APC

APPLICATION NOTE #112

# Best Practices for Deploying the InfraStruXure InRow SC

**By David Roden**

## Abstract

The InfraStruXure® InRow™ SC (ACSC100 and ACSC101) is a self-contained air conditioner for server rooms and wiring closets. This application note outlines best practices to be used when deploying the units in these IT spaces.

## Introduction

The InfraStruXure InRow SC is an air cooled, self-contained, cooling-only air conditioner designed to be placed in-row. The in-row design allows waste heat from the IT equipment to be drawn into the return of the SC unit and neutralized before it mixes with the room air. Conditioned air is discharged into the cold aisle for immediate use by the equipment in the adjacent racks. The heat absorbed from the air stream must then be rejected from the room; this is accomplished by the condenser section in the upper half of the InRow SC enclosure. The condenser section is designed to be connected to a drop ceiling plenum. See **Figure 1** for a diagram of the airflow.

*Figure 1 – InRow SC airflow*

The InRow SC has a nominal net cooling capacity of 5kW and is primarily intended to serve the wiring closet and computer room spaces. Small data center users, possessing a ceiling plenum suitable for the unit heat rejection requirements and have no access to chilled water will often find the SC a compelling value given its scalability and easy of installation.

## Placement of InRow SC Units

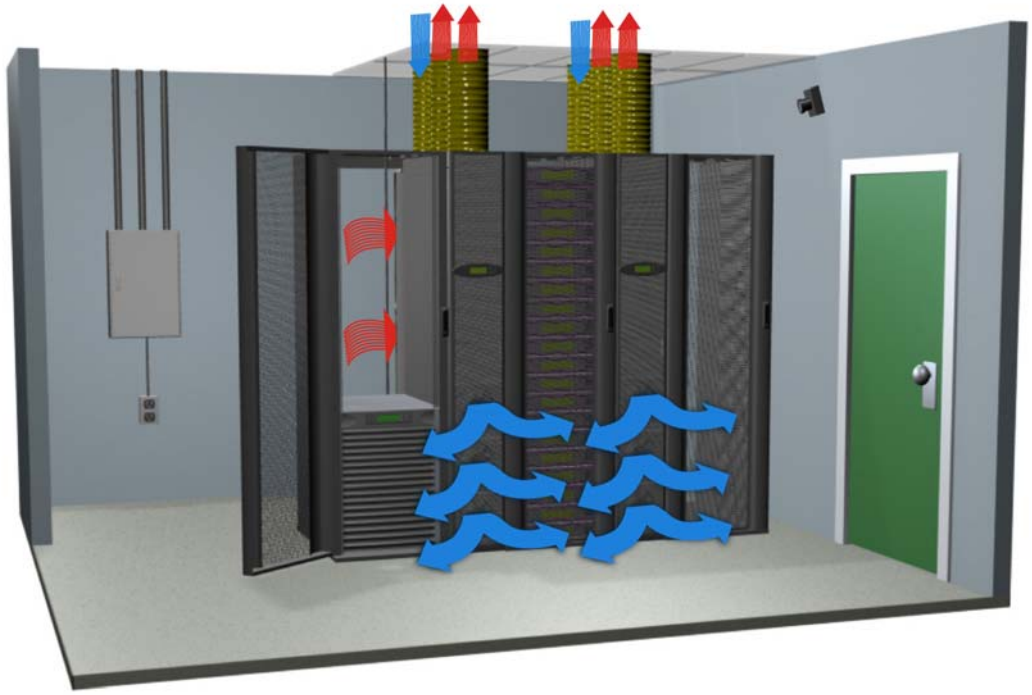
Hot air mixing within the IT room is the fundamental cause of many thermal problems. As the InRow units draw inlet air directly from the hot aisle it is critical that best practices involving unit placement are followed to maximize the effectiveness of the heat removal. The region within which an InRow SC unit has a cooling effect on neighboring IT racks is known as the sphere of influence. The sphere of influence is affected by the distance between the rack

and cooling unit, the heat density of the rack, and the airflows of the rack and the cooling unit.

## Single row placement

In general the InRow SC units should be spaced evenly throughout the row of racks; placing the SC at the end of a row should be avoided. See **Figure 2** for an example. This arrangement helps maximize the ability of the InRow units to capture all of the hot exhaust air effectively before it can mix with the cool air in the room. In many wiring closets there are often a very limited number of racks and placing the SC at the end of the row cannot be avoided. In those circumstances it is best to place the SC next to the rack with the highest heat load. The only exception to these guidelines is when using a Rack Air Containment System (RACS). See Containment Systems section below and refer to Application Note #114 for a thorough discussion on RACS usage.

