VERTIV APPLICATION PAPER

Thermal Management Solutions for Small Technological Rooms

V/TM-127

Abstract:

Ensuring efficient operation without compromising reliability is essential to operational success in achieving business continuity. Unfortunately, owing to multiple factors like rapid and anticipated growth in infrastructure and misinformation about the cooling requirements of sensitive electronic equipment - some data center professionals, particularly managers of small remote facilities, are not pondering adequate attention to their small technological room infrastructure system design.

Many critical infrastructure managers end up using comfort cooling solutions in small technological rooms to meet their environmental control needs. At first glance, these systems may seem simple and economically beneficial. However, as they are not designed to meet the unique needs of critical IT equipment, reliance on comfort cooling systems can increase the risk of premature system failures, and can also grossly result in inflated operating costs.

This application note leans towards the possibility and implementation of thermal management solutions for these small technological rooms. Another aspect is the way thermal management solutions deliver those essential needs.

Introduction:

In small or remote critical facilities, essential equipment for a reliable operation is frequently overlooked in favor of other aspects of the planning process. However, achieving critical continuity is dependent on power and environmental support systems as advanced networking equipment. The high sensitivity of electronic components in data center and networking environments means that temperature, humidity, air movement, and air cleanliness must be kept consistent and within specific limits to prevent untimely equipment failures and costly downtime.

Thermal Management systems unlike comfort air conditioners such as window/split/package type comfort AC are specifically engineered for facilities that require year-round constant cooling, precise humidity control, and a higher cooling capacity per square foot.

In this application note, we shall put some light on optimum thermal management solutions in small technological rooms mentioning challenges, prerequisite parameters, and Vertiv's solution. A detailed competitive study between critical thermal management and comfort solutions are explained in the paper.

General Condition:

Technology rooms produce an unusual, concentrated heat load and are very sensitive to changes in temperature and humidity. For such equipment rooms, temperature and/or humidity swings can produce many problems as well as a complete system shutdown. These problems depending on the length of interruption and the value of time & data loss will have a massive impact on the costs for the organization. Standard comfort air conditioning is not designed to handle the heat load profile of critical purpose areas, nor is it designed to provide the precise temperature and humidity set point required for these applications. Precision air conditioning systems are designed for close temperature and humidity control. They provide high reliability for year-round operation, with the ease of service, system flexibility, and redundancy necessary to keep critical applications running 24 hours a day.

Here, we shall discuss various applications where small technological rooms are involved and that can be served better by Liebert thermal management products and solutions.

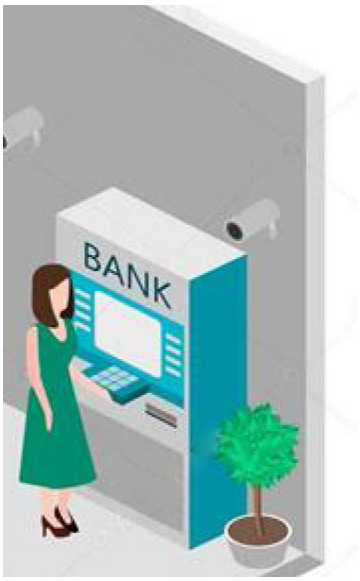
While comfort cooling systems are appropriate for "comfort" environments - such as facilities occupied by people or that house routine equipment and supplies - they are not well-suited for environments that require precise temperature, humidity, and air quality regulation.

A summarized table convey the situation as hereunder:

Parameter	Technological Room	Comfort Application
Sensible Heat Ratio	0.9 to 1	0.65 to 0.7
Temperature Control	+/- 1 °C	+/- 3 °C
Humidity Control	+/- 5%	<60%
Operating Hours	8760 hrs/Yr	2000 hrs/Yr
Air Movement	930-1020 CFM/TR	595-680 CFM/TR
Filtration Efficiency	>85%	65%

1. Small Technological Rooms (UPS & Battery Room, ATMs, and IT Rooms):

- Every mid-size organization nowadays has a small IT facility that comprises servers and a networking setup placed in rack/s. These facilities also have hardware rooms that contain secondary power equipment such as UPS, batteries, and inverter.
- Not only IT infrastructure, but any industry does have secondary power back up equipment room which comprises UPS, electrical panel room, batteries, inverter, etc.
- Another example of a small equipment room is ATM. 24x7 based critical cooling is a prime requirement for ATM service.



