DOCUMENT RESUME

ED 024 238 EF 002 342

Lite-therm Design Manual. Second Edition.

Environmental Systems Corp., Atlanta, Ga.

Pub Date 67

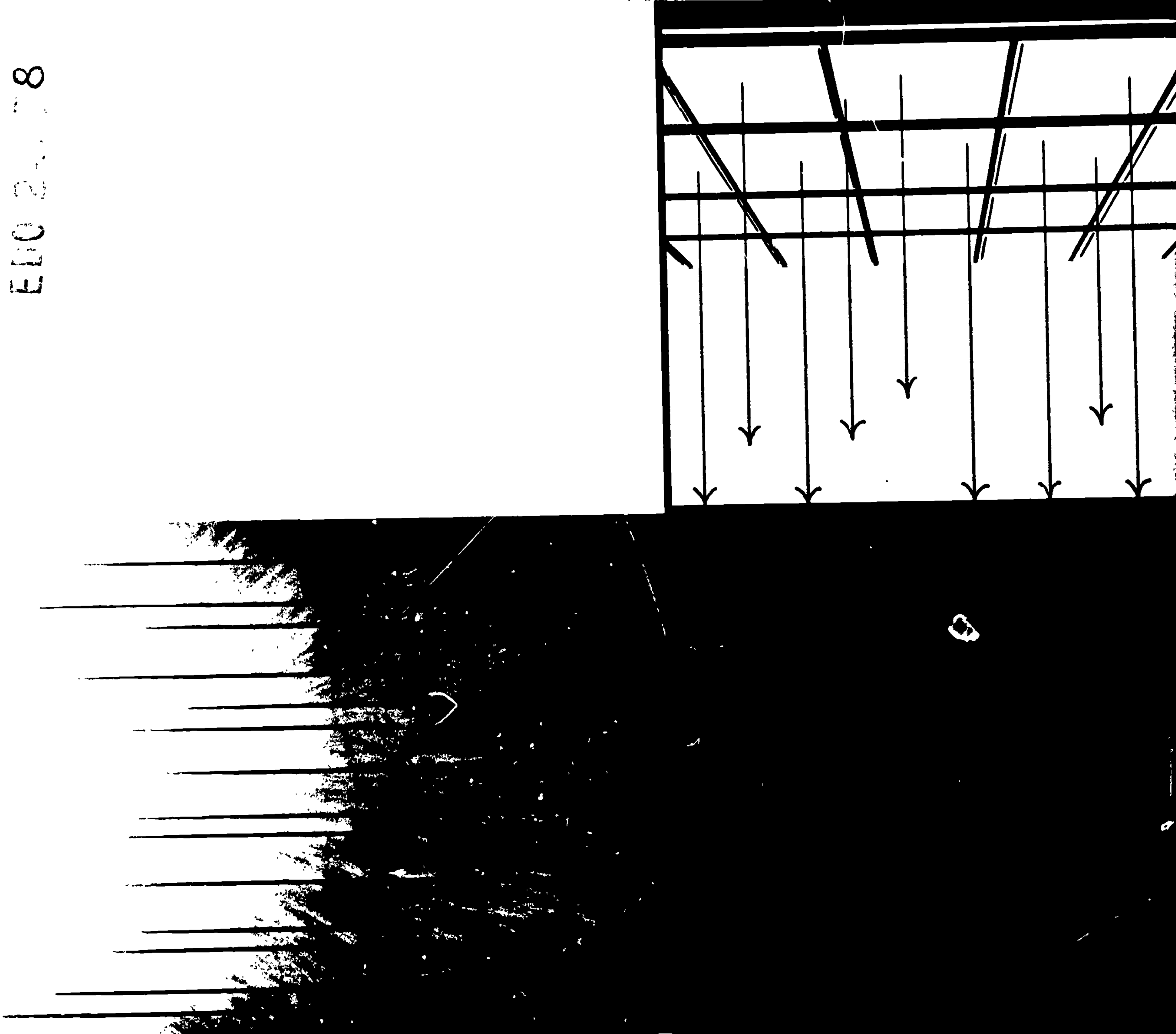
Note-28p.

Available from-Environmental Systems Corporation, Subsidiary of Building Dynamics, Inc., 148 Cain St. N.W., Suite 410, Atlanta, Georgia 30303

EDRS Price MF-$0.25 HC-$1.50

Descriptors-*Air Conditioning, Building Design, *Component Building Systems, *Heating, *Lighting, Lights, Mechanical Equipment, *Solar Radiation, Ventilation

Occupant comfort in glass facade buildings is the problem for which a solution is suggested. Optimum comfort is obtained by intercepting radiant heat before it enters the room. Through a combination of luminaires, induction boxes, and louvers, a "Lite-Therm System" is presented which integrates lighting, heating, and cooling systems into the design of the building. (JS)



LITE-THERM

- systems
- luminaires
- induction boxes
- thermal louvers

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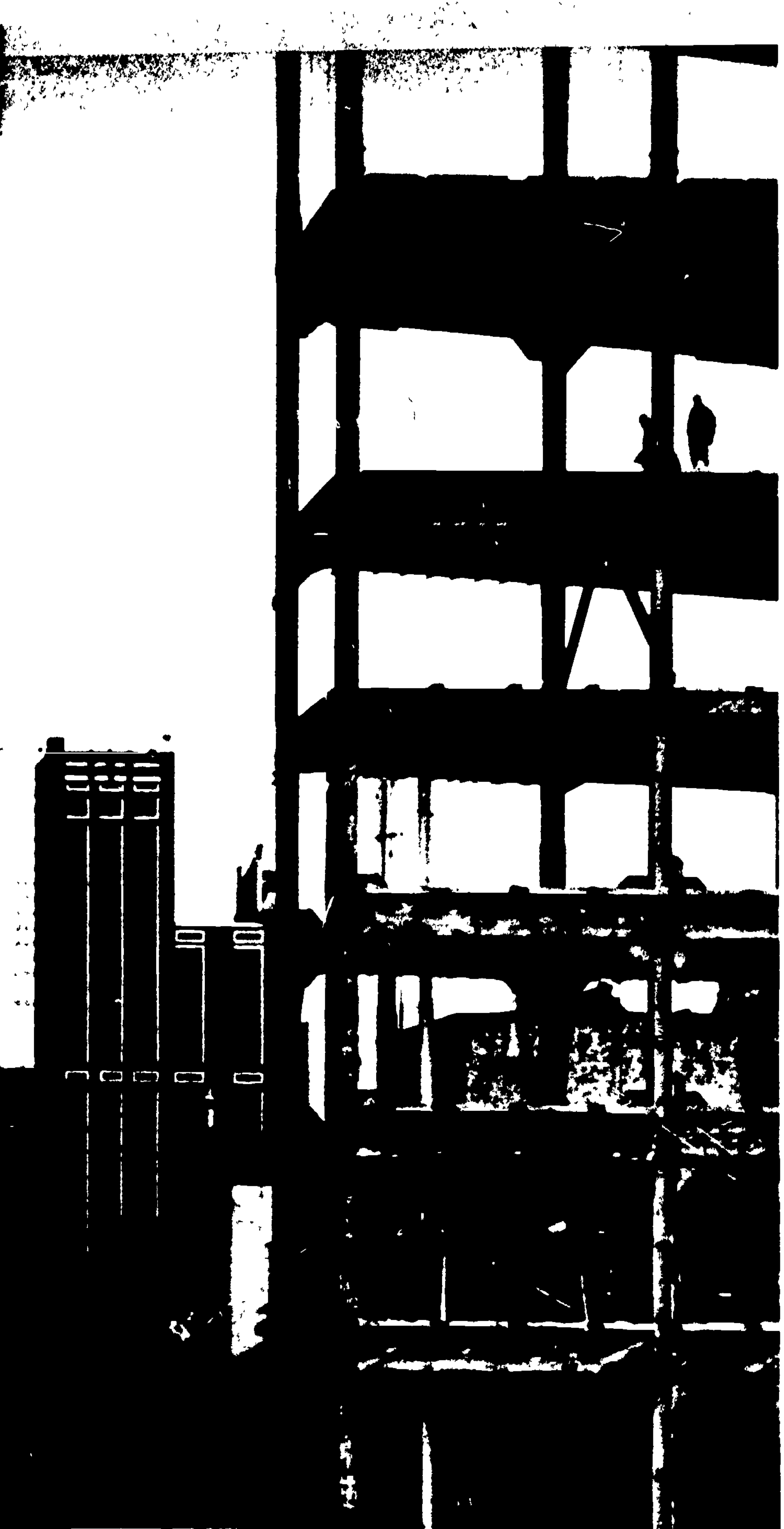
ENVIRONMENTAL SYSTEMS CORPORATION

Subsidiary of ~~Lithonia Lighting, Inc.~~ Building Dynamics, Inc.



design

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IN THE PAST, lighting, heating, and cooling systems technology developed separately and independently of architectural aesthetics and structural considerations in building design. Today, new standards of comfort have been established, levels of illumination have greatly increased, a wider variety of building materials are being used, and there is an awareness that one of the key criteria of building design must be to create an optimum environment for human occupancy.

The mechanical and electrical systems continuously consume and control energy and, therefore, are related to each other and to the building by their operating characteristics and energy consumption. Creating a functionally successful building, one which provides maximum human comfort and an atmosphere conducive to efficient performance at minimum cost can be accomplished only by efficiently inter-relating the energy of the lighting, heating, and cooling systems to the architectural aesthetics and the visual and thermal requirements.

To achieve these objectives, all factors that contribute to creating the environment should be evaluated concurrently. Dual-purpose products that are common to lighting, heating, and cooling and that utilize available internal energy for heating requirements and reduce total energy input by eliminating the refrigeration and air distribution associated with the lighting and solar-radiant heat gain must be integrated into systems. The result is optimum occupant comfort through the interception and proper utilization of radiant energy before it can enter the space.

philosophy

Heat Problem: Heat transmitted through the walls and roof, heat radiated from sunlight, heat emitted by people, and the heat generated by lighting and equipment all contribute to the instantaneous heat gain of a structure. The portion of the actual building cooling load attributable to each of these sources will vary with the way in which building materials, orientation, and architectural design influence the effect of energy on the environment.

The radiant heat associated with lighting and solar energy is the largest single factor contributing to occupant discomfort and the high cost of air-conditioning systems. The two major components, solar heat gain and lighting, represent 80% of the total requirements for refrigeration and air conditioning in a building consisting of approximately 25% glass at the perimeter and 5 watts/sq. ft. of lighting energy. The percentage of these two major components increases significantly as the lighting levels and percent of glass increase. The significant thing about the lighting and solar loads is that both come into the space by radiation at an elevated temperature.

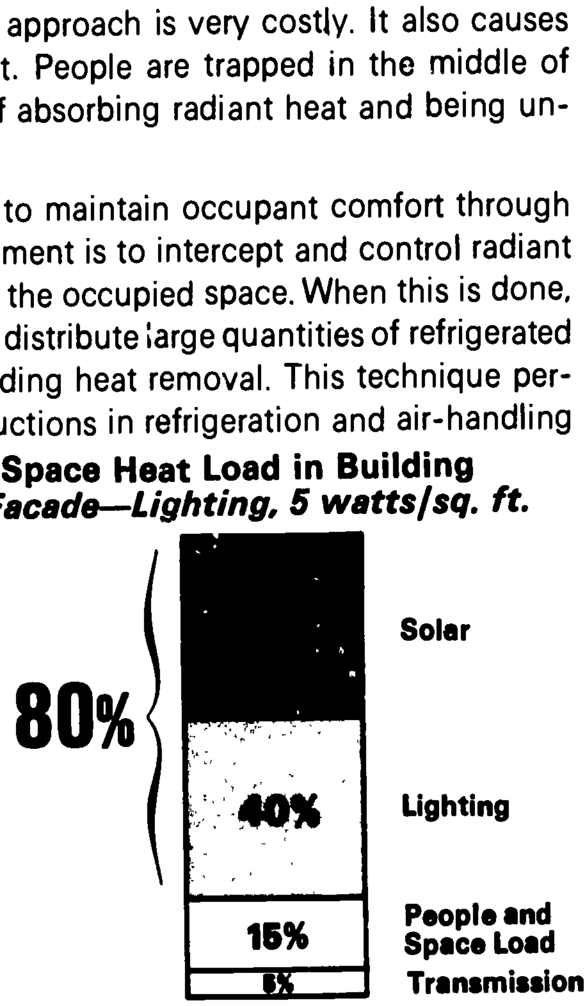
Conventional systems cannot intercept solar and lighting radiant heat; it is permitted to enter the space. Simultaneously, large quantities of cold air or radiant cooling must be introduced to remove this heat after it is absorbed by the occupants. This approach is very costly. It also causes occupant discomfort. People are trapped in the middle of the mixing action of absorbing radiant heat and being uncomfortably cooled.

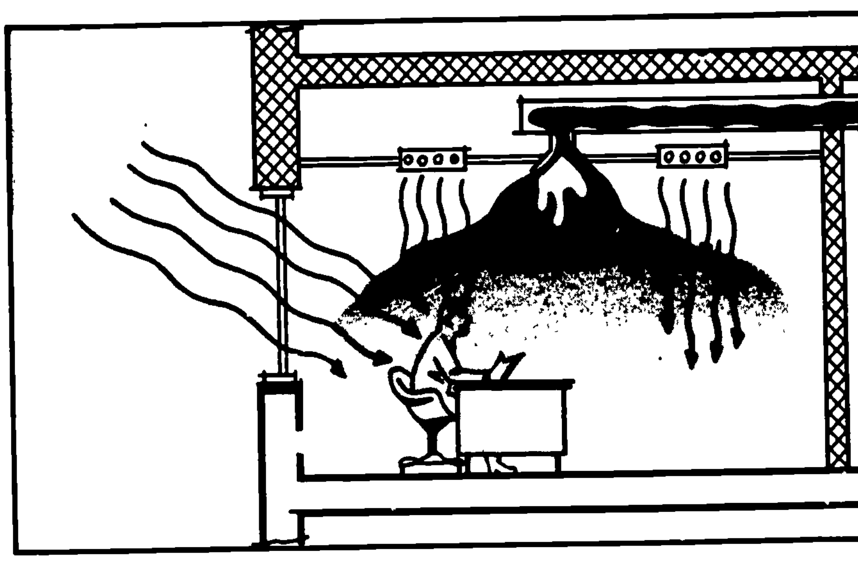
The ideal approach to maintain occupant comfort through a controlled environment is to intercept and control radiant heat *before* it enters the occupied space. When this is done, it is not necessary to distribute large quantities of refrigerated air or water for building heat removal. This technique permits significant reductions in refrigeration and air-handling equipment and offers large savings in initial and operating costs, as well as creating a properly controlled environment.

Through use of non-refrigerated water products, a neutral panel or barrier is established. This barrier keeps the hot radiant energy out of the occupied space before it becomes a problem. The neutral panel or barrier does not require expensive piping, installation or controls. It is simply part of a system of newly developed products through which non-refrigerated water is circulated to intercept the energy source and utilize it when needed or expel it through an evaporative cooler. With the positive control of radiant energy, environmental comfort is maintained with very small quantities of refrigerated air—eliminating condensation, dehumidification, temperature control and wasteful energy so prevalent in conventional systems.

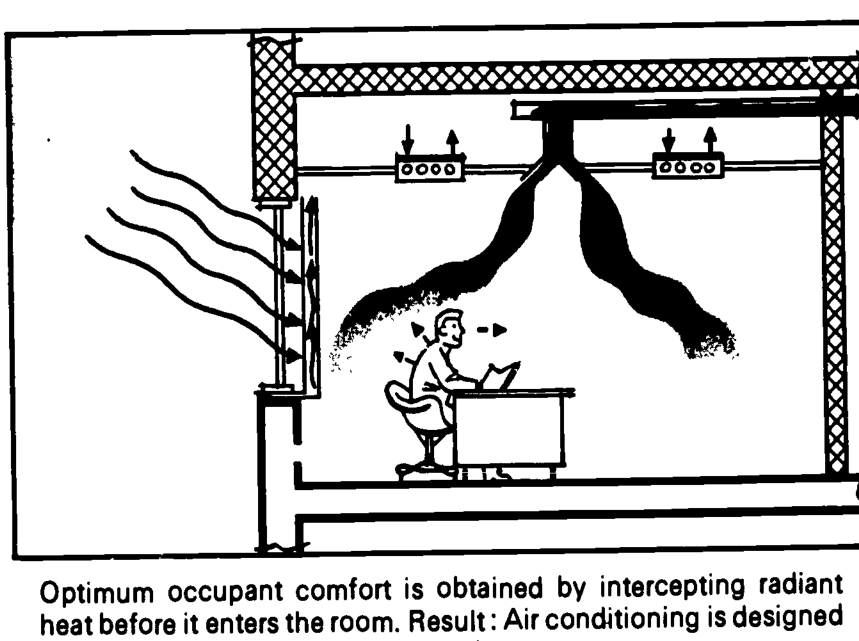
Sources of Space Heat Load in Building
25% Glass in Facade—Lighting, 5 watts/sq. ft.

A typical building energy diagram, graphically illustrates the magnitude of energy associated with lighting and solar radiation. The radiant heat associated with lighting and solar energy is the largest single factor contributing to occupant discomfort and the high cost of air conditioning systems.





Conventional systems introduce large quantities of cold air to counteract extensive radiant heat entering the room. Result: Occupants are caught in an uncomfortable mixing action.



Optimum occupant comfort is obtained by intercepting radiant heat before it enters the room. Result: Air conditioning is designed for optimum occupant comfort and economy.

LITE-THERM LUMINAIRES

The thermal effect of lighting on the environment is considerable at lighting levels above 3.5 watts/sq. ft. Every watt of electrical energy consumed by a lamp generates heat at the rate of 3.4 BTU/hr. Light itself is converted to heat. It will raise the temperature of any object which absorbs it. In addition, a light source generates all forms of heat such as invisible infrared radiant energy plus conduction-convection and ballast heat.

