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Presents planning considerations in selecting proper temperature control systems. Various aspects are discussed including--(1) adequate environmental control, (2) adequate control area, (3) control system design, (4) operators rate their systems, (5) type of control components, (6) basic control system, (7) automatic control systems, and (8) variables that affect system performance. (RH)

HONEYWELL PLANNING GUIDE

TEMPERATURE CONTROL

Man's own environment: The indoor air we breathe, work in, play in, sleep and eat in. We heat it, cool it, dry it, add moisture to it. It commands more of our attention each day. And well it should. Tests have shown that it affects our productivity, our attitudes, our safety, even the way we think and learn. In fact, the implications of indoor environment, the atmosphere we can control, are as practical and sophisticated as today's imaginative building architecture and its multiple uses. Today, environmental control design and application deserves the serious consideration of building owners, builders, engineers, and architects as well as control system manufacturers.

Choosing the proper environmental control system presents a quandary of choice for the commercial building owner or builder. A choice he is often not prepared to make. Generally, before a decision is made, he will rely strongly on the technical judgment of his consulting engineer. The engineer, in turn, must bring his training and experience to bear in making a recommendation for a certain type of system. To do this, he must understand the operation, application, benefits and weaknesses of the basic systems available. In addition, he must be able to judge design efficiency in relation to value offered by environmental control manufacturers. As a matter of practice, the consulting engineer must be capable of determining complete building environmental system needs and then suggesting the most efficient system to do the job.

The basic objective of any environmental control system is to maintain a correct balance between the heat removed and the heat added to a given area. The function of automatic control is to maintain this delicate balance by controlling the heat flow as changes in heat rate occur so the controlled temperature remains nearly constant. Success of the control system depends on the selection and application of the individual control components along with the proper design of the system itself.

Selection and application of a commercial temperature or environmental control system should be made only after careful study of the exact system requirements in terms of human, economic and mechanical factors. System performance based on these factors will, in turn, help determine the equipment and components selected.

This booklet includes an outline of some important factors that should be considered in the design of any temperature control system.

Heating or cooling systems are generally designed to meet maximum conditions yet, most of the time, they function at only partial capacity. This "portion of capacity" requirement forms the real burden of modern control systems. The ability to positively control an environmental system is probably the single most important factor in the design of the system. Control is the key to system efficiency and economy. For this reason, the proper use and application of controls should be considered at the time the heating and cooling system is being designed. Whenever possible design should facilitate efficient control operation.

The Human Factors

The right temperature in the right rooms at the right time for every purpose is no longer a privilege. With modern environmental control systems, it's a physical right, expected . . . even demanded . . . by employees, tenants, or customers who use commercial buildings on a daily basis. For all such buildings, temperature or environmental control is as essential to the effective use of the building as a solid foundation and adequate space. In new buildings careful control system planning can preclude expensive modifications later on. For existing buildings, efficient redesign can provide a modern, healthy environment.

People come in a range of ages, attitudes, preferences and have widely varying heat requirements. These facts are particularly well known to hotel and motel owners. Their problem is to keep people comfortable and happy, regardless of the weather. These particular commercial applications illustrate the basic universal control problem. Individual comfort can only be accomplished with individual room thermostats. As one owner has said, "If the little old lady in No. 6 wants her room hot as an oven, she can have it that way, and if the ex-halfback in No. 7 wants no heat at all, he can have it that way, too."

The Ideal System

The ideal environmental control system for any building is one that is capable of maintaining a desired temperature in each room at all times, regardless of location and occupancy. For schools, hospitals and offices individual room temperature control is the answer.

Control of the temperature in each room overcomes the problems involved in attempting to regulate the temperature of a building as a whole or of large areas or zones. Each individual thermostat controls the heat input to or heat removal from its particular area regardless of occupancy or exposure to sun and wind. The obvious advantage of individual room control is in fuel economy and comfort for the occupants. Each room should have a thermostat that controls all of the sources of heating and cooling.

Without individual thermostats, it is virtually impossible to heat or cool all units or areas the same and suit the requirements of each individual. In other words, there really is no such thing as an "ideal temperature". Without individual control, the coldest occupant in winter (or the warmest occupant in summer) will set the minimum requirements for your entire system. Occupants of other areas may have no choice but to open windows and dump valuable heating or cooling to the outdoors.

Too often the economies of minimum systems are lost through load imbalance. It may be necessary to overheat much of the building on windy days to meet special needs of exposed rooms. Similar and more costly wastes may occur with cooling in the summer. In any building, it is well to consider long-range operating costs before planning your system for short range economies. Even though the use of the building may not indicate the need for multiple zones, the added economies of operation will make a more complete system a wiser investment.

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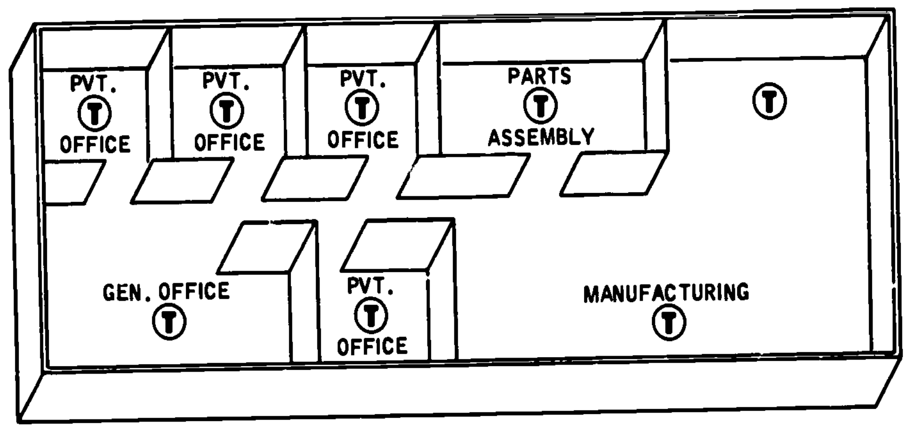
Because of the problems of adequate distribution and finding a location for the space controls, individual control areas should not be too large. A thermostat can measure conditions only at the point of location. It cannot adjust for uneven temperatures caused by improper distribution. Uniform temperature control demands good engineering design, care in the choice of equipment size and proper balancing of the system. Areas having dissimilar load characteristics or different conditions to be maintained, should be individually controlled. And, the general overriding rule should be: the smaller the control area the better.



