

Table 3 Range of Costs of High Pressure Dual Duct Systems Including Refrigeration and Piping

Size of Average Zone CFM	Complicated Layout		Average Layout		Simple Layout	
	Cost per Sq Ft of Net Area	Cost per Ton	Cost per Sq Ft of Net Area	Cost per Ton	Cost per Sq Ft of Net Area	Cost per Ton
300	\$5.00	\$1670	\$4.04	\$1336	\$3.48	\$1160
500	4.70	1570	3.71	1240	3.17	1060
1000	4.44	1480	3.45	1150	2.90	970
4000	4.20	1400	3.23	1080	2.67	890

From Air Conditioning, Heating and Ventilating, May 1956, p. 93.

Special effort should always be made to achieve simplicity in the duct system by utilizing structural and architectural features of the building and judicious location of the risers, mains and apparatus rooms, etc.

The effect of the last two variables on the cost of the system is shown in Table 3. The range of costs shown in the table is common and may be extended upward or downward by special factors peculiar to a particular project, or by the effect of the first two variables.

PART II: INDUCTION UNIT SYSTEMS

The induction unit system is well adapted to meeting the load characteristics of perimeter rooms in multi-room buildings.

The perimeter rooms of a multi-room building are subject to wide variation of both external and internal heat gain loads. These include solar, lighting, occupant, and transmission loads. Maintenance of a uniform design temperature in these rooms is difficult, particularly in marginal weather (say 50 F outdoor temperature) when a room exposed to sun may require cooling while an adjacent one which is shaded, actually requires heat. In addition to meeting these wide variations in load, any air-conditioning system must also provide ventilation and air motion without drafts, and also provide adequate dehumidification.

Loads in the Multi-room Building

It is important to know the nature and magnitude of the sensible and latent room heat loads in perimeter rooms. The sensible loads under varying outdoor conditions are:

1. Transmission load which would be zero at 75 F. It reverses at 75 F. Above 75 F, the transmission is heat gain; below 75 F, it is a heat loss. This load varies with the ratio of wall to glass areas. Corner rooms and rooms on the top floor have greater transmission losses or gains than the typical room.
2. Heat from occupants which is always a cooling load and is added to the transmission.
3. Heat from lights which is always a cooling load.
4. Heat from the sun which is always a cooling load. Heat gain from the sun varies depending upon glass area, shading, orientation and other factors. The peak occurs at different times of the year, and different hours of the day for various exposures, but the magnitude is approximately equal for all exposures except north.

A summation of all four room sensible loads represents the maximum possible load, while the transmission load represents the minimum load at any outdoor temperature.

When the complete building is considered, the sun shifts around the building during the day, and in metropolitan areas, odd shadow patterns are created by adjacent structures. These shadows are irregular and vary from hour to hour as

well as season to season. Rooms that are shaded may require heating, while other rooms on the same exposure may require cooling. This presents a complex problem in system design to achieve individual room temperature control.

While the variation in room sensible load creates a complex problem, the room latent load offers fewer complications, since it is usually only necessary to maintain room relative humidity below some pre-determined level.

ALL-AIR INDUCTION UNIT SYSTEM

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

The problems that are solved by applying the all-air induction principle are listed below:

1. It is possible to supply smaller air quantities at lower temperatures than with a conventional system, since the induced neutral or warm secondary air precludes the discharge of abnormally low temperature air to the room.
2. Individual room control is provided by the unit heating coil which supplies reheat when necessary during the cooling season and heating during the winter.
3. The unit is designed primarily for under the window installation. Downdrafts at the windows can be eliminated.

The all-air induction unit system is especially suitable for small buildings (100 units or less) and any existing buildings, where the design sensible cooling load is low (about 30 Btu per square foot) and when a serviceable steam or hot water distribution system is available. Hospitals and hotels are commonly in this special category. Apartment houses, professional buildings and even some office buildings may also qualify.

In addition to the applications listed above, the all-air induction unit system is now being effectively applied to laboratories, motels and schools. In schools it provides a heating and ventilating system which can, at a later date, be readily converted to complete air conditioning with little additional expense other than the refrigeration equipment.

Advantages of All-Air Induction Unit Systems

The all-air induction unit system has the ability to provide desired conditions in each room of a multi-room building. In addition it has the following inherent advantages:

1. It can be used with low floor to floor heights (particularly with high velocity distribution).
2. It has centralized equipment, services, and outdoor air intake.
3. Maintenance and service problems are reduced.
4. No moving parts are required in the unit.
5. The supply of air to the room is positive.
6. The system has high latent load capacity and good control of maximum humidity.