Fluorescent Lamp Energy Distribution (77°F)

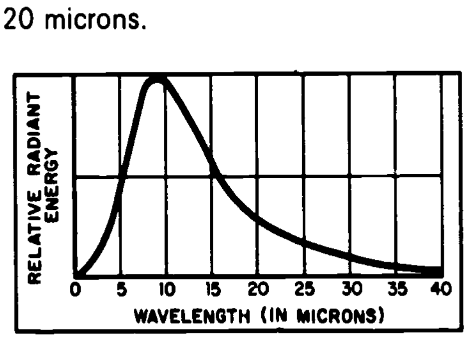
Type of Energy	Amount of Energy Per Lamp Type		
	F40CW 425 ma	F96T12/CW/HO 800 ma	F96PG17/CW 1500 ma
Light	19%	18%	18%
Infrared	31%	31%	42%
Conduction-Convection	33%	35%	28%
Ballast	17%	16%	12%

Today, fluorescent lamps are practically always installed in luminaires. Thus, heat emission characteristics of lamp-luminaire combinations are important. When luminaires with fluorescent lamps are first energized, the heat from the ballast and the conduction-convection heat from the lamp are trapped. At the same time, a portion of the light and the infrared energy is absorbed by the reflector surfaces of the luminaire.

Fluorescent Lamp-Luminaire Energy Distribution

Type of Energy	Amount of Energy
Infrared	36%
Convection-Conduction	28%
Ballast	12%
Light	11%
Heat Initially Absorbed in Luminaire	87%
Light Heat Initially Entering Space	13%

When the lamp is energized, the ionized gases within the lamp produce visible light. Simultaneously, the glass envelope of the lamp reaches a temperature of 110°F to 140°F depending on the lamp type. At these temperatures the glass envelope of the lamp approximates that of a greybody radiator and emits a spectral distribution of thermal infrared radiation in the wavelength range of 5 to 20 microns.



Surface material has varying effects on infrared radiation in the 5 to 20 micron wavelengths of the lamp energy spectrum. The reflectance of these wave lengths depends upon the material from which the troffer is made. Polished aluminum reflects most of the energy, but synthetic enamel on steel or aluminum absorbs most of the energy. Thus the troffer is an absorber of heat and reflector of light. However, in operation, the troffer absorbs the infrared radiation, holds it, then re-radiates it into the space.

Reflectance Characteristics of Various Luminaire Materials

Material	Reflectance at Indicated Wavelength					
	4 μ	7 μ	10 μ	12 μ	15 μ	20 μ
Polished Aluminum	92	96	98	98	—	—
Diffuse Anodized Aluminum	12	21	9	8	6	6
Synthetic Enamel on Steel or Aluminum	3	1	1	0	0	0
Porcelain on Steel	5	3	9	5	6	13

If the heat build-up continues, the luminaires and the ceiling areas surrounding them become secondary heat sources. Then, the heat is carried into the occupied space by convection or re-radiation to cooler objects and surfaces in the occupied room. The temperature of the luminaire surfaces can reach 105-130°F in conventional lighting systems. Thus, they become, in reality, panel heating elements and complicate temperature control of the room. If techniques are used for drawing off or controlling much of this heat before it enters the occupied space, high lighting levels become a useful energy source instead of an energy problem.

Advantages in comfort control are not all that is gained by removing heat generated by light sources—lighting system operating efficiency also can increase.

Since lighting heat contributes about 40% of the total heat load to the space, is radiant, and is generated at high temperatures, with respect to the space temperatures, a water cooled fixture was developed which could intercept and capture this heat at a *water temperature* above that of *room temperature* —eliminating the need for refrigeration of the lighting heat. A series of prototype fixtures was designed, constructed and, tested under closely controlled conditions in a specially designed laboratory.

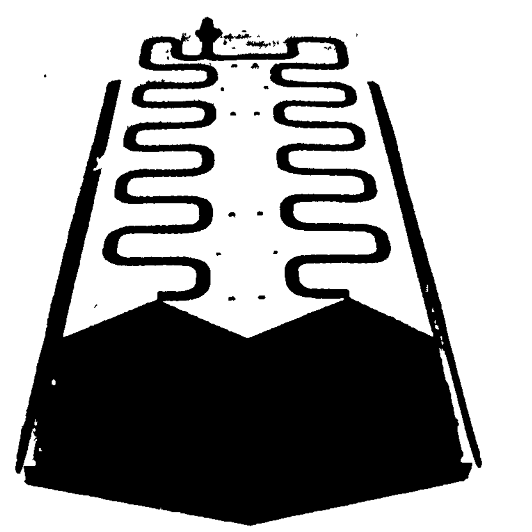
Results from extensive testing showed that 70% of the total KW input to the lighting fixture was being captured with 77 to 85°F water. Since about 20% of the KW input to lighting fixtures comes out in the form of light, 87% of total heat available at the fixture was captured by non-refrigerated water.

The most significant feature in the development of the water cooled luminaire is the fact that the luminaire is able to achieve this 90% heat-pickup efficiency because the luminaire housing is kept cool (77°-80°F) and is able to capture the 30% to 40% of energy that comes off in the form of infrared radiation.

An air-cooled luminaire cannot approach this efficiency of heat extraction because the luminaire housing still remains relatively hot. The 30% to 40% of infrared radiation cannot be captured by the air and has its infrared portion of the spectrum re-radiated into the occupied space. The portion of heat extracted by an air-cooled luminaire is basically conduction and convection and, with a ceiling plenum system, a large percentage of this extracted heat still finds its way back into the space by conduction through the ceiling. Air-cooled luminaires can reduce space load to some degree, but the conditions of ceiling return air leakage and conduction of extracted load back to the space make the space load reduction a variable which is difficult to determine. Moreover, the total lighting energy input load still falls completely on the central plant refrigeration system.

Returning enough air through a luminaire to achieve optimum possible heat extraction by air requires a larger air quantity than that necessary for ventilation requirements. Therefore, if the lighting load on the return air should be exhausted instead of taken back to the cooling coil, a larger load is imposed on the cooling coil from outside air makeup than was originally present from the lighting load.

Heat transfer characteristics of the lamp-luminaire combination established that the non-refrigerated water-cooled luminaire was the only way that the lighting heat energy could be reclaimed and utilized if required, or completely rejected to the outdoors if not required, without imposing a load on the space or central plant refrigeration.



LITE-THERM INDUCTION BOX

The objective of an air-conditioning system is to maintain comfort in a space by simultaneously controlling temperature and humidity levels. In multi-story buildings, where modular zone control is required, this can be accomplished through the use of an all-air system such as the dual-duct system, or through the use of the induction system which utilizes refrigerated air and chilled water.

Two major load components establish the size of the air-conditioning system and may represent 80% of the sensible load. They are heat gain from solar radiation and energy input to luminaires. As use of glass in buildings increases, and as lighting levels rise, the volume of refrigerated air that must be supplied by an all-air system to handle these loads becomes excessive. Ducts become so large that they occupy a substantial portion of the building volume. To keep duct size within reason, high-pressure air distribution is utilized, dictating large horsepower requirements for both fans and compressors.

The induction system provides a means for reducing the size of the air distribution system, but it requires addition of a chilled water circuit. Complex temperature controls are required—to compensate for seasonal variations in load. And three and four-pipe distribution systems are needed.

Ideally, an air-conditioning system should employ a compact system of air distribution and permit simple control of space temperature at the required humidity level. The Lite-Therm system was developed to accomplish this. With this system, non-refrigerated water is used to intercept high-temperature radiant space loads from lights and sun before they enter the space. The remaining space load is small enough to be handled by refrigerated outside ventilation air. This means that only the minimum amount of ventilation air need be distributed for heat removal purposes.

To ensure adequate air circulation within the space, the Lite-Therm induction mixing box was developed to utilize refrigerated ventilation air and induced secondary air from the room to provide the required circulation rate. The box also includes mixing dampers which provide a means for controlling space temperature.

Three advantages are gained through the combination of non-refrigerated cooling and the Lite-Therm induction box.

1. Primary supply duct work reduced to the absolute minimum. Distribution duct work required only to handle outside fresh ventilation air (30% of air circulated in occupied space).

2. All the cooling capacity necessary for space temperature and humidity control is packaged in the ventilation air.

3. Individual zone temperature control is provided on a modular basis, utilizing lighting heat for heating without the penalty of refrigerating the lighting load.

To effectively match the capabilities of non-refrigerated cooling with induction box air distribution, a ceiling-mounted constant-volume induction box was designed to lay into a 2' x 4' "T"-grid suspended ceiling. It features a perforated return grill, a supply diffuser, and an access panel. Other models mount in the plenum, and are supplied with duct collars for room air returns and room air supply.

Each box is equipped with a mechanical constant volume regulator to provide a constant volume of primary dehumidified ventilation air at 1" static pressure. A space thermostat transmits temperature requirements to a pneumatic motor controller in the induction box, which actuates tandem dampers regulating induced air flow either directly from the room or from the room through the luminaires into the box, where it is mixed with the primary air to the required temperature to be supplied to the room.

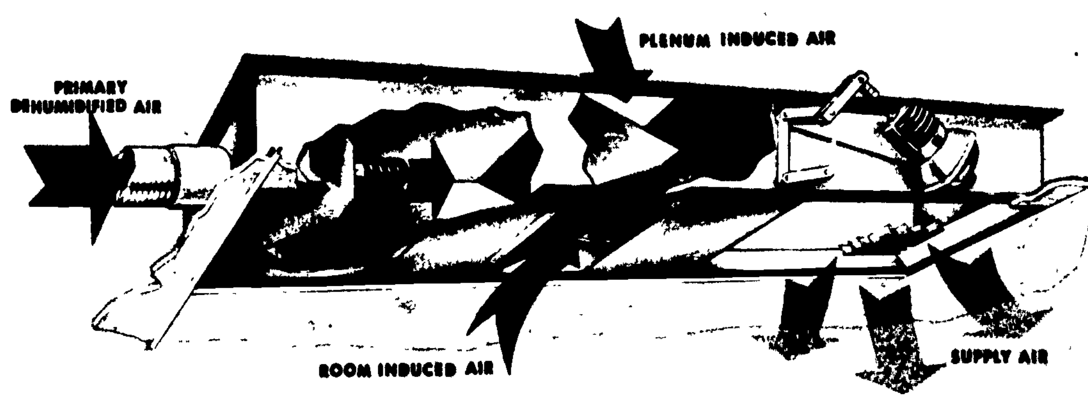
On *cooling* demand, dampers in the induction box are positioned so that all induced air to the box comes through the direct connection from the occupied space, thereby tempering the primary air enough to provide comfortable discharge temperature. At the same time, heat is removed from the luminaires by non-refrigerated water and rejected directly through an evaporative cooler. Results: A reduced capacity Constant Volume Primary air system for ease of control and a 70% reduction of central plant refrigeration load associated with lighting heat.

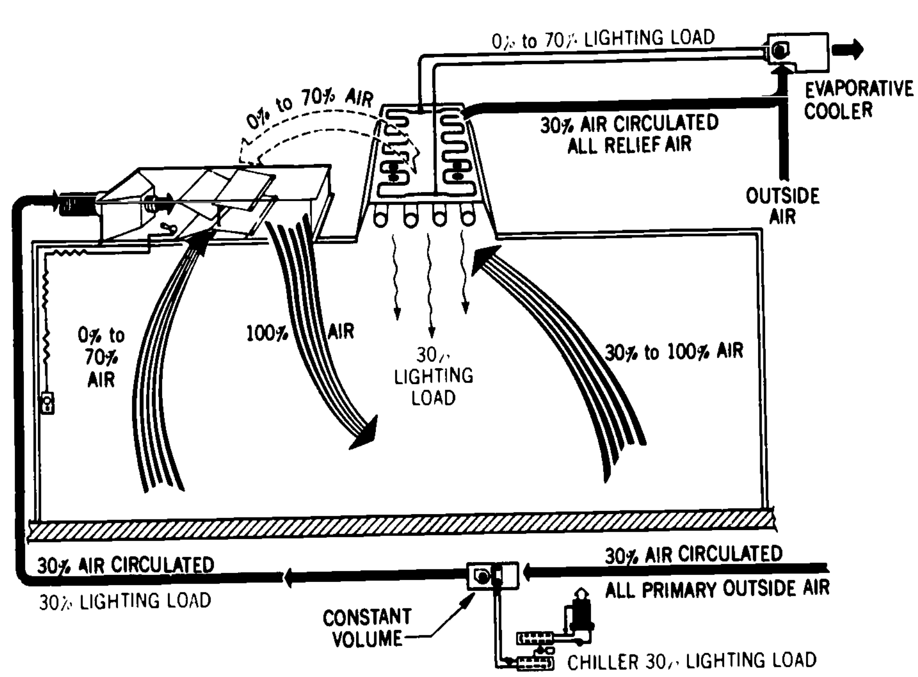
On *heating* demand, dampers in the induction box are positioned so that induced air to the box comes from the ceiling plenum after it has been induced through the Lite-Therm luminaires, thereby being heated directly by the luminaire. During this cycle, non-refrigerated water flow through the luminaires is stopped so that maximum available lighting heat can be transferred to the air and distributed through the ceiling plenum for reheat at the induction boxes as required. The induction box is selected on the basis of heating so that the ratio of induced air to primary air is enough to offset the primary air in addition to satisfying heating requirements. Results: The same volume of primary air is used for ease of control, making it practical for lighting to be used for heating without creating the penalty of increased central plant refrigeration.

The function of the system on cooling and heating has been described, but it must also be noted that the system maintains independent temperature and humidity control throughout all seasons of the year by automatically modulating as required.

The induction box, acting as a zone control device through zone reheat from lighting fixture return air, makes it possible to effectively redistribute lighting energy directly by air for heating due to the induction ratio. With a 75°F space temperature, and 85°F ceiling plenum temperature, and 60°F primary air temperature, effective heating can be maintained above the room temperature of 75°F.

LITE-THERM MIXING BOX



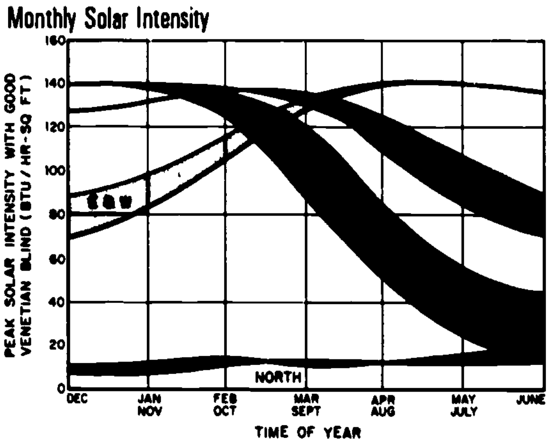


LITE-THERM LOUVERS

Since solar radiation through glass (even with a good venetian blind) constitutes between 25% to 75% of the total heat gain for an entire building (depending on the amount of glass in the facade), it is important to establish the effect of solar radiation with various shading devices on a building load.

An analysis of the peak monthly solar intensities during a 3 hour period for the entire country (30 to 40 degrees north latitude) indicates that, regardless of the latitude, East and West have a peak solar intensity in summer, Southeast and Southwest peak in the fall and the South has a peak in the winter. In the southern or northern parts of the country, the north wall is thermally stable with respect to solar gain. On the south, southeast and southwest exposures, however, cooling due to solar load can be required in the fall and winter when the building mechanical system is on heating cycle.

Monthly Solar Intensity

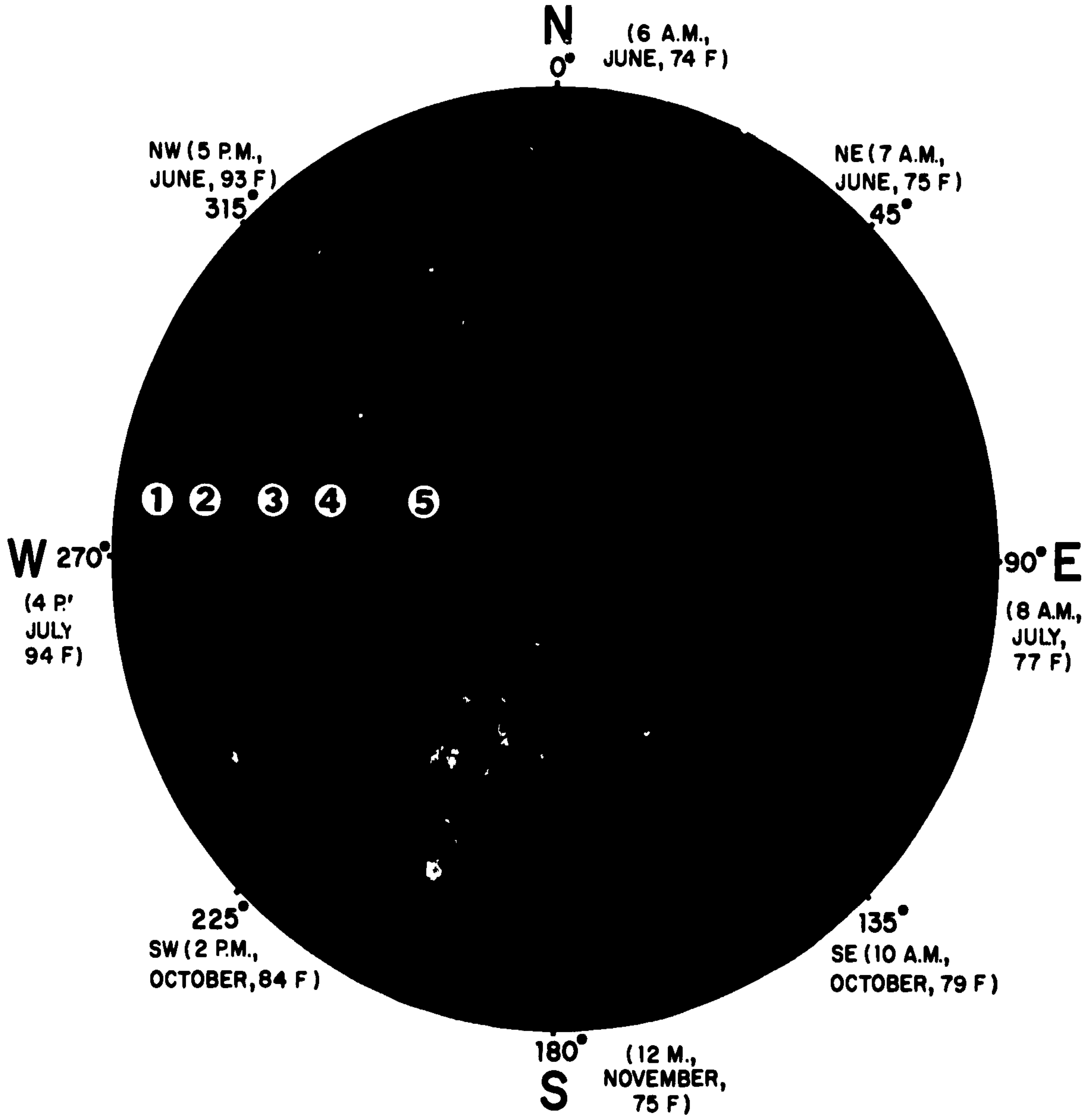


Under this condition, the solar load creates a condition of rapid load reversal upon the occupied space, which fluctuates with the amount of sunshine. Unless an expensive perimeter treatment system is made available with heating and cooling available year round, it becomes impossible to maintain a comfortable controlled environment.

