ENGINEERING GUIDE FOR ENVIRONMENTAL CONTROLS

1. GENERAL

1.01 This section provides guidelines for the design of building environmental local control systems and centralized monitoring/management systems. Design standardization of these systems will facilitate operation and maintenance activities.

1.02 Whenever this section is reissued, the reason(s) for reissue will be stated in this paragraph.

2. APPLICATIONS--TELEPHONE SWITCHING EQUIPMENT SPACE

2.01 The environmental requirements of electronic switching machines generally call for an operating range from 40° to 100°F with humidity levels between 20% and 55%. There are exceptions, however. Refer to the equipment manufacturer's recommendations for specific environmental requirements.

2.02 Wide band temperature operation is recommended for most telephone equipment space. This method of control specifies that building spaces will not be heated above 65°F or cooled below 80°F. Between these limits the temperature is allowed to drift. (See section 7 for detailed operation of typical wide band temperature controls.)

2.03 Fans are operated only when required to supply heating or cooling (that is, fans are thermostatically cycled).

2.04 Continuous fan operation is permitted for #4ESS, special ventilation needs, or special equipment cooling requirements. Other exceptions are offices that have excessive dust related problems such as may be experienced during dust storms, building alterations, or equipment installations.

In these cases, continuous fan operation is recommended until the dust generating activity is completed or the dust infiltration problem no longer is present.

2.05 Tests indicate that the air-handling system air filters will remove dust particles and help reduce dust concentrations during the previous stated extreme conditions.

2.06 Ventilation air: The ventilation air requirements for a central office are small because of the low occupancy load. Field experience with existing buildings indicates that in most cases leakage air provides adequate ventilation. For that reason the control schematic (Exhibit 1) does not include a minimum position or ventilation air damper. If your codes require that you provide minimum ventilation air, you will have to modify the control description. Keep in mind that most ventilation codes require ventilation only when people are occupying the building.

3. TYPES OF AUTOMATIC CONTROL SYSTEMS

3.01 Environmental control systems may be either electric, pneumatic, electronic (utilizing micro-processor based direct digital control loops), or a combination of these types of controls as economic special conditions dictate. Electric and/or electronic systems are generally more appropriate for smaller buildings. Larger buildings with more than 15-20 actuators for valves and/or dampers are candidates for either pneumatic or combination electronic-pneumatic systems.

3.02 Pneumatic control is inherently adaptable to modulating operation, and positive positioning of dampers and valves is simple, economical, reliable, and requires less maintenance than electric actuators.

3.03 Electronic control may be effectively used for all types of heating and air conditioning equipment in commercial buildings and is frequently used in residences.

3.04 Electronic (micro-processor based) automatic control offers a number of advantages which should be considered if automatic control equipment is to be selected for new buildings, or if existing heating or air conditioning systems are to be modernized with automatic temperature control. These advantages are:

(a) The sensing elements of electronic controllers have a simple construction. They have no moving parts and therefore provide dependable operation. Their low mass provides speedy response to load changes.

(b) The regulatory element, i.e., the micro-processor, is usually some distance from the sensing element(s). Such an arrangement has these advantages: (1) all adjustments can be made at a central location, (2) the central location may be an area which is cleaner than those areas in which the sensing elements are located, and (3) temperature averaging can be easily accomplished by wiring two or more sensing elements in series and connecting the series arrangements to the regulatory element through electric and electronic circuitry.

(c) Only simple, low voltage connections between the sensing element and the electric circuitry are required.

(d) Electronic control systems have the advantage of flexibility. Electronic circuits can be combined with either electric or pneumatic circuits. Electronic circuitry can coordinate temperature changes from (1) space thermostat(s) and/or a remote temperature selector, (2) the discharge-air thermostat, and (3) the outdoor-air thermostat to provide a degree of stability and convenience of adjustment otherwise unattainable. For temperature averaging in a wide duct, inexpensive elements are available. Wide band operation with automatic changeover from heating to cooling and automatic use of ventilation or other types of sequencing can be provided from one thermostat without the use of interlock.

4. AUTOMATIC DAMPERS

4.01 Modulating control dampers should be equal to the following specifications:

(a) Control dampers shall be of opposed blade construction and properly sized for linear flow output.

(b) Damper frames shall not be less than 13 gage galvanized steel formed for extra strength with mounting holes for flange and enclosed duct mounting.

(c) All damper blades shall not be less than 16 gage galvanized steel roll formed for high velocity performance. Blades on all dampers shall not be over 8" wide.

