How to Calculate CFM for an HVAC System

This standard operating procedure explains how to calculate CFM for an HVAC system and how to determine the resulting air velocity when duct dimensions change. Use this procedure whenever you need to size ductwork, verify airflow, or evaluate the effect of reducing duct dimensions to route around obstacles such as structural beams.

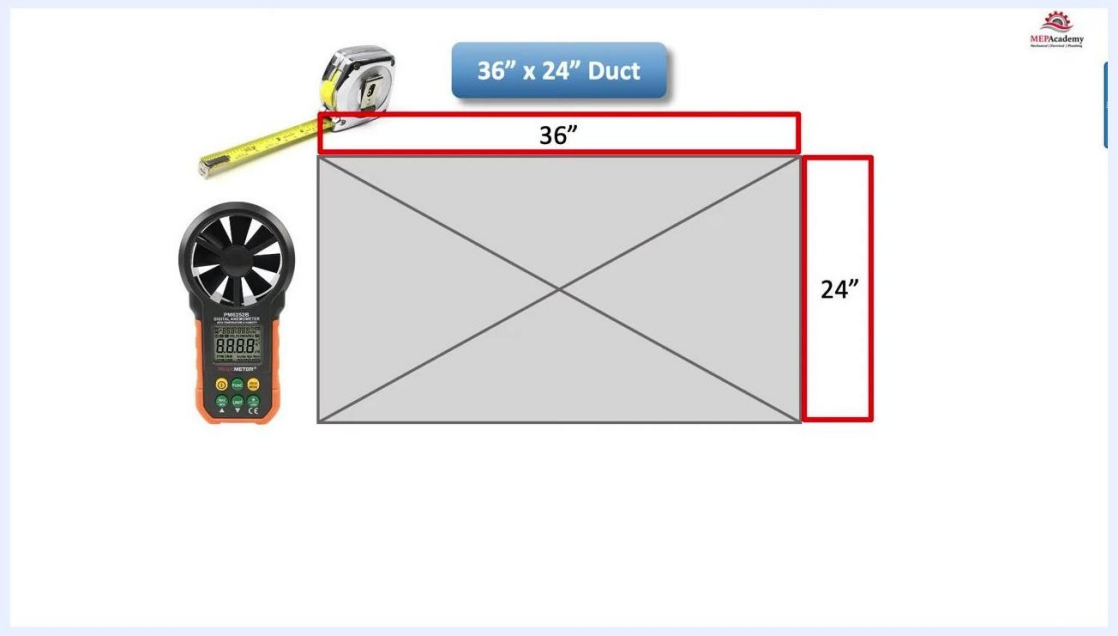


Diagram showing a 36-inch by 24-inch duct with a tape measure and anemometer, with "Anemometer" highlighted

Purpose

This procedure provides a step-by-step method to calculate total Cubic Feet per Minute (CFM) of airflow in a duct and to understand how air velocity changes when duct size is altered while CFM remains constant.

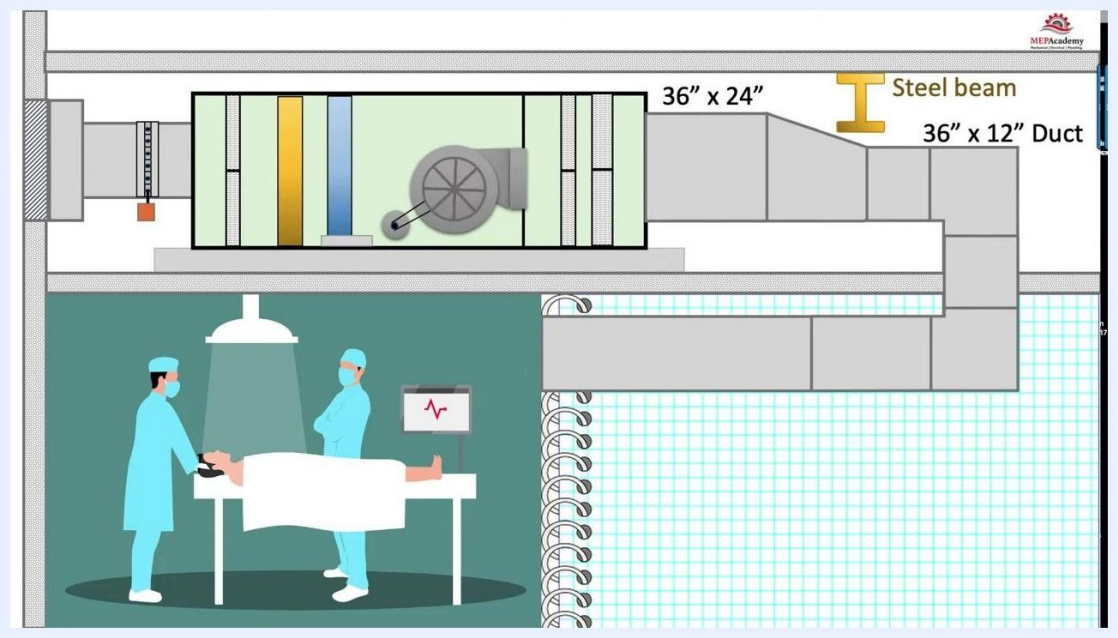


Illustration showing a 36" x 24" duct, a tape measure, an anemometer, and a presenter in front of a screen labeled "How to Calculate Total CFM"

Scope

This procedure applies to any duct section where you need to determine airflow (CFM), cross-sectional area, or velocity, including situations where duct dimensions must be reduced to clear obstructions.