Because this solar load is radiant by nature, it can only be removed after it enters the space and is absorbed by objects within the space. It is the interaction of this kind of energy plus the energy input within the space that really affects our comfort because it affects the thermal balance.

If, however, a radiant energy trap is established to intercept this solar load before it gets into the occupied space, all exposures of a building become in essence North exposures with no high-radiant energy load to control and no rapid load reversal taking place within the space. The environment then becomes very easy to control.

Development of Lite-Therm Louver—To solve the problems associated with solar heat resulting from the use of large exterior glass areas in buildings, a technique for intercepting the solar radiation through those building glass areas was invented.[3] This technique was developed to utilize a water-cooled thermal louver similar in appearance to a vertical venetian blind inside the building adjacent to the glass.



Effectiveness of Various Shading Devices in Intercepting Solar Radiation

CURVE 1
Lite-Therm Louver
CURVE 2
Exterior Sun Screen or Louver
CURVE 3
Reflecting Glass
CURVE 4
Clear Glass With Venetian Blind
CURVE 5
Unshaded Clear Glass

Chart shows total BTU input of solar radiation plus transmission loads entering the space through glass areas with various shading devices for all building orientations when the total load is maximum. *Through use of thermal louvers, all building exposures become thermally equivalent to a north exposure.* Thus, the problem of rapid load reversal due to solar radiation is eliminated completely.

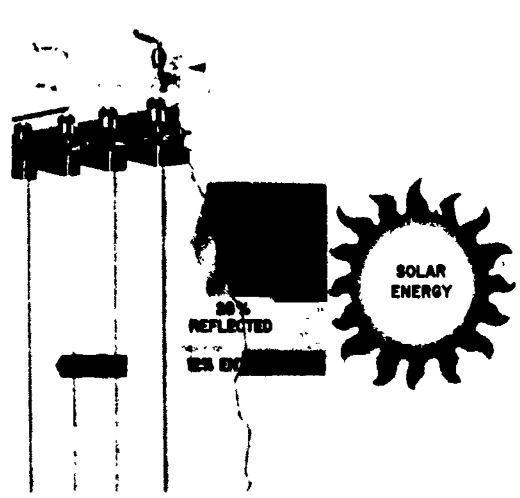
A prototype was designed, built and tested in the ASHRAE calorimeter to establish design data and to determine if it would be possible to reduce the air-conditioning requirements of buildings with large glass areas.[3]

With thermal louvers inside the calorimeter, but without water circulation, approximately 65% of the sun gain actually came into the space. Approximately 28% was reflected. This could be expected from any conventional venetian blind. When water was circulated through the louvers, even at a water temperature as high as 95°F, only 12% of the solar heat entered the space. Thus, the shading coefficient for the louver was established as 0.12 for design purposes.

In addition to the interception of solar radiant heat, the thermal louvers reduced by 75% the heat transmission through glass due to outdoor-indoor temperature difference.

Theoretically, when a point is reached where the outside air temperature exceeds the glass surface temperature, heat is delivered from the outside air to the interior space. With louvers interposed between the glass and the interior space, and the louvers held at constant temperature, most of this added heat is carried out in the circulating water.

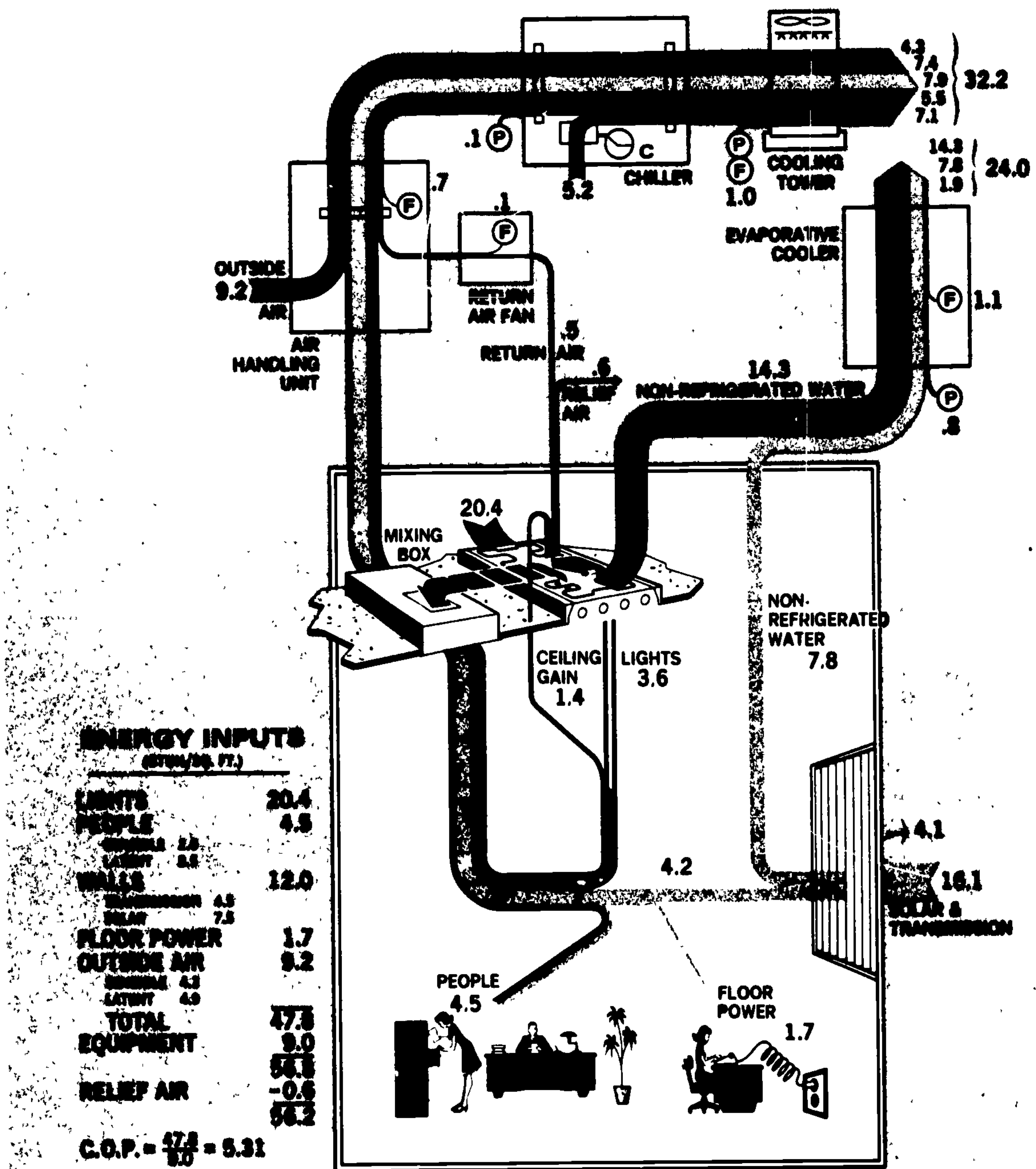
Through use of thermal louvers, all building exposures become thermally equivalent to a north exposure.



THE LITE-THERM SYSTEM

ENERGY DIAGRAM

LITE-THERM COOLING SYSTEM
LOUVERS & INDUCTION BOXES



Development of the Lite-Therm system makes it possible to intercept radiant heat from luminaires and sun, and to provide a comfort conditioning system which responds automatically to climate changes, assuring total indoor comfort twelve months of the year.

Perfected after many years of research and development, this technique uses non-refrigerated water to control heat gains from the sun and lighting fixtures—before that heat enters the occupied space. This is accomplished by circulating non-refrigerated water through louvers, located inside the building adjacent to exterior glass areas, and through the lighting fixtures. *Because the heat from these two sources is generated at high temperatures*, use of non-refrigerated water is an extremely effective and economical method of absorbing it. The absorbed heat can be rejected when cooling is required, or utilized when heating is needed.

Heat Removal: Non-refrigerated water circulates continuously through the lighting luminaires and window louvers. The water captures heat, *up to 70% of the lighting input energy and 88% of the solar heat*, and rejects it through an evaporative cooler located outside the building. *Result: A major reduction in the amount of refrigeration and distribution normally required to cope with these heat loads.*

Heat Utilization: Because heat losses normally occur at the perimeter of a building, heat from the lighting fixtures is transferred—through the non-refrigerated water—to the louvers—at the perimeter glass areas—to offset these losses. *Result: Heat from lighting fixtures is not wasted but is used to heat the building.*

Air System Control: Removal and utilization of heat through the use of non-refrigerated water permits a major reduction in size and complexity of the air distribution system. Use of the induction box permits reduction of the air quantity distributed and permits space temperature control directly through the use of lighting heat.

The Energy Picture: The Energy Diagram shows what takes place in a Lite-Therm air conditioning system, the various loads that come into the space, and where they go in a particular system.

20.4 BTUH per square foot out of a total load input of 47.8 BTUH per square foot of building floor area, enters as electrical energy for lighting. In most air-conditioning systems, this all becomes load on the refrigerated air part of the system. With the Lite-Therm system however, 14.3 BTUH per square foot is funneled off to the evaporative cooler, by-passing the air and refrigeration systems. When lighting heat is needed for space temperature control, the mixing box provides a means for diverting part, or all of this 14.3 BTUH per square foot, back into the space and under controlled conditions.

Solar and transmission loads amount to 16.1 BTUH per square foot of floor area for this typical building. Of this, 7.8 BTUH per square foot can be intercepted and carried off in the non-refrigerated water system.

If a typical dual-duct system were employed to cool this building, electrical energy input to drive compressors, fans, and pumps would amount to 19.6 BTUH per square foot of floor area. With the Lite-Therm system, the comparable figure is 9.2 BTUH per square foot. *Thus, the over-all system coefficient of performance (C.O.P.) is doubled by taking advantage of economies permitted by Lite-Therm dual-purpose products employing non-refrigerated water.*

Economics: In comparison with conventional all-air systems, use of non-refrigerated water for heat-transfer reduces the amount of air required by as much as TWO-THIRDS and refrigeration by approximately ONE-HALF. *Net result: Significant savings in first cost and operating cost—through economies in duct capacity, building volume, conventional refrigeration and heating equipment, and fan refrigeration horsepower and energy utilization.*

system design

PRODUCT DESIGN DATA

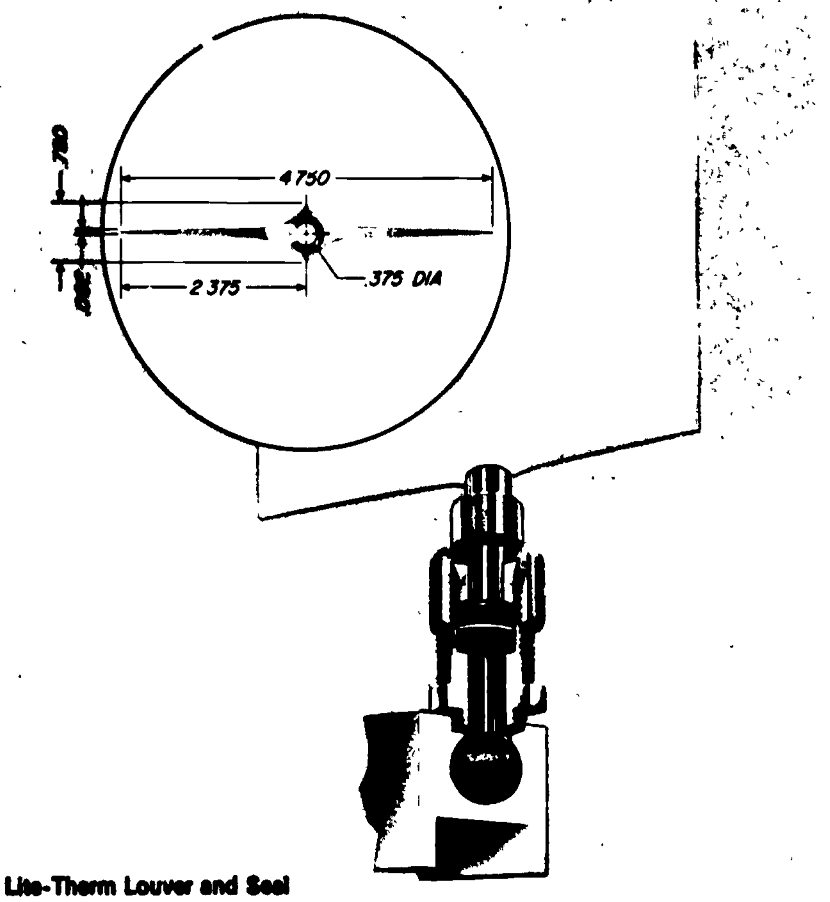
Lite-Therm Louver—The Lite-Therm louvers are mounted inside the building adjacent to the perimeter glass areas. The louver blades are made from extruded aluminum and have a hollow center core through which water is circulated. The blades are connected to concealed manifolds which are in turn connected to the water-transfer system.

In operation, the louvers are automatically controlled from the open position by a solar cell which rotates the louver blades so that they intercept the sun rays, absorbing heat and controlling glare. Positioning of the louvers can also be accomplished manually.

The extrusion indicated here is standard, but custom shapes can be obtained to provide individual freedom in architectural design. Finish may be of various anodized colors, vinyl covered, or painted to any desired color.

The Lite-Therm louvers are supplied mounted in a framework consisting of top and bottom extruded manifolds and side angles. This framed assembly is mounted in the window opening, between the glass and the room. Linkage is provided for moving the blades in unison, and a plate is provided for mounting an operator.

Connections for supply and return piping are provided at the upper right or left hand corner (or both for large assemblies). A variety of piping main systems can be used, including: two pipe reverse return with scheduled water temperatures, four pipe with three-way control valves, or two pipe with primary-secondary pumping and three-way control valves.



Lite-Therm Louver and Seal

Table 1—LITE-THERM LOUVER RATINGS (Cooling)

Solar Load to Occupied Space (Shading Coefficient)	Solar Load to Louver Water	Transmission Load to Occupied Space	Transmission Load to Louver Water	Supply Water Temp. Range (°F)	Return Water Temp. Range (°F)	Water Temp. Difference (Δ T) (°F)	Pressure Drop (ft hd/10 sq ft)	Flow Rate (gpm/10 sq ft)
0.12	0.60	0.25	0.75	77-85	80-88	2.8	2.0	1.0

Results from University of Florida ASHRAE Calorimeter Laboratory tests.

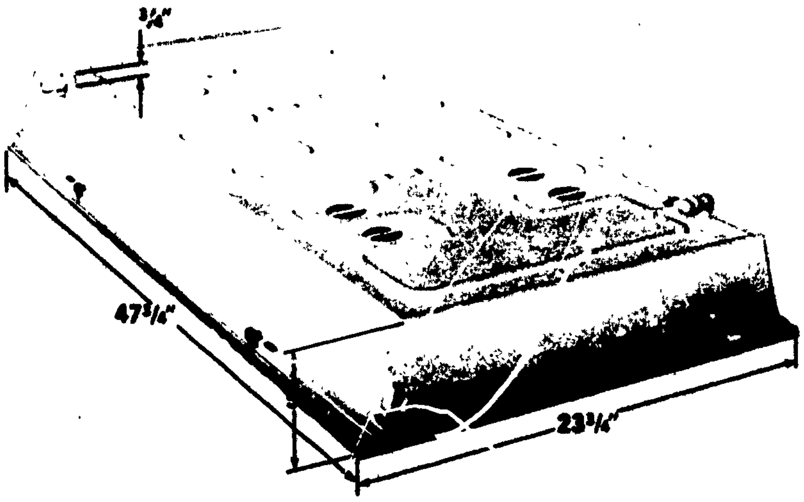
COOLING EXAMPLE (August, 4:00 P.M., 32° Latitude, West Exposure 1 sq ft of glass)

Solar Intensity (BTU/hr/sq ft)	Solar Load to Occupied Space (BTU/hr/sq ft)	Solar Load to Louver Water (BTU/hr/sq ft)	(Air Temp. °F) Outside	(Air Temp. °F) Inside	Transmission Load to Occupied Space (BTU/hr/sq ft)	Transmission Load to Louver (BTU/hr/sq ft)	Total Load to Occupied Space* (BTU/hr/sq ft)	Total Load to Louver Water** (BTU/hr/sq ft)	Water Δ T (°F)	Flow Rate (gpm/sq ft)
202	24	121	98	75	6	19	30	140	2.8	.10

*Cooling load to space = Solar intensity x 0.12 + transmission load x 0.25

**Cooling load to louver water = Solar intensity x 0.60 + tansmission load x 0.75
Heating capacity of louver = 150 BTU/sq ft (use 3° for water Δ T)

Lite-Therm Luminaire—The Lite-Therm luminaires are similar in exterior appearance to any conventional fluorescent lighting fixture. They differ from conventional fixtures in that they have embossed water tubes integral with the reflector housing through which the non-refrigerated water is circulated. As the water circulates, it absorbs the heat from the lamps and ballasts, achieving greater light output (approximately 12%).

