APC

APPLICATION NOTE #96

Rack Air Removal Unit SX Application Guidelines

By David Roden

Abstract

The Rack Air Removal Unit SX (ARU SX) is a rack mounted fan system for use with NetShelter enclosures. This application note outlines various considerations for applying the ARU SX.

Introduction

The Rack Air Removal Unit SX is a rack mounted fan system for the NetShelter SX and VX enclosures; designed to draw in exhaust air from rack mounted IT equipment and allow the hot air to be properly managed as part of a total cooling system. The ARU SX consists of a fan box and an adjustable frame; it mounts to the rear of the enclosure, replacing the rear doors, and discharges upwards into a ducting kit. See **Figure 1** for a diagram of the airflow. The ARU SX can move a maximum of 2000 CFM of air and is rated up to 23 kW of heat removal.

Figure 1 – Rack Air Removal Unit airflow diagram

Rack Compatibility

The ARU SX is designed for use with NetShelter SX and VX enclosures. No special adapters or accessories are required to mount on either rack type. The user must determine the width of rack that the ARU will be utilized with, 600 mm or 750 mm and select the appropriate unit – ACF400 or ACF402 respectively. No other selection for ARU SX is required; both models are suitable for mounting on 42U, 47U and 48U racks. The adjustable mounting frame extends as needed and can be adjusted in the field to adapt to the current installation.

Ducting Kits

The ducting kit for the ARU SX mounts above the unit, attaches to the adjustable mounting frame and allows the fan box to swing open without interfering with the duct kit itself. The kit consists of a ceiling tile adapter and two (2) ducting tubes. The ceiling tile adapter is available in either 24" or 600 mm sizes; the user must select the appropriate kit for their needs – ACF126 or ACF127 respectively. The ducting kit is a ship loose item, purchased separately; however it is required for installations where the ceiling height is less than 12 feet (3.66m) and recommended for all ARU SX installations regardless of ceiling height. Modeling done using computational fluid dynamics (CFD) software shows that the high velocity air jets exiting the ARU will impinge on the ceiling and circulate downward towards the IT equipment rather than forming a layer of hot air at the ceiling; this happens even with relatively tall ceilings. This often makes it easier for the hot exhaust air to be drawn into the IT equipment inlets, the exact opposite of the intended results. Depending on the layout of the space, ceiling height, ARU airflows and other factors in the room, using an ARU without the duct kit could potentially be less beneficial than not using an ARU at all. **Figure 2** shows the air patterns of a rack and ARU with and without a ducting kit. **Figure 3** shows the temperatures associated with that comparison.

***Figure 2** – Airflows ducted vs. unducted*

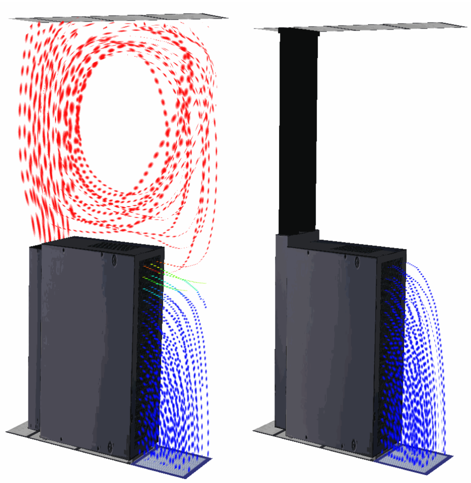
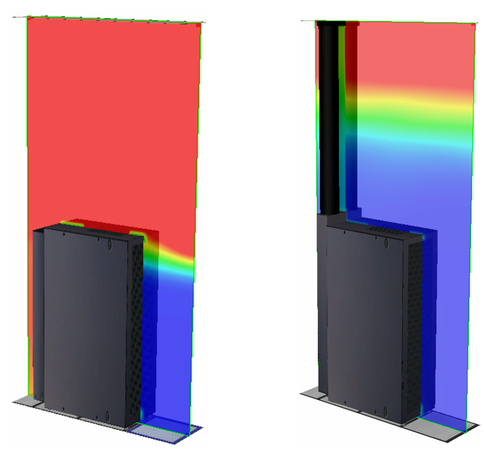


