Q_{11} = Q_{main} = 1750 cfm (10 diffuser); 18″ = 16″x17″ = 400x425 mm

For Duct 2:

Q_2=175 cfm ; P_D = 0.045″ P_L = 0.08″

$V = \frac{1750\ cfm}{\frac{(16x17)}{144}} = 926.47\ fpm$ $\quad \frac{A_2}{A_{11}} = \frac{Q_2}{Q_{11}} = \frac{175}{1750} = 0.1$;

$0.1\ and\ 0.1\ C_b = 0.32 \rightarrow \quad P_{F1} = C_b\left(\frac{v}{4000}\right)^2 = 0.017"$

$P_{T2} = P_D + P_L + P_{F1} = 0.045 + 0.08 + 0.017 = 0.142" \rightarrow$ *Friction chart for Duct size*

Using Friction chart: 0.142″ and 175 cfm; 6.5″ (6x6) => **150x150 mm**

For Duct 1-2:

Q_{12} = 1750-175 = 1575 cfm; P_L = 0.08″

Using Friction chart: 0.08″ and 1575 cfm; 17″ (16x16) => **400x400 mm**

For Duct 3:

Same size of Duct 2: $Duct_2$ = $Duct_3$: 6.5″ (6x6) => **150x150 mm**

For Duct 1-3:

Q_{13} = 1575-175 = 1400 cfm; P_L = 0.08″

Using Friction chart: 0.08″ and 1400 cfm; 16″ (14x15) => **350x375 mm**

For Duct 4:

Q_4=175+175 = 350 cfm ; P_D = 0.045″ P_L = 0.08″

$V = \frac{1400\ cfm}{\frac{(14x15)}{144}} = 960\ fpm$ $\quad \frac{A_4}{A_{13}} = \frac{Q_4}{Q_{13}} = \frac{175+175}{1400} = 0.25 \approx 0.3$;

$0.3\ and\ 0.3\ \ C_b = 0.73 \rightarrow \ P_{F4} = 0.73\left(\frac{960}{4000}\right)^2 = 0.042"$

$P_{T4} = P_D + P_L + P_{F4} = 0.045 + 0.08 + 0.042 = 0.167" \rightarrow$ *Friction chart for Duct size*

Using Friction chart: 0.167″ and 350 cfm; 8.5″ (9x7) => **225x175 mm**

For Duct 5:

Q_5=175 cfm ; P_D = 0.045″ P_L = 0.08″

$V = \frac{350cfm}{9x7/144} = 800\ fpm$

$\frac{A_5}{A_4} = \frac{Q_5}{Q_4} = \frac{175}{350} = 0.5$;

$0.5\ and\ 0.5\ C_s = 0.04 \rightarrow\ P_{F5} = 0.04\left(\frac{800}{4000}\right)^2 = 0.00016"\ (negligible)$

$P_{T5} = P_D + P_L + P_{F5} = 0.045 + 0.08 + 0.042 = 0.167" \rightarrow$ *Friction chart for Duct size*

Using Friction chart: 0.167″ and 175 cfm; 6.5″ (6x6) => **150x150 mm**

For Duct 1-4

Q_{14}=1400-350 = 1050 cfm ; P_L = 0.08″

Using Friction chart: 0.08″ and 1050 cfm; 14.5″ (12x15) => **300x375 mm**

For Duct 6:

Q_6=175 cfm ; P_D = 0.045″ P_L = 0.08″

$$V = \frac{1050\ cfm}{(12x15)\ /144} = 840\ fpm$$

$$\frac{Q_6}{Q_{14}} = \frac{A_6}{A_{14}} = \frac{175}{1050} = 0.167 \approx 0.2\ ;$$

$$0.2\ and\ 0.2\ C_b = 0.32 \rightarrow\ P_{F6} =\ 0.32\left(\frac{840}{4000}\right)^2 = 0.014"$$

$$P_{T6} = P_D + P_L + P_{F6} = 0.045 +\ 0.08 + 0.014 = 0.139" \ \rightarrow\ Friction\ chart\ for\ Duct\ size$$