*Figure 2 – InRow SC units with racks*

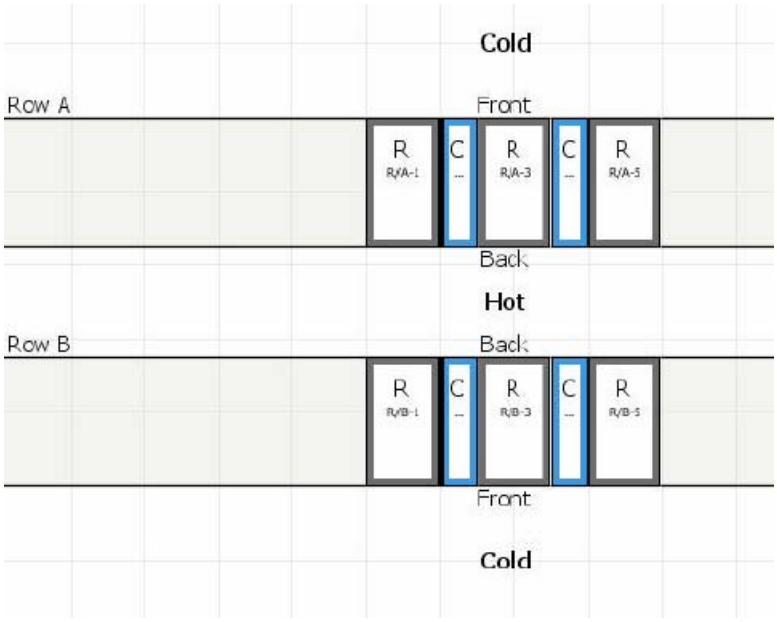


## Multiple row placement

When two or more rows of racks are configured, always use hot aisle/cold aisle layouts. InRow SC units should be placed directly across the hot aisle from each other. See **Figure 3** for an example. Using a center hot aisle design provides significantly better hot air capture and should be used whenever possible. If InRow units face each other across a cold aisle this placement also ensures that the cold air being discharged from the cooling unit is not blowing directly on the rack across

the aisle. Having cold air discharge directly onto a rack could influence the rack inlet probe of an InRow SC unit in that row; this could result in false readings causing the unit to provide less cooling than required.

*Figure 3 – InRow SC units and racks in multiple rows*




### Stand alone placement

SC units can be placed against a wall or in the middle of a room as a stand alone unit. The unit is tall and narrow and must be bolted to the ground and/or wall in these circumstances to prevent it from tipping over.

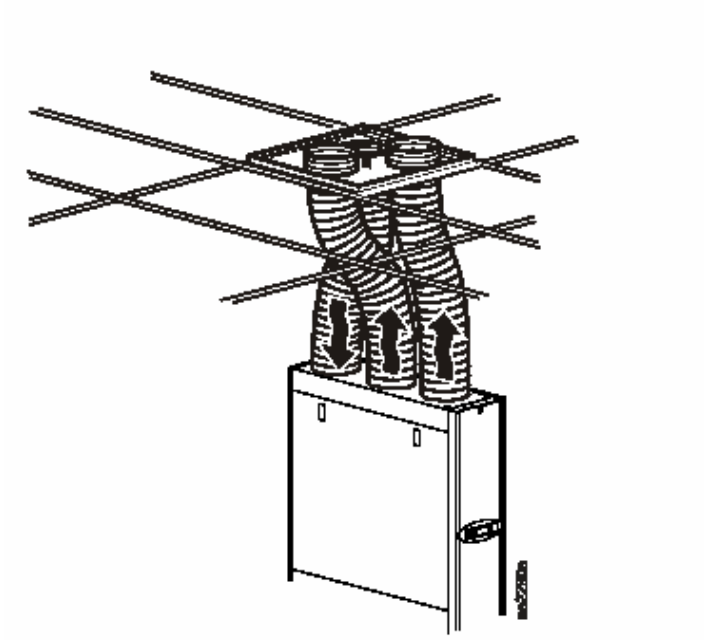
## Condenser Duct Considerations

The upper half of the InRow SC enclosure is the condenser section which connects to the plenum via the ducting kit. The plenum must provide an adequate volume of airflow, within a set temperature range, and be able to treat the heat rejected by the unit on a continuous (24x7) basis in order to ensure proper operation and prevent downtime. The maximum condenser airflow is 850 CFM (1440 $m^3$/hr) which requires the plenum to provide at least this much airflow to the condenser inlet and remove that much from the condenser discharge. The condenser must also receive air that is between 32 - 105 F (0 - 40 C), temperatures outside those limits will impact the unit performance and can cause the unit to shut down. Finally, the InRow SC total heat of rejection (not cooling capacity) can be up to 10 kW (34000 BTU/hr). The building comfort cooling system must be capable of removing this additional load. Consult with your engineer, mechanical contractor, or HVAC specialist to determine if