(d) Blade bearings shall be nylon with 1/2" zinc-plated steel shafts.

(e) Shafts and blades shall be bolted through to prevent misalignment.

(f) All blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance after installation.

(g) Blade side edges shall seal-off against spring stainless steel seal to obtain minimum leakage.

(h) Teflon-coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation.

(i) All control dampers shall submit leakage and flow characteristics data.

(j) All blade linkage hardware shall be constructed of corrosion-resistant zinc-plated steel and brass.

(k) Leakage rating shall be less than 1/2% of flow rate at 2000 FPM at 4 inches W.C. pressure difference across the damper.

5. AIR COMPRESSORS

5.01 Air compressors for pneumatic control systems shall be designed specifically for instrumentation applications, with minimum oil carry-over, and shall be sized for a maximum operating time of 35 percent. Furnish filters, pressure-reducing and relief valves, and an electric alternator when more than one compressor is provided. Provide a manual valved connection to the plant air compressor to serve as a standby air supply. And, provide a refrigerated control air dryer.

6. CENTRAL MONITORING AND ALARM SYSTEMS

6.01 In general, alarms should be provided to indicate security violations or any hazardous condition in the building or in its environmental services. Refer to Section 760-230-140 for a list of possible building alarms and for a discussion of several types of telemetry systems that may be utilized to transmit the alarm signals to a central building maintenance location.

6.02 A number of centralized building management systems are available that utilize digital transmission between the remote building micro-processor based data collection panels and the central processor.

6.03 Centralization of the building operation and maintenance function at a Building Operations Control Center (BOCC) can result in improved reliability of service with more efficient manpower and energy utilization. However, the incremental cost of each additional building management function, over and above the basic alarm monitoring recommended by Section 760-230-140, must be compared with its respective projected operational savings to justify the additional investment. Maximum quality at building environmental control would require corrective building mechanical and control system action and a very large number of input points to permit early trouble detection, analysis, and prompt corrective action from the central location. This method of operation also requires a high skill level of the operator as well as extensive analytical software programs.

6.04 The following guidelines and considerations should be evaluated when considering the purchase and installation of a centralized automatic control system:

(a) A prime consideration is the reliability of the total system including backup and the need for a simple, easy-to-use interface with the building operations personnel involved.

(b) The system should easily accommodate change. The central control system and the assumptions made relative to its use should allow systems and points to be added and subtracted, or operating routines and capabilities to be changed cost-effectively. Consider the need for updating and expanding the system because of addition and removal of facilities or modifications and improvement to existing mechanical and electrical systems.

(c) System justification must include an ample allowance for maintenance support of mechanical and electrical system modification, software support, and continuous improvements as system and operational needs become apparent.

(d) It is important that competent support is provided to correct all problems when they occur. If this is not done, the accuracy and reliability of the system will deteriorate until portions of the system are bypassed by the operations personnel.

(e) The entire system must be completely debugged during construction and during the first year of use. Considerable time and expense should be anticipated relocating sensors to points that are representative during all climatic conditions, calibrating services, establishing alarm points, and training operating personnel.

(f) The system should be fully documented so that it can be expanded and maintained by in-house personnel.

(g) System flexibility should be built into the system during design. Features which help provide flexibility include:

(1) Use of standard instrumentation signals for system inputs and outputs.

(2) Redundant system components to assist operation during maintenance, repair, or modification.

(3) Central processor peripherals that use standard data transmission cables and codes.

(4) Software language which is relatively easy to learn and apply. Original system software should provide for the addition or deletion of similar building subsystems without requiring any changes in the software.

(5) Remote location equipment that has incremental capability so that it can be applied to working with one analog signal up to monitoring and controlling a complex central equipment room.

(6) Equipment with leased telephone or dial-up telephone line communication capability for remote monitoring.

7. TYPICAL WIDE BAND TEMPERATURE OPERATION

7.01 Wide band temperature operation is the recommended basic method of local temperature control for most telephone equipment spaces.

7.02 The following control sequence gives a functional description of wide band temperature operation for a single zone heating, ventilating, and air conditioning system serving central office space.

7.03 This is a general description of the control sequence using conventional controls. In application, consideration must be given to the specific equipment utilized on a job; some of these considerations are discussed in the application section. There are available micro-processo based control systems which could possibly provide the specified functions with less equipment.

7.04 The control schematic (Exhibit 1) illustrates a system that does not use a return air fan. For proper operation, it is necessary to keep the static pressure drop in the exhaust path to a minimum.