Required equipment

- Tape measure (to measure duct width and height)
- Anemometer (to measure air velocity)
- ASHRAE Handbook of Fundamentals (for recommended maximum velocity guidelines)

Procedure

Step 1: Review the CFM formula

Use the following formula to calculate airflow:

CFM = Velocity × Area

- CFM = Cubic Feet per Minute (airflow)
- Velocity = Feet per Minute (FPM)
- Area = Square Feet (cross-sectional area of the duct)

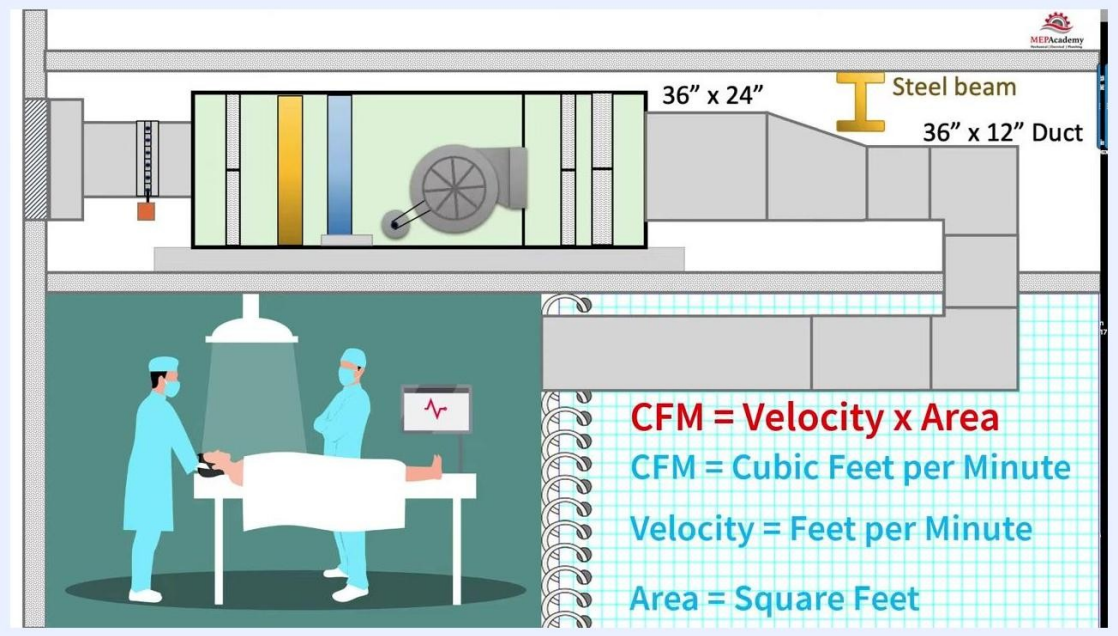


Diagram showing the formula CFM = Velocity x Area with definitions for each term, alongside a duct system above an operating room

A cubic foot of air is a volume measuring 1 ft × 1 ft × 1 ft.

Step 2: Measure the duct dimensions

Measure the width and height of the duct using a tape measure. For this example, the recorded dimensions are:

- Width = 36 inches
- Height = 24 inches

Step 3: Measure the air velocity

Use an anemometer to obtain an average velocity reading across the duct section. For this example, the recorded velocity is:

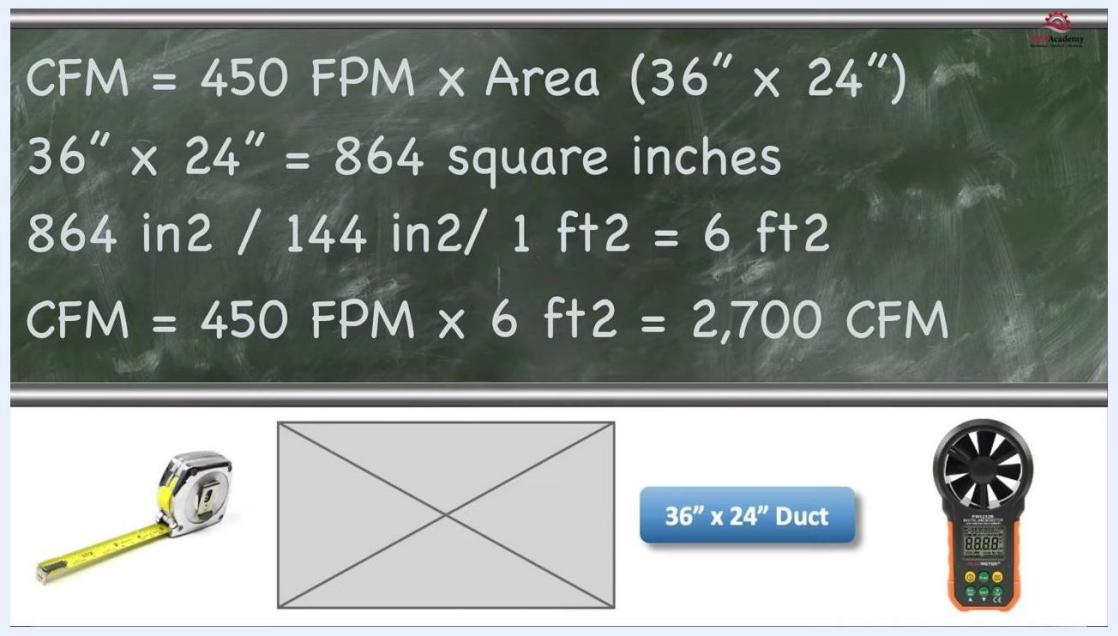
- Velocity = 450 feet per minute (FPM)

Step 4: Convert the duct area to square feet

Calculate the area in square inches by multiplying width by height:

- Area = 36 in × 24 in = 864 in²

Convert square inches to square feet, using the conversion that 1 square foot equals 144 square inches:



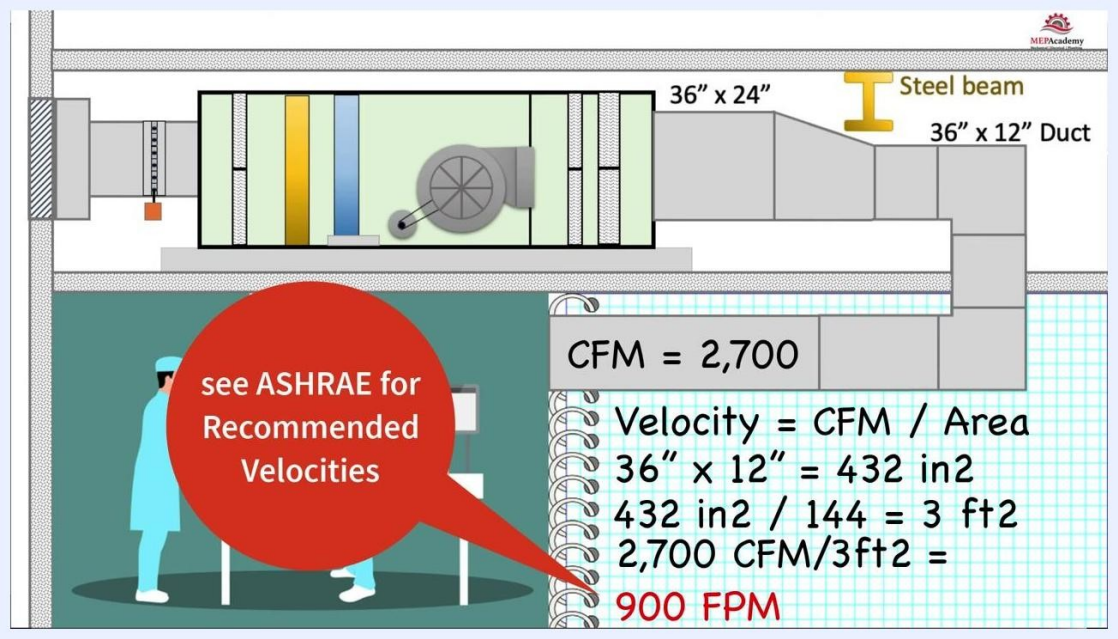
Chalkboard showing the calculation: 36 inches by 24 inches equals 864 square inches

- Area = 864 in² ÷ 144 = 6 square feet

Step 5: Apply the CFM formula

Substitute the measured velocity and calculated area into the formula:

CFM = 450 FPM × 6 ft² = 2,700 CFM



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This result is the total airflow through the duct section.

Reference: The chalkboard below shows the formula applied with the measured velocity value before the final area is substituted.

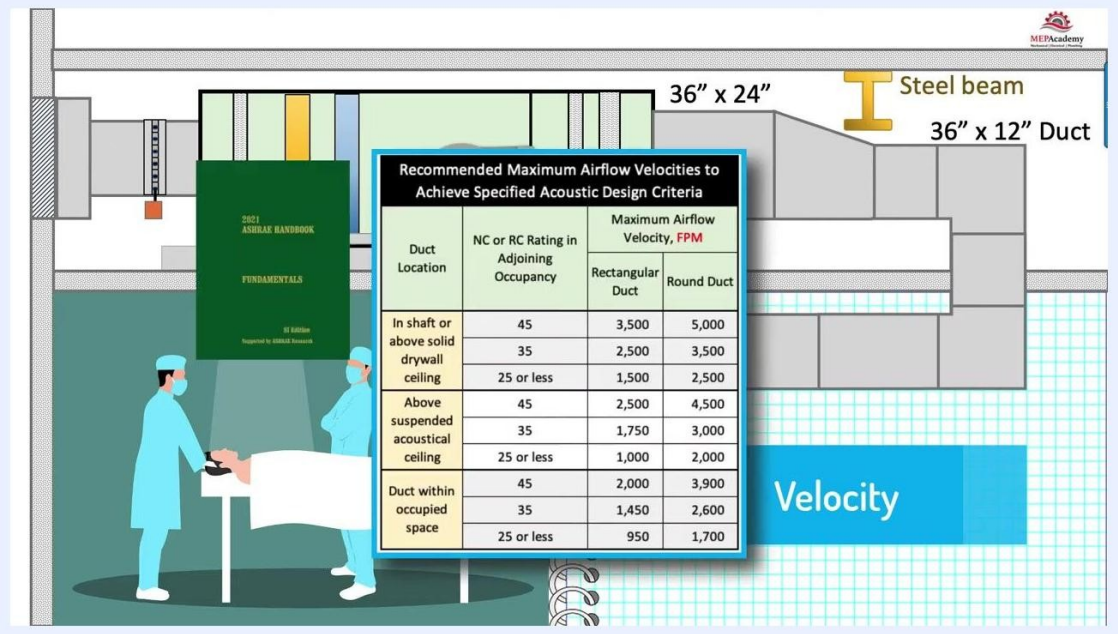
Step 6: Note the relationship between duct size and velocity

If you reduce the duct size while keeping the CFM the same, the velocity will increase. Keep this relationship in mind for system design and noise considerations, as covered in the following steps.

Calculating velocity after reducing duct size

Step 7: Reference recommended velocity guidelines

Consult the ASHRAE Handbook of Fundamentals for recommended maximum velocities in ductwork. Maximum recommended velocities for rectangular ducts range from 950 to 3,500 feet per minute (FPM), depending on location and noise criteria. Actual velocities are often kept lower than these maximums for noise and comfort considerations.



Recommended Maximum Airflow Velocities to Achieve Specified Acoustic Design Criteria

Duct Location	NC or RC Rating in Adjoining Occupancy	Maximum Airflow Velocity, FPM	
		Rectangular Duct	Round Duct
In shaft or above solid drywall ceiling	45	3,500	5,000
	35	2,500	3,500
	25 or less	1,500	2,500
Above suspended acoustical ceiling	45	2,500	4,500
	35	1,750	3,000
	25 or less	1,000	2,000
Duct within occupied space	45	2,000	3,900
	35	1,450	2,600
	25 or less	950	1,700

Diagram showing a duct transition from 36 inches by 24 inches to 36 inches by 12 inches under a steel beam, with a chart of recommended maximum airflow velocities from the ASHRAE Handbook

Safety and design note: When routing ducts under obstacles like beams, verify that any resulting velocity increase stays within these recommended limits.