the building air conditioning system is capable of supporting this load. For additional details on the application of the SC condenser see Application Note #109.

The condenser ducting kit consists of three flexible tubes, each 6 foot (1.8m) long and 10" (254mm) in diameter, with a ceiling tile adapter. See **Figure 4** for an illustration of this. The ducting kit should be installed so that the tubes are as straight as possible; excessive bending can restrict the condenser airflow and will impact the unit performance. When planning the layout of the equipment racks and SC units the position of the SC relative to ceiling obstructions must be considered. Place the InRow SC so that the unit is not located under light fixtures, sprinkler heads, duct work from the building HVAC system and other objects that cannot be easily relocated.

*Figure 4 – InRow SC ducting kit*



## Containment Systems

The Rack Air Containment System (RACS) consists of a set of plenum sections that mount to APC NetShelter® SX 42U 600mm Enclosures and InRow SC units in various configurations to provide flexibility in deployment. It can be used for rear containment only or with front and rear containment. RACS should be used in conjunction with a SC unit when the limitations of the room prevent using a proper row layout or when the density of a rack prevents proper air capture. See **Figure 5** for an example of an InRow unit with front and rear containment.

The SC with RACS has a limited number of configurations that can be used. Careful attention to applying the SC with RACS must be undertaken to prevent the compressor from cycling off during low load conditions. If the compressor cycles off, there is a minimum off time delay period of 2-minutes where no cooling is provided and the desired rack inlet temperatures may be exceeded. It is therefore recommended that one carefully assess the minimum operating IT load that can be expected prior to operating the InRow SC within a RACS configuration. This can be accomplished by actually measuring the IT load while the system is in a state of low CPU utilization. Refer to Application Notes #90 and #114 for a thorough discussion on RACS usage.

*Figure 5 - Rack Air Containment System configured with InRow unit and NetShelter SX enclosure*

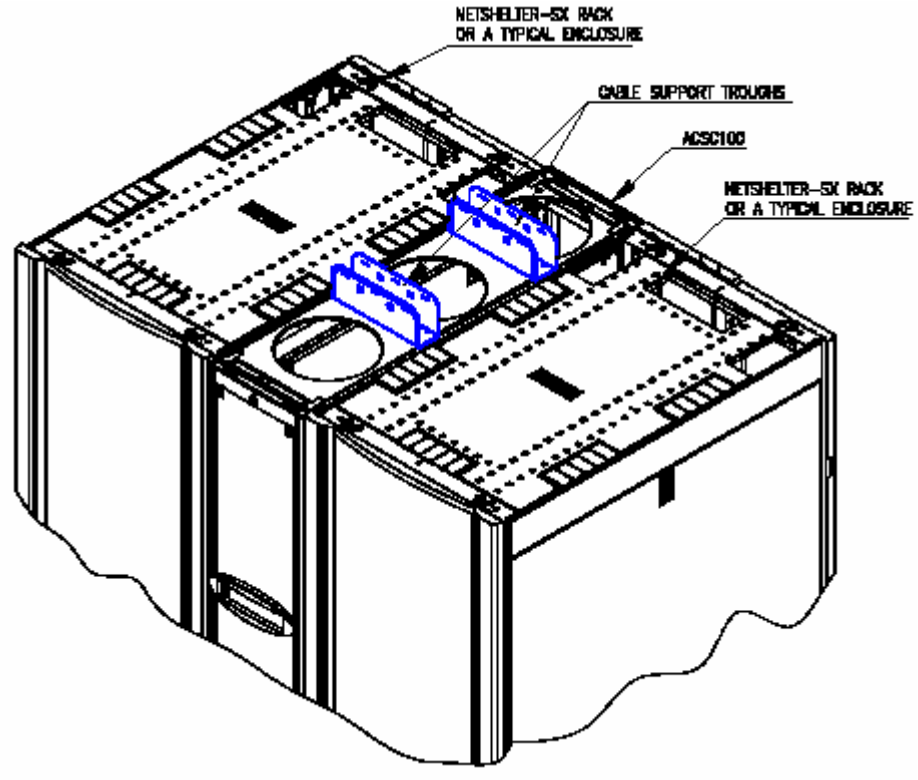
The Hot Aisle Containment System (HACS) is made up of a series for roof panels and door kits to accommodate a variety of configurations using APC racks, UPSs, and power distribution units. It is designed to enclose an entire hot aisle, not just the rear of a single row of racks. The roof panels of the HACS are not compatible with the condenser duct tubes for the InRow SC and therefore the SC and HACS cannot be used together.