Unit Description

A schematic diagram of the induction unit is shown in Fig. 21. It consists of five major components: (1) primary air plenum, (2) nozzle, (3) heating coil, (4) mixing chamber, and (5) cabinet or enclosure.

1. **Plenum.** The conditioned (primary) air is introduced in the plenum which has two functions: (1) provides even air distribution across the slotted nozzle; and (2) helps to attenuate noise generated in the system.

Dual-Duct, Induction Unit, and Fan-Coil Conditioner Systems

2. **Nozzle.** The nozzle is an outlet for the primary air which provides the motivating force to induce the secondary air (room air) across the unit coil. The air quantity is adjusted by a damper in the unit, or in the ductwork approaching the unit, by an adjustable nozzle, or both. The quantity of induced secondary air across the heating coil is determined by the nozzle pressure.

3. **Heating Coil.** The unit coil is designed for operation with steam or hot water.

4. **Mixing Chamber.** This chamber is the space where the primary and secondary air mix. It also provides the stack height required for gravity heating.

5. **Enclosure.** The enclosure can be a factory furnished cabinet or furring to suit the job. It must be designed to allow proper flow of secondary air through the coil and an unobstructed discharge.

Unit Selection Criteria

Three factors govern the selection of the all-air induction unit.

1. The unit air quantity must: (a) offset the maximum room sensible load, (b) satisfy latent load requirements to limit maximum room relative humidity, and (c) provide the proper quantity of outdoor air for ventilation.
2. The unit coil must have sufficient heating capacity to offset the room transmission loss and to temper the primary air.
3. The unit must be selected to operate at suitable sound levels.

Range of Available Units

The following summary shows the general range of sizes, air quantity, heating and cooling capacities, and pressure drops of current units.

All-Air Induction Units Summary

Number of Available Sizes: 6

Cabinet Dimensions: Width 7 to 10 in., length 29 to 72 in., height 24 in.

Air Quantities: 100-1700 cfm.

Nozzle Pressure: 0.07 to 1.0 in. of water.

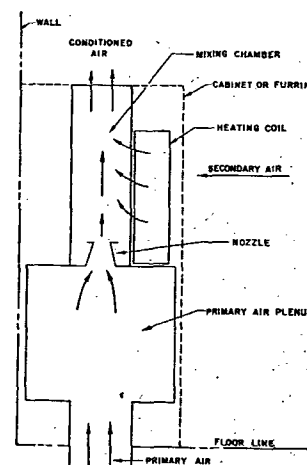


Fig. 21 All-Air Induction Unit

Steam Heating Coil Capacity (2 lb. steam and 70 F entering air temperature):

Gravity: 2600 to 4500 Btuh.

Induced Air: 3400 to 25,300 Btuh.

Hot Water Heating Capacity (180 F entering air temperature):

Gravity: 1600-3100 Btuh.

Induced Air: 2100-17,500 Btuh.

Water Pressure Drop Through Coil (0.5 to 2.0 gpm):

0.20 to 3.27 ft. water.

Unit Application

Units can be mounted either vertically, or horizontally (except steam), recessed, or with cabinet. The preferred arrangement in northern climates (below 20 F design) is vertically underneath windows to minimize downdraft. There are few limitations in unit location in very temperate climates other than physical layout and economics. Units are available for free standing wall, or ceiling hung applications.

Most units are equipped with serpentine coils. For steam applications this type of coil must be installed with all tubes level to assure condensate drainage. For proper air distribution across the unit nozzle on low velocity systems, duct connections should be made and vanes installed as shown in Fig. 22. Velocities below the limits indicated usually do not require vanes.

Units for application with high velocity systems are designed to achieve good air distribution without supplementary vanes.

System Description

This is a dew point (actually supply air temperature) and reheat controlled system and consists of central station con-

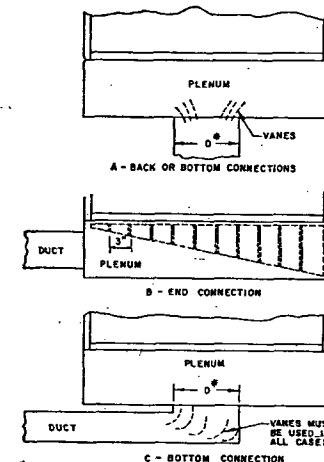


Fig. 22 Duct Connections (Low Velocity) for All-Air Induction Unit