The Zone System

Zone control is the use of one set of controls to regulate the heating or cooling effect in a number of adjacent rooms or areas having similar size or occupancy.

Overall zone control of the basic system even with individual room control may be desirable for certain system designs.

This means the zone system must bear an important part of the control burden while individual room controls make final adjustments for more accurate space control. Certain factors should be considered in determining the number and arrangement of zones:

1. Exposure: the effects of sun, wind and the shelter of nearby buildings.
2. Occupancy: temperature requirements for various activities and times of occupancy.
3. Construction: the structure of the building will determine how the system will be divided into zones.
4. Floors: even though several floors have the same wall exposure, it is advisable to have separate zones on the lowest and highest floors, due to variations of basement or ground floor requirements and the effect of roof exposure. A separate zone or zones is also desirable for intermediate floors.

Initial investment often influences the decision on the final number of zones to be used. In larger buildings, at least one zone for each exposure is common. For higher buildings, each exposure may require subdivision vertically into two or more zones. Wings may require more restrictive zoning. When the street floor or any other portion of the building is used for public occupancy or activities which differ from those carried on in the remainder of the building, it is wise to provide separate thermostats and controls for each individual area.

Zone controls alone may not provide satisfactory temperature conditions in all rooms or areas within the zone because occupancy factors cannot always be accurately predicted. A combination of zone controls and individual room controls in strategic areas may be necessary for complete satisfaction.

The Economic Factors

Sound economics suggests the selection of equipment to fit the application. The designer of the system and its controls should take into consideration the nature and type of building in which they are used and the desired results. This means the simplest system which will produce the necessary results is usually the best.

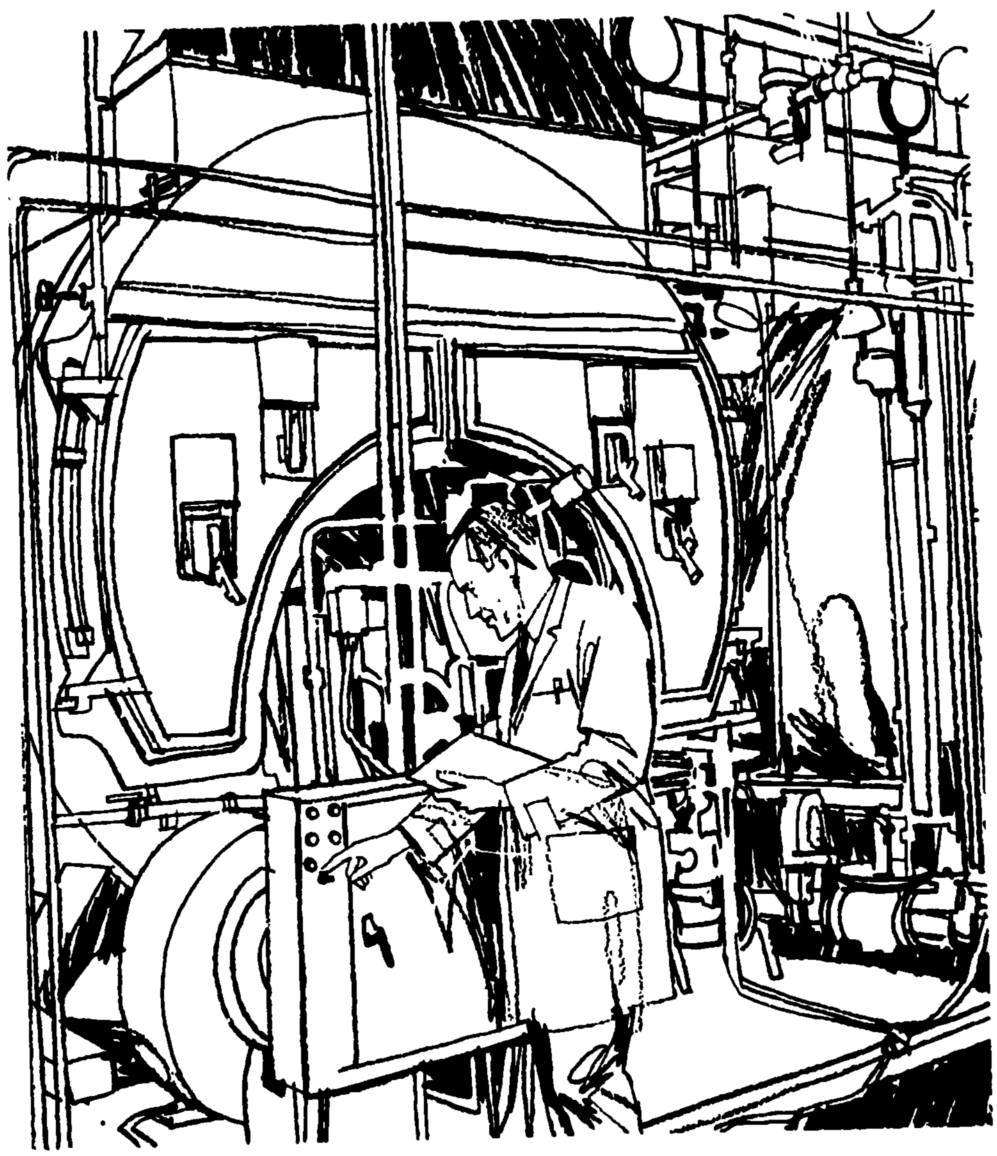
Quality of the control equipment should be consistent with the accuracy of the control desired. Controls can be made to produce almost any degree of accuracy. When results more precise than normal are required, as in the case of certain manufacturing areas, constant temperature rooms and the like, both the air conditioning system and the controls system should be given special consideration so the required results can be produced.