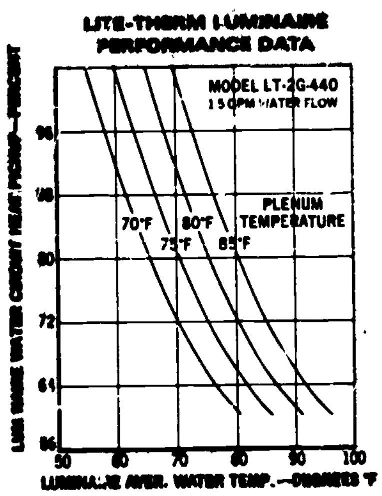


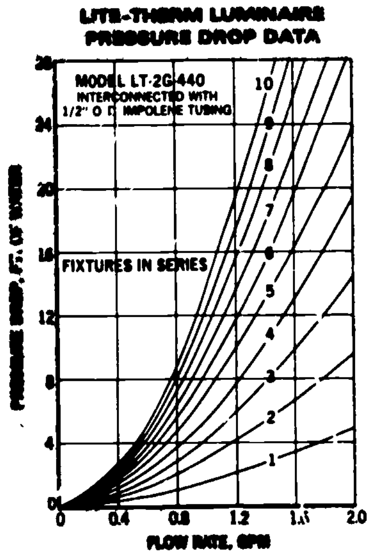
Lite-Therm luminaires can be furnished for recessed or surface mounting and with a variety of shielding mediums. Recessed fixtures can be supplied with heat removal provisions for use in conjunction with the Lite-Therm induction box system. They can also be arranged to permit attachment of air-supply bonnets.

Groups of three to seven luminaires are connected in series between supply and return mains. Flexible ½" O.D. polypropylene tubing is used for the interconnections.

The fixtures are suitable for use with water working pressures up to 100 psi. They have a burst pressure in excess of 600 psi and are furnished with compression union connectors designed to make a suitable seal with polypropylene tubing.

A Lite-Therm luminaire will pick up about 70% of the energy input to the fixture. In addition, it will pick up heat from a warm plenum, such as would occur under a roof exposed to the sun. Figure 1 shows the effect of plenum temperature and luminaire average water temperature on the net heat pickup efficiency of the luminaire.





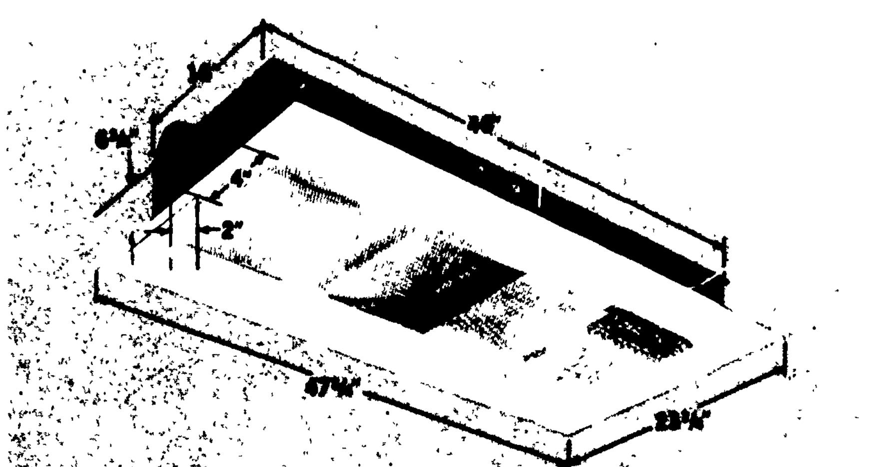
The pumping head and flow capacity required for circulating water through the luminaire is a function of the number of fixtures connected in series and the flow rate through each group of fixtures. The pipe size of the mains is also a function of these same factors. Figure 2 illustrates the head required for various groups of luminaires. Figure 1 illustrates the effect of increased average water temperature. Decreasing flow rate through the fixture from 2 gpm to 1 gpm decreases heat pickup efficiency about 3%. Table 2 shows typical performance for a system designed for a 16 foot head pressure drop across the fixtures. For balanced flow distribution the lengths of groups of fixtures should not vary by more than three fixtures in a given piping system.

For piping mains, galvanized steel or PVC plastic pipe are preferred over copper. Piping mains should be designed to provide a reverse return arrangement for approximately equal flow of water through all groups of fixtures. All the groups of fixtures in a zone should be piped to the mains at one point for easy installation of isolation and control valves.

TABLE 2—LITE-THERM LUMINAIRES—COOLING EXAMPLE
(2' x 4' fixtures with four F40 CW lamps, 188 watts/fixture=640 BTU/Hr)

Number Fixtures in Series	Flow Rate (gpm)	Supply Water Temp. Range (°F)	Water ΔT (°F)	Load to Water (BTUH)	Load to Space (BTUH)	Pressure Drop (Ft. Hd.)
3	2.0	77-85	1.3	1350	570	16
4	1.8	77-85	2.0	1800	760	16
5	1.6	77-85	2.8	2250	950	16
6	1.4	77-85	3.3	2700	1140	16
7	1.3	77-85	4.8	3150	1330	16

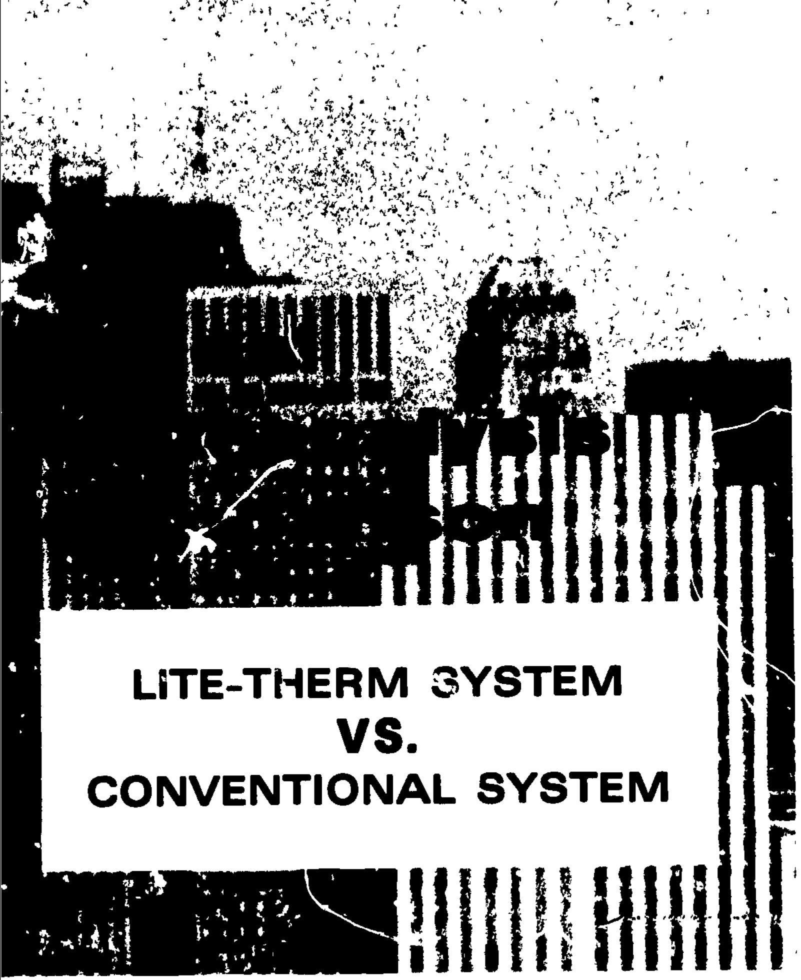
Lite-Therm Induction Box—The Lite-Therm induction box mounts in or above the ceiling. The 4G box is designed to lay into a 2' x 4', "T" grid, suspended ceiling and is complete with perforated return grill, supply diffuser, and an access panel.



Each box is equipped with a mechanical constant volume regulator to provide a constant volume of primary air at the induction nozzle. Dampers and linkage permit selection of secondary air from two secondary air inlets—either directly from the conditioned space, or through the luminaire and plenum.

TABLE 3—LITE-THERM 4G INDUCTION BOX DATA

Primary Air CFM / Static Pressure	100 / 0.75"—1.00"	117 / 0.75"—1.00"	135 / 0.75"—1.00"
Secondary Air CFM	100	118	135
Total Air CFM	200	235	270
Throw-Ft.			
50 FPM	9	10	12
100 FPM	7	[illegible]	9
150 FPM	4	5	6



LITE-THERM SYSTEM VS. CONVENTIONAL SYSTEM

Heat Losses		BTU/hr
Roof	60,000 x 0.15 x 75 =	675,000
Floors	60,000 x 2 =	120,000
Walls	37,000 x 0.20 x 75 =	555,000
Glass	24,600 x 1.13 x 75 =	2,090,000
Ventilation	46,000 x 1.08 x 75 =	3,725,000
Total		7,165,000

Heat Sources		BTU/hr
Lighting	230,000 x 5.0 x 3.4 =	3,910,000
Floor Power	230,000 x 0.5 x 3.4 =	391,000
Recovery Coil	46,000 x 1.08 x 25 =	1,241,000
Heat Compression (70% lighting+recovery coil) x .3 =		1,191,000
Occupancy	2300 x 250 =	575,000
Total		7,308,000

The following winter energy balance and summer air-conditioning load comparison indicate, through actual calculations, the benefits of a Lite-Therm system over conventional heating and air-conditioning systems. The calculations also are a guide in applying the ratings and design factors of the new dual-purpose Lite-Therm luminaires and louvers when designing Lite-Therm systems.

An exclusive Lite-Therm feature is the winter energy balance (the extraction of lighting and solar heat without the penalty of refrigeration and utilization of this heat to satisfy the winter heating requirements) which cannot be applied to any other system. The lighting, recovery coil and heat of compression together generate over 70% of the heat required to heat a building. But, no system—except Lite-Therm—can make use of these heat sources by efficiently capturing (through a positive transfer media—water) and redistributing the heat to where it is needed. In fact, with conventional systems a penalty is imposed—cooling for interior areas must be paid for, while at the same time 100% of the heat for perimeter areas must be purchased.

The summer air-conditioning load comparison shows the significant savings possible in air handling equipment (fans, distribution ductwork, etc.) and central plant refrigeration equipment (chiller, compressor, cooling tower, etc.). This not only means large first cost savings, but reduced operating power requirements and hence, significant operating cost savings. These calculations show a savings of 60% is air distribution and approximately 40% in central plant refrigeration equipment. The values are typical for an average building, but may vary slightly depending on the particular application. Values in blue indicate areas where the Lite-Therm system introduces savings over conventional systems.

Basic Considerations

Building Type	5 story office
Building Dimensions	300' x 180'
Building Glass Area	40%
Building Location	40 N. latitude
Lighting Load	5.0 watts/sq ft
Floor Power Load	0.5 watt/sq ft
Occupancy	1 person/100 sq ft
Ventilation Rate	0.2 cfm/sq ft
Occupied Floor Area	230,000 sq ft
Roof and Floor Area	60,000 sq ft ea.
North and South Wall Area	6,500 sq ft ea.
North and South Glass Area	4,300 sq ft ea.
East and West Wall Area	12,000 sq ft ea.
East and West Glass Area	8,000 sq ft ea.
Winter Design Temp.	0°F
Outside Summer Design Conditions	95°F DB, 75°F WB
Inside Space Conditions	75°F DB, 50% RH
Transmission Coefficients—Wall	0.20
Roof	0.15
Glass Summer	1.06
Glass Winter	1.13
Glass Solar Shading Coefficients—Conventional	0.64
Lite-Therm	0.12
Lighting Load Removal by Non-refrigerated Water	70% of KW input

No Lite-Therm Louvers on North Exposure

	Calculation		Conv. BTU/hr	Lite-Therm BTU/hr
1. Transmission				
Glass	24,600 x 1.06 x 20 x 0.25	=	~~521,000~~	130,000
Walls	37,000 x 0.20 x 20	=	148,000	148,000
Roof	60,000 x 0.15 x 20	=	180,000	180,000
	Total		~~849,000~~	458,000
2. Total of Solar Peaks for Each Orientation (Use for Air Load)				
North Glass	4,300 x 18	=	77,000	77,000
East Glass	8,000 x 200 ~~x 0.64~~ x 0.12	=	~~1,023,000~~	192,000
South Glass	4,300 x 200 ~~x 0.64~~ x 0.12	=	~~550,000~~	103,000
West Glass	8,000 x 200 ~~x 0.64~~ x 0.12	=	~~1,023,000~~	192,000
East Wall	12,000 x 0.20 x 2	=	5,000	5,000
West Wall	12,000 x 0.20 x 16	=	38,000	38,000
Roof	60,000 x 0.15 x 40	=	360,000	360,000
	Total		~~3,076,000~~	967,000
3. Total Solar Coincident—West, August, 4:00 P.M. (Use for Central Plant Tonnage)				
North Glass	4,300 x 13	=	56,000	56,000
East Glass	8,000 x 13	=	104,000	104,000
South Glass	4,300 x 32 ~~x 0.64~~ x 0.12	=	~~88,000~~	16,000
West Glass	8,000 x 200 ~~x 0.64~~ x 0.12	=	~~1,025,000~~	192,000
South Wall	6,500 x 5	=	32,000	32,000
West Wall	12,000 x 16	=	192,000	192,000
Roof	60,000 x 0.15 x 35	=	315,000	315,000
	Total		~~1,812,000~~	907,000
4. Electrical Load				
Lighting Load	230,000 x 5.0 x 3.4 x 0.3	=	~~3,910,000~~	1,175,000
Floor Power	230,000 x 0.5 x 3.4	=	391,000	391,000
	Total		~~4,301,000~~	1,566,000
5. Occupant Sensible	2,300 x 250	=	575,000	575,000
6. Occupant Latent	2,300 x 200	=	460,000	460,000
7. Ventilation	46,000 x 4.45 x (10.2 enthalphy)	=	2,090,000	2,090,000
8. Total Air Quantity (20° ΔT)				
1. + 2. + 4. + 5.	= 3,566,000 ~~8,801,000~~ / 1.08 x 20	=	~~408,000~~ cfm	**165,000 cfm**
9. Total Central Plant Refrigeration Load				
1. + 3. + 4. + 5. + 6. + 7.	= 6,056,000 ~~10,087,000~~ / 12,000	=	~~840~~ tons	**505 tons**

indirect transfer lite-therm system

The indirect transfer system utilizes single-zone air distribution at constant temperature to supply both interior and perimeter areas. When heating is required, heat removed from the Lite-Therm luminaires is redistributed by the water from the split condenser to the air through zone reheat coils in the ducts. This condenser water also supplies heat to the Lite-Therm louvers when required. When heat removal is required, the non-refrigerated water removes the heat from the luminaires and louvers and expels it through the evaporative cooler.

Winter energy balance calculations and a comparison of the glass area involved with lighting heat source available for re-distribution will establish if the indirect system should be used or whether the direct transfer induction Lite-Therm system (on next page) is more appropriate for a specific application.

Design Procedure

1. Establish zoning arrangement for building or space to be heated or cooled.

2. Determine heat loss and heat gain for each room requiring heating and cooling using ratings of Lite-Therm products, and establish air quantity requirements.

3. For cooling load calculations, apply a shading coefficient of 0.12 to the solar load and a factor of 0.25 to the transmission gain for glass areas with Lite-Therm louvers. Apply a factor of 0.30 to the total KW input of Lite-Therm luminaires. All other heat gains or losses are determined by conventional ASHRAE procedures.

4. Main air handling unit (A) is sized to handle total air cooling load using a low-velocity, single-zone air distribution system. Supply air temperature varies from 55°F in summer to 65°F in winter. This is achieved through a master outdoor thermostat which resets the sub-master, cold-deck thermostat. Use of a humidifier and either a dry-coil or sprayed-coil air-handling unit is determined by the designing engineer.

5. Develop air distribution layout. Air distribution (B) is through one zone of low-velocity (0.10"SP), constant-temperature air, heated as required by zone reheat coils.

6. Develop piping distribution layouts. Lite-Therm luminaires (C) have supply and return mains serving three to seven luminaires connected in series. Water flow is determined from ratings given in Table 2, Page 9.

7. Lite-Therm louvers (D) may have one of several piping systems. Illustrated is a one-pipe system with small in-line circulating pumps (P). One hot-water main serves as a common supply and return and one non-refrigerated water line circulating pump takes water from the mains to heat or cool the louvers as required and puts it back into the proper main through two-position diverting valves. A pump of sufficient capacity to serve the required louver area should be selected. Water flow must be adequate to handle the optimum coincident BTU requirements of the louvers in the zone served and is determined from ratings given in Table 1, Page 8.

8. Chiller and compressor (E) are sized only for the capacity of the summer load on the cooling coil in the air handling unit (A) and are based on an 85 to 95°F condenser water temperature. Chilled-water supply temperature is 42°F, with a 10°ΔT. Cooling coils selected with 45 to 55°F water for safety. Variations in these conditions are the option of the designing engineer.

9. Cooling tower (F) and one-half of split condenser (G) are sized to handle maximum chiller load (summer load on main cooling coil) with 85 to 95°F condensing water.

10. The other half of split condenser (H) is sized to handle the chiller load required to cool: 70% of lighting, coincident solar load on louvers in winter, relief air load, and minimum load on main air handling unit coil if a minimum load occurs. In selecting this side of condenser, use a 130°F condensing temperature and 115 to 125°F condensing water.