It incorporates the ventilation economizer system, utilizing higher than normal changeover temperatures, to approximate the savings possible from enthalpy control systems. Enthalpy controls tend to lose calibration and require considerable maintenance for proper operation.

7.05 Following is the sequence of operations. (See Exhibit 1.)

(a) When the supply fan start button is pressed, the control system is energized.

(b) A time clock indexes heating controls for "occupied" and "unoccupied" conditions. During "occupied" hours, space thermostat T2 (65^{O}F) is in control, and during "unoccupied hours space thermostat T3 (55^{O}F) maintains a reduced temperature setting.

(c) Alarms indicating that space conditions are out of limits are sent when any one of the set points of humidistat H2 (60%) and thermostats T4 (85%F) and T5 (50^{O}F) are exceeded. Alarms should be remoted to the Switching Control Center (SCC) and the Building Operations Control Center (BOCC).

(d) Fire detection controls stop the fan system when their set points are exceeded. The fan also stops when the early warning fire detection system, covering the building area served by the fan system, is activated.

(e) Freeze stat T7 (40^{O}F) stops the fan when it senses a temperature below its set point. This control is for the protection of steam, hot water, and chilled water coils and to prevent the formation of ice buildup in conjunction with water spray humidifiers. The control can be omitted if no components of this type are included in the system.

(f) The control system should incorporate the following interlocks:

(1) Mechanical refrigeration and mechanical heating shall not operate simultaneously.

(2) Heating and mechanical refrigeration shall be inoperative when the supply fan motor is not running.

(3) Humidifiers, if provided, should be inoperative when the fan is off and also when the refrigeration is on. (Humidification is generally not provided except for #4ESS equipment in colder northern regions, i.e., Missouri and Kansas.)

(g) Cooling when outside air temperature is <u>below</u> set point of outside thermostat T6:

(1) On a rise in space temperature (above the first stage set point of room thermostat T1) the supply fan starts and concurrently the return air (RA) Damper D2 modulates closed, the fresh air intake (FAI) Damper D1 and the exhaust air (EA) Dampers D3 and D3' modulate open to maintain set point of T1.

Should the space temperature exceed the second stage set point of T1, the refrigeration system is energized and operates to maintain second stage set point of T1 (80^{O}F).

(2) On a drop in temperature below the first and second stage set points of T1, the reverse action to that specified in #1 above occurs.

(3) On a rise in space relative humidity above the set point of space humidistat H1 (55%), FAI Damper D1 and EA Dampers D3 and D3' close; RA Damper D2 opens. The refrigeration system is energized and operates to maintain second stage set point of T1 (80^{O}F).

(h) Cooling when outside air temperature is <u>above</u> set point of outside air thermostat T6:

(1) FAI Damper D1 and EA Dampers D3 and D3' close; RA Damper D2 opens.

(2) On a rise in space temperature above the second stage set point of space thermostat T1 (80°F), the supply fan starts and the refrigeration system operates to maintain the second stage set point of T1 (80°F). The general control sequence only covers one stage of refrigeration control.

Most #1 and #2ESS buildings will utilize DX package type air conditioning units which may require two-stage control of the refrigeration system. This can be accomplished by using a three-stage thermostat for T1 set to operate the air economizer cycle to maintain a space temperature of 78°F, operate the first stage of mechanical refrigeration to maintain a space temperature of 80°F, and operate the second stage of mechanical refrigeration to maintain a space temperature of 82°F. Another solution would be to install a separate ventilation cycle modulating thermostat and a separate, two-stage, mechanical cooling thermostat.

(i) Heating:

(1) On a drop in space temperature below the set point of space mounted thermostats T2 (65°F) or T3 (55°F), as selected by a time clock, the supply fan starts and the heating coil operates to maintain the space conditions. For smaller buildings, a night setback thermostat with integral time clock and override switch may be used to provide this function.