It is neither good practice nor economical to select equipment capable of producing far more precise control than the application requires, or to complicate the system to obtain special sequences or cycles of operation when they are not necessary. Likewise, it is false economy to select a system which will not produce results demanded by the use of the building.

Current standards of comfort combined with the rapid response of modern heating and cooling equipment, mean that an air conditioning system must be considered as an integrated control where each component plays an important part in the overall performance. A basic performance criterion includes: (1) system stability; the absence of excessive periodic temperature changes; (2) control offset, the minimum difference between the desired temperature and the actual temperature under normal conditions; and (3) system response, the ability to correct rapidly for system disturbances.

A leading industry magazine asked building operators across the country not long ago to assess their automated control systems. Response, in general, indicated a high regard for existing systems and their performance.

However, some specific and significant control system weaknesses and recommendations were revealed by the survey.



The Value of Adequate Control

Far too often cost factors interfere with efficient design. In an effort to cut initial mechanical system costs, quality and accuracy of control may be impaired. The survey points out that it is the responsibility of the designer to motivate his client to install the best control system available for his operation. In other words, the air conditioning system is only as good as the control system. Operating efficiency, economy and reliability should be the primary considerations. Initial cost should be secondary.

The Design of Adequate Control

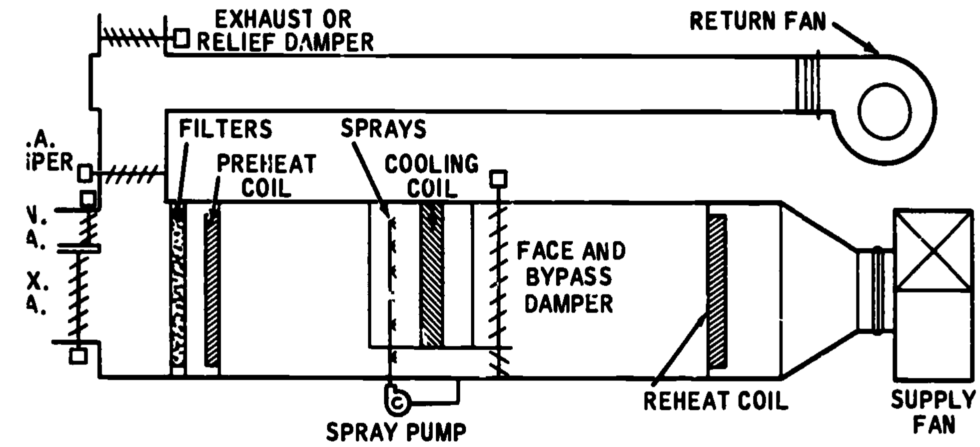
The total design of the building and the design of the air conditioning system may not be properly matched. This places heavy demands on the automatic controls and has led to many problem areas that could have been eliminated if a more complete study of the system in relation to the building design had been made.

The Cost of Adequate Control

In most new buildings only a minor percentage of the total cost is invested in the automatic controls for heating, air conditioning and ventilating systems. Yet, when the building is occupied, the automatic control system can cause 90% of all the complaints by the building's occupants and the building owner. In effect, the difference between a marginal system and an adequate system would be less than half of 1% of the total building cost.

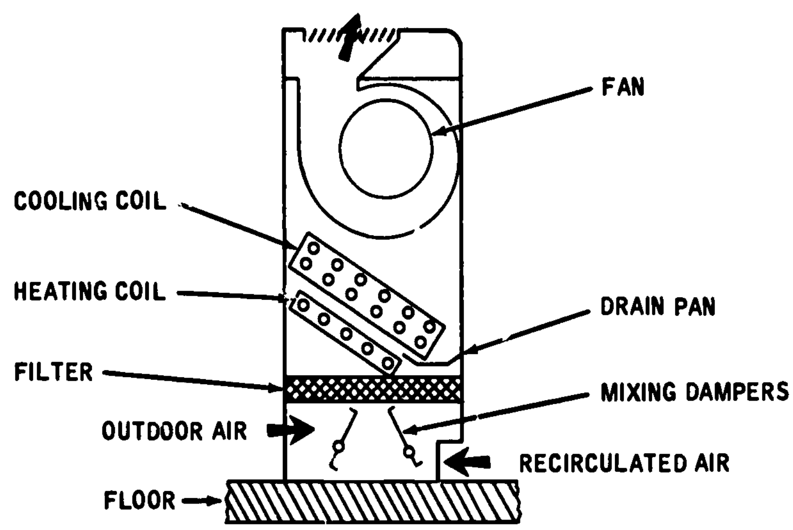
The Mechanical Factors

In making his decision about the basic type of control components for a system, the building owner must consider many factors. For example, he must consider standardization of requirements, the type and background of the maintenance personnel available, and his preference for an individual manufacturer's equipment. He may be limited to a specific appropriation making it impossible to choose the system with the greatest engineering advantages. He must also temper his decision with his engineer's original study of the performance and operating requirements making sure that they are satisfied. He must then decide on the complexity of the control system from engineering recommendations. Basically he must choose components to control one of several air distribution systems in common use in commercial environmental control applications.



Central Fan System

A central fan system is essentially a one zone system which provides the convenience and isolation of equipment located outside occupied space. It may be installed in a basement or service area of a commercial building, or in the truss space of a factory. It can be located adjacent to the heating and refrigeration equipment, or at a distance from it using circulating chilled water, hot water or steam.