Step 8: Identify the new duct dimensions

Determine the reduced duct size needed to clear the obstruction. In this example, the duct is reduced from 36 inches × 24 inches to 36 inches × 12 inches to fit under a steel beam. The CFM remains constant at 2,700.

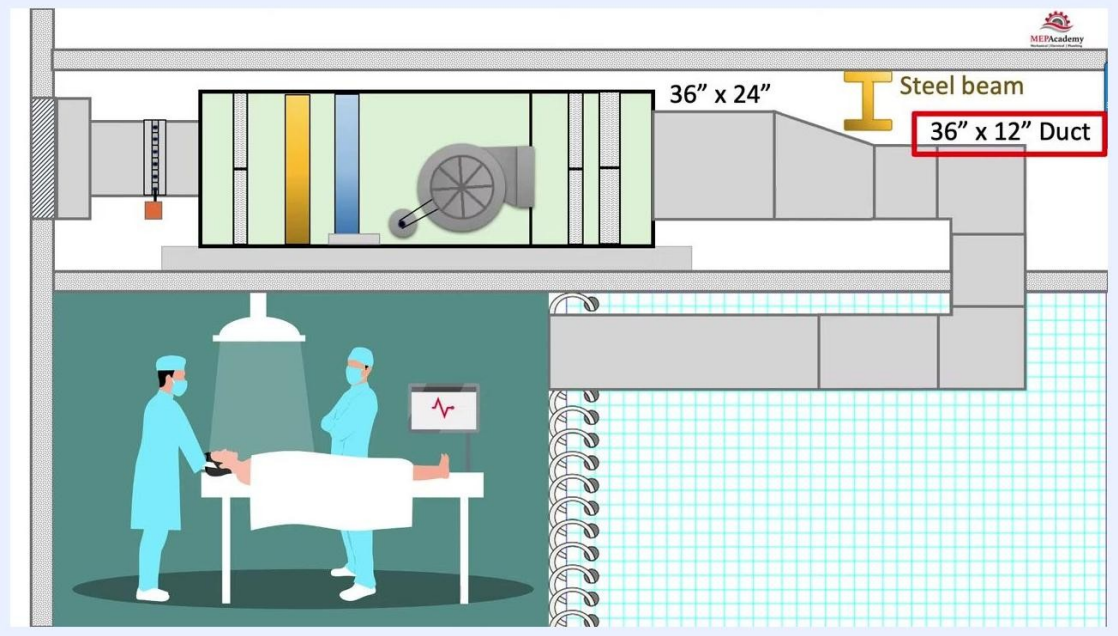


Diagram showing the duct transition from 36 inches by 24 inches to 36 inches by 12 inches under a steel beam, with labeled dimensions and an operating room below

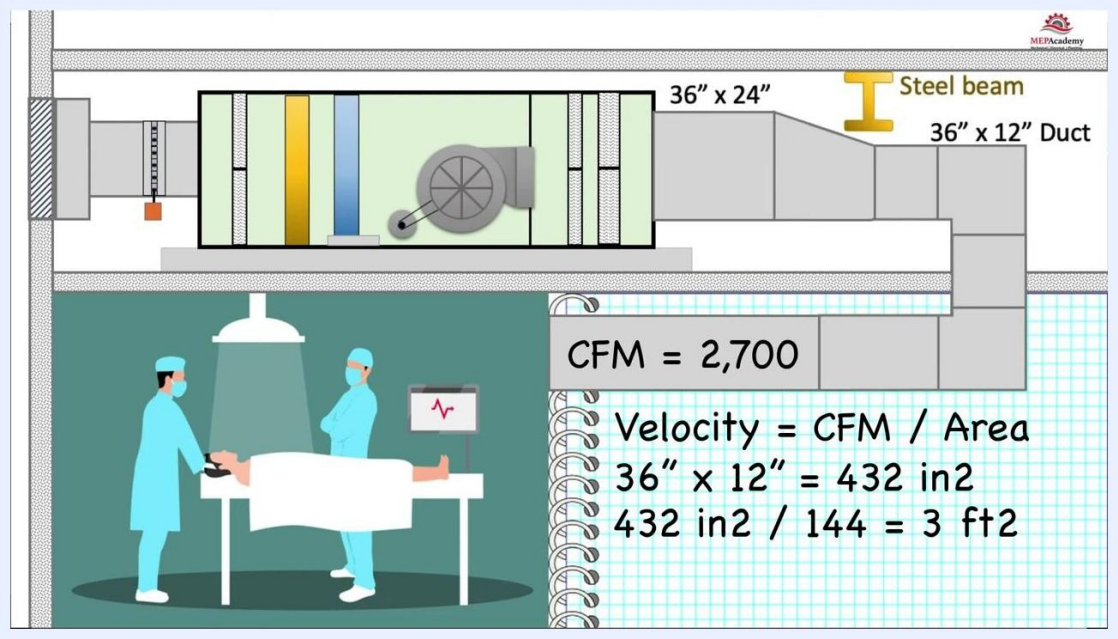
Step 9: Convert the new duct area to square feet

Calculate the area in square inches:

- Area = 36 in × 12 in = 432 in²

Convert to square feet:

- Area = 432 in² ÷ 144 = 3 square feet



Visualization comparing airflow velocity: 450 FPM in a 36-inch by 24-inch duct versus 900 FPM in a 36-inch by 12-inch duct, with blue cubes representing air volume

Step 10: Apply the velocity formula

When CFM and area are known, rearrange the CFM formula to solve for velocity:

Velocity (FPM) = CFM ÷ Area (ft²)

Substitute the known values:

Velocity = 2,700 CFM ÷ 3 ft² = 900 FPM

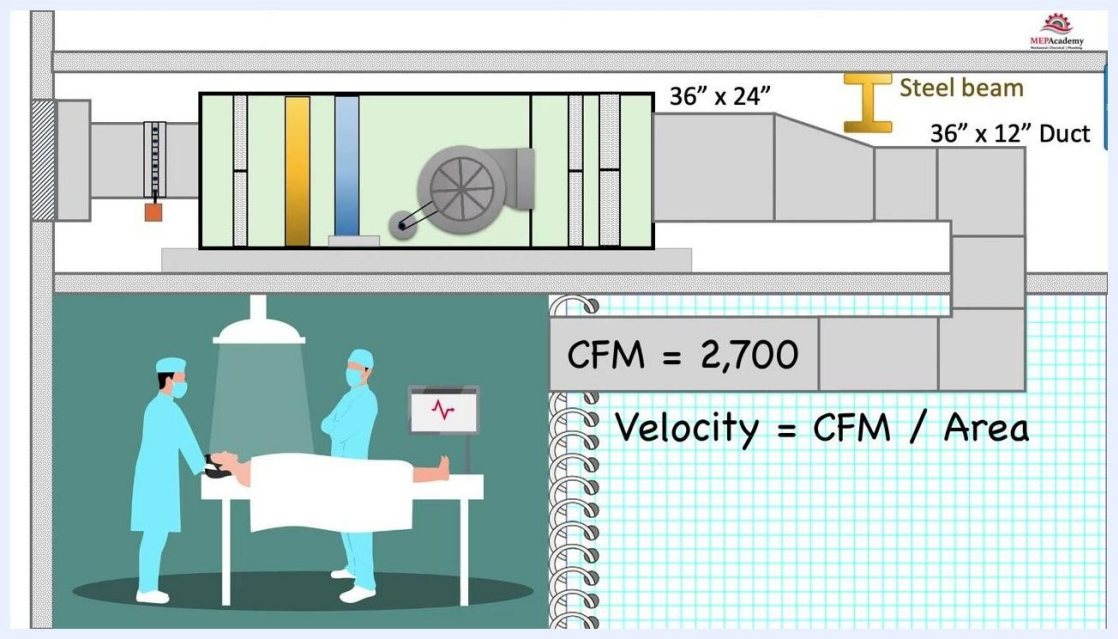


Diagram showing the velocity formula and area conversion, with CFM equal to 2,700 and area equal to 3 square feet

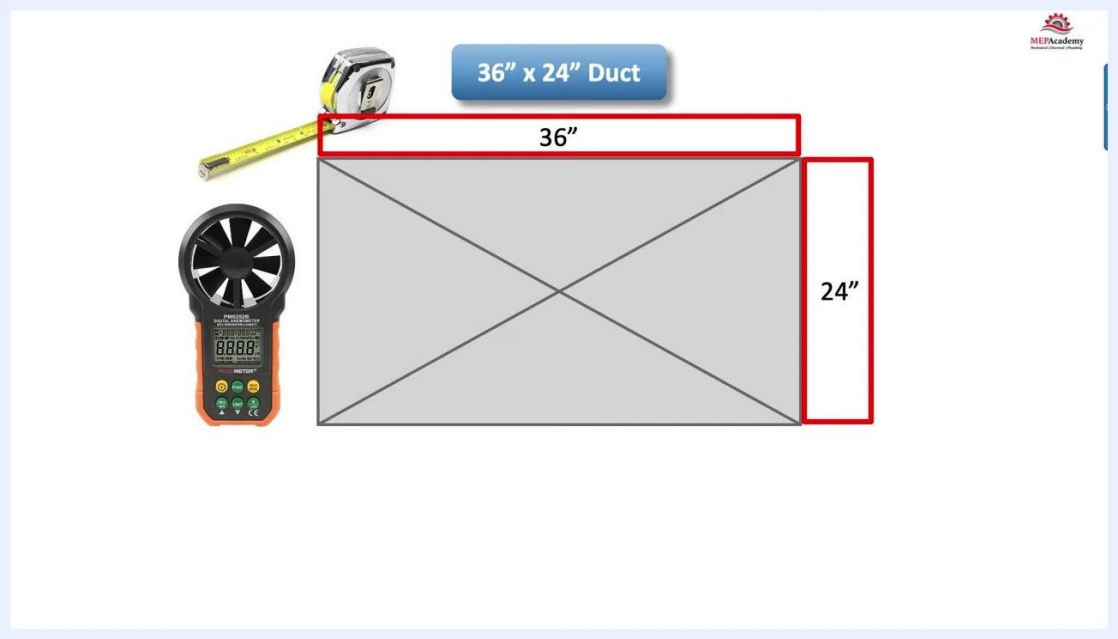
The velocity doubles compared to the previous duct size because the area is halved.

Step 11: Compare velocities before and after duct reduction

Review the change in velocity resulting from the duct size reduction:

- Previous velocity with 36" × 24" duct (6 ft²): 450 FPM

- New velocity with 36" × 12" duct (3 ft²): 900 FPM



Chalkboard showing "CFM = 450 FPM x Area" with a duct, tape measure, and anemometer below

The velocity increases as the duct area decreases, given constant airflow.

Verification and summary

Step 12: Confirm the direct correlation between area and velocity

Verify that when duct area is cut in half (from 6 ft² to 3 ft²), the velocity doubles (from 450 FPM to 900 FPM), provided the CFM remains constant. This confirms the relationship: if CFM is constant, reducing duct area increases velocity proportionally.