11. Supplementary water heater (I) used for partial supplementary heating and night heating of the water is sized to handle 100% of heating losses (no outside air) that are on the water circuit. Supply water temperature is 125°F, with a 10°ΔT.

12. Heat exchanger (J) is sized to cool 70% of lighting load plus winter coincident solar load picked up in water system.

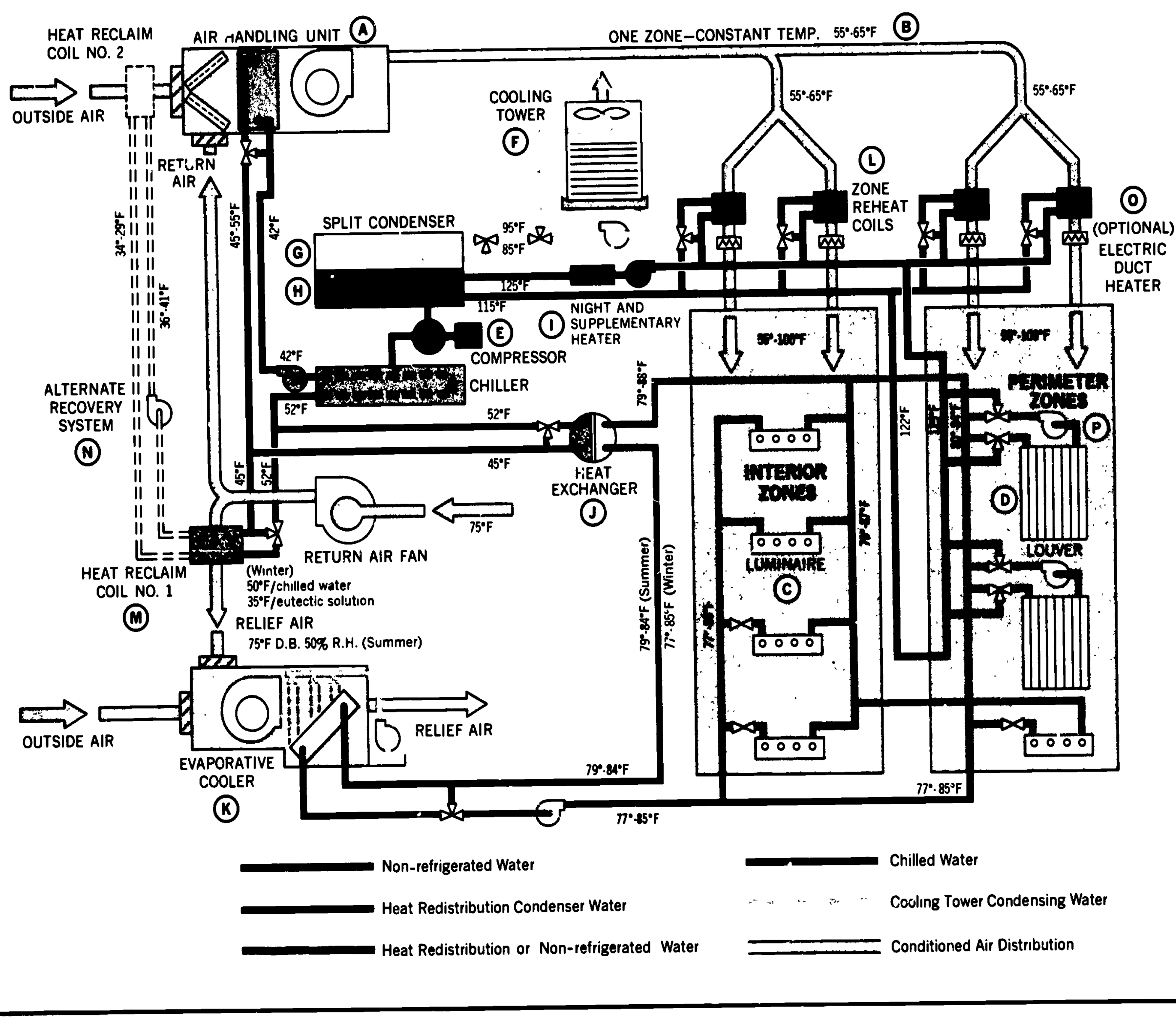
13. Mix all relief and exhaust air with outside air serving evaporative cooler (K) to lower the ambient WB temperature through the unit. Then, size evaporative cooler to handle total flow required to cool lighting system (70%), coincident summer solar load, and transmission load on louvers. Water temperature difference is determined from product rating schedules and varies between 2 and 3°ΔT. Water leaving the evaporative cooler may vary from 77 to 81°F, depending on geographic location and ambient WB temperature. The lower water temperature is more feasible.

14. Zone reheat coils (L) are sized at a maximum velocity of 500 fpm, a 125°F entering water temperature with a 10°F ΔT, and a 60°F entering air temperature. Leaving air temperature must be sufficient to handle remainder of heat losses not taken care of by perimeter louvers or the lighting heat sources in the interior spaces. Additional air zone control may be achieved through electric duct heaters (O).

15. Heat reclaim coil (M) is sized to cool relief and exhaust air from 75 to 50°F with chilled water. In colder geographic locations, it may be feasible to apply a straight run-around recovery system (N) using a eutectic solution of 40% ethylene glycol. This offers a larger source of heat reclaim as well as a simple preheat system.

16. All pumps are selected to handle design flow rates and friction losses incurred.

INDIRECT TRANSFER SYSTEM



direct transfer induction lite-therm system

The direct transfer induction system utilizes single-zone air distribution at constant temperature to supply both interior and perimeter areas. When heating is required, heat removed from the Lite-Therm luminaires is transferred directly to the louvers and to the supply air. It can also be transferred indirectly in extreme weather using condenser water. When heat removal is required, the heat from louvers and luminaires is carried to the evaporative cooler where it is expelled to the outside air.

Winter energy balance calculations, the ratio of perimeter to interior area, and the amount and size of glass areas will determine if the direct transfer induction system should be used or whether the indirect transfer Lite-Therm system (on page 12) should be used.

Design Procedure

1. Establish zoning arrangement for building or space to be heated and cooled.

2. Determine heat loss and heat gain for each room requiring heating and cooling using ratings of Lite-Therm products, and establish air quantity requirements.

3. For cooling load calculations, apply a shading coefficient of 0 12 to the solar load and a factor of 0.25 to the transmission gain for glass areas with Lite-Therm louvers. Apply a factor of 0.30 to the total KW input of Lite-Therm luminaires. All other heat gains or losses are determined by conventional ASHRAE procedures.

4. Main air handling unit (A) is sized to handle total air cooling load using a medium-velocity, single-zone, air distribution system. Supply air temperature is held at a constant 50°F summer and winter. Use of a humidifier and either a dry-coil or sprayed-coil air-handling unit is determined by the designing engineer.

5. Develop air distribution layout. Air distribution (B) is through one zone of medium velocity (4.5" SP) constant-temperature air delivered to induction mixing boxes. The air to perimeter boxes is tempered using a reheat coil to a temperature determined by outdoor temperature.

6. Develop piping distribution layouts. Lite-Therm luminaires (C) are connected in groups of circuits of three to seven luminaires between supply and return mains. The groups of circuits of luminaires for each zone should be arranged to permit bypass and shut-off valving and the mains should be arranged for reverse return for balanced water flow through the luminaires in each zone.

7. Lite-Therm louvers (D) for each exposure are supplied from a secondary circuit drawing from either the non-refrigerated return or the condenser water loop, depending on solar exposure and outdoor temperature. The water flow should be selected to provide 0 05 to 0.1 gpm per square foot of louver blade area supplied

8. Chiller and compressor (E) are sized only for the capacity of the summer load on the cooling coil in the air handling unit (A) and are based on 85 to 95°F condenser water temperature. Chilled water supply temperature is 42°F with a 10°F ΔT. Variations in these conditions are the option of the design engineer.

9. Cooling tower (F) and one-half of split condenser (G) are sized to handle maximum chiller load (summer load on main cooling coil) with 85 to 95°F condensing water.

10. The heating section of the split condenser (H) is sized to handle: 70% of lighting, coincident solar load on louvers in winter, relief air load, and minimum load on main air handling unit coil if a minimum load occurs. In selecting the heat transfer surface for this side of the condenser, use a 130°F condensing temperature and 115 to 125°F condensing water.

11. Supplementary water heater (I) used for partial supplementary heating and night heating of water is sized to handle 100% of heating losses (no outside air) that are on the water circuit. Supply water temperature is 125°F with a 10° ΔT.

12. Heat exchanger (J) is sized to cool 70% of the lighting load plus the winter coincident solar load picked up in the water system.

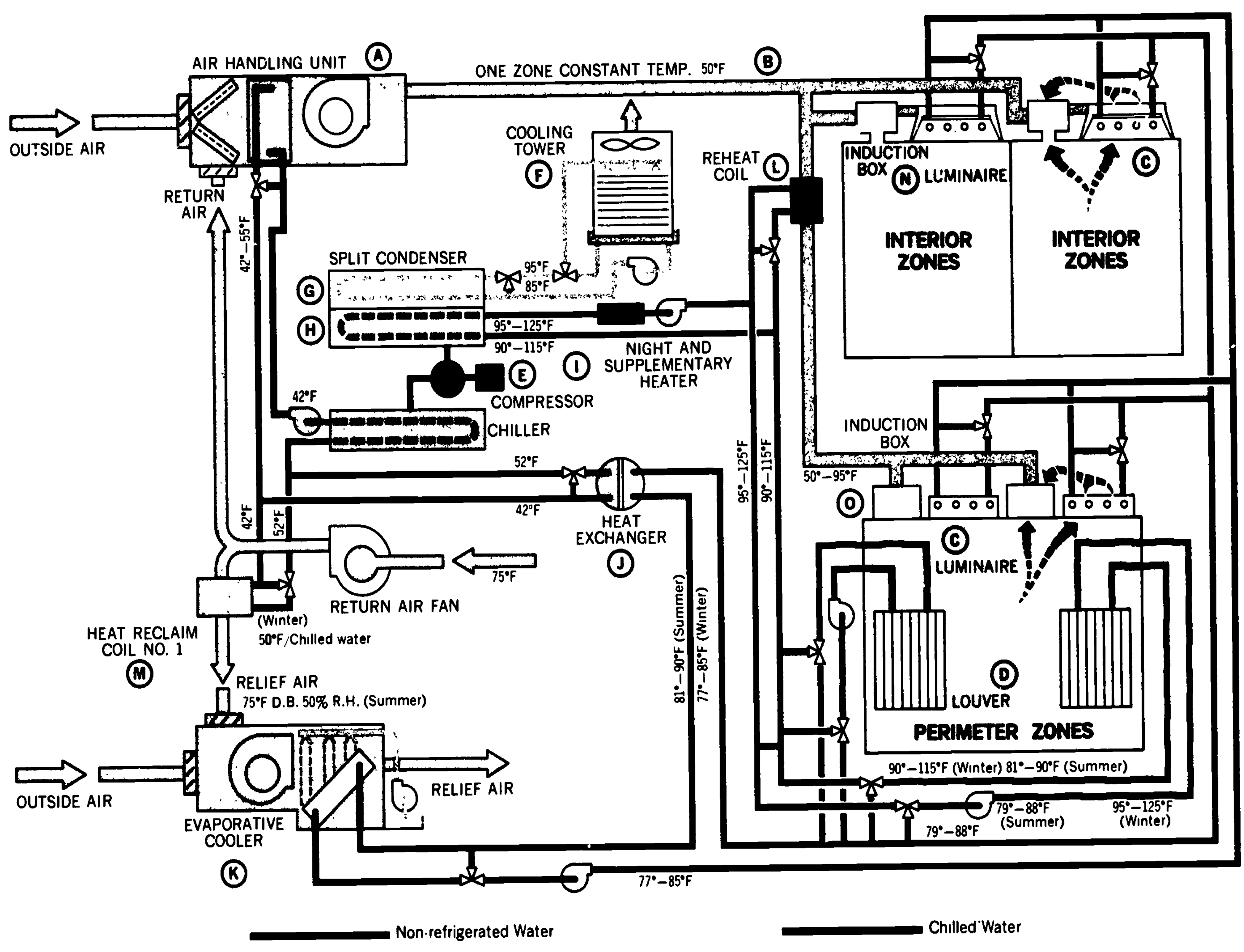
13. Mix all relief and exhaust air with the outside air serving the evaporative cooler (K) to lower the ambient WB temperature through the unit. Then, size the evaporative cooler to handle the total flow required to cool 70% of the lighting system load, the coincident summer solar load, and the transmission load on louvers. Water temperature difference is determined from product rating schedules and varies between 2 and 5°F. Water leaving the evaporative cooler may vary from 77 to 85°F, depending on geographic location and ambient WB temperature.

14. Perimeter air reheat coils (L) are sized at a maximum velocity of 500 fpm, a 125°F entering water temperature with a 10°F ΔT, and a 50°F entering air temperature. Leaving air temperature must be sufficient to handle the remainder of heat losses not taken care of by perimeter louvers or radiation.

15. Heat reclaim coil (M) is sized to cool relief and exhaust air from 75 to 50°F with chilled water.

16. All pumps are selected to handle design flow rates and friction losses incurred.

DIRECT TRANSFER INDUCTION SYSTEM



Non-refrigerated Water
Heat Redistribution Condenser Water
Heat Redistribution or Non-refrigerated Water
Chilled Water
Cooling Tower Condensing Water
Conditioned Air Distribution

floor piping distribution

1. Floor piping distribution shall consist of non-refrigerated water piping to the water-cooled luminaires, and supply and return mains for thermal louver assemblies.

2. Luminaires are to be piped in groups of three to seven fixtures. The groups of fixtures for a given zone should be piped to mains with gate valves or shut-off cocks for isolation of the zone. If Lite-Therm induction boxes are used, the connection to supply and return mains should be in close proximity to permit installation of valves for control of water flow to the zone.

3. Luminaires are supplied with compression unions for connection of ½" O.D. water tubing. For interconnecting fixtures, polypropylene tubing such as Imperial Eastman's "Impolene" 88PP is generally used. For connection to the mains, an adaptor union such as Imperial Eastman's "Nylo-Seal" 268-N ½ x ½ is used.

4. Thermal Louver piping may be two pipe, three pipe, or four pipe — depending on building layout and the extent to which louvers are to be used for zone temperature control. Two types of two-pipe systems are common. In one system, water temperature supplied to the louvers is scheduled on the basis of outdoor temperature. In the other, one hot-water main and one non-refrigerated main each act as a common supply and return. Three-way valves select hot or non-refrigerated water for supply to the louver — dependent upon zone temperature control demands. A secondary pump assures positive circulation through the louver assem- Regardless of the piping system used, pumping capacity must be sufficient to supply 0.05 to 0.10 gpm of water per square foot of louver blade area.

5. Connections for supply and return of louver water are ½" aluminum pipe connections in the upper right or left corner. Large assemblies have connections in both upper corners. Dielectric unions, vents, and isolation cocks are to be included in the piping between the louver assembly and mains. Piping between the louver and union is to be aluminum or plastic such as PVC or polypropylene.

6. Coils shall be selected for a 10°F water ΔT and a pressure drop of 5 to 10 feet. Piping shall include appropriate three-way control and bypass valves, balancing cocks, dielectric unions, and vents.

7. Piping shall be sized for a friction loss of 2.0 to 5.0 feet per 100 feet of pipe. See the piping size recommendations table.

8. For piping mains in the ceiling space, steel or PVC plastic piping is preferred. Galvanized steel pipe is good for non-refrigerated water, but black steel pipe should be used for heated water louver mains. Copper in the system is best kept to a minimum.

9. Mains are to be arranged for reverse return where feasible. Balancing cocks are to be used where the piping is not inherently self balancing.

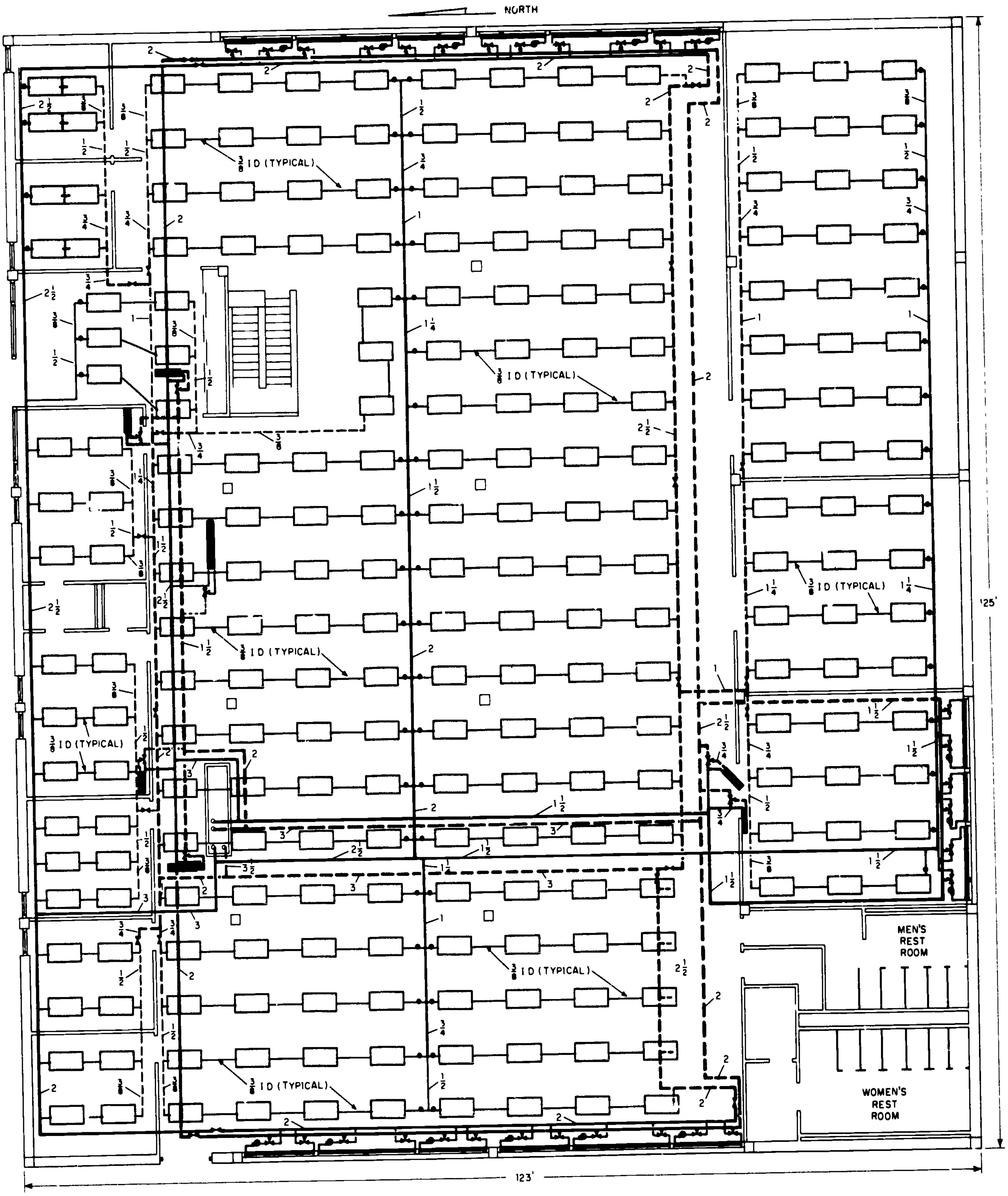
10. Drain and shut-off valves and vents shall be provided and suitably located so that sections of lighting, louver, and other water systems can be drained without draining the entire system. However, piping shall be arranged so that the entire system could be drained.

