Using the Rack Air Containment System with 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 provides guidelines for using the Rack Air Containment System (RACS) with these units. Additional information regarding RACS with InRow units can be found in Application Note AN-90.

Introduction

The InfraStruXure InRow SC is an air cooled, self-contained, cooling-only air conditioner designed to be placed in-row, between equipment racks. The in-row design allows the SC to draw in air from the rear, capturing heat from the IT equipment in the hot aisle and neutralizing it before it mixes with the room air. Conditioned air is then discharged into the cold aisle, ready for immediate use by the equipment in the adjacent racks.

Figure 1 – InRow unit with RACS

The Rack Air Containment System (RACS) is a modular front and rear plenum for use in isolating the supply and return air between an APC Netshelter SX rack enclosure and an APC InRow cooling solution. The containment system is designed to create a separate environment for air distribution in order to prevent mixing of hot and cold air streams, resulting in a more predictable cooling pattern. The modular design and ability to retrofit to an existing Netshelter SX rack enables medium to high density racks to be cooled in an autonomous environment without overcooling the room mixed with lower density loads.

Rear containment only configurations capture the hot exhaust air in a plenum that is also connected to one or more in-row cooling unit. The in-row cooling units are designed to draw air in a back to front pattern. The warm air in the RACS plenum is drawn to the in-row cooling unit(s) where it is cooled and discharged out the front and back into the room at a room neutral temperature.

1

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Front and rear (full) containment configurations not only capture the hot exhaust air, but also the supply air from the in-row cooling unit, directing it to the IT equipment inlets in the adjacent rack(s). See **Figure 1** for a diagram that shows the airflow in a configuration that includes both front and rear containment.

There are limitations to the number of racks and cooling units that can be configured into a single RACS. 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 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. In situations where the minimum possible load must be known when the IT equipment is not already in place, contact the IT equipment manufacturer for details.

Capacity Limits and Room Conditions

As a general rule of thumb, the InRow SC can support loads from a minimum of 3kW per unit, up to a maximum of 7kW for the ACSC100 and 6.3kW for the ACSC101, when used with full containment. The upper and lower per unit limits will be affected by the choice of full or rear-only containment and by the normal ambient temperature within the room, which is the average temperature of the entire room during normal operating conditions. The maximum load supported represents the IT load in the rack, not the cooling capacity of the SC unit. Approximately 500 Watts of heat will escape because of air leakage from the RACS and conduction through the component enclosures. This loss is reflected in the lower unit cooling capacity at the rated conditions, as published in the **InRow SC Technical Data manual (990-8700)**.

Rear-Only Containment Systems

In configurations where only rear containment is used, the min and max heat loads are very dependant on the normal ambient room temperature. As the room temperature increases, the minimum load requirement decreases, as does the maximum load limit. For example, if a server room is normally 72 F (22.2 C) then the minimum load requirement is only 1.25kW. Additionally, the maximum load limit also falls, to 6.0kW for the ACSC100 and 5.4kW for the ACSC101. See **Figures 2 and 3** for charts that show the relationship between room temperature and heat load limits. Minimum heat load requirements are not changed between ACSC100 and ACSC101; only maximum heat load limitations are impacted.

Full Containment Systems

Configurations that include both front and rear containment are less dependent on the ambient room temperature. For rooms with average temperatures in the range of 69 – 75 F (20.6 – 23.9 C) the recommended minimum load is 3kW and the maximum limit is 7kW for the ACSC100 and 6.3kW for the ACSC101. In rooms where the normal ambient falls above or below this range, the heat load minimum and maximum limitations would change in a similar manner to the rear-only containment configurations.

2

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Figure 2 – Minimum Heat Load versus Room Temperature – Rear Containment Only

Room Temperature vs Min Heat Load
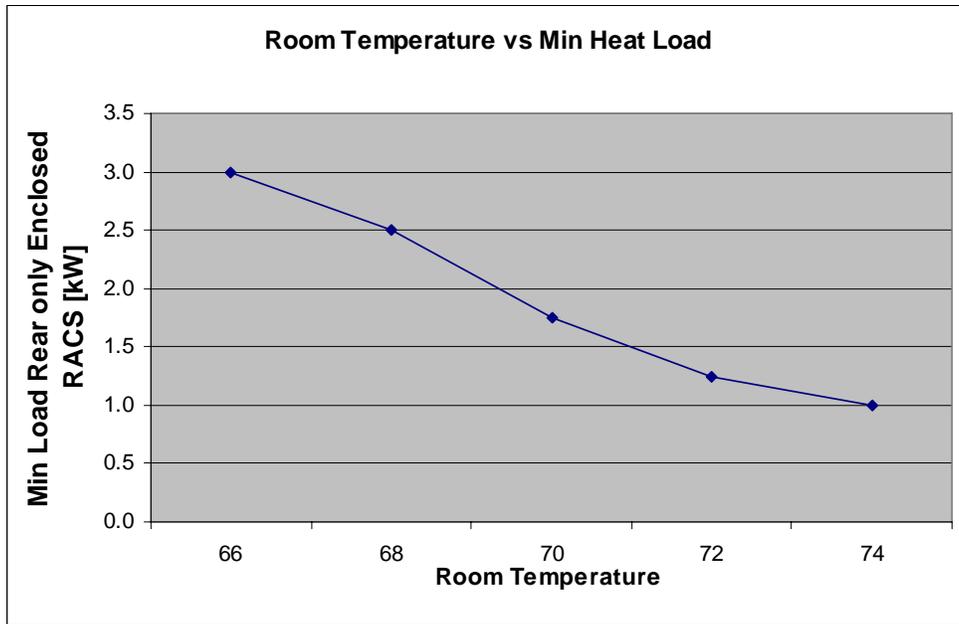
Figure 3 – Maximum Heat Load versus Room Temperature – Rear Containment Only