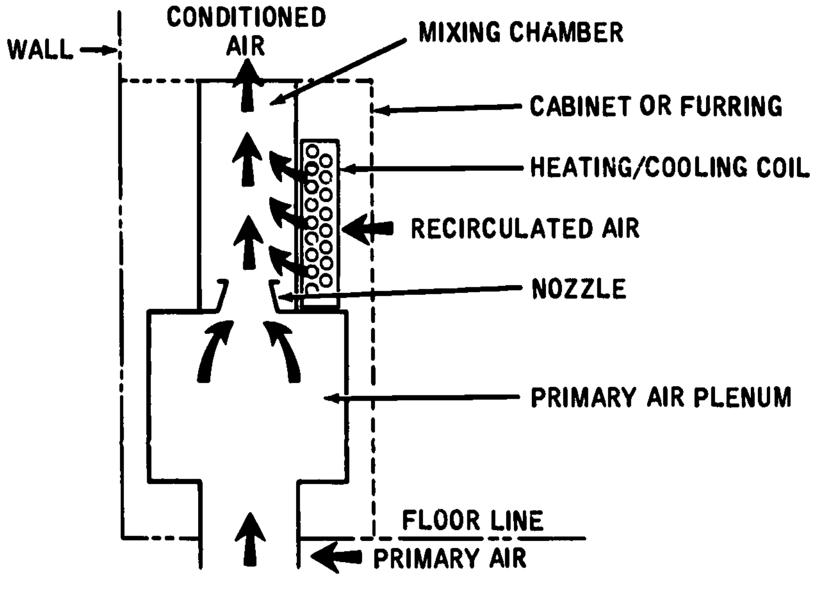


Unit Ventilator System

A heating unit ventilator is an assembly of components: fans, motors, a heating element, dampers, filters and outlet grilles (or diffusers).

Its function is to heat, ventilate, and cool a space by bringing in outdoor air and mixing it with air in the room. The heating medium may be steam, hot water, or electricity.

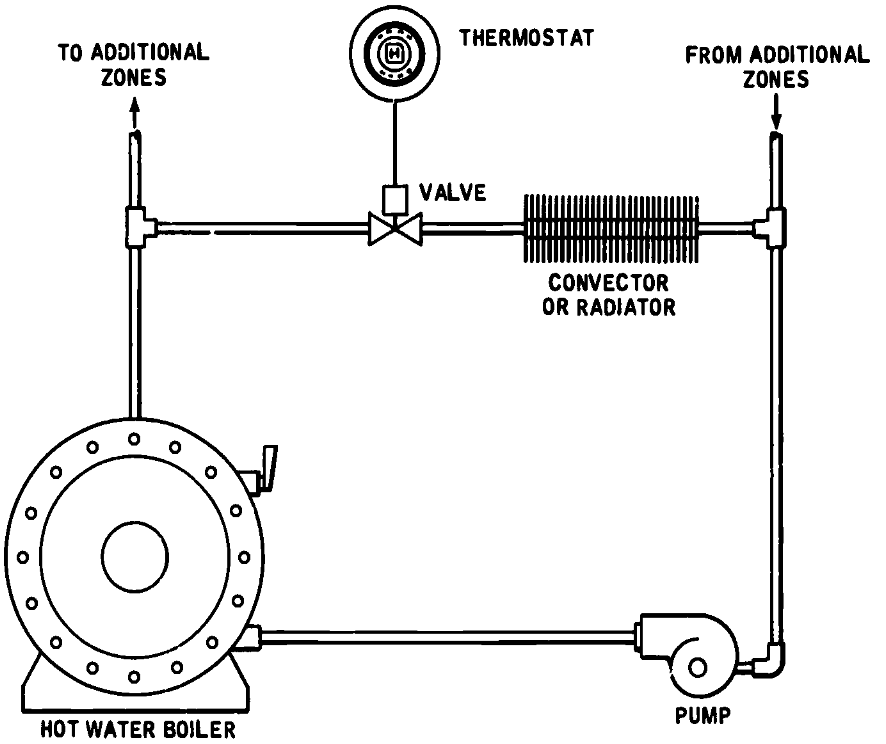
A cooling unit ventilator is similar to a heating unit ventilator but in addition to the normal winter season function of heating, ventilating and cooling, with outdoor air, it is equipped to cool and dehumidify during the summer season. It is usually arranged and controlled to introduce a fixed quantity of outdoor air for ventilating during warm periods with a combination of hot water and chilled water coil or, alternately, with a chilled water or direct expansion coil used with a separate heating coil. The unit ventilator system is particularly suitable for use in schools and colleges.



All Air Induction Unit System

The all air induction unit system provides individual room temperature control and permits draftless air circulation and smaller ductwork than required by conventional systems. Conditioned, low temperature air is supplied to the induction unit where it mixes with room air that is heated as it passes over the unit coil, and is discharged into the room at a temperature and velocity which satisfy room requirements. Room temperature is controlled by regulating the flow of steam or hot water through the coil.

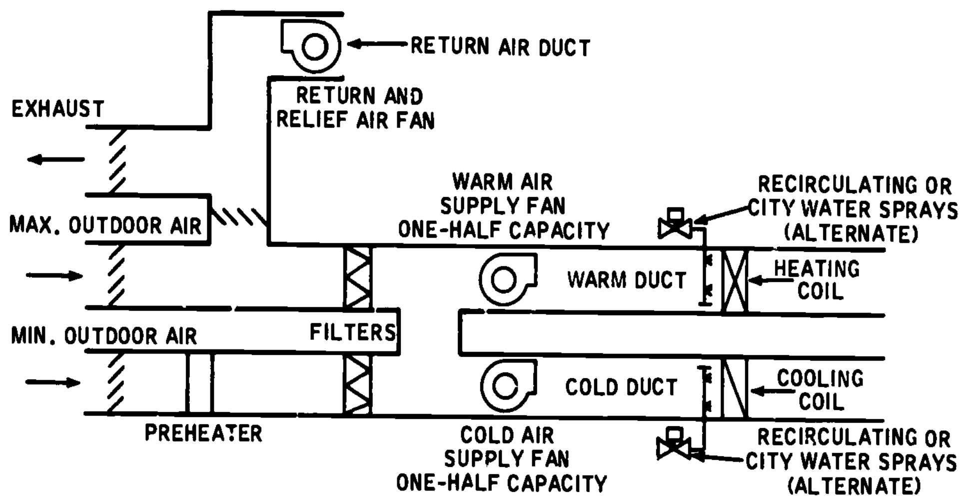
The all-air induction system is now being effectively applied in laboratories, motels and office buildings. In office buildings it provides a heating and ventilating system which can, at a later date, be converted to complete air conditioning with small additional expense other than the refrigeration equipment.



