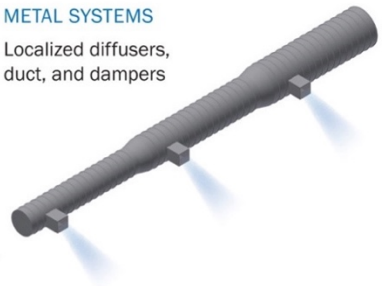
Optimizing Acoustics

HIGH-PERFORMANCE AIR DISTRIBUTION FOR SOUND STAGES

PREPARED FOR ARC ENGINEERING
BY QIHENG ZHENG, P.E.

Traditionally, HVAC systems for filming stages rely on sheet metal ductwork due to its durability and proven performance. However, filming stages are characterized by large open volumes, where most of the space—from floor level up to the grid ceiling—is reserved for set construction and filming activities. To maintain maximum flexibility for various set configurations, this space must remain unobstructed. Accordingly, no building systems can extend below the grid ceiling. All infrastructure—including lighting, AV cabling, ductwork, and electrical conduits—must be carefully coordinated within the ceiling zone. This often results in significant congestion & coordination challenges. To address this, a hybrid approach is recommended: combining traditional sheet metal ductwork with fabric duct systems (e.g., DuctSox).

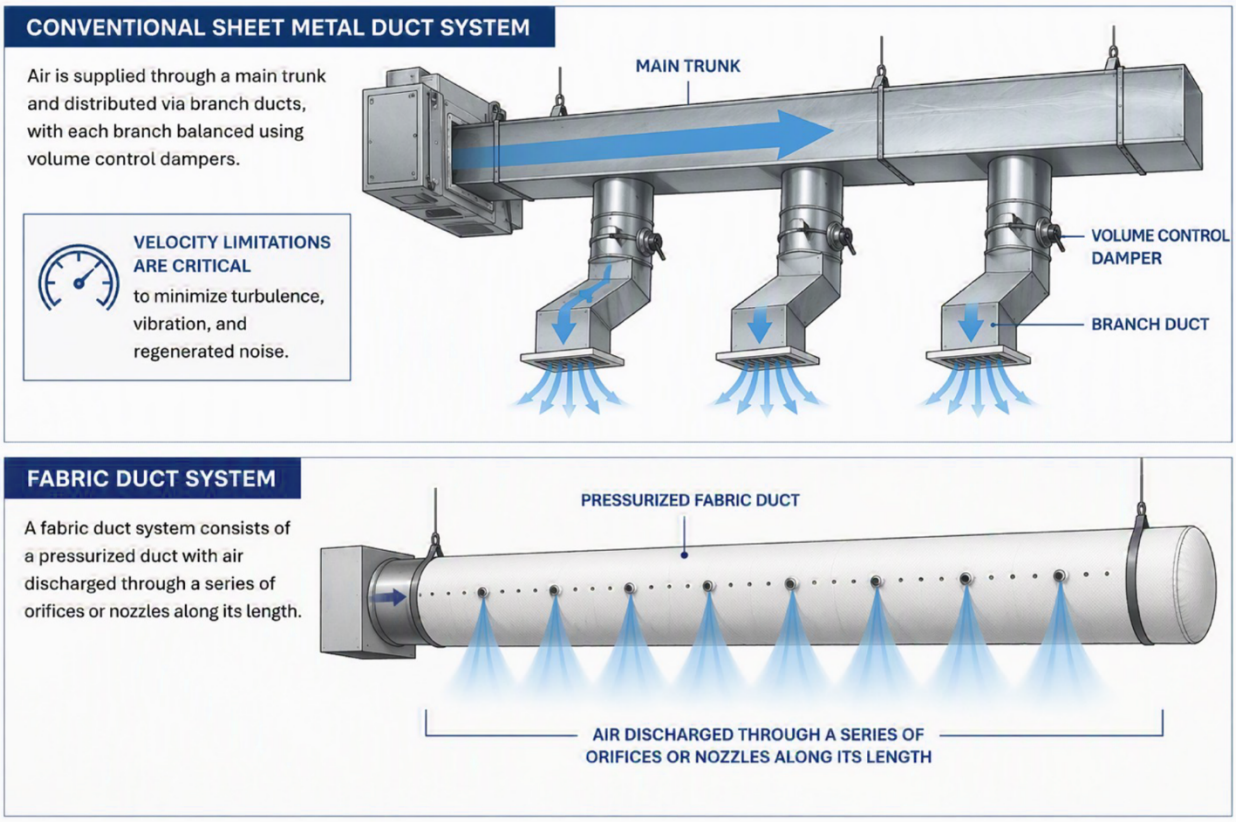
Sheet metal ductwork remains essential for spot cooling applications, particularly when multiple enclosed sets or rooms are constructed within the stage.