***Figure 3** – Temperature profiles ducted vs. unducted*

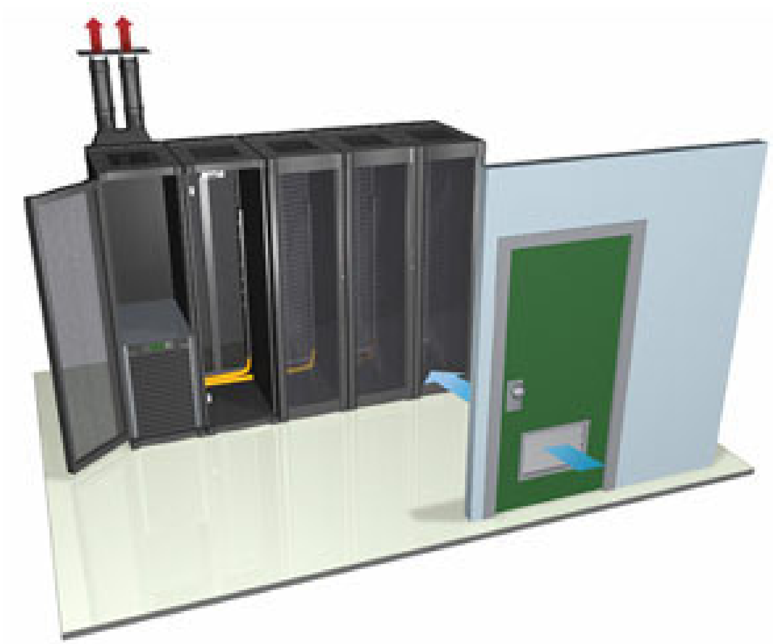


Rooms that are extremely tall, well above the 14 foot ceilings studied here, might avoid this situation. With sufficiently tall ceilings the exhaust air will eventually lose momentum and not reflect off of the ceiling. Additional techniques to mitigate the recirculation of hot air may be possible - properly situated return air ducts at the ceiling level to scavenge the hot air, or open grates above the racks to allow the air jets to travel into a drop ceiling plenum for return to a CRAC. These methods draw off the warm air or keep it separated from the cool air in the space without the use of a ducting kit.

Ceiling Plenums

The ceiling plenum that receives the ARU exhaust air, whether a ducting kit is employed or not, should be directly connected to the air conditioning system that is cooling the overall space. In data center applications the ceiling plenum should be isolated from the surrounding space and not be part of a building comfort cooling return system. This helps drive up the efficiency of the CRAC units by increasing return air temperatures and helps prevent uncontrolled make up air from intruding into the data center. However, in small IT rooms were no dedicated cooling is provided, the ARU should exhaust into a building comfort cooling return system. Conditioned air from an adjacent space must then be allowed to enter the closet to provide cooling to the IT equipment; typically wall or door mounted grills are used for this. See **Figure 4** for an example of this arrangement.