Radiation System

Radiation systems are used for heating only. They may be the principal source of heat but more frequently they serve as a supplemental source with air systems such as mixing boxes, central air systems and the like to eliminate cold wall effect. Radiation systems usually take the form of baseboard or wall units positioned under windows. They may be controlled individually with a thermostat in each room or with zone control. Hot water is the heating medium. Radiation systems have a wide range of applications and they are in general use in all types of commercial buildings.

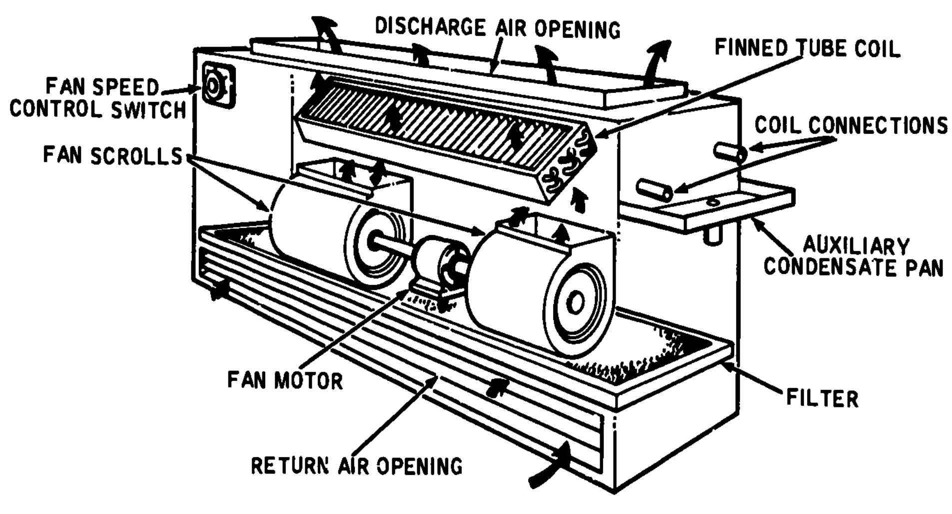
The components of a radiation baseboard heating system are shown above. A pump moves hot water from a boiler to the radiator in the baseboard unit. A signal from the thermostat increases or decreases the amount of water to the radiator.



Dual Duct System

The dual-duct system conditions all the air with central heating/cooling equipment and distributes it to the conditioned spaces through two parallel mains or ducts. One duct carries cold air, the other warm air. This provides air sources for both heating and cooling at all times. In each space or zone, a mixing valve responsive to a room thermostat mixes the warm and cold air in proper proportions to satisfy the requirements of the space.

The dual duct system of air conditioning is efficiently applied in structures requiring a multiplicity of zones, such as office buildings, hotels, schools, apartment houses and hospitals. The requirements of different zones are met by mixing cold and warm air in a device responsive to a room thermostat. A return duct carries air from the room back to the central unit for recirculation.



Fan Coil System

The fan-coil unit system is primarily applied to air conditioned perimeter areas. Proper temperatures within the space are obtained by use of terminal units called room fan-coil air conditioners. The basic elements of these units are a finned-tube coil and a fan section. The fan section recirculates air from within the space through the coil which is supplied with either hot or cold water. In this way the recirculated room air is either heated or chilled. Fan-coil units are also available with both a heating and cooling coil which provides heating and cooling at all times.

The recirculated air is filtered as it is drawn into the unit enclosure. This improves the sanitation within the space and protects the motor and coil from becoming plugged with dirt, lint, and other contaminants.

Fan-coil units can remove moisture and ventilate the space with air drawn through an aperture in the exterior wall. The chilled water and hot water piped to each fan-coil conditioner is supplied from central heating and cooling equipment. The system may be centrally changed from hot to chilled water, or both may be supplied simultaneously for selection at the individual units.

In addition to supplying each fan-coil conditioner with water, electrical circuits must be provided to operate the fan motors. Automatic control of fan speed or water flow is commonly used to insure proper room temperature.

The greatest advantage of the fan-coil system to building owners and consulting engineers is its flexibility for adaption to many building requirements.

The Mechanics of Environmental Control

While the variations and styles of available temperature control systems appear to be virtually unlimited, it is possible to group them into three general categories:

Pneumatic, Electric and Electronic

Each can be used alone or in combination. In other words, pneumatic or electric power can be used alone or in various combinations to position the dampers, valves and switches that regulate temperature balance in a temperature control system.

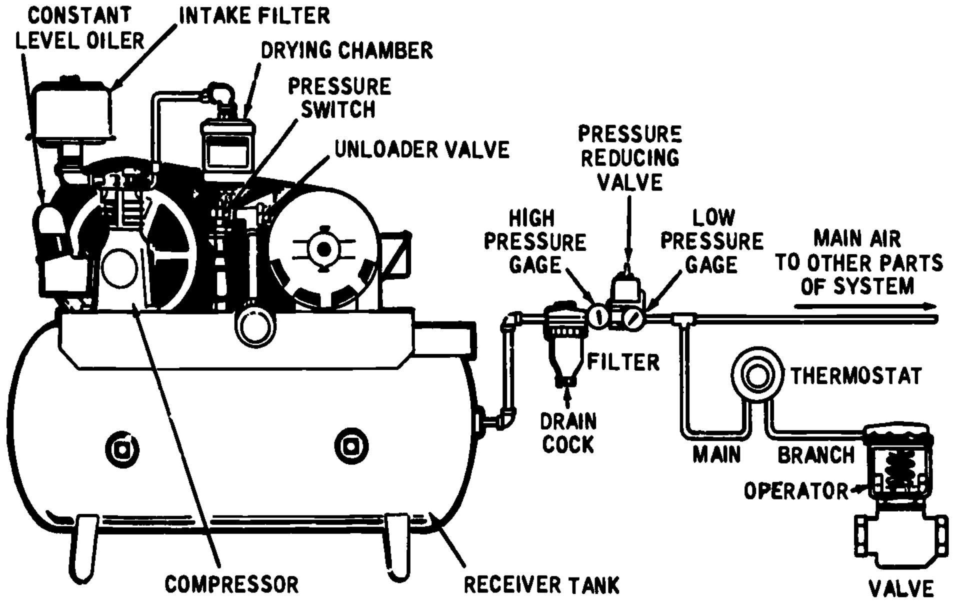
Pneumatic Control

Pneumatic control uses compressed air to supply the power for operation of the valves, dampers, relays and other devices in the system. Circuits consist of air passages, valves, orifices, and similar mechanical devices. Pneumatic control systems are presently used in most large commercial buildings.