In these cases, flexible ducts can be connected to sheet metal branch “fingers” or vertical drops to deliver targeted airflow.
Fabric duct systems can be utilized to handle the building envelope load and general space conditioning outside of active shooting zones. This approach helps reduce ceiling congestion while maintaining flexibility and performance.

1. Acoustical Performance

Filming stages typically require a stringent acoustical criterion of NC-25. For conventional sheet metal duct systems, duct sizing is based on velocity criteria provided by the acoustical consultant (see Fig.1, standard guidance from RWDI). Maintaining airflow velocities within these limits ensures compliance with the required noise criteria. However, these velocity guidelines are not directly applicable to fabric duct systems due to fundamental differences in air distribution.



While discharge velocities at these openings can reach approximately 1000 FPM—exceeding typical velocity limits for metal duct design—this does not result in equivalent noise levels.
Acoustic testing conducted at Intertek Testing Services (Cortland, NY) demonstrates that fabric duct systems can still achieve NC-25 performance at these discharge velocities. This is primarily due to the characteristics of the fabric material:

- It absorbs vibration rather than transmitting it
- It minimizes duct-borne noise
- It reduces sound reflection and reverberation within the duct system

By comparison, similar velocities in sheet metal ducts may result in vibration, duct rumble, and increased radiated noise. Therefore, conventional duct velocity tables remain applicable to metal duct design but should not be directly applied to fabric duct systems.

AIR-VELOCITIES

DUCTWORK SHALL BE SIZED SO AS TO CAUSE AIR VELOCITIES NO MORE THAN F.P.M. VALUES SHOWN IN THE FOLLOWING TABLE.

NOISE CRITERION	NC 45	NC 40	NC 35	NC 30	NC 25	NC 20
MAIN BRANCH EXPOSED RECTANGULAR DUCT	1600	1500	1200	-	-	-
MAIN BRANCH ABOVE SUSPENDED CEILING - RECTANGULAR DUCT	2000	1800	1500	1300	-	-
DUCT WITHIN 10 TO 20 FEET OF SUPPLY DIFFUSER/RETURN GRILLE	1000	950	900	800	650	500
DUCT WITHIN 0 TO 10 FEET OF SUPPLY DIFFUSER/RETURN GRILLE	800	750	700	600	500	400
SUPPLY DIFFUSER 'FREE' VELOCITY	550	500	450	400	300	200
RETURN GRILLE 'FREE' VELOCITY	650	600	550	500	400	250
OPEN RETURN DUCT ABOVE CEILING	850	750	650	-	-	-