Using Friction chart: 0.139″ and 175 cfm; 7″ (6x7) => **150x175 mm**

For Duct 1-5:

Q_{15} = 1050-175 = 875 cfm; P_L = 0.08″

Using Friction chart: 0.08″ and 875 cfm; 13.5″

Based on space availability of 200mm max height: (7x24) => **175x600 mm**

For Duct 7:

Same size of Duct 6: $Duct_7$ = $Duct_6$: 7″ (6x6) => **150x175 mm**

For Duct 1-6:

Q_{16} = 875-175 = 700 cfm; P_L = 0.08″

Using Friction chart: 0.08″ and 700 cfm; 12.5″

Based on space availability of 200mm max height: (7x20) => **175x500 mm**

For Elbow Duct :

$Q_{16elbow}$ = 700 cfm; P_D = 0.045″ ; A_{elbow} = A_{16} = 7x20

H = 175mm : W = 500mm : r = (6.25″) 150 mm

H/W = 0.35≈0.5 ; r/W = 0.30≈0.5 ; K = 1.0 for 90 degrees

$$0.4\ and\ 1.0\ C_p = 1.38 \rightarrow\ C_o =\ K_f C_p = 1.0(1.38) = 1.38$$

$$V = \frac{700cfm}{\frac{(7x20)}{144}} = 720\ fpm$$

$$P_{elbow} =\ 1.38\left(\frac{720}{4000}\right)^2 = 0.0447"$$

$$P_{total} = P_D + P_{elbow} = 0.045 + 0.0447 = 0.0897"$$

Using Friction chart: 0.0897″ and 700 cfm; 12.5″ (7x20) => **175x500 mm**

Since pressure is negligible, we can use same area of intake duct

For Duct 8:

Q_8=175 cfm ; P_D = 0.045" P_L = 0.08"

$\frac{Q_8}{Q_{16}} = \frac{A_8}{A_{16}} = \frac{175}{700} = 0.25 \approx 0.3;$

$V = \frac{700cfm}{7x20\ /144} = 720\ fpm$

$0.3\ and\ 0.3\ C_b = 0.73 \rightarrow\ P_{F6} =\ 0.73\left(\frac{720}{4000}\right)^2 = 0.024"$

$P_{T8} = P_D + P_L + P_{elbow} + P_{F1} = 0.045 + 0.08 +\ 0.024 = 0.149"$

Using Friction chart: 0.149" and 175 cfm; 6.5" (6x6) => **150x150 mm**

For Duct 1-7:

Q_{17} = 700-175 = 525 cfm; P_L = 0.08"

Using Friction chart: 0.08" and 525 cfm; 12"

Based on space availability of 200mm max height: (7x18) => **175x450 mm**

For Duct 9:

Q_9 = 175 cfm; P_D = 0.045" P_L = 0.08"

Same size of Duct 8: $Duct_7$ = $Duct_6$: 6.5" (6x6) => **150x150 mm**

For Duct 1-8:

Q_{17} = 525-175 = 350 cfm; P_L = 0.08"

Using Friction chart: 0.08" and 350 cfm; 10"

Based on space availability of 200mm max height: (7x12) => **175x300 mm**

For Bullhead Tee Duct:

Q_{18Tee} = 350 cfm; P_D = 0.045" P_L = 0.08"

$\frac{Q_{10}}{Q_{tee}} = \frac{A_8}{A_{16}} = \frac{175}{350} = 0.5$

$V = \frac{350cfm}{7x12\ /144} = 600\ fpm$

$0.5\ and\ 0.5\ C_{b1} = 1.01 \rightarrow\ P_{tee} =\ 1.01\left(\frac{600}{4000}\right)^2 = 0.023"$

$P_{total} = P_D + P_L + P_{tee} = 0.045 + 0.08 + 0.023 = 0.148"$

Using Friction chart: 0.148" and 350 cfm; 8.5"

Based on space availability of 200mm max height: (7x9) => **175x225 mm**

For Duct 10 and 11:

Q_{10} = 175 cfm

We use the bullhead tee size : 8.5"

Based on space availability of 200mm max height: (7x9) => **175x225 mm**