Figure 4 *– Small IT room with no dedicated cooling*



Custom Ducting Systems

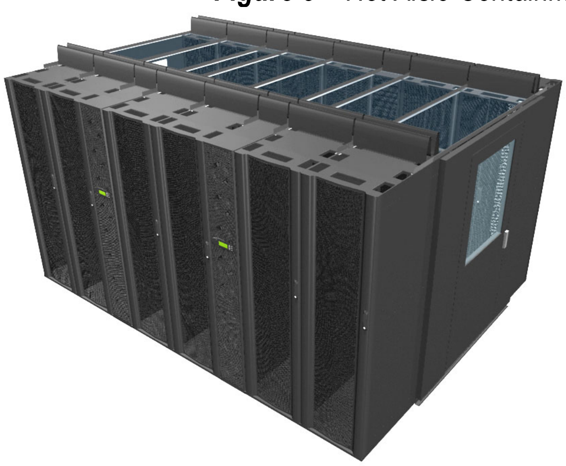
Computer rooms and wiring closets may not have ceiling plenums that are suitable to duct the hot air from the ARU, or lack a drop ceiling entirely. In these situations users may still utilize an ARU and have the exhaust air discharge into custom duct work. Care needs to be taken during design to ensure the duct work can accommodate the maximum airflow of the ARU(s). Additionally, field supplied booster fans may be needed depending on the design of the duct system; in those cases it should be assumed that the ARU SX can not over come any external static pressure drop beyond that created by the ARU duct kit itself. It is recommended that you utilize a consulting engineer or design-build contractor to ensure proper layout, design and code compliance for any duct system.

Air Containment Systems

Two air management solutions that are often used in conjunction with NetShelter enclosures are the Rack Air Containment System (RACS) and the Hot Aisle Containment System (HACS). RACS is a field installed, rack mounted enclosure system to close-couple SX racks with InRow cooling units. It can be configured to contain the front and rear of the enclosure(s) and InRow unit(s) or only the rear. In both cases there are limitations to the number of racks and cooling units that can be configured into a single RACS, see Application Note #90 for a discussion of RACS configurations. HACS is similar in concept, except it encloses an entire hot aisle, rather than a single row or rack. See **Figure 5**.

The ARU SX should not be used with either RACS or HACS under any circumstances; in either situation the containment system will interfere with the mounting of the ARU. Additionally, the use of either RACS or HACS negates the function of the ARU; they are close-coupled rack- and row-oriented air management systems instead of a hybrid system used in conjunction with room- or building-oriented cooling systems.

***Figure 5** – Hot Aisle Containment and Rack Air Containment examples*



Customized Operating Modes

After installing the ARU SX the user will need to set up the unit for their conditions. There are three (3) preset operating modes the user can select from – Standard IT, Mixed IT, and Blade Server. The configurations for these modes are listed in the Installation and operational manual. If these are not suitable for the conditions present, then the user may create a custom operating mode. The user must input a Flow Rate, Airflow Ratio, Temperature Override On/Off, and Temperature Override Set point. The Flow Rate is the minimum airflow the ARU SX fans will draw; this value should be no lower than airflow discharged by the IT equipment in the rack. You can estimate this number by multiplying the kW of rack load by the Airflow Ratio. For example – a rack has 5 kW of load and a 120 CFM/kW Airflow Ratio; this gives you a minimum Flow Rate of 600 CFM. The settings are in 100 CFM increments between 400 and 1000 CFM, and in 200 CFM increments thereafter. A rack with 8 kW of load and 160 CFM/kW ratio therefore would have a minimum Flow Rate of 1400 CFM. The Airflow Ratios available are the same as the presets – Standard IT (160 CFM/kW), Mixed IT (120 CFM/kW), and Blade Server (80 CFM/kW).

The Temperature Override On/Off determines whether or not the ARU SX will automatically increase fan speed when the set point is reached. The user then inputs the temperature set point that triggers the Override. It is recommended that the set point be approx 5°F (3°C) above the expected exhaust temperature. For example – a rack of equipment typically ingests 75°F air and has a 30°F rise across the IT equipment; the expected exhaust temperature would be approximately 105°F and therefore an Override Set point of 110°F would be suggested.
The user an either directly measure the inlet and exhaust temperature across the rack to determine the temperature rise, or estimate it based on the Airflow Ratio used. The 160 CFM/kW ratio corresponds to approximately a 20°F rise, 120 CFM/kW and 80 CFM/kW ratios have approximately 30°F and 40°F temperature rises respectively.

About the Author:

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