Features of pneumatic control are:

1. A variety of control sequences and combinations can be had by using relatively simple equipment.
2. Pneumatic equipment requires little maintenance and is highly reliable.
3. Pneumatic equipment is suitable where explosion hazards exist.
4. In large installations, pneumatic equipment is usually the lowest-cost system.
5. Adjustment and indication are possible at a central location and controllers may be mounted where accessible.
6. Pneumatic equipment matches heating and cooling output to needs by true modulation of valves and motors.

Pneumatic Control System



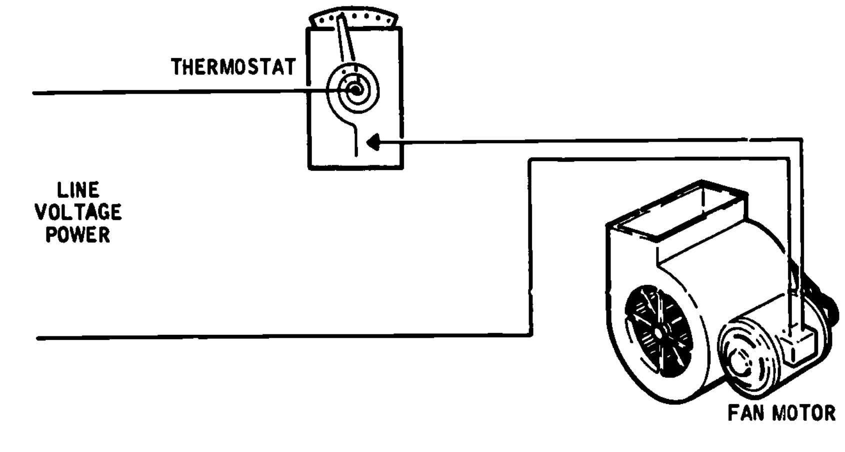
Pneumatic Control System Components

The components of a typical pneumatic control system are shown on the left below. The source of air is an electrically driven compressor. Air is supplied to a storage tank which stores air until it is needed by the control equipment. Before passing into the air main, the air is filtered and dried and the pressure is reduced to a proper value by the pressure reducing valve. Next, it flows through the air main to the controller (thermostat) and to other controllers, relays and operators of the system.

Electric Control

Since all buildings have electricity, it is natural that electric power should be used for many automatic control functions. In electric control systems, the thermostats and electric limit controls sense changing temperature and then operate electric motors controlling dampers and valves and other operations in the system.

Electric Control System



Electric Control System Components

One of several basic electric control circuits, the components of a Honeywell 40 circuit are shown above. When the controller switch is open, current is cut off from the valve, motor relay or other controlled device. When the controller switch is closed, the control device is energized.

Features of electric control are:

1. Electric wiring is usually simple and installation is well understood by virtually all electricians.
2. The impulse received from the thermostat can be applied directly to produce one or several combinations or sequences in electric output. For this reason, one actuator can be made to perform several desired functions.

3. Operations and maintenance of electric systems is simple and easily mastered by building operating personnel who have electrical backgrounds.
4. It is the most simple and direct system for controlling electric devices such as pump motors and compressor motors.

Electronic Control

The basic difference between electric and electronic control is in the sensing devices. Electric thermostats employ switches, but electronic thermostats have *no* moving parts. They sense temperature changes electronically with great accuracy and speed of response. Electronic signals operate relays which operate electric valves, damper motors or other units in the system.

Electronic control systems may be used in the control of all types of heating and air conditioning equipment in commercial buildings.

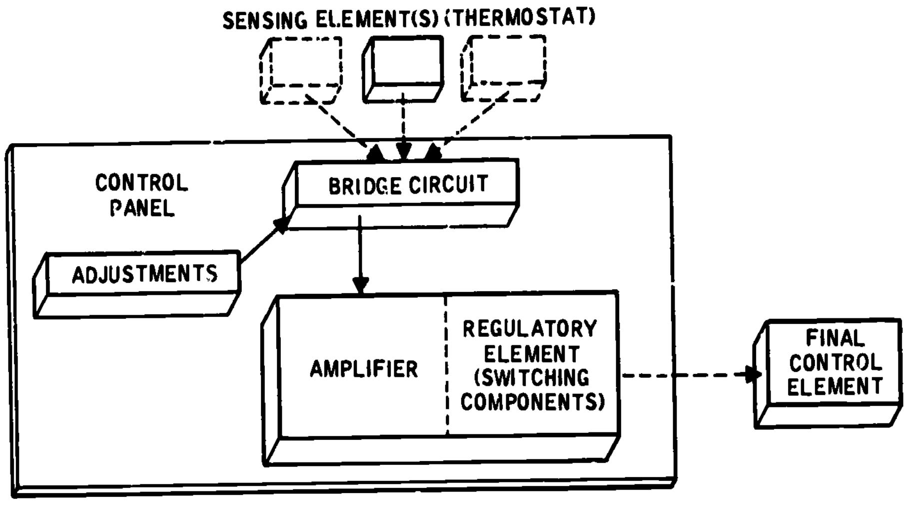
This type of system features:

1. Reliability and long life. The thermostats or sensing elements have no moving parts, nothing to wear out or maintain. They provide dependable operation. Their low mass provides speedy response to local changes. Modern electronic controllers use solid state components—the ultimate in reliability.
2. Central control. The regulator element of the controller or controlling mechanism is usually located remote from the thermostat. This means all adjustments may be made at a central location.
3. Simple, low-voltage connections between the sensing element and the electric circuitry. In many applications this means that wiring may be accomplished without using expensive conduit.
4. Flexibility. Depending on the job requirements, electronic circuits can be combined with either electric or pneumatic circuits to give efficient results, results which ordinarily cannot be achieved using only one type of control.