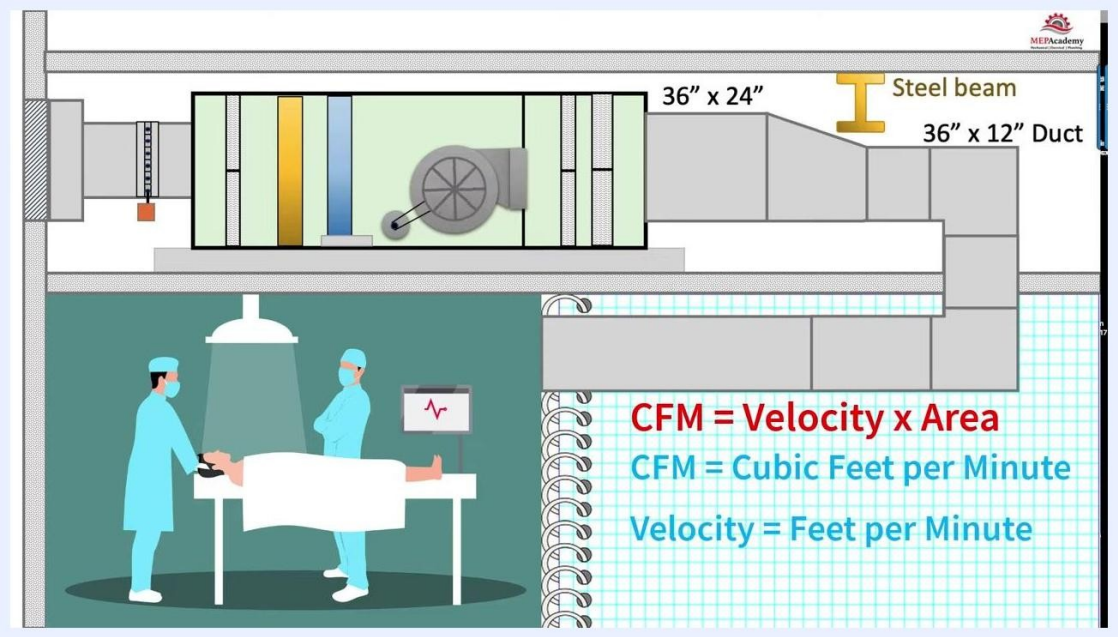


Diagram showing a 36-inch by 24-inch duct with a tape measure and anemometer, with dimensions labeled

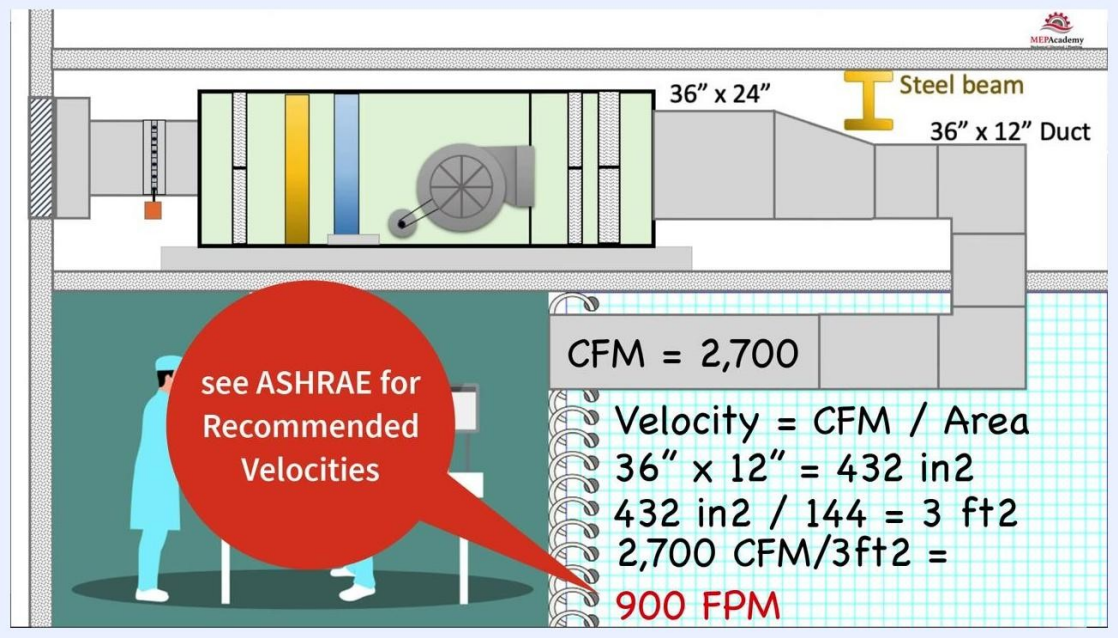
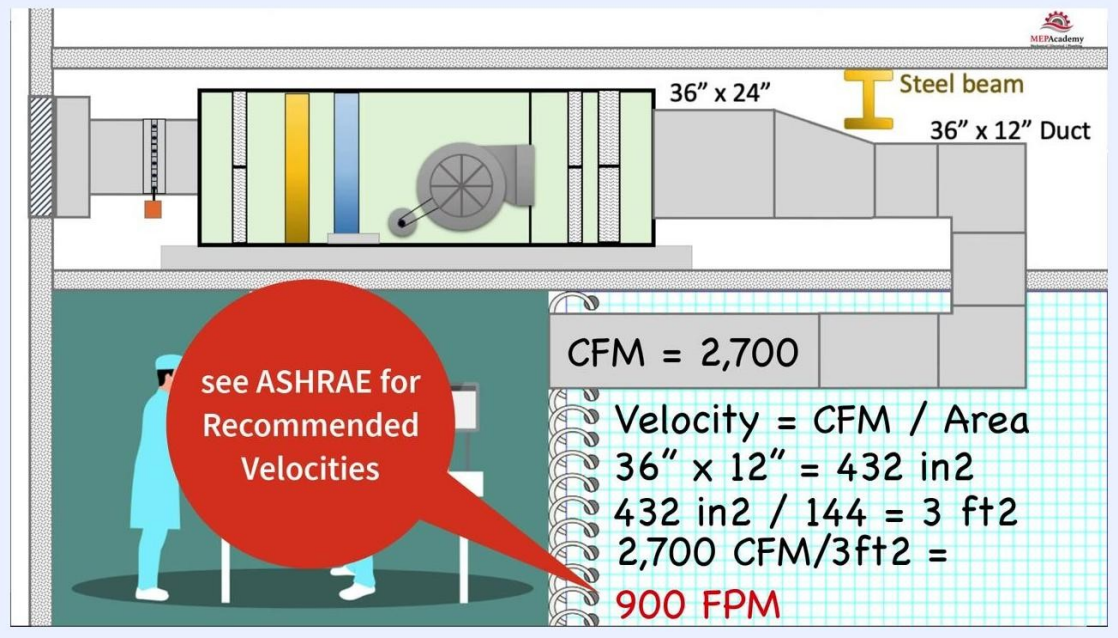


Diagram showing a duct transition, steel beam, CFM of 2,700, velocity calculation, and a callout stating "see ASHRAE for Recommended Velocities"

Step 13: Verify against industry standards

Always check ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) guidance for recommended air velocities in ductwork to confirm compliance and optimal system performance.