11. All water piping should be pitched 1" in 40'-0" in the direction of flow and so vented that all the air can be purged through automatic relief vents with drained overflows. Isolated high points, particularly at louver risers, must also be vented.

12. Only hot (condenser) water lines and chilled water lines shall be insulated.

PIPE SIZING RECOMMENDATIONS

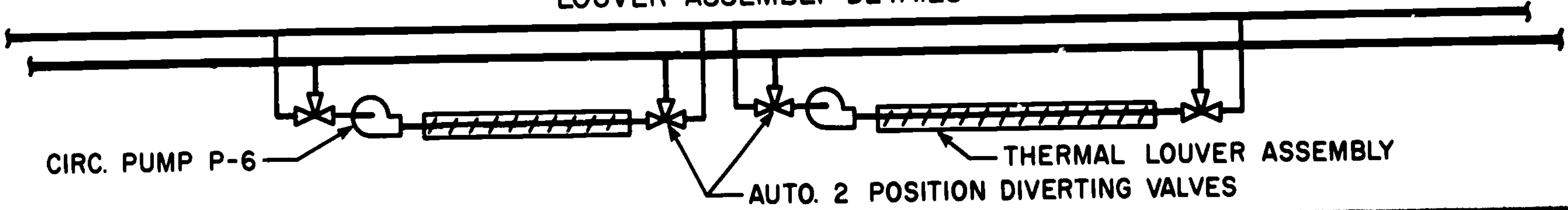
Maximum Flow Rate gpm	Pipe Size inches
2	½
4	¾
8	1
17	1¼
25	1½
50	2
80	2½
140	3
280	4
520	5
850	6



Non-refrigerated Water Supply
Non-refrigerated Water Return
Heat Redistribution Condenser Water Supply
Heat Redistribution Condenser Water Return
Lite Therm Water Cooled Luminaire
Reheat Coils
Lite Therm Louvers

Building: Employers Group Insurance—Executive Park, Atlanta, Georgia **Architects:** Stevens and Wilkinson

LOUVER ASSEMBLY DETAILS



air distribution—indirect transfer system

1. Air distribution shall be low velocity and sized on the basis of 0.10 inches of water friction drop per 100 feet of ductwork.

2. Air shall originate from one single-zone air distribution system and shall branch off into the required number of zones with zone reheat coils as established by the designing engineer.

3. The various thermal louver assemblies or space heaters shall have the ability to override each other and control the zone reheat coil to satisfy cooling demand with reheat being added by louvers or resistance to those areas that may become overcooled. This procedure, outlined in detail in the control sequence, provides additional breakdown in zone control to meet all requirements of the owner or design engineer.

4. It is recommended not to provide less than 0.6 C.F.M. of air per sq. ft. of floor area in order to meet minimum air change per hour code requirements.

5. Air diffusers, grilles, etc. shall be selected as in any conventional system.

6. Water cooled luminaires may also be provided with side slots for *supply air distribution* from bonnet connections that are manufactured by several companies for adapting to lighting fixtures. The water cooled luminaire, however, is not a return air troffer.

7. All exhaust and relief air shall be arranged so as to be relieved through the evaporative cooler.

8. Contractor shall verify all field conditions and shall be responsible for making required changes in piping and ductwork accordingly.

9. Contractor shall check all plumbing, electrical and architectural drawings and co-ordinate his work with these trades to eliminate interferences.

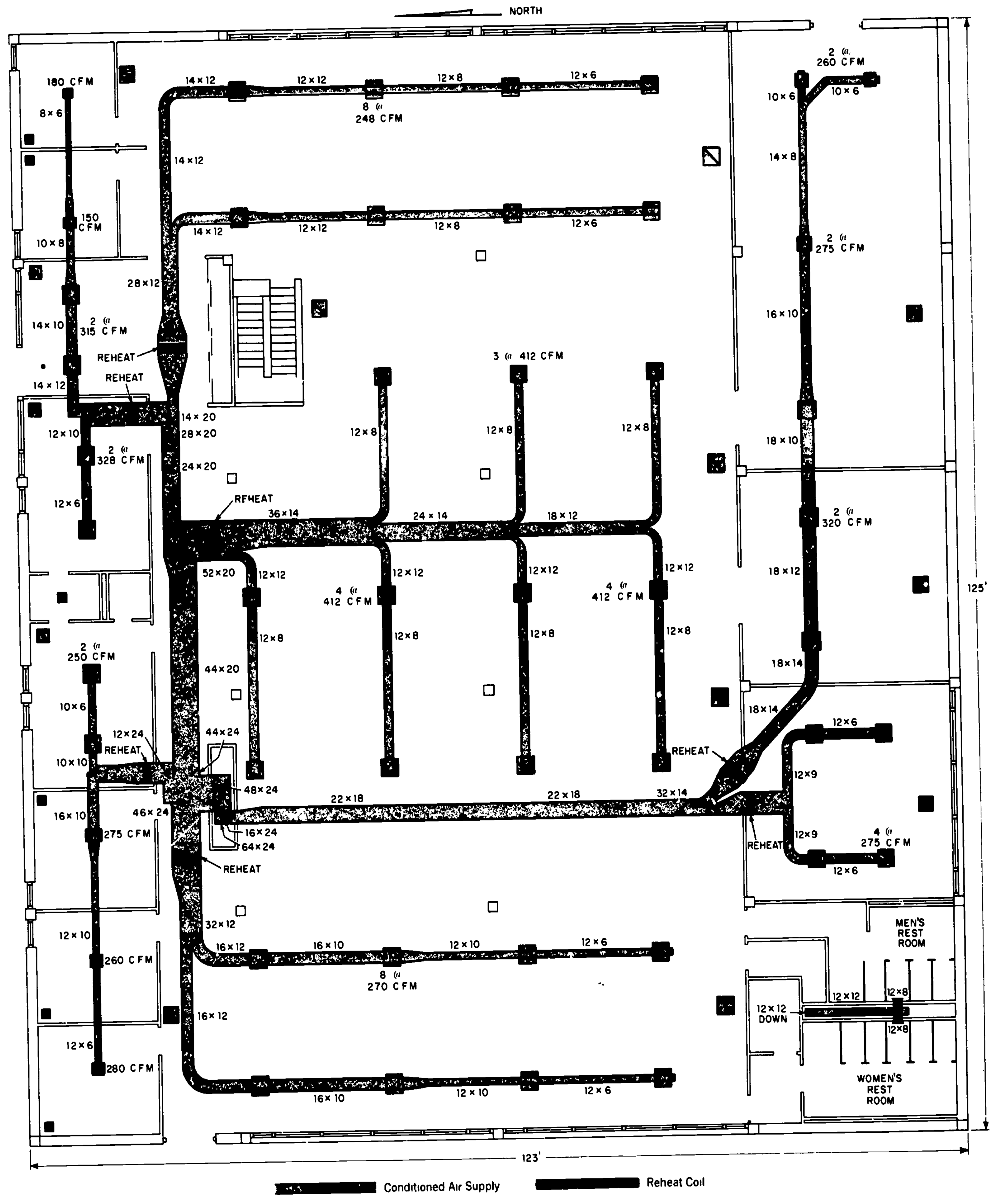
10. Duct sizes shown are net free area.

11. Ductwork shall be provided with ducturns where shown or required and at all 90° square ducturns.

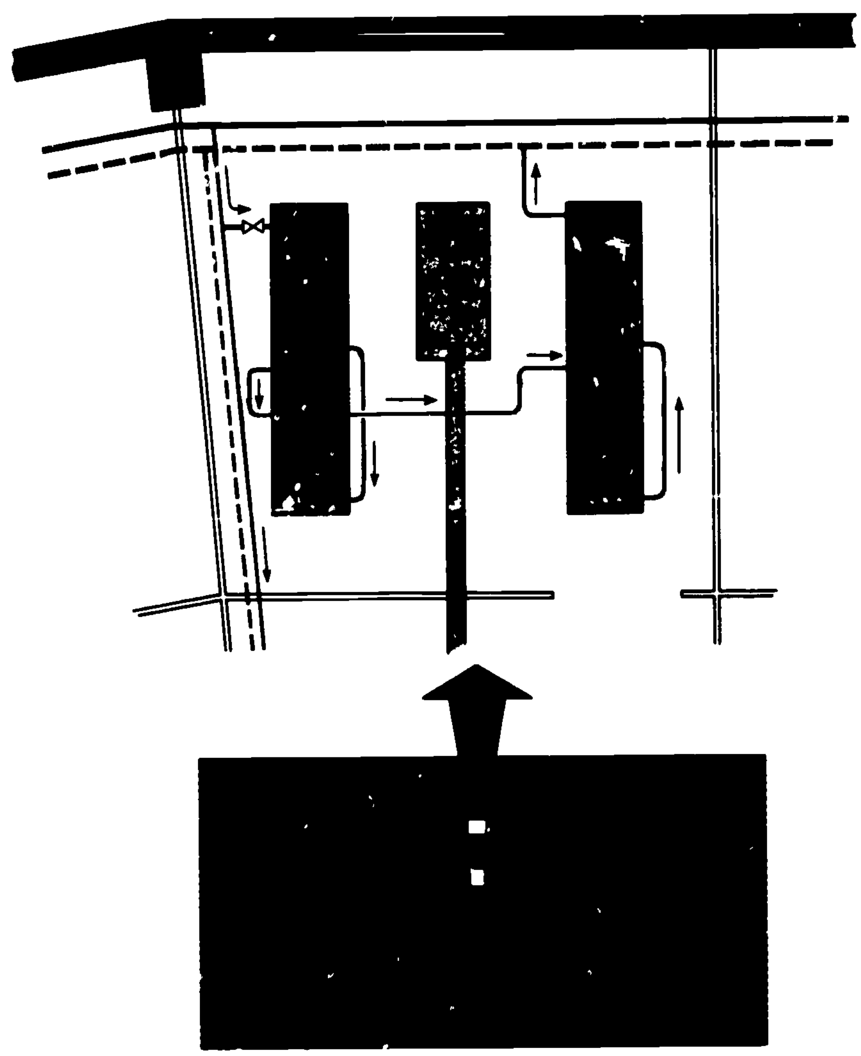
12. All neck runouts in ductwork shall be provided with splitter dampers and sized for larger portion of the duct.

13. Provide volume dampers as required to balance air distribution system.

14. Provide fire dampers where required by code or the owner.



Building: Employers Group Insurance—Executive Park, Atlanta, Georgia **Architects:** Stevens and Wilkinson



Building: The Benjamin Fox Pavilion, Jenkintown, Pennsylvania.
Architect: George S. Idell, F. A. I. A. **Mechanical Engineer:** James L. Wolf, P. E.

air distribution—direct transfer induction system

1. Air distribution shall be medium velocity and sized on the basis of the static regain method with an operating pressure of 1.0" water in the duct behind each outlet.

2. Air shall originate from single-zone air handling units and shall branch off into the required number of zones as established by the designing engineer. It may prove desirable to use a reheat coil in the branch to the perimeter zones.

3. Zone temperature control is maintained with the induction box by selection of secondary air from either the conditioned space or from the plenum where the secondary air has been warmed by passage through the luminaire. When secondary air is drawn through the luminaires into the plenum, water flow to the luminaires is controlled by a valve to provide greater temperature control capabilities. This procedure, outlined in detail in the control sequence, provides full zone control capabilities.

4. It is normal practice to provide not less than 0.8 cfm of mixed air per square foot of floor area for good circulation and to meet minimum air change requirements.

5. The 4G induction box includes the supply diffuser and return grill as an integral part of the box. The box is simply laid into the ceiling and connected to the supply air main.

6. All exhaust and relief air shall be arranged so as to be relieved through the evaporative cooler.

7. Contractor shall verify all field conditions and shall be responsible for making required changes in piping and ductwork accordingly.

8. Contractor shall check all plumbing, electrical and architectural drawings and coordinate his work with these trades to eliminate interferences.

9. Ductwork shall be provided with ducturns where shown or required and at all 90° square ducturns.

10. Provide volume dampers as required to balance air distribution system.

11. Provide fire dampers where required by code or owner.

equipment room layout

1. All major equipment shall be selected as outlined in the design procedure.

2. Piping and ductwork shall be sized on the same basis as the floor distribution systems.

3. In each closed water system in the proximity of the pump suction piping, include an expansion tank with an air level control, an ASME pressure relief valve, and a system fill valve. If an automatic fill valve is used, means must be provided for limiting the fill rate when the system is unattended and for detecting excessive filling. A water-treatment feeding pot should be connected between the pump suction and discharge piping.

4. Number and location of indicating thermometers and pressure gauges shall be determined by the design engineer.

5. The evaporative cooler should be located inside the building if possible to eliminate the problem of freeze-up protection which is more difficult to obtain than with a cooling tower.

6. Control and function of all major equipment shall be as outlined in the control sequence.

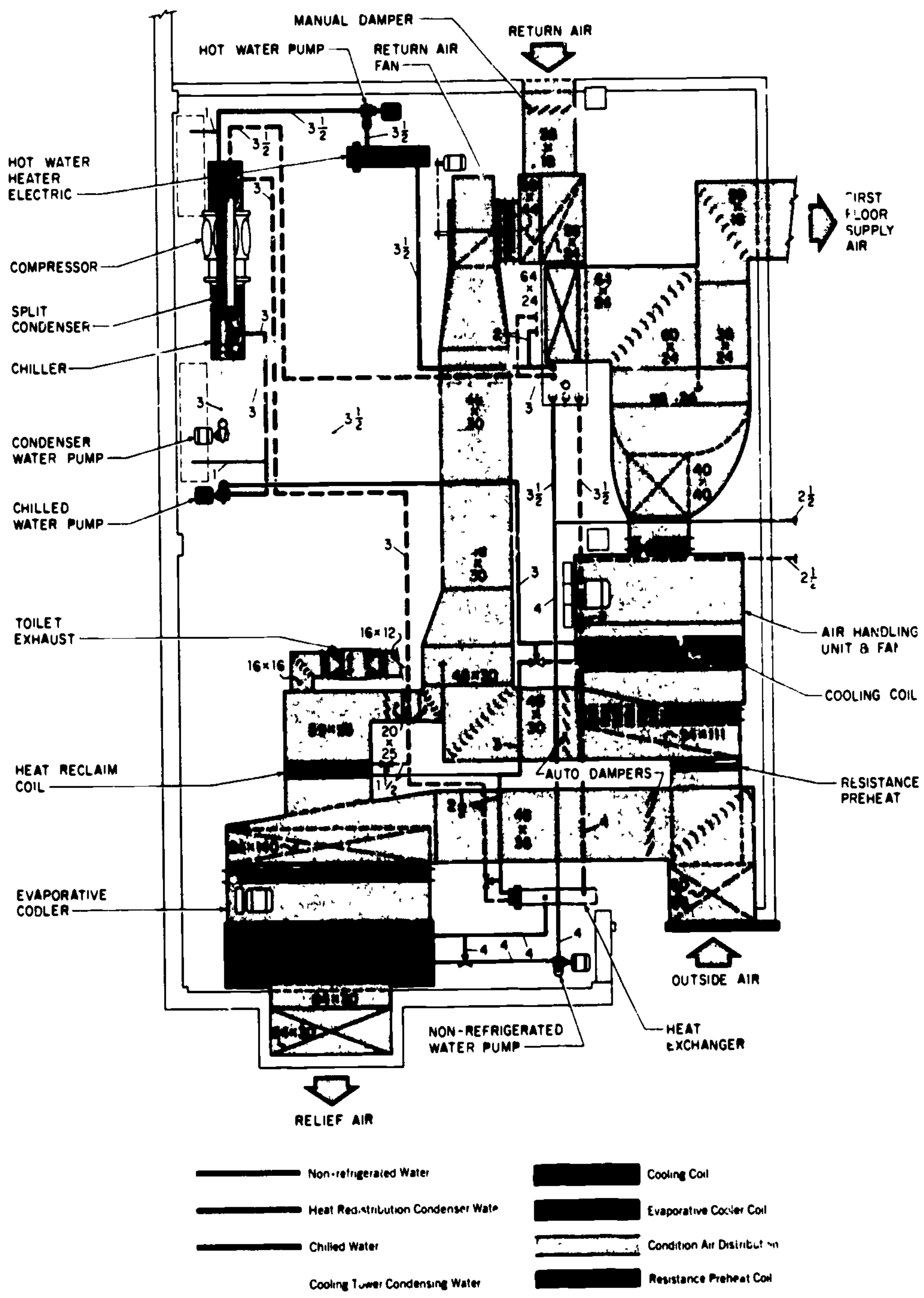
7. Cooling tower freeze-up protection may be as shown or one of several methods. All of these methods are available in printed form from various cooling tower manufacturers giving procedures and methods of BTU determinations to prevent cooling tower freeze-up.