# Overhead Cabling

The InRow SC has three condenser duct tubes connecting the top of the unit to the ceiling plenum, these tubes limit the amount of cabling that can be routed across the unit. It is recommended that the Cable Support Bridge Trough (ACAC10021) be used when routing cables over the SC, see **Figure 6** for a sample installation. The cable trough can be used by itself or in conjunction with data partitions (AR8162ABLK, etc.); it is compatible with power troughs (AR8160ABLK, etc.) when used in a "non-bridge" application only. See **Figure 7** for an example of this installation. The amount of cabling that the cable bridge can support will vary based on the exact type of cabling used. It is generally recommended that no more than approximately 80 CAT5 cables or 8 SO type cords be placed across the cable bridge. Rooms with raised floors can use under floor cable distribution to avoid this situation.

*Figure 6 – InRow SC with cable support bridge troughs and NetShelter SX enclosures*

*Figure 7 – InRow SC with cable support bridge troughs in "non-bridge" application*



# Configuration Type Selection

The InRow SC has three primary configuration types: Spot Cooling, In-row Cooling, and RACS mode. The best operating mode will depend on the intended application. See Application Note #113 for detailed information on the sequence of operations for each configuration.

The RACS mode should be used only when employing the SC in conjunction with the Rack Air Containment System. Regardless of physical arrangement, a minimum IT load of 3kW per SC should be maintained in order to prevent the compressor from cycling off and allowing the equipment inlet temperatures to rise to levels, or at rates, that are unacceptable. Maximum IT loads per unit should be as follows: 7kW for the ACSC100, 6.3kW for the ACSC101; these capacities are based on a return air temperature of 96 F db, 68 F wb (35.6 C db, 20 C wb). Refer to Application Note #114 for a thorough discussion on RACS usage.

Spot Cooling mode is appropriate for applications in small rooms with only a few racks. In this configuration type, the unit is focused on cooling the entire room, rather than a specific row. This configuration also has the choice of two capacity control modes: Discrete and Proportional. In the Proportional mode, the SC will modulate the evaporator fans and the hot gas bypass valve in order to best match the unit cooling capacity required; this typically reduces cycling of the compressor and can be better suited for rooms with variable IT loads and no external influences. In rooms where there are significant external influences, such as vents from a building HVAC system or frequent foot traffic into and out of the room, the fans may change speed frequently and be a nuisance to workers in the area. In these situations the Discrete mode may be more suitable as the unit maintains a fixed fan speed. Additionally, as the compressor cycles off more frequently in Discrete mode, the overall power consumption will be reduced. The downside of this however is the temperature in the room could fluctuate more than is desired as the compressor must observe a minimum off time. See the section below for a discussion on reducing compressor cycling.

The In-row configuration is intended for situations where one or more SC units are used in a row (or multiple rows) of equipment racks, typically with a center hot aisle. This application is more frequently seen in small data center and large server rooms, rather than the wiring closet environment. The SC unit(s) will attempt to control the temperature of the row, or a section of the row, rather than the entire room.

## Reducing compressor cycling

In lightly loaded situations there is a greater tendency for the compressor to cycle; this leads to less stable control of the environmental conditions in the room. To minimize this, the cooling and supply air set points can be adjusted. The SC uses the evaporator fans to regulate return air or rack inlet temperatures above the cooling set point in Spot Cooling Proportional and In-row modes respectively. The electronic hot gas bypass valve is used to regulate the supply air temperature according to the Supply Air set point. The default cooling set point is 72 F (22.2 C) in both modes, the default Supply Air set points are 57 F (13.9 C) and 64 F (17.8 C) respectively.