Application Area & Cooling Requirement

Application Area	Load Profile	Prerequisite Parameter	Cooling Need of the Application Area Segment Wise				
			Reliability (24X7)	Temp. Control	Humidity Control	Power Saving	Air Quality
Small Server Room, UPS Room, ATM Rooms	>90% sensible load due to servers, automated equipment, machine heat load, heat dissipation by equipment and very minimal latent load due to limited manpower presence	Generally, 24+/-1 ºC with less than 60% RH and high efficiency filtration					

High Moderate Low

Challenges & Constraints:

- Due to the misconceptions (related to precision air cooling units), most of the facility managers use traditional comfort units; however, these units are incapable of supporting the high sensible load.
- Deployment of comfort units leads to the removal of a high amount of sensible load simultaneously injecting an extra amount of latent heat which needs to be removed by deploying a standalone dehumidifier. It results in unorganized and frail system architecture and escalates the TCO.
- Continuous duty cycle is imperative for the success of the mentioned services and therefore, uptime of power and cooling services are the crucial factors in operations.

Vertiv Solutions:

Application Area	Cooling Load (Approx.)	Recommended Type of Cooling Unit
Small Server/IT Room	Typical 2 to 7 TR	Small DX solution. Both SRC-G (wall mounted) and Liebert DM; for frontal flow configuration Liebert DM is the best choice.
UPS Room & Battery Room	3~10 TR depends on sizes of UPS	Wall mounted Precision AC solution is preferred due to space crunch in the said room; SRC-G wall mounted & ceiling mounted configuration are good to go; also, Liebert DM can be a good solution, if space is available.
ATM Room	1.5~3 TR	Wall mounted Precision AC solution is preferred; SRC-G is the best suit.

Note1:

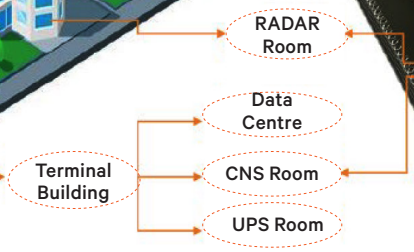
- Vertiv thermal management solution comes with an energy-efficient refrigerant (R410A) and the latest compressor technology.
- Depending on the criticality of the above sites, N+1 configuration is offered unlike comfort AC offers N+N solution as those is only capable to run 12 hours/day, whereas said application demands 24 hours/day throughout the year.
- Liebert DM series is available (in 7 to 27 kW; in greater India region, for 22 & 27 kW capacity & configuration, please contact the Vertiv local representative); SRC-G is now available up to 11 kW, and higher models (mainly ceiling suspended models) will be launched soon.

2. Aviation Industry:

- Growing demand, policy support, and increasing investment are growth drivers in the aviation industry.
- Key areas of precision cooling requirement in airports are the radar room, data center, CNS room, and UPS room.
- CNS room & UPS room are ideal for small critical room cooling applications. CNS room is a communication, navigation, and surveillance room located outside of airports that need 24x7 based cooling to reduce failure of equipment due to high temperature.