In addition, electronic circuitry can coordinate temperature changes from space thermostats, and/or remote temperature selectors such as the discharge-air thermostat or the outdoor-air thermostat to provide a degree of stability and convenience of adjustment otherwise unattainable.

Automatic changeover from heating to cooling or automatic use of ventilation will carry out part of the cooling load. Other types of sequencing can be provided from one thermostat.

Electronic Control System



Electronic Control System Components

The components of an electronic control system are shown above. Temperature changes at the thermostat unbalances the bridge circuit. This results in a voltage increase by the amplifier to activate the controller. The activated relays will mobilize one or more final control elements to bring the temperature back to the thermostat setting.

Combination Control

Pneumatic, electric and electronic systems are often combined for certain commercial applications.

Pneumatic-electronic transducers (which translate electronic signals to pneumatic signals) make it easy to coordinate operations and take advantage of the best features of each type of control. For example, you may use the speed and sensitivity of electronics in critical areas and for remote indication.

You may use electric controls to tie in with operation and switching of electrical systems. And, you may use the smooth operation and power of pneumatic controls for positioning large dampers and valves. Any or all of these three types may be used in combination in any proportion to give your building the features you want with maximum economy.

Central Control

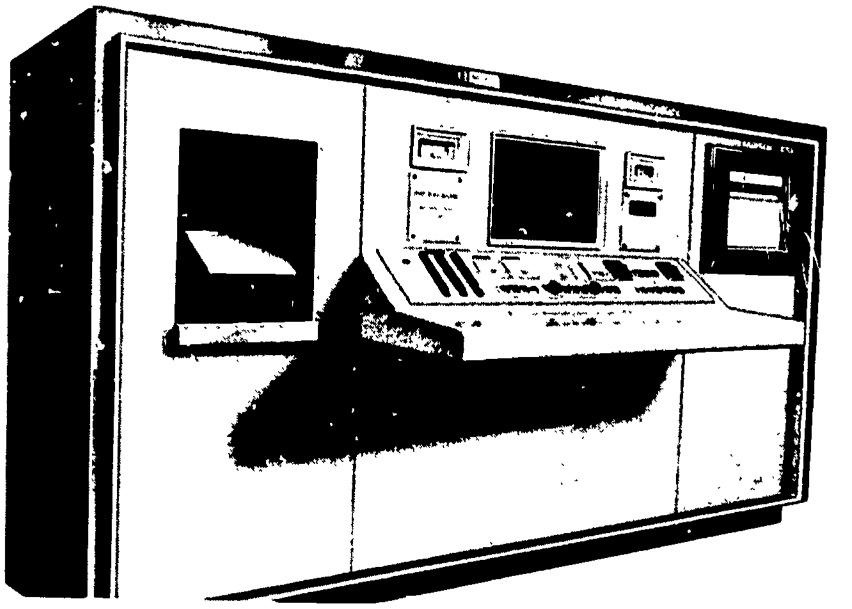
The concept of centralization and automation of building control systems began as true centralization or the removal of controls and indicating instruments from equipment areas and other remote locations and bringing them together at a central point or console.

Refinements of the central panel include loggers, scanners and viewing screens to give the operator an accurate evaluation of system operation especially with respect to malfunctions and off-normal conditions. Based on this information, the operator would control the mechanical system from the central panel.

Two basic considerations in the choice of an automated central control system are the complexity of the air conditioning system, which is most often a function of the building size, and the number of variables the control system must accommodate. The larger the building, and the more variables such as temperature, humidity, air flow, pressure, the greater the system size. This need for greater capacity in recent years has led innovators to control system circuitry that has increased its capability enormously while at the same time making the central panel itself much simpler to read and operate.

Determining the exact control needs of a building, then matching them with the appropriate system is a key step in a building automation program. Moreover, each system selected may require further tailoring to match it precisely with individual building needs.

Honeywell provides components and complete consoles for all levels of automated central control systems used today.



The use of each area in your building will automatically create certain temperature demands. Early planning for the needs of each area is important so all desirable features for temperature control can be included. This chart is designed as a helpful aid for early planning and later review with your consulting engineer. Check each applicable blank on the chart to indicate the features you want.

Outline of basic system requirements by application	Individual Control — Temp. Selection: Local	Individual Control — Temp. Selection: Central	Zone Control — Temp. Selection: Local	Zone Control — Temp. Selection: Central	Temperature Limits To Be Maintained: ±10°	±8°	±6°	±4°	±2°	±1°	Centralized Indication And Control	Off Hours Operation Occupants Option on Central Control Only
CONFERENCE ROOMS												
INDIVIDUAL OFFICES												
HALLWAYS												
LOBBIES												
STORE ROOMS												
REST ROOMS												
PRODUCTION ROOMS												
LOCKER ROOMS												
SHIPPING AREAS												
PRINCIPAL TRAFFIC AREAS												
HOSPITAL ROOMS												
OPERATING ROOMS												
SPECIAL CARE AREAS												
OUTPATIENT AREAS												
EXERCISE AREAS												
WAITING ROOMS												
EXAMINATION ROOMS												
CORRIDORS												
CLASSROOMS												
PROJECTION ROOMS												
STUDY HALLS												
LIBRARY												
LUNCH ROOMS												
GYMNASIUM												
SHOWER ROOMS												
SPECIAL PURPOSE ROOMS												
BASEMENTS												

Honeywell controls may be purchased in three ways:

- Your contractor can buy the controls and apply and install them himself;
- They can be furnished as part of factory-built air conditioning units;
- Or, your contractor can purchase the complete control system including installation or supervision directly from a nearby Honeywell Branch Office.

The complete control system installed or supervised directly by Honeywell (described below) is your assurance of satisfactory comfort levels and performance the year around.

Honeywell insures system performance that meets exact specifications:

a. Equipment and components are ordered to meet performance specifications.

b. The delivery of equipment to the building site is administered on a scheduled basis.

c. Installation of control wiring, air piping, and equipment in a professional, efficient and economical manner (under an optional program, Honeywell will furnish diagrams for wiring and electrical control equipment installed by others.)