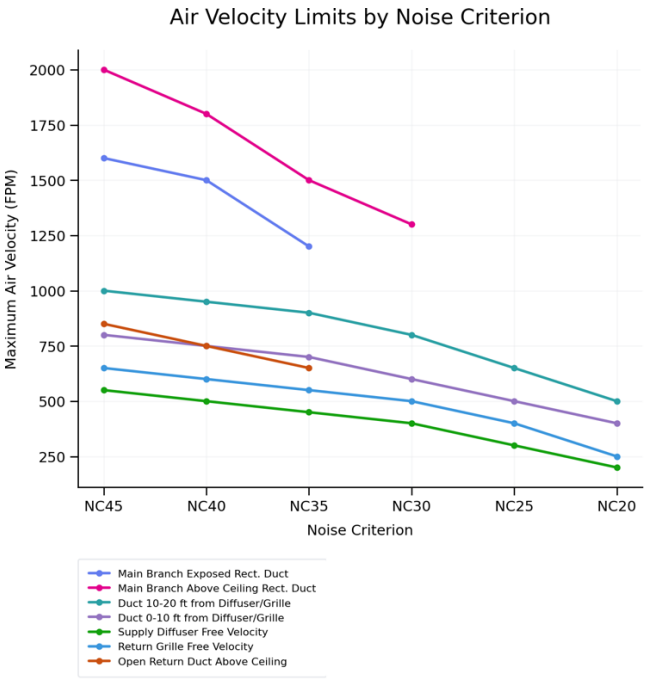


Fig.1 Typical Velocity Table from Newson Brown/RWDI

2. Reduced Ductwork and Support Requirements

To deliver 10,000 CFM using conventional sheet metal ductwork, a typical configuration would include one main trunk with approximately ten branch ducts. In contrast, a fabric duct system can deliver the same airflow using a single main duct.

As shown in Table 1:

- Sheet metal duct system weight: approximately 1,600 lbs
- Fabric duct system weight: approximately 22 lbs

This substantial reduction in system weight provides several benefits:

- Reduced structural support requirements
- Lower installation labor
- Decreased material costs

Additionally, minimizing ductwork significantly alleviates ceiling congestion, allowing better coordination with other trades such as electrical, AV, and fire protection systems.

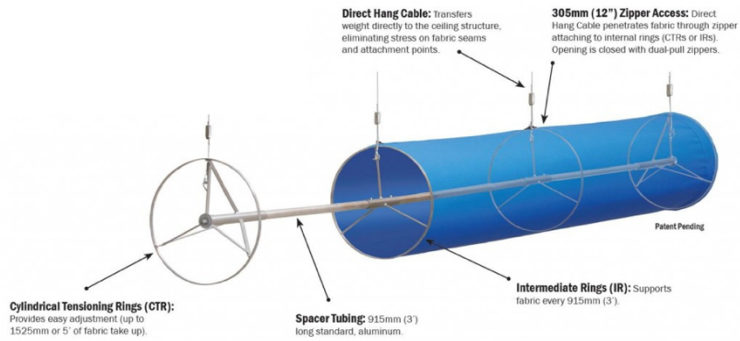
It is important to maintain a clear airflow path for fabric duct discharge. A clearance of approximately 3–4 feet should be preserved in front of the orifices or nozzles. Obstructions within this zone may cause airflow disturbance, resulting in whistling noise and potential failure to meet acoustical requirements.

Duct Type	Design CFM	Velocity (FPM)	Duct Width (Inch)	Duct Height (Inch)	Duct Dia. (Inch)	Duct Length (Ft)	Weight (Lb/SF)	Total Weight	Note
Metal Duct Main Truck	10000	650	46	48	/	30	1.406	718	1
Metal Duct Branch Duct	1000	500	/	/	20	10	1.406	883	2
DuctSox	10000	600	/	/	56	30	0.05	22	
Note: 1. 1.156 lb/SF for 24 Ga. Galvanized duct. 0.25 lbs/SF for 2" lining. 2. Assume total (10) branches.									

Table 1 – Sheet Metal Duct vs. Fabric Duct in Weight

3. Ease of Installation

Fabric duct systems utilize an internal support framework (skeleton system) combined with a direct cable suspension method. The internal framework maintains duct shape and prevents collapse during low airflow conditions.



The system is supported by cables attached directly to the structural framing above, simplifying installation compared to conventional duct hangers. Due to the lightweight nature of the fabric system, installation typically does not require heavy lifting equipment, reducing installation time, labor effort, and site constraints.

4. Aesthetics and Maintenance

The fabric duct is available in various colors to match the architectural palette or stage wall finish without the cost of high-performance field painting. They also offer several long-term advantages:

- Corrosion resistance: Fabric materials do not rust
- Ease of maintenance: Sections can be unzipped and machine-washed, supporting improved indoor air quality
- Sustainability: Reduced material weight lowers manufacturing and transportation impacts, contributing to LEED or other green building goals

Conclusion

A hybrid HVAC approach that combines sheet metal ductwork with fabric duct systems provides an effective solution for filming stage environments. It maintains the durability and flexibility required for spot cooling while significantly reducing ceiling congestion, improving acoustical performance, simplifying installation, and enhancing overall system efficiency and maintainability.