Airport

Telecommunication/Aviation RADAR



Application Area & Cooling Requirement

Application Area	Load Profile	Prerequisite Parameter	Cooling Need of the Application Area Segment Wise				
			Reliability (24X7)	Temp. Control	Humidity Control	Power Saving	Air Quality
CNS Room	>90% sensible load due to critical equipment, machine heat load, high temperature due to heat dissipation by equipment and very minimal latent load due to limited manpower presence	Generally, 24+/-1 °C with less than 55% RH and high efficiency filtration					
UPS Room	>95% sensible load due to only equipment heat load gain and need higher air volume to remove heat	Generally, 25+/-1 °C with less than 60% RH and high efficiency filtration					

High *Moderate* *Low*

Challenges & Constraints:

- These application needs year around continuous cooling support to reduce equipment failure and fail-safe operation.
- Deployment of comfort units leads to removal of a high amount of sensible load simultaneously injecting an extra amount of latent heat which needs to be removed by deploying a standalone dehumidifier. It results in an unorganized and frail system architecture and escalates the TCO.
- Due to limited space in small equipment rooms (UPS and CNS) wall mounted/ceiling mounted or very compact Precision AC is required.

Vertiv Solutions:

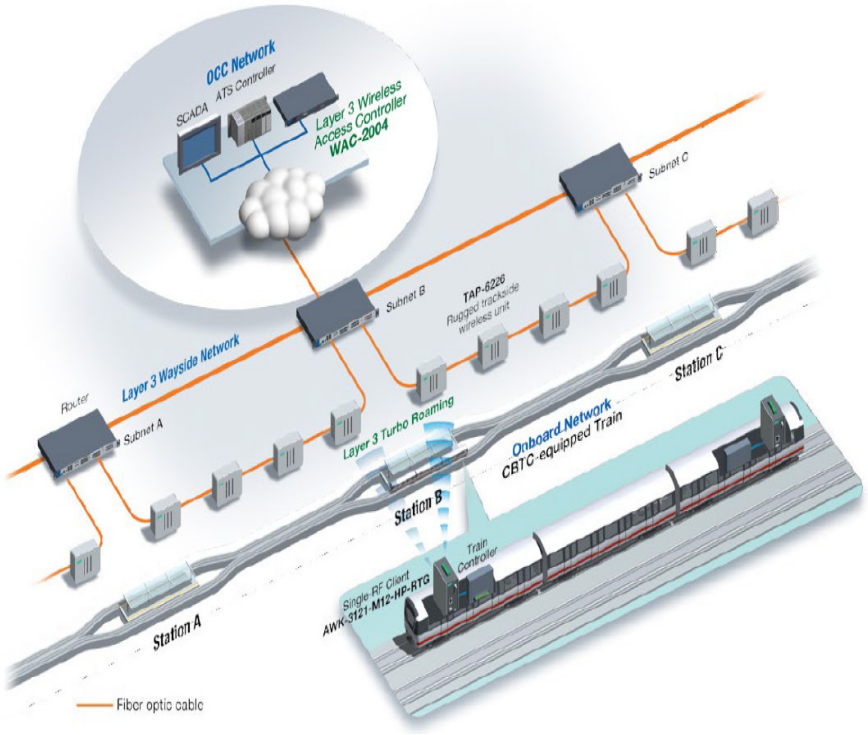
Application Area	Cooling Load (Approx.)	Recommended Type of Cooling Unit
CNS Room	Typical 6 to 12 TR	Multiple small DX solution. Liebert DM is the best suit. Frontal down & up-flow are the right configurations. Ideally large capacity of Liebert DM is the solution.
UPS Room & Battery Room	5~10 TR depend on sizes of UPS	Multiple wall mounted Precision AC solution is preferred due to space crunch in the said room; SRC-G wall mounted & ceiling mounted configuration are good to go; also, Liebert DM can be a good solution, if space is available and cooling load is more.

Note2:

- Kindly refer to all pointers of Note1.
- CNS room is like equipment/instrument rooms that produce sensible load only. Considering cooling load, medium size Precision cooling unit such as Liebert DM is an ideal solution.
- In UPS & battery room, a metallic body-based SRC-G unit is a better choice than a plastic body-based comfort AC to avoid fire and temperature hazards.