Room Temperature vs Max Heat Load

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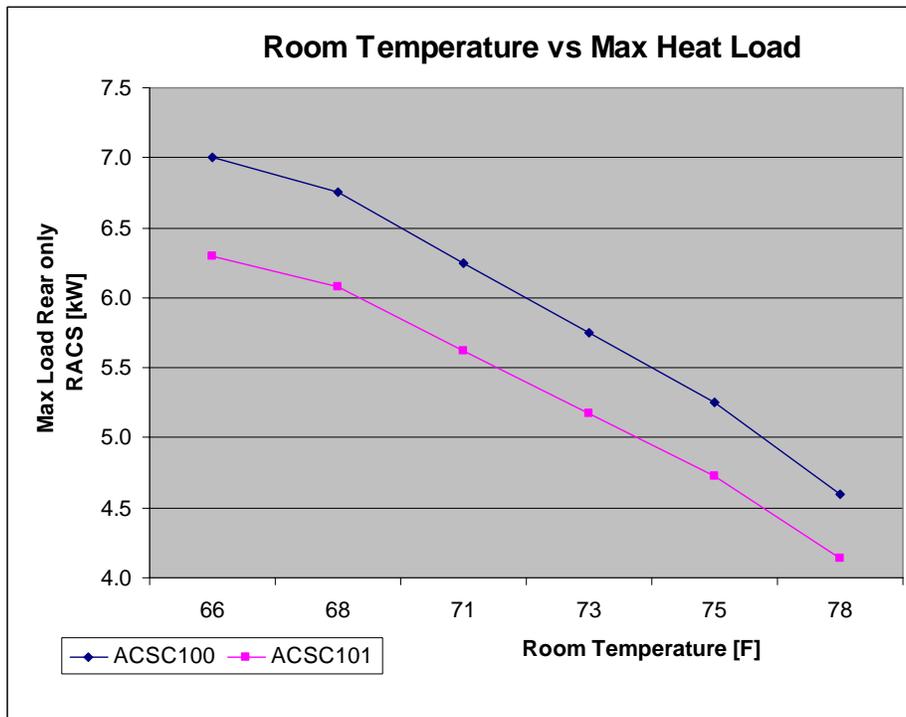
Available Configurations

A limited number of configurations are possible to suit customer needs. Combinations allowed include, 1 SX rack with 1 SC unit, 2 SX racks with 1 SC unit, and 1 SX rack with 2 SC units. See **Figure 4** below. In any of these configurations the capacity limitations per SC unit must be met. Given the number of racks with associated heat loads, we can determine if the SC unit (or units) can adequately cool the load in a particular room. See the example below.

2 NetShelter SX enclosures with 2kW heat load each
**1 InfraStruXure InRow SC unit**
Rear containment only
Ambient room temperature 72 F (22.2C)

The total heat load is 4kW, which corresponds to 4kW per SC unit since there is only one. Referring to the charts we see that for this average room temperature we need a minimum heat load of 1.25kW and a maximum of 6.0kW per SC unit. Therefore, this configuration is viable based on the capacity limitations.

Configurations other than those specified here should not be attempted. They have not been validated by Engineering and undesirable behavior may result.