Side-by-side visualization of airflow in 36-inch by 24-inch and 36-inch by 12-inch ducts, with blue cubes representing air volume and the formula "Velocity = 2,700 CFM / 3 ft² = 900 FPM" displayed

Step 14: Review the complete calculation in context

Confirm the final summarized calculation:

- Duct size reduced to 36" × 12"
- Area = 432 in² = 3 ft²
- Velocity = 2,700 CFM ÷ 3 ft² = 900 FPM

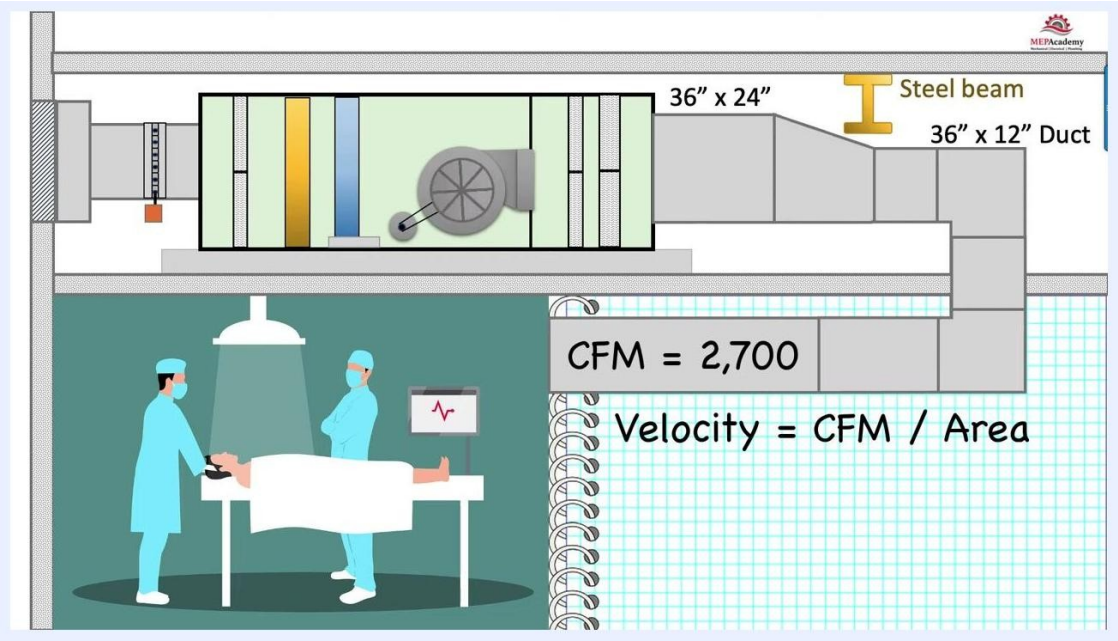


Diagram showing the calculation: 36 inches by 12 inches equals 432 square inches, and 432 square inches divided by 144 equals 3 square feet, with CFM and the formula displayed

This calculation is especially important in critical environments, such as above an operating room, where proper airflow control is essential.