3. Railways Transportation:

- With the advent of swift urbanization, transit systems play a vital role as they provide mobility, flexibility, and accessibility to the population.
- Be it a smart ticketing system, tracking & signaling system, remote monitoring, or mass data capture, Mission-Critical Continuity is the most important factor.
- Control rooms, UPS room, Telecom room, & Signaling room are ideal for small critical room cooling applications. Modern railway systems use an Automatic Train Control system, which essentially boils down to a Communication based Train Control (CTBC) system for signaling and train control. CTBC is ushering in a new era of rail transit control, with advanced flexibility and reduced serviceability costs, not to forget effective interoperability. The control room is in each station and supervised by the OCC.



Every station has a control room. This particular room hosts an array of optical fiber-based network devices which works in sync with the OCC (as shown in the Figure above).

Application Area & Cooling Requirement

Application Area	Load Profile	Prerequisite Parameter	Cooling Need of the Application Area Segment Wise				
			Reliability (24X7)	Temp. Control	Humidity Control	Power Saving	Air Quality
Signaling Room	>90% sensible load, Avg heat load approx. 14~20 kW	Generally, 24+/-1 °C with less than 55% RH and high efficiency filtration	High	High	Moderate	High	Moderate
UPS Room	>95% sensible load due to only equipment heat load gain and need higher air volume to remove heat	Generally, 25+/-1 °C with less than 60% RH and high efficiency filtration	High	High	Moderate	High	High
Control Equipment Room	Sensible load application but very compact room	Wall mounted Precision AC and 25+/-1 °C with less than 60% RH	High	High	Moderate	High	Moderate

High Moderate Low

Challenges & Constraints:

- These application needs years around continuous cooling support and almost standalone units are preferred due to less space. So, the reliable cooling solution is a prime selection factor.
- Deployment of comfort units leads to removal of a high amount of sensible load simultaneously injecting an extra amount of latent heat which needs to be removed by deploying a standalone dehumidifier. It results in unorganized and frail system architecture and escalates the TCO.

Vertiv Solutions:

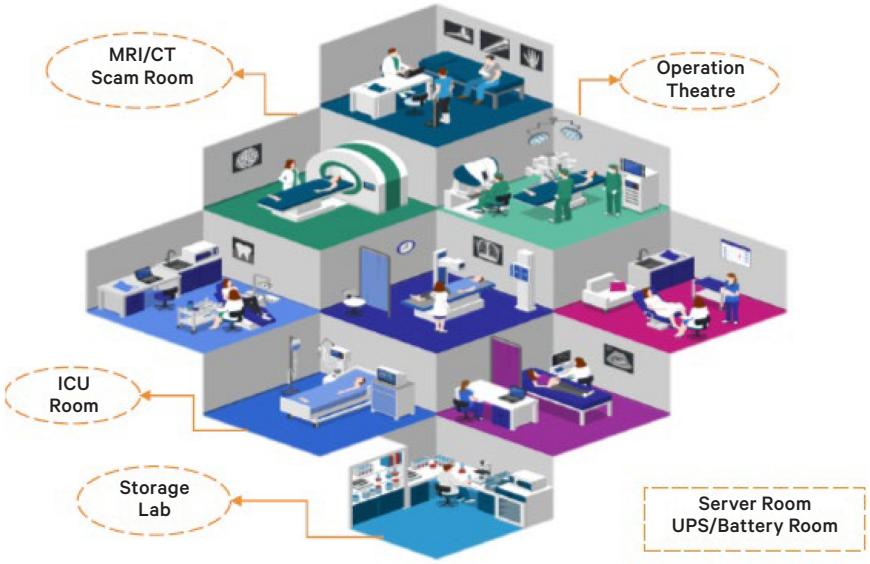
Application Area	Cooling load (Approx.)	Recommended Type of Cooling Unit
Control Equipment Room	Typical 4 to 8 TR	Small DX solution like Liebert DM is the best suit. Frontal down & up-flow are the right configurations. Ideally >15 kW of Liebert DM is the solution.
UPS Room & Battery Room	5~10 TR depends on sizes of UPS	Multiple wall mounted Precision AC solution is preferred; SRC-G wall mounted & ceiling mounted configuration are good to go; also, Liebert DM is applicable for cooling more load and is available in compact footprint.

