the system configuration editor. Once the manual override ends, the controlled devices are released to normal system control by programmed sequence of operation.

Duty Logs: The software tracks and displays various types of information; last time on, last time off, daily machinery runtimes, temperatures (or other analog input), kWh and even remote panel hardware performance.

The system accumulates monthly runtimes for each piece of machinery controlled or monitored. This can be displayed for any month and any piece of equipment. Machinery runtimes are divided into occupied and unoccupied categories. The occupied times are those runtimes which occurred within the scheduled "on" periods. Unoccupied times are runtimes accumulated during optimum start, manual override, temperature set back or tenant override equipment operation.

Temperature, and other analog information can be displayed in either graphic or table format of historical trends. Hard copies of displayed data can be made instantly.

Changes of state are logged for all loads and can be reviewed for any time period for selected groups of loads.

Energy consumption logs are kept separately for every pulse metered point. For kWh, these energy logs record data (by the day) such as KW demand peak, time the peak occurred, selected demand limit, day's usage, time that any load was in shed, minimum, maximum and average outside temperatures and degree day information. kW demand profiles can be graphed and printed as needed.

Alarm Reporting: The ELEMCO System workstation registers alarms, displays them on the screen and records them on disk for the following conditions:

1. Manual override of machinery at the remote location.
   Example - If a piece of equipment has a Hand/Off/Automatic switch that has been left in the Hand position and the equipment fails to comply with the automation system's STOP command.

2. Equipment failure
   Example - If a piece of equipment is given the "GO" command and does not start.

3. High temperature (user selectable)
   Example - Each temperature point is assigned a user selectable upper limit. If the reported temperature exceeds this limit, the high temperature alarm will be activated.

4. Low temperature (user selectable)
   Example - Each temperature point also has a corresponding lower limit. If the temperature drops below this limit, the low temperature alarm will be activated.

5. Invalid temperature (sensor is being tampered with)
   Example - If the rate of change of a sensor is very rapid, an invalid temperature report may be the cause. If an attempt is made to fool the system by putting something cold or warm on the sensor, then the rate of change will be too fast, causing an Invalid Temperature alarm to be activated and the temperature reading to be disregarded.

6. Communications problem
   Example - If an answer from a remote location/panel/controller is not received within a specified period of time, the “No Respnse” alarm will be activated.

7. Disk full
   Example - If the hard disk has less than a user selectable amount of free space available, the Disk Full alarm will display.

All alarms are displayed on the screen and an alarm history is maintained on disk. Audible alarm signals and/or automatic printing of alarms as they occur can be activated by a simple configuration. If desired, output events such as alarm lights, emails, pages or telephone dial outs can be incorporated into the system.

After-Hours Overrides & Billing: For multiple tenant, commercial facilities, the "ENERGY EXECUTIVE III"® can provide after-lease-hours overrides controlled by the individual tenant and recorded automatically by the central controller with the addition of the “TENANT EXECUTIVE III”® module. The system will list the equipment for each tenant and the amount of time it ran for each billing period. The system can also separate lighting and HVAC loads.

If a piece of equipment is shared by more than one tenant and multiple overrides are requested simultaneously, usage will be allocated on a pro-rata basis. For example, if tenant #1 requests an override from 5:00PM to 7:00PM and tenant #2 requests the same equipment override from 5:00PM to 6:00PM, usage for the hour between 6:00PM and 7:00PM will be allocated entirely to tenant #1. Usage for shared loads for the hour between 5:00PM and 6:00PM will be allocated to tenant #1 and to tenant #2 based on relative square footage of tenant space.

Billing for after-hours consumption is handled automatically by the system and can be processed from a remote monitoring location through telecommunications. Charges can be allocated based on time of override, calculated consumption or actual metered consumption.

Power Failure/System Start Up: The software modules and data base are all stored on disk to prevent loss of the operating parameters in the event of a power failure. When the system starts, it first re-loads all the stored operating parameters and attempts an orderly restart of all controlled loads.

Control Algorithms: One of the key features of the EBC System is the ability to interface with the many types of environmental control equipment. The software utilizes various disk files as well as internal variable matrices to identify the control algorithms to be used for each piece of equipment.

The EBC System is a field proven, automated energy management system that combines state-of-the-art data acquisition techniques and user friendly, efficient software to provide optimum energy savings without compromising occupant comfort.

The system is composed of industrially proven components that have a history of reliability established through field testing and operating sites. Interfaces are available to control equipment from many manufacturers. (See separate list of hardware interfaces.) The software is flexible enough to accommodate the control and/or modulation of different types of equipment including fans, pumps, boilers, chillers, humidity control, VAV dampers, variable speed motors/starters, intake and exhaust dampers, heat pumps and lighting. The system is capable of interfacing standard operators such as pneumatic motors on dampers and valves or standard electric motors used for positioning (i.e. modutrol type). The software is custom configured from standard time-proven routines for each facility to guarantee optimal environmental control and energy efficiency.