2. Calibration and adjustment of all automatic controls to assure proper operation.
3. Service performed as required under the terms of Honeywell's automatic control system guarantee without charge for a period of one year following installation.
4. An optional Honeywell Maintenance Contract that provides preventive maintenance services and emergency service on the automatic control system beyond the one year guarantee period.


Honeywell

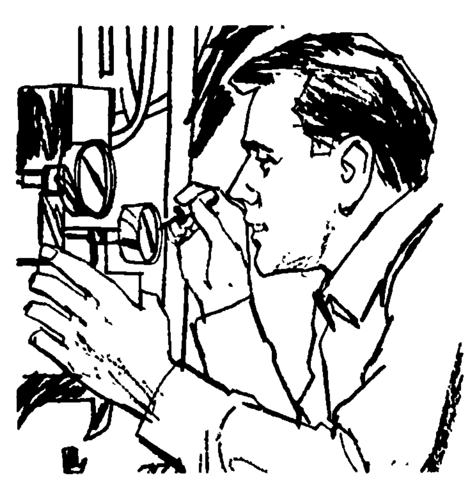
When the consulting engineer makes his recommendations to the building owner and submits specifications for a system design, the environmental control of a building has been shaped. But three important variables remain which can seriously affect the success of control system performance.

Selecting the Right Equipment

Honeywell assures the consulting engineer that his specifications will be faithfully carried out according to detail with certified products and workmanship.

Installation and Adjustment

When an automatic control system is installed by Honeywell, it is done so that all components will work in harmony with each other right from the start. Quality control includes piping, calibrating and adjustment of the working control system to insure that it is operating at optimum efficiency.



Service

Honeywell automatic control systems are guaranteed and serviced for one year. In addition, if the building owner chooses to select a Honeywell Preventive Maintenance plan to take over after the guarantee period, Honeywell automatic control specialists are available to keep the control system working at peak efficiency. They have the tools and test equipment to help them complete each job efficiently . . . and keep the system operating effectively.

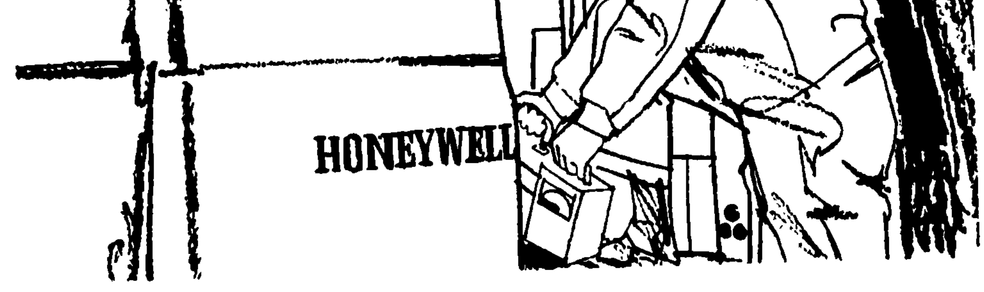
Systems Control Counsel

You and your engineer can take advantage of Honeywell's specialized help in fitting controls to your building needs. At your disposal is the free counseling assistance of the world's largest manufacturer of automatic controls.

Complete Control Systems

Honeywell is the only control manufacturer with a complete line of matched pneumatic, electric and electronic and centralized controls and systems for heating, ventilating and air conditioning, along with Honeywell manufactured industrial instrumentation, MICRO SWITCH switches, computers, fire detection and alarm systems, security and surveillance systems as well as clock programming systems. In fact, Honeywell offers components and complete systems for every practical control and supervisory function of any commercial building.

As specialists in these systems, Honeywell engineers are in a position to offer complete system know-how that pays off in better performance. You can also be sure of nearby service through Honeywell offices in major cities. Honeywell will help you train your own personnel in operation and service. Or, you can arrange for Honeywell to maintain your control equipment for you. In every way from design to operation, Honeywell backs every product and system.

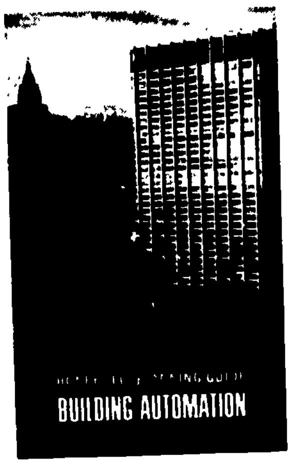


Whatever your building requirements may be, Honeywell can provide technical assistance, systems and components in these technologies:

Building Automation
Temperature Control
Security
Fire Detection
Equipment Surveillance
Clock Programming System

In addition, Honeywell provides all supporting services, such as maintenance programs and personnel training in the operation of these systems.

For a thorough discussion of exactly what Honeywell's capabilities can mean to you and your building, call your local Honeywell Commercial Division Branch Office. Honeywell is listed in the Yellow Pages under "Controls, Control Systems & Regulators." Or if you prefer, write to Honeywell, Commercial Division, 2701 Fourth Avenue South, Minneapolis, Minnesota 55408.

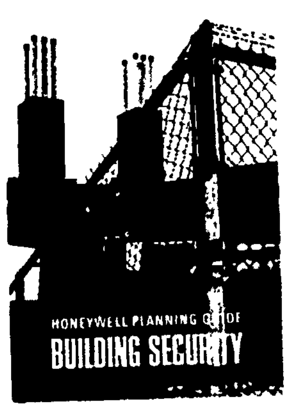


Form Number 54-0347

This booklet presents a basic discussion of the functions, benefits and economic advantages of various types of automation systems for commercial and institutional buildings.

Form No. 54-0350

This guide on maintenance for automatic control systems and mechanical systems tells how a scientific maintenance program can prevent costly, unexpected building system failures.



Form Number 54-0349

This booklet reviews building security systems designed to protect areas, buildings or objects from burglars, intruders and fire. Also discusses the technology of these systems and equipment monitoring.

Form Number 54-0362

Explaining the reasons for and approaches to fire protection, this booklet compares the advantages of watchmen and various automatic systems.