Figure 4 – Available Configurations of InRow SC and RACS
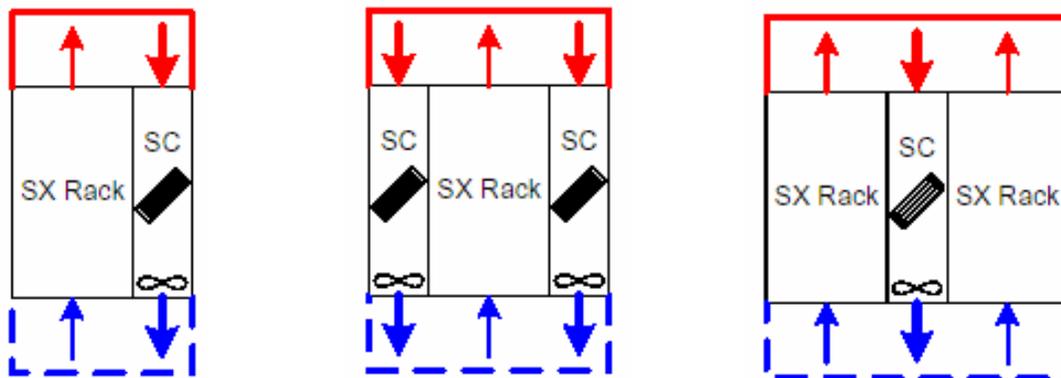
Component Selection

There are several components that can be used for a RACS configuration. See **Application Note AN-90** for a list of SKUs and descriptions. The exact configuration of the SC with RACS system will determine the quantities of each component required. For example, when using rear containment only a rear assembly will be required for each rack and SX unit, also one set of end

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caps will be required. The end cap SKU contains a pair of air blocks to terminate both open ends of either a front or rear plenum section. Using front containment as well will necessitate the addition of a front assembly for each rack and SC unit, as well as another set of end caps.

The example below demonstrates how to select the bill of material (BOM) for a SC with RACS configuration. Using **Figure 5** as our intended configuration we will select the RACS components required. The system consists of two InRow SC units and one NetShelter SX rack with rear containment only. For this example we select a rear containment assembly for each SC and the rack, as well as one set of end caps. See **Table 1** for a summary of the BOM. A second example assumes one SC unit with one rack and full containment. **See Figure 6**, the BOM for this example is also summarized in **Table 1**.

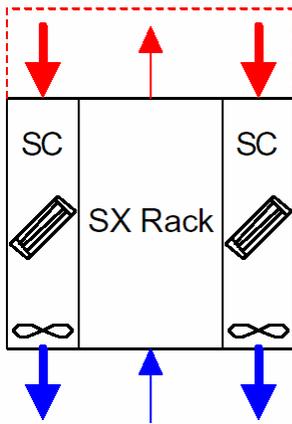*Figure 5* –*Two InRow SC units and one NetShelter SX rack with rear-only containment*

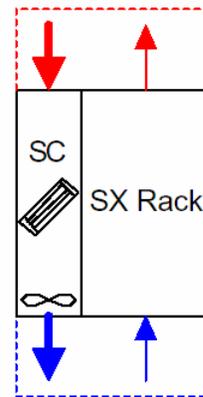*Figure 6* – *InRow SC unit and NetShelter SX rack with front and rear containment*

Table 1 – Summary of BOMs for SC with RACS examples

Configuration	Quantity	SKU	Description
Figure 2	2	ACCS1000	Rear Assembly for InRow RC/InRow SC
	1	ACCS1001	Rear Assembly for NetShelter SX 42U 600mm Wide
	1	ACCS1002	Rack Air Containment End Caps
Figure 3	1	ACCS1000	Rear Assembly for InRow RC/InRow SC
	1	ACCS1001	Rear Assembly for NetShelter SX 42U 600mm Wide
	2	ACCS1002	Rack Air Containment End Caps
	1	ACCS1003	Front Assembly for InRow RC/InRow SC
	1	ACCS1005	Front Assembly for NetShelter SX 42U 600mm Wide

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Operating Modes

When using the Rack Air Containment System with the InRow SC, either with full containment or rear-only containment, the user should select the RACS configuration type. Refer to **Application Note AN-113** for a thorough discussion on the sequence of operations and configuration types for the InRow SC unit. Using the Spot Cool or In-row configuration type could result in undesirable behavior.

Currently the SC does not provide any group control feature. In the configuration that includes two InRow SC units, both need to be operating at all times; they will not operate in a lead-lag manner.

Harsh Environments

The Rack Air Containment System is not designed to protect the SC unit, or the IT equipment from environmental hazards. This includes, but is not limited to: dust, dirt, sprayed or dripping water, moisture and corrosive or combustible vapors. If the SC and RACS are used in these, or any similar environments, the unit warranties will be voided.

Conclusions

The Rack Air Containment System provides added flexibility, efficiency and higher density capabilities for the InRow SC. Multiple configurations of SC units and RACS components are available to satisfy customer needs and with careful planning the installations and operation can be trouble free. For all configurations it is important to carefully consider the minimal and maximize loads that each SC unit will see during operations. During light load conditions, if the minimum load requirement is not observed, the compressor will cycle off. There is a minimum off time period of 2-minutes where no cooling is provided and the desired rack inlet temperatures may be exceeded.

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.

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