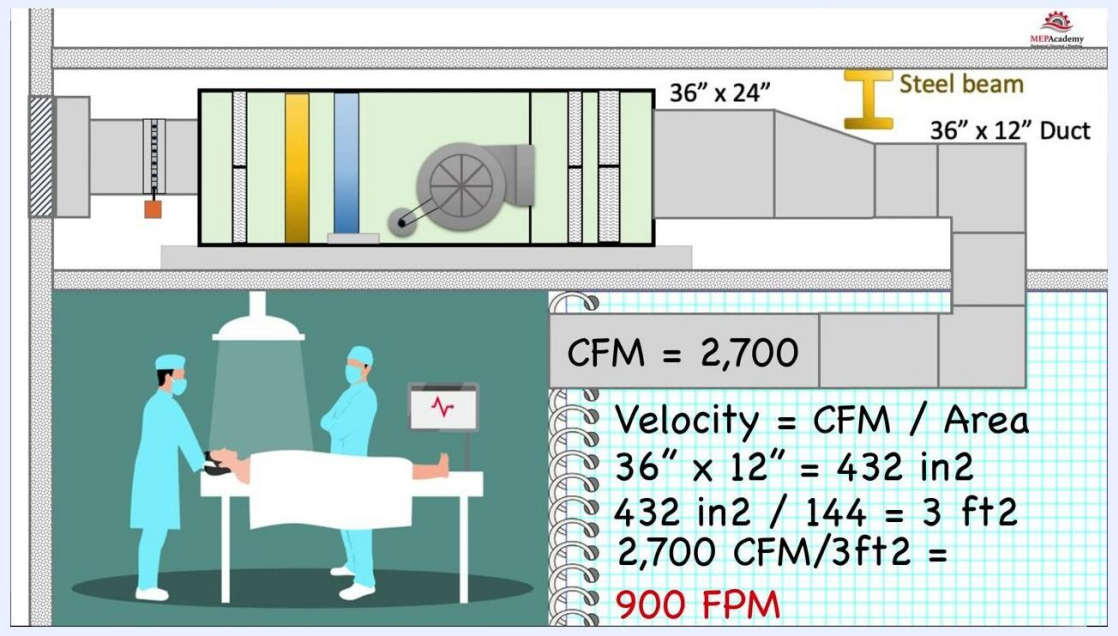
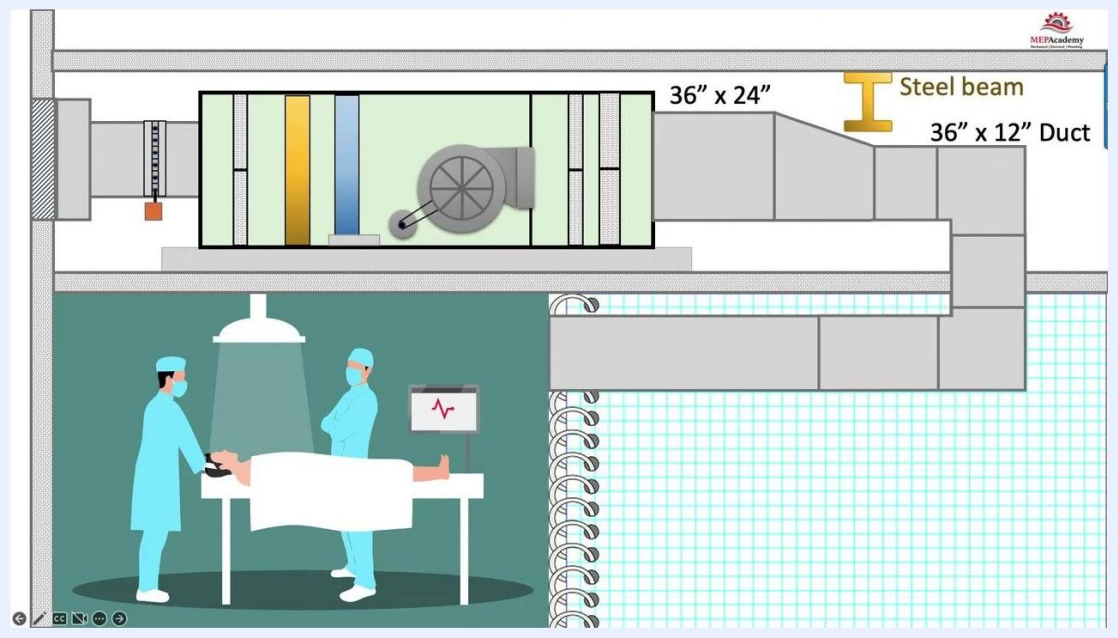


Diagram of a duct system above an operating room, with CFM and velocity calculations shown on a notepad background

Summary table

Duct Size	Area (ft²)	Velocity (FPM)	CFM
36" × 24"	6	450	2,700
36" × 12"	3	900	2,700



Chalkboard showing the full calculation: CFM equals 450 FPM times 6 square feet equals 2,700 CFM

Key takeaways

- Velocity increases as duct area decreases, if CFM is unchanged.
- Always verify that resulting velocities are within recommended guidelines (see ASHRAE).

- Proper duct sizing is critical for system efficiency and occupant safety, especially in sensitive environments like operating rooms.

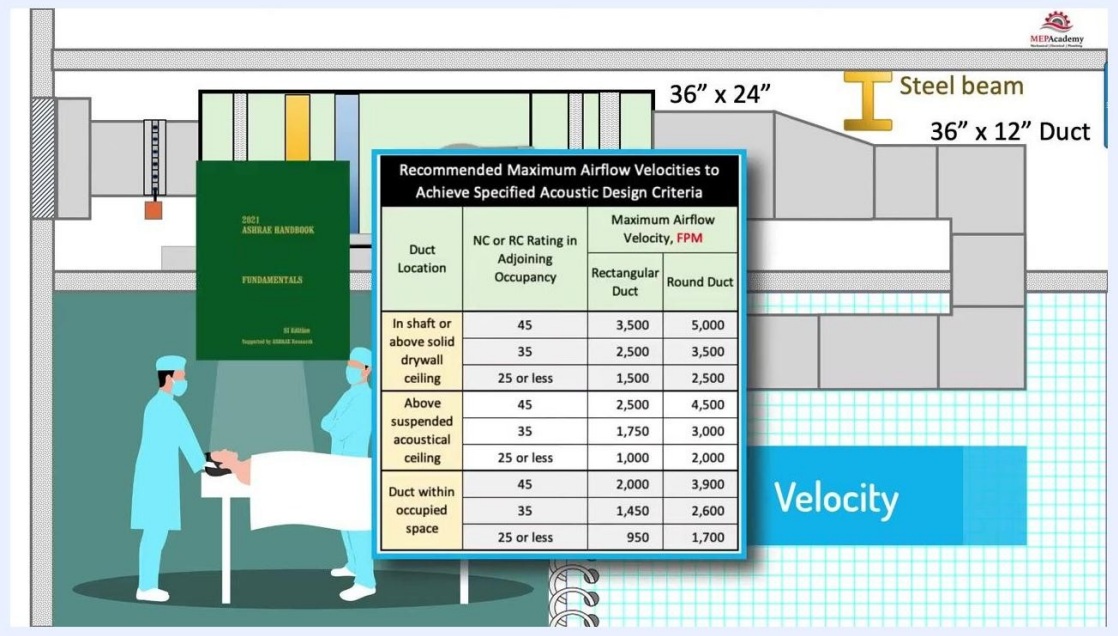


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Diagram showing a duct system above an operating room, with a transition from a 36-inch by 24-inch duct to a 36-inch by 12-inch duct under a steel beam, alongside a chart of recommended maximum airflow velocities

What's next

Apply this same method to other duct sections in your system, always measuring dimensions and velocity directly, converting units carefully, and checking final velocities against ASHRAE recommendations before finalizing any duct size changes.