Note3:

- Kindly refer to all pointers of Note1.
- Control room is used to produce sensible load only. Considering cooling load, medium size Precision cooling unit such as Liebert DM is an ideal solution. Apart from temperature control and 24x7 operation, BMS integration is another aspect to look into. It is very much possible with Vertiv thermal management solution.

4. Healthcare:

- The share of healthcare in GDP is expected to rise 9.7% by 2027.
- Some areas in healthcare applications are semi-critical, but there are areas that requires mission critical cooling.
- MRI/CT scan room, Storage area, small server room, ICU, OT, UPS/Electrical rooms, etc. are potential areas where machine cooling plays an important role, but small room cooling (critical) are applicable only in a few.



Application Area & Cooling Requirement

Application Area	Load Profile	Prerequisite Parameter	Cooling Need of the Application Area Segment Wise				
			Reliability (24X7)	Temp. Control	Humidity Control	Power Saving	Air Quality
MRI/CT Scan	To maintain temperature of helium & superconductive magnetic coil to be cooled	Generally, 21+/-1 °C with less than 55%+/-5% RH and high efficiency filtration	●	●	●	●	●
UPS Room	>95% sensible load and continuous cooling required; uninterrupted power is essential for medical equipment & setup	Generally, 25+/-1 °C with less than 60% RH and high efficiency filtration	●	●	●	●	●
Small Server Room	Sensible load application but very compact room	Wall mounted Precision AC and 25+/-1 °C with less than 60% RH	●	●	●	●	●
Storage/ Cath Lab	Equipment generates dry heat	12~17 kW avg heat load; 21+/-1 °C with less than 60% RH	●	●	●	●	●

● *High* ● *Moderate* ● *Low*

Challenges & Constraints:

- Healthcare infrastructure, surrounded by a control and equipment room, needs sensible cooling.
- The special comfort system supports the application but does not provide facilities like precise control. If the facilities are provided externally, the entire system architecture becomes extremely complex.
- These application needs year around continuous cooling support and almost standalone units are preferred due to less space. So, the reliable cooling solution is a prime selection factor.

Vertiv Solutions:

Application Area	Cooling Load (Approx.)	Recommended Type of Cooling Unit
MRI/CT Scan Room	Typical 4 to 8 TR	MRI machine is cooled by a small chiller. Inside MRI room and adjoining equipment rooms frontal up-flow precision AC are required for cooling; the mission-critical unit should have heater and humidifier for precise control; Liebert DM is the best suit.
UPS Room & Battery Room	4~8 TR depends on sizes of UPS & heat dissipation	Multiple wall mounted Precision AC solution is preferred; SRC-G wall mounted & ceiling mounted configuration are good to go; N+1 configuration to be chosen for uptime solution.
Small Server Room	Typical 2 to 5 TR	Small DX solution. SRC-G (wall mounted).

Note4:

- Kindly refer to all pointers of Note1.
- MRI, CT room, and Storage room are very critical rooms in the healthcare segment. Apart from sensible cooling on a 24x7 basis, precision control of the inside environment, and air filtration is one of the very important factors. Unlike the comfort cooling unit, Vertiv's small cooling system does have a MERV8 filter as standard, and it can be upgraded based on request.
- Both Liebert DM and Liebert SRC-G are effective small critical room cooling units; but for small room like battery room and small IT room wall mounted precision unit (Liebert SRC-G) is more suitable.

5. Power Plant

Multiple sub-segments such as Thermal-based power, Hydro-based power, and Renewable power exist in power plants. The control room is the backbone of any power plant as it helps monitor hundreds of critical parameters and also commands the process flow in a certain hierarchy.

Following are the sub-segments where small but critical thermal management solutions are deployed:

- ESP & small VFD Control Room
- Ash Handling Control Room
- DM Plant Control Room
- CHP Control Room
- Control Room for Power Transmission

Load Profile: More than 95% of the load comprises sensible heat generated by electro-mechanical/electronic equipment and systems. Latent load is limited to a minimum due to the presence of personnel.