8. All air conditioning supply air ductwork in non-conditioned space shall be insulated. Outside air intake ductwork shall be insulated.

9. General contractor to provide concrete foundations under all pumps and equipment.

10. Electrical contractor shall provide and install all wiring under another division of the specifications.

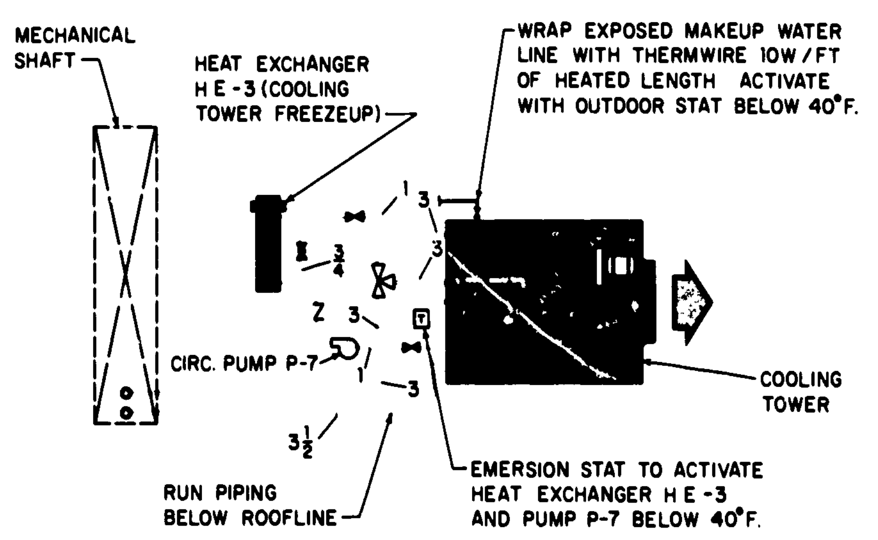
11. All fans shall have flexible connections to ductwork and all pumps and equipment shall be provided with spring-type vibration eliminators.



Building: Employers Group Insurance—Executive Park, Atlanta, Georgia

Architects: Stevens-Wilkinson

FREEZE-UP PROTECTION



installation details

Lite-Therm Luminaire

Water-cooled *luminaires* shall be *installed* and *wired* by the *Electrical Contractor* with the same normal procedures used when installing conventional luminaires. Care must be exercised in handling to prevent damage to water passages and fittings. The fixture should be kept in its shipping carton until just prior to hanging and handled by two sides when it is placed into the ceiling. Fixtures for installation in continuous rows in T-grid ceilings must have the wiring knockout removed from adjoining ends before they are hung.

After the luminaire is installed and wired the *Mechanical Contractor* shall *make final piping connections* between fixtures and to supply and return mains. Polypropylene tubing, such as Imperial Eastman's Impolene 88-PP, is normally used. Fixtures come equipped with compression unions for ½" O.D. tubing on each end. The contractor shall supply the tube and fittings for interconnections and connections to the mains. All piping of dissimilar metals shall have union joints of dielectric insulating material

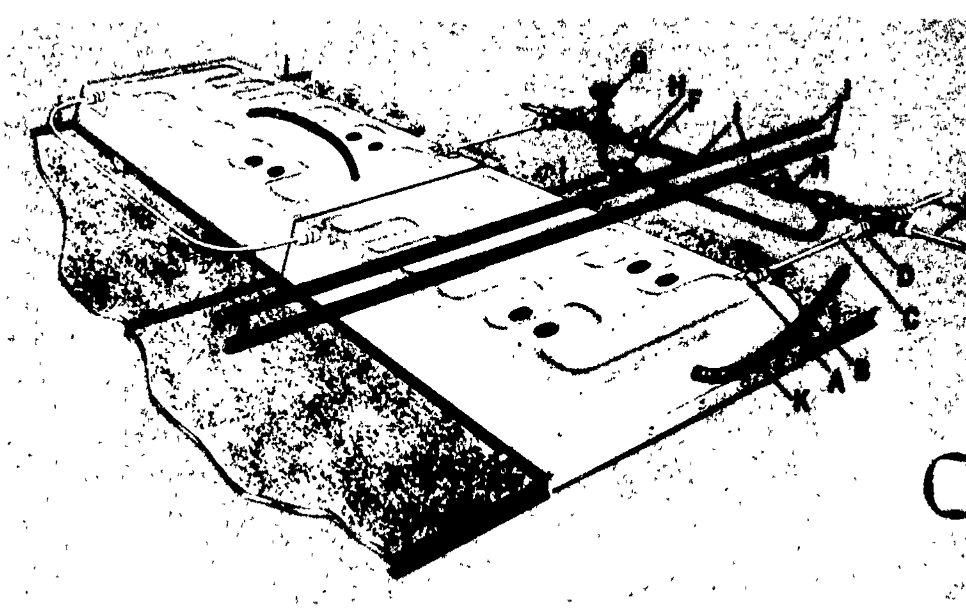
Unions supplied with the fixture have been factory tightened on the fixture. The nut on the free end should be screwed on, to an "easy" finger-tight position. Then slide tube end into the nut and push until it bottoms Tighten nut 2 to 2½ full turns.

When all connections have been made, check the system for leaks at a pressure 1½ times operating pressure, but not more than 150 psi. The test may be an air and soap bubble test, or a water test. Check *both* nuts on each union. If any leaks occur that do not close with an additional one or two quarter turns of the nut, replace the union. Excessive tightening will crack the nut.

When filling the system, bleed all high points in the main supply and return lines and run a small continuous bleed for several hours after the pump is started—to allow air to work its way out of the system. Fixtures will purge themselves in a short period of time. After bleeding the system, check for blocked or air-bound fixtures. With lights on, these fixtures will be much hotter to the touch than fixtures where water is circulating.

Immediately after the system has been tested for leaks and filled, it must be cleaned and flushed—and water treatment added.

If air supply bonnets are used, they can be installed as soon as the fixtures are hung since they do not affect water connections. Remove the air slot cover after the fixture has been installed in the ceiling, and put the bonnet in place. When bonnets are ordered, the manufacturer must know the make and model fixture on which it is to be installed Air-handling fixtures are gasketed for dust tightness. Do not damage this gasketing. When plastic diffusers are supplied on air-return fixtures, they are UL listed and labeled for air-handling fixture service. Replacement diffusers must also be so labeled.



A. ½" O.D. aluminum tubing integral with the luminaire.

B. ½" nylon compression union supplied with the luminaire.

C. ½" O.D. polypropylene tubing such as Imperial Eastman 88PP "Impolene". Supplied by the Mechanical Contractor.

D. ½" O.D. tube x ½" M pipe adaptor fitting such as Imperial Eastman 268-N Nylo-Seal®. Supplied by Mechanical Contractor.

E. Connections to all groups of fixtures in the zone or area.

F. Bypass and balancing cock. Used only with the Lite-Therm Induction Box system.

G. Three-way automatic water-flow control valve. Used only with the Lite-Therm Induction Box system.

H. Gate valves or shutoff cocks for fixtures in the zone or area.

I. Connection to water distribution main by Mechanical Contractor.

J. Water distribution mains by Mechanical Contractor.

K. Electrical connection by Electrical Contractor.

Lite Therm Louvers

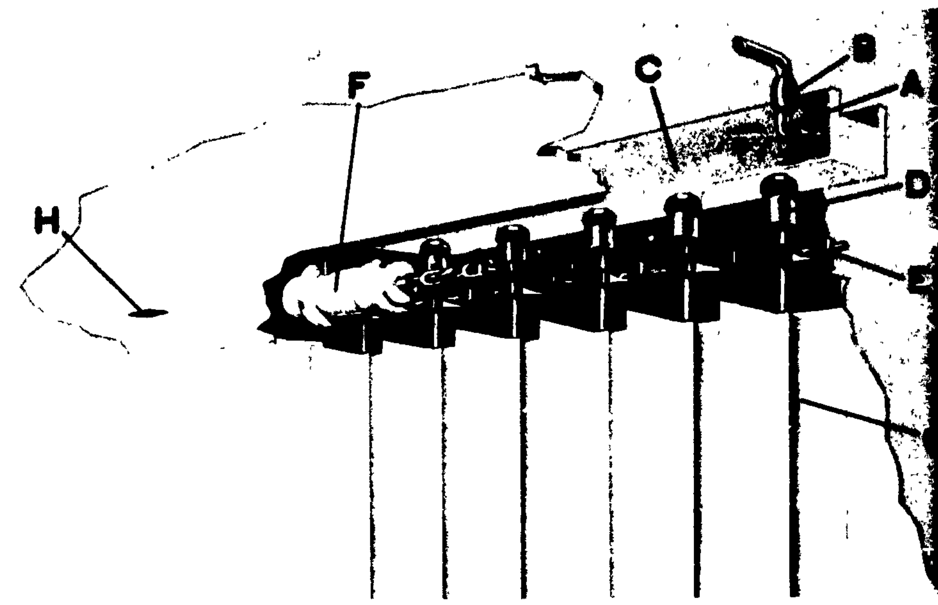
Louvers are shipped assembled in a frame which slides into place in the window opening, with the center of the louver blade about 4 to 5 inches from the glass. Clips are provided for bolting the assembly to the side walls or to floor and ceiling supports. On assemblies with more than 7 blades, a support for the center of the upper manifold will be needed.

After the louver assemblies are installed, the Mechanical Contractor shall make his piping connection between the louver assembly and the mains. The connection at the louver shall be ½" aluminum pipe and fittings to a dielectric union or ½" PVC pipe.

Care must be taken in arranging piping to provide valves and vents for purging all air from the louver assembly. Usually flow is set by the design of the piping, but in certain instances a balancing cock may prove desirable.

The Controls Sub-Contractor shall mount and connect motor operators to the blade linkage supplied with the louver assemblies. Blade positioning may be by a manual controller or by a solar cell acting through a transducer with a manual override. Usually, one solar cell controls all louvers on an exposure and individual areas are controlled by manual overrides. The cell is usually mounted in the conditioned space directly behind a louver in an area where the override is not likely to be used, such as a lunch room. The cell is mounted in the ceiling about one-half a blade length from the outside wall with the louver. With the lights on, the transducer is adjusted to allow the blades to open just enough to prevent entry of direct sunlight.

All cover plates, trim pieces, and enclosures shall be provided by the General Contractor.



A. ½" pipe connection to thermal louver assembly. Connection by Mechanical Contractor.

B. Balancing valve by Mechanical Contractor.

C. Thermal louver assembly water-supply header.

D. Water seal assembly connection to header.

E. Thermal louver opening and closing linkage connection.

F. Pneumatic motor operator controlled automatically to operate the thermal louver linkage.

G. Thermal louver blades formed by an extrusion process.

H. Photo cell mounted on the ceiling to automatically position the thermal louvers and maintain required illumination level.

Lite-Therm Induction Box

The type 4G induction box is a self contained unit which lays into a standard T-grid 2 x 4 ceiling. Connect a four-inch round air duct to the primary air connection. This duct must be sealed to contain the 1.0" plus static pressure existing at this point.

The box includes a constant volume primary air flow regulator and linkage for control of the secondary air inlet dampers. The Controls Sub-Contractor shall mount and connect motor operators for the box damper linkage. The dampers shall operate in sequence with the water flow control valve in the water-cooled fixture piping, and both the dampers and the valves shall be controlled by room temperature.

A. Primary air duct by Mechanical Contactor.

B. Induction Nozzle.

C. Mechanical Constant Volume Regulator

D. Plenum Secondary Air Inlet.

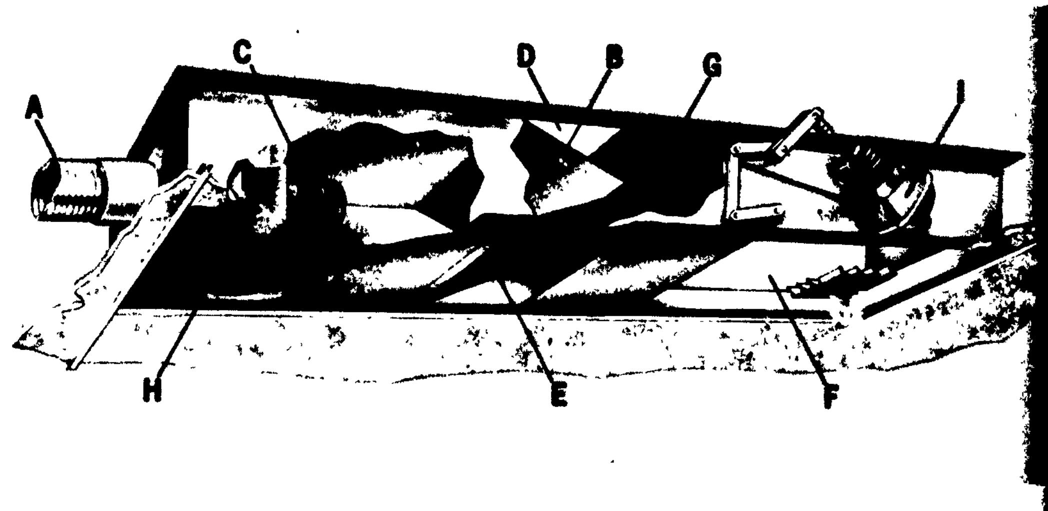
E. Room Secondary Air Inlet.

F. Supply Diffuser

G. Damper Plates.

H. Access Panel.

I. Damper Control Motor by Controls Sub-Contractor.



SPECIFICATIONS

LITE-THERM THERMAL LOUVERS

General

All clear unshaded glass areas except the north exposure shall be shielded by vertical non-refrigerated water cooled thermal louver assemblies which shall provide radiant temperature zone control through space thermostats and illumination level control through a selenium photo cell that automatically rotates the thermal louvers to intercept the direct rays of the solar radiation

Thermal louver assemblies shall be as manufactured by Environmental Systems Corporation

The louver Contractor shall furnish all labor, materials and equipment necessary for the finished installation of each unit as shown on the drawings The Mechanical Contractor shall furnish and install all interconnecting piping to the thermal louver assemblies including piping runouts, balancing valves, etc., as indicated on the drawings. Automatic temperature controls shall be provided by others

Installation

Materials shall be delivered to the job in the manufacturer's packages with unbroken seals and shall be stored in a protected area until installed in place

The complete louver unit shall be put in place and adjusted by a contractor approved by Environmental Systems Corporation Work shall be coordinated with curtain-wall or window-wall contractors and other trades and shall meet the approval of the architect

Each louver assembly shall be driven by positioning motors as required which shall be supplied by the automatic control contractor

All units shall be tested and balanced by the louver contractor

Materials

Material for louver and header extrusions shall be 6063-T5 aluminum. Each louver bank assembly shall include a frame including upper and lower water manifolds, bottom drain connection, side mounting and bracing angles, rotatable vertical louvers mounted in 75 P S I water, pressure seals on the upper and lower manifold, and linkage arms and rods to move the louvers in unison The louver assembly shall have ½" supply and return piping connections in the upper right or left hand corners above the ceiling.

Louver finish may be anodized to any sun proof color available or may be painted to any desired color Finish samples shall be supplied to the architect for approval.

Perfomance Design

Each thermal louver assembly shall meet the thermal ratings in design tables and criteria set forth by the manufacturer when supplied with the specified water temperature and G P M/Sq Ft of thermal louver area.

Engineering liaison shall be provided by Environmental Systems Corporation to assist in the evaluation and design of energy integrated systems utilizing the louvers

Lite-Therm thermal louvers are to be guaranteed to be free of all mechanical defects

LITE-THERM LUMINAIRES

General

Lighting shall be by fluorescent lamps mounted in enclosed non-refrigerated water cooled luminaires with solid translucent shielding Units shall be 2' x 4' model LT2G440 flush mount for grid "T" bar lay in ceiling as manufactured by Environmental Systems Corporation. Luminaires shall be for connection to ___ volt, 60 cycle power supply.

Installation

Materials shall be delivered to the job in the manufacturer's packages with unbroken seals and shall be stored in a protected area until installed in place.

Water cooled *luminaires* shall be *installed* and *wired* by the *Electrical Contractor* with the same normal procedures used as installing conventional luminaires.

After the luminaire is installed and wired the *Mechanical Contractor* shall make final piping connections with Impolene tubing or approved equal and shall make connections to supply and return piping mains For interconnecting the luminaires the contractor only supplies the tubing The tubing is inserted into the union fittings supplied on the luminaire and made pressure tight by a simple two and one-quarter turn with a wrench All piping of dissimilar metal shall have union joints of dielectric insulating material

All water piping and connections shall be *tested* by the *Mechanical Contractor* and all water flow *balanced* to meet thermal transfer requirements.

Materials

The luminaire housing top and sides shall be die formed 060 inch number 1100 aluminum with integral water tubes arranged for connection to ½" O D Impolene tubing (or equal) through union fittings supplied with the luminaire The integral tubing shall be suitable for a 100 PSI WWP The housing is to be die formed and contoured into a reflector with an integral wiring compartment.

The other sheet metal parts are to be .032" steel The reflector and wiring compartment cover combination is to be die formed and retained to the housing with locking devices designed for "no tool" maintenance. Knockouts are to be die embossed in top and ends.