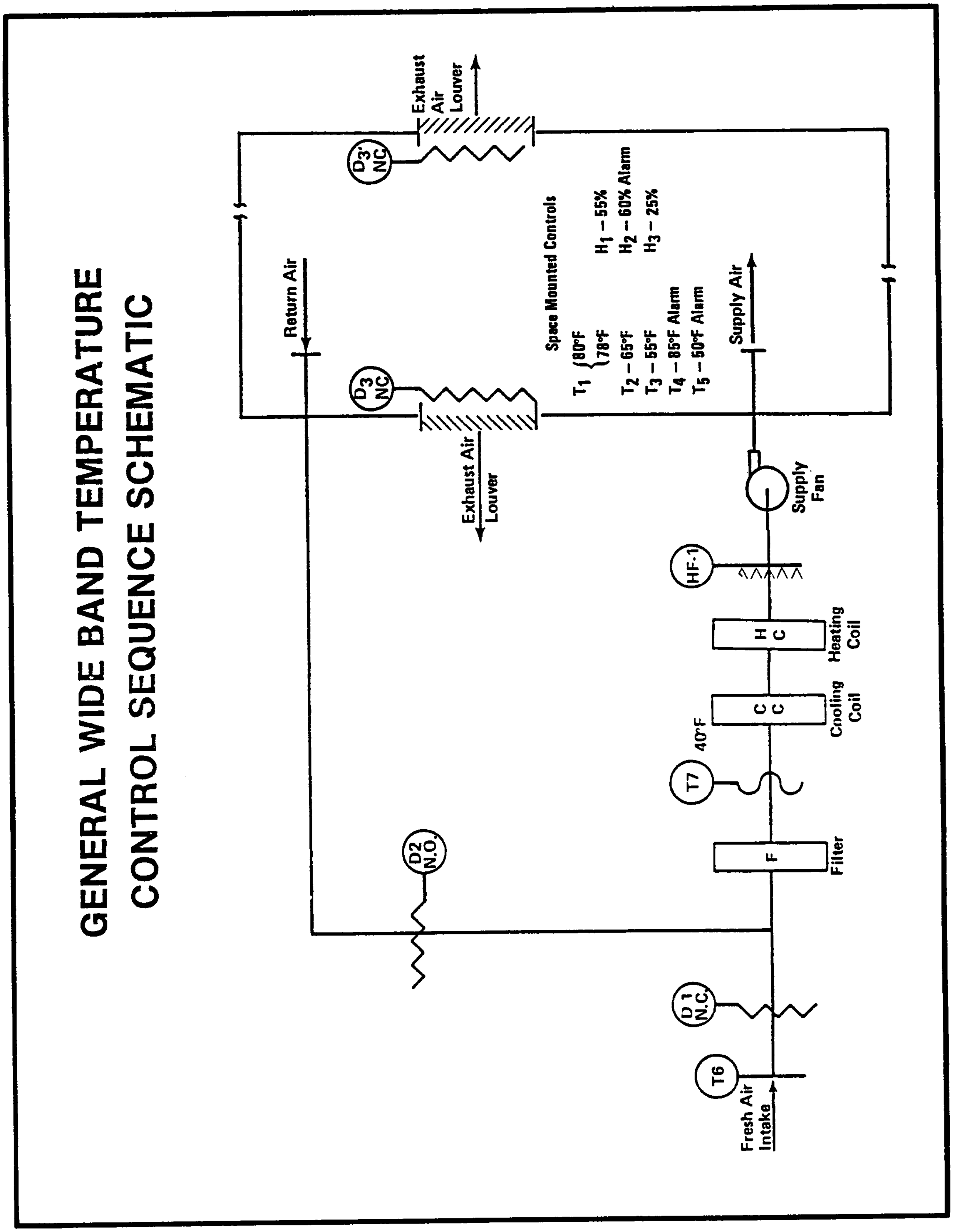
(2) On a rise in space temperature above the set point of T2 or T3, the reverse action to that specified in #1 above takes place.

(3) On a drop in space relative humidity below the set point of humidistat H3 (25%), the supply fan starts and humidifier HF-1 operates to maintain space conditions.

(4) On a rise in space relative humidity above the set point of humidistat H3 (25%), the reverse action to that specified in #3 above takes place.

(5) A one-hour manual timing switch should be provided to facilitate manual override of the time clock to permit operation at "occupied" standards for a one-hour period with each operation of the timer switch.

EXHIBIT 1


GENERAL WIDE BAND TEMPERATURE
CONTROL SEQUENCE SCHEMATIC
Exhaust Air Louver
D3' NC
Space Mounted Controls
H_1 – 55%
H_2 – 60% Alarm
H_3 – 25%
Return Air
D3 NC
T_1 {80°F 78°F
T_2 – 65°F
T_3 – 55°F
T_4 – 85°F Alarm
T_5 – 50°F Alarm
Supply Air
Exhaust Air Louver
Supply Fan
HF-1
H C
Heating Coil
C C
Cooling Coil
40°F
T7
D2 N.O.
F
Filter
D1 N.C.
T6
Fresh Air Intake