Challenges:

- Though the cooling units must be fully functional 24x7 perennially, comfort conventional cooling systems can run for 12 hours at a stretch.
- Heat removal rate should be equivalent to the heat generation rate.
- Optimum control on the moisture content to avoid malfunctioning of electronic components.

Prerequisite Parameter: High SHR (>0.8) along with temperature and humidity control, high filtration level, and round-the-clock operations.

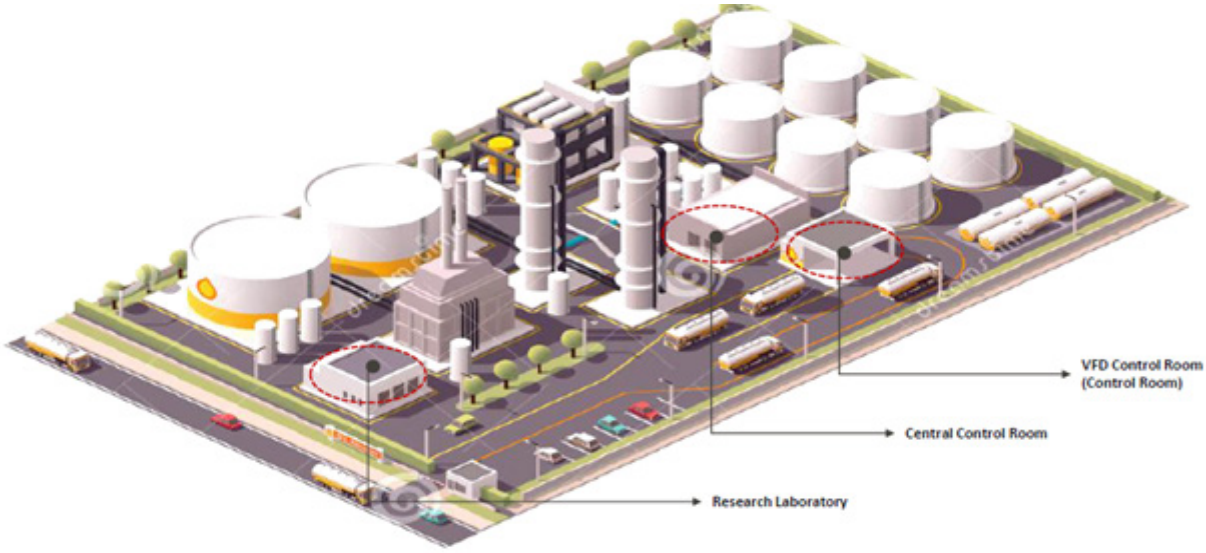
Load Profile: More than 95% of the load comprises sensible heat generated by electro-mechanical/electronic equipment and systems. Latent load is limited to a minimum due to the presence of personnel.

Vertiv Solutions:

- Liebert's cooling units are fully functional throughout the year and have a higher degree of availability compared to the traditional cooling units which can work at a maximum of 12 hours per day.
- The unit delivers more than 900 CMH/TR thereby removing the heat faster than common comfort cooling units.
- Vertiv introduces a small critical room cooling solution with Liebert SRC-G and Liebert DM. Both series do have extensive capacity ranges and are capable to handle sensible load operation years around 24x7 basis. Both series are available with energy-efficient refrigerant i.e., R410A, the latest compressor technology and energy-efficient fan technology.
- Except for very small control rooms such as 10~15 kW heat load; Liebert DM is the best option for all control room applications.

6. Oil & Gas (Refinery)

- Growing energy demand in all major & medium cities, policy support, and strong investments are growth drivers in the refinery industry.
- Key areas of small & medium sized precision cooling requirements in refineries are UPS & battery rooms, EPBAX room, small control room, IT room, and DCS room.
- Above mentioned applications are located at Admin buildings as support blocks of refineries but these are nerves of the entire system. These rooms need 24x7 based cooling to maintain uninterrupted operation and the best uptime.



Application Area & Cooling Requirement

Application Area	Load Profile	