Performance Design

Each luminaire shall meet the thermal ratings in the design tables and criteria set forth by the manufacturer when supplied with the specified water temperature and G.P.M. flow

Each luminaire shall be capable of removing 70% of the total electrical K.W input energy when supplied with the correct water flow and temperature The enclosure temperature shall not exceed the water flow temperature by more than 3° F. and there shall be no positive air flow through the luminaire. The ballast is to be certified, higher power factor, ETL, CBM rated with built in thermal protective device. The ballast is to be mounted on the flat housing surface, with non-turning screws, to assure positive heat dissipation and long ballast life

Engineering liaison shall be provided by Environmental Systems Corporation to assist in the evaluation and design of energy integrated systems utilizing Lite-Therm products.

Lite-Therm luminaires are guaranteed to be free of all mechanical defects.

WATER TREATMENT

Heating and air conditioning system piping shall be flushed and a water treatment applied to each water system to assure satisfactory performance of metallic parts of the system exposed to water. Treatment shall be applied under the supervision of an approved water treatment service company. A continuing service contract shall be included when the building is accepted by the owner, covering a recommended normal chemical supply and two service calls per year. The contract shall provide for:

(A) Service calls at intervals of not more than six (6) months.

(B.) Water analyses at intervals of not more than six (6) months.

(C) Installations of coupons in each system to determine effectiveness of the treatment; and

(D) Furnishing the Owner at intervals of not more than six (6) months a report of the findings of the requirements set forth in (a), (b), and (c) above.

The piping in each system shall include a pot type feeder of size and type recommended by the water treatment manufacturer and installed in accordance with their recommendations. A test kit for the water treatment used shall be included as part of the heating and air conditioning system equipment.

The water treatment shall be as specified by the water treatment service company, suitable for use in a closed system including copper, aluminum, steel, plastic, rubber and solder. No other inhibitor or anti-freeze chemical shall be used with this water treatment compound.

Immediately after the system has been checked for leaks and these leaks have been sealed, but before the system is put into operation for temporary heating or cooling, the system shall be cleaned and flushed. The cleaning and flushing procedure used shall be that recommended by the water treatment supplier.

After flushing, the system is to be recharged with fresh, clean water and with treatment as recommended by the water treatment service company. Typically this will be 300-400 ppm of a buffered chromate. The treatment level should be checked immediately after charging, and periodically thereafter, under the supervision of the water treatment supplier.

TEMPERATURE CONTROL SEQUENCE — INDIRECT TRANSFER SYSTEM

The control sequence shall be designated on the automatic temperature control diagrams and under "Sequence of Operation" as follows. Where discrepancies occur between Specifications and Drawings, Specifications shall control.

1. General

Day or night operation is activated by either manual selector switch S-1 or by time clock and E. P. relay when S-1 is on "auto" position. Heating or cooling cycle (65°F) is activated by either manual S-2 or by master adjustable outdoor thermostat through a pressure regulator when S-2 is on "auto" position.

2. System Heating Cycle

Day Operation — Evaporative cooler outside air damper is closed. The 3-way valve is positioned to bypass all water around the evaporative cooler. Thermostat in the non-refrigerated water supply modulates 3-way chilled water valve on heat exchanger (J) to maintain predetermined water temperature. Pressure switches are open so that evaporative cooler fan and spray pump do not run.

P. E. switches are closed so that supply, return and exhaust air fans and chilled, condenser, hot, non-refrigerated and louver circulating pumps are operating.

Outside, return and relief air dampers are positioned to a predetermined but adjustable position by a pressure regulator.

Submaster supply air thermostat modulates 3-way chilled water mixing valve on main air coil to maintain fan discharge temperature. Master outdoor thermostat between 65°F and 20°F readjusts the setting of submaster thermostat with averaging element in the cold deck to call for warmer cold deck temperature (55°F to 65°F) as the outdoor air temperature decreases. Sensitivity and readjusting ranges of the master and submaster thermostats are adjustable so that settings can be made on the job in order to suit operating conditions. If return air relative humidity rises above its setting, return air humidostat will override submaster supply air thermostat through a pressure selector to call for cooling.

For cooling tower control outside air thermostat and cooling tower suction line immersion thermostat maintain desired cooling water temperature in the following manner. When outdoor temperature is below 35°F outside air thermostat shall position 3-way cooling tower valve to bypass all water directly into the pan of the cooling tower. When outdoor temperature is above 35°F outside air thermostat shall change the action of the valve from a one positive position to a modulating valve and place it under control of the immersion water thermostat. Under control of the immersion thermostat when water temperature is below its setting 3-way cooling tower valve is positioned to bypass water around cooling tower and cooling tower fan is off. On a rise in temperature immersion thermostat gradually positions 3-way valve to allow water to flow through tower and then closes P. E. switch to start cooling tower fan. As temperature falls, immersion thermostat first gradually positions 3-way valve to bypass water around tower and then opens P. E. switch to stop cooling tower fan.

When water temperature in the cooling tower pan drops below 40°F another immersion thermostat in the cooling tower basin shall activate freeze-up protection circulating pump and electric heat exchanger through P. E. switches to maintain a minimum water temperature of 40°F in the cooling tower basin.

For reclaim coil control an outside air thermostat shall control 3-way chilled water valve on the reclaim coil in the following manner. When outside air temperature is above setting, 3-way valve shall be positioned to full bypass around reclaim coil. As the outside air temperature drops below the adjustable setting (65°F to 35°F) outside air thermostat shall gradually modulate 3-way valve to a full open position. The reverse sequence occurs on a rise in outdoor temperature.

For condensing temperature, control on outdoor master thermostat (between 65°F to 35°F) shall readjust the setting of a submaster pressure regulator in the refrigerant system to call for higher head pressure at lower outside temperature so that the resultant condenser water used for reheat coils and thermal louvers will be higher at lower outside temperatures. The submaster pressure regulator shall modulate a 3-way valve at the split condenser to maintain its setting.

In addition to condenser head pressure control to maintain hot water temperature, the same master outdoor thermostat (between 65°F and 35°F) shall readjust setting of a submaster thermostat in the hot water system to call for higher water temperature at lower outside temperature. This submaster thermostat shall stage the electric hot water heater (I) to add supplementary heating to the hot water system coming from the condenser if required and shall supply the night heating requirement to the hot water system. The step control staging of the hot water heater shall be accomplished through individual P. E. switches for each stage as required by the design engineer and size of the unit.

The mixed air thermostat shall activate 2 step outside air intake electric duct heater to insure freeze-up protection should any stratification occur across the main cooling coil. This electric duct heater would not be necessary if the alternate heat recovery system (N) were used.

Night Operation — P. E. switches are open, so that exhaust fan, evaporative cooler fan and spray pump, chilled condenser, and non-refrigerated water pumps do not operate. P. E. switches are closed so that supply and return air fans, hot water, thermal louver circulating and freeze-up protection circulating pump are operating. Freeze-up protection heat exchanger shall still be controlled by immersion thermostat.

Outside and relief air dampers are closed and return air damper is positioned to 100% return air.

Other controls operate same as on day cycle.

Electric duct heaters shall be interlocked with supply fan so as to be de-energized at any time the fan stops and energized when the fan starts.

Terminal Zone Control

For all zones control shall be arranged so that any one thermostat calling for cooling out of several stats in a particular air zone will be capable of cutting off heat to the zone reheat coil. This shall be accomplished by use of high pressure selector relays.

Interior zone control is as follows: On a call for heat controlling, zone stat gradually positions hot water 3-way valve to allow flow of hot water through the zone reheat coil. Lighting fixture piping may be arranged in zones with flow control valves so that on a further call for heat room stat shall shut off the flow of water to the water cooled luminaires. This allows lighting heat to come directly into the space to provide reheat in any areas that may tend to become overcooled due to the main air zone controlling stat that is satisfying cooling demand.

The same sequence shall apply where there is resistance heating instead of valving the water cooled luminaires except that on a further call for heat controlling room stat shall activate electric resistance through P. E. switches to satisfy heating requirement. The cycle is reversed on a call for cooling. Water flow through the water cooled luminaire shall be continuous in this case.

The cycle is applied only to the room thermostat controlling the zone at that time to maintain its cooling requirement. Other room thermostats control only the flow control valve on the water-cooled luminaire or the resistance heating.

Perimeter zone control is as follows: On a call for heat controlling room stat first gradually positions hot water 3-way valve to allow flow of hot water through the zone reheat coil. On a further call for heat room stat shall position 3-port diverting valves on the thermal louvers to hot water flow through the thermal louvers. The cycle reverses on a call for cooling. The 3-port valves on the thermal louvers shall not be modulating valves but strictly two-position diverting valves. The in-line circulating pump (P) shall run continuously and water flow through the water cooled luminaire shall be continuous. The cycle is applied only to room thermostat controlling the zone at that time to maintain its cooling requirement. Other room thermostats control only the 3-port diverting valves on the thermal louvers, or instead of thermal louvers, either baseboard or duct heaters; except that on a further call for heat controlling room stat shall activate electric resistance through P. E. switches to satisfy heating requirement. The cycle reverses on a call for cooling. Water flow through the water cooled luminaire shall be continuous. Again the cycle is applied only to the room thermostat controlling the zone at that time to maintain its cooling requirement. Other room thermostats control only electric baseboard radiation.

3. System Cooling Cycle

Day Operation — Evaporative cooler outside air damper is open Chilled water 3-way valve is positioned to bypass all water around heat exchanger (J) Non-refrigerated supply water immersion thermostat maintains predetermined water temperature by: first, modulating non-refrigerated water 3-way valve to allow water to pass thru the evaporative cooler, and then, closing P E switches to, in sequence (1) start evaporative cooler fan on low speed, (2) start spray water pump, (3) change evaporative cooler fan to high speed The cycle reverses on a fall in temperature

P E switches are closed so that supply, return and exhaust air fans, chilled, condenser, hot, non-refrigerated, and thermal louver circulating water pumps are operating.

Outside, return and relief air dampers are positioned to a predetermined, but adjustable, position by a pressure regulator.

Control of the main cooling coil is same as for winter day cycle.

Room zone controls and control of cooling tower fan and 3-way valve operate same as on winter day cycle.

Night Operation — All fan and pump P E switches are open, thus, stopping all fans and pumps—to shut down system

4. Illumination Control

Mounted on the ceiling for each orientation a B10M selenium cell, sensing light intensity operates a transducer so that when light level is too low, transducer output to high-low switch will be below 6 psi and close the contact. A motor turns pressure regulator to decrease pressure to allow operators on windows to gradually open louvers. Between 6 and 7 psi the high-low switch moves to dead zone and the motor stops. If light intensity becomes too great transducer output will increase beyond 7 psi and high-low switch will make contact and motor will rotate regulator in the opposite direction causing an increase in pressure to cause operators to gradually close window louvers. Selector switches may be used to allow manual operation of dampers in various areas by a manual positioning switch.

TEMPERATURE CONTROL SEQUENCE — DIRECT TRANSFER SYSTEM

The control sequence shall be designated on the automatic temperature control diagrams and under "Sequence of Operation," as follows Where discrepancies occur between Specifications and Drawings, Specifications shall control

1. General

Day or night operation is activated by either manual selector switch S-1 or by time clock and E. P relay when S-1 is on "auto" position Heating or cooling cycle (65°F) is activated by either manual S-2 or by master adjustable outdoor thermostat through a pressure regulator when S-2 is on "auto position"

2. System Heating Cycle

Day Operation — Evaporative cooler outside air damper is closed The 3-way valve is positioned to bypass all water around the evaporative cooler Thermostat in the non-refrigerated water supply modulates 3-way chilled water valve on heat exchanger (J) to maintain predetermined water temperature Pressure switches are open so that evaporative cooler fan and spray pump do not run

P. E switches are closed so that supply, return and exhaust air fans and chiller, condenser, hot, non-refrigerated and louver circulating pumps are operating.

Outside and return air dampers are positioned to a predetermined but adjustable minimum position Evaporative cooler outdoor air damper is closed.

Supply air thermostat maintains the fan discharge temperature by first modulating outdoor air damper beyond its minimum setting. On a further call for cooling after the outdoor damper is 100% open, the supply air thermostat will control main cooling coil 3-way valve to maintain the required temperature

For cooling tower control, outside air thermostat and cooling tower suction line immersion thermostat maintain desired cooling water temperature in the following manner When outdoor temperature is below 35°F, outside air thermostat shall position 3-way cooling tower valve to bypass all water directly into the pan of the cooling tower When outdoor temperature is above 35°F, outside air thermostat shall change the action of the valve from a one positive position to a modulating valve and place it under control of the immersion water thermostat Under control of the immersion thermostat when water temperature is below its setting, 3-way cooling tower valve is position to bypass water around cooling tower, and cooling tower fan is off. On a rise in temperature, immersion thermostat gradually positions 3-way valve to allow water to flow through tower and then closes P E. switch to start cooling tower fan As temperature falls, immersion thermostat first gradually positions 3-way valve to bypass water around tower and then opens P E switch to stop cooling tower fan.

When water temperature in the cooling tower pan drops below 40°F, another immersion thermostat in the cooling tower basin shall activate freeze-up protection circulating pump and electric heat exchanger through P E switches to maintain a minimum water temperature of 40°F in the cooling tower basin

For reclaim coil control, an outside air thermostat shall control 3-way chilled water valve on the reclaim coil in the following manner When outside air temperature is above setting, 3-way valve shall be positioned to full bypass around reclaim coil As the outside air temperature drops below the adjustable setting (65°F to 35°F), outside air thermostat shall gradually modulate 3-way valve to a full open position The reverse sequence occurs on a rise in outdoor temperature.

For condensing temperature, control on outdoor master thermostat (between 65°F to 35°F) shall readjust the setting of a submaster pressure regulator in the refrigerant system to call for higher head pressure at lower outside temperature, so that the resultant condenser water temperature available to reheat coils and thermal louvers will be higher at lower outside temperatures The submaster pressure regulator shall modulate a 3-way valve at the split condenser to maintain its setting

In addition to condenser head pressure control to maintain hot water temperature, the same master outdoor thermostat (between 65°F and 35°F) shall readjust setting of a sub master thermostat in the hot water system to call for higher water temperature at lower outside temperature This submaster thermostat shall stage the electric hot water heater (1) to add supplementary heating to the hot water coming from the condenser, if required, and shall supply the night heating requirement to the hot water system The step control st‹ ing of the hot water heater shall be accomplished through individual P E switches for each stage, as required by the design engineer and size of the unit

The mixed air thermostat shall activate a 2 step outside air intake electric duct heater to insure freeze-up protection should any stratification occur across the main cooling coil This elecric duct heater would not be necessary if the alternate heat recovery system were used

Night Operation

P.E switches are open, so exhaust fan, evaporative cooler fan and spray pump, chilled condenser, and non-refrigerated water pumps do not operate P E switches are closed, so supply and return air fans, hot water, thermal louver circulating and freeze-up protection circulating pump are operating Freeze-up protection heat exchanger shall still be controlled by immersion thermostat

Outside and relief air dampers are closed, and return air damper is positioned to 100% return air

Other controls operate in the same manner as on day cycle

Electric duct heaters shall be interlocked with supply fan so as to be de-energized at any time the fan stops and energized when the fan starts.

Terminal Zone Control

Interior Zone -- On a call for heat, the controlling zone thermostat operates a damper motor on the zone induction box to select secondary air from the plenum On a further call for heat, a three way valve operates to bypass water flow around the water cooled luminaires in the zone, making lighting heat directly available to the secondary air for heating the space. The sequence is reversed for cooling, lighting heat is removed by non-refrigerated water and secondary air is taken directly from the space

Areas in the zone requiring extra heat, such as an area including a windowless exterior wall, may be controlled by use of resistance baseboard with an integral thermostat

Perimeter Zone — Submaster perimeter primary air thermostat modulates a 3-way condenser water valve on a reheat coil to maintain the perimeter air supply temperature A master outdoor thermostat (between 65°F and 20°F) readjusts the setting of the submaster thermostat to call for warmer perimeter primary air (50°F to 90°F) as outdoor temperature decreases

A 3-way diverting valve directs non-refrigerated water to the louvers for outdoor temperatures above 65°F, and condenser water for temperatures below 65°F. Secondary pumps maintain circulation thru the louvers

Individual perimeter zone temperatures are controlled thru use of induction boxes and Lite-Therm luminaires, as is done in the interior.

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LITE-THERM Systems

Owner: Financial Programs, Inc.--Denver Colorado   Architect: W. C. Muchow Associates
Consulting Mechanical Engineer: McFall & Konkel   Consulting Electrical Engineer: Swanson-Rink and Associates

Give you these advantages . . .

Ideal Occupant Comfort and Productivity

- Elimination of objectionable radiant heat from sun and lights
- Optimum health due to elimination of the "Air-Conditioned Feeling" normally experienced with "all air" systems
- System is designed specifically to provide occupant comfort, not just building heat removal
- Elimination of mechanical equipment noise in the occupied space
- No drafts

Lower Building Costs

- Less air-handling and refrigeration equipment installed
- Elimination of central heating plant
- Less building material and field labor

Lower Operating Costs

- Less installed horsepower for heating and cooling equipment
- Lower combined heating-cooling-lighting energy requirements
- Solar and lighting energy is used to heat building
- Increased light from lamps

Greater Freedom in Architectural and Structural Design

- Higher lighting levels become practical
- No limitation to use of glass fenestration
- Elimination of structural constraints related to mechanical design
- System easily adapts to future space requirements

More Usable Building Space

- Reduced floor-to-floor height
- Less space for mechanical equipment

Simpler and More Effective Control

- Simultaneous heating and cooling is easily accomplished
- Heating and cooling seasonal changeover is eliminated
- Low pressure air distribution system is used
- Humidity control maintained independent of building heat gain

Environmental Systems Corporation will be pleased to assist architects and engineers in the evaluation and application of Lite-Therm systems to specific building designs. Our design liaison staff evaluates all building variables, prepares energy balances and cost analyses and offers technical assistance in the application of Lite-Therm products to system design.
We invite your inquiry—it will receive our prompt attention.

ENVIRONMENTAL SYSTEMS CORPORATION

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Subsidiary of ~~Lithonia Lighting, Inc.~~
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