In Spot Proportional Mode, the 15 F (8.3 C) differential between the two set points typically results in continuous compressor operation when the heat load per SC unit is above 3.5 kW; when the load is less, the likelihood of compressor cycling increases. Lowering the Cooling set point will reduce the unit's cooling capacity; additionally, raising the Supply Air set point will cause the hot gas bypass valve to open sooner and further reduce the unit cooling capacity. With less unit capacity the compressor will run for longer periods of time. Suggested setting for low load conditions are: Cooling set point of 68 F (20 C) and Supply Air set point of 61 F (16.1 C). At a minimum the differential between the set points should always be 6 F (3.3 C) or greater.

For the In-row mode, the default settings are most effective at loads above 3.5kW per unit. In lighter load conditions, the same steps can be taken to reduce unit cooling capacity – reduce the Cooling set point and increase the Supply Air set point. One key difference however is that here the differential between set points is not important; in fact, the Supply Air set point can be higher than the Cooling set point. Suggested setting for low load conditions are: Cooling set point of 68 F (20 C) and Supply Air set point of 70 F (21.1 C).

If the IT equipment loads increase above 4 kW, regardless of the Configuration Type, it is recommended that the set points be changed back to the default settings.

## Sensor Placement

The SC comes equipped with a remote temperature probe; this is used to sense the temperature of the air inlet at the front of an adjacent rack. In In-Row Cooling mode, the unit attempts to maintain the measured Rack Inlet Air Temperature at the user-specified Cooling Set point. In order to get the most accurate temperature readings and appropriate amount of cooling for the adjacent rack the probe should be place in front of the warmest heat source in the rack that continuously draws intake air. Do not place the probe in front of a blanking panel or other device that does not move air. In situations were the all the rack mounted equipment is equally hot, position the probe approximately two thirds of the way up the front of the rack. In Spot Cooling and RACS modes, the remote temperature sensor can be used for monitoring purposes, but has no effect on the behavior of the unit.

## Powering the InRow SC

The SC comes equipped with a single power cord: NEMA L6-20P LCDI for ACSC100 and IEC309 16A for ACSC101. The unit allows for either a top connection or bottom connection of the cord, the unit cannot be hard wired. When using either connection the unit can be plugged into a receptacle on the wall or a PDU in an adjacent rack. When using the bottom connection it is also possible to connect to a receptacle on the floor or on the sub-floor when raised flooring is present. Users with overhead cable distribution will most likely find the top power connection more accessible. In most circumstances the InRow SC will be powered directly from the utility. For the LCDI corded ACSC100, a dedicated circuit is recommended for each

unit to minimize the potential for nuisance trips. The SC compressor has a significant in-rush current; this must be taken into account when making a UPS selection. For additional information on UPS sizing or generator selection for the SC, refer to Application Note #115.

## Condensate Management

The SC is designed to provide high sensible heat ratios and to minimize the production of condensate. In some operating environments however latent cooling will occur and the condensate must be managed. The unit comes equipped with a factory installed condensate pump. The pump can remove up to 1.3 gal/hr (5.9 l/hr) of condensate at 50 feet (15.2m) of total run, of that 16 feet (4.9m) can be vertical lift. Therefore if you had 10 feet of lift then you could have 40 feet of horizontal run. When determining the amount of vertical lift in the system, measure from the pump, not the top of the unit. The unit comes with 9' (2.75m) of 3/16" ID clear PVC tubing, additional tubing must be field provided. Condensate tubing should be routed in a manner that has the least numbers of bends to maximize flow rate and must end at a location that can receive any condensate that is discharged, such as the building DWV system, a floor drain, custodial sink or the outside environment.

## Conclusions

There are many different design options for today's wiring closets and server rooms. Deploying the InRow SC requires that some fundamental best practices are followed to ensure proper performance of the in-row cooling system. Proper unit placement, careful attention to the condenser requirements, cable routing and condensate management are all key elements to a successful installation. Adhering to the best practices outlined in this paper will ensure worry free operation while using the InfraStruXure InRow SC. While these guidelines will not lend themselves to all applications they should prove useful for the majority of situations.

### About the Author:

**David Roden** is the Product Manager for Small System Cooling at American Power Conversion (APC). Previously David was the Senior Applications Engineer for precision cooling solutions at APC, supporting data center projects worldwide. Prior to joining APC, David served as an officer in the United States Army. He received a Bachelors degree in mechanical engineering from Rensselaer Polytechnic Institute in Troy, NY and is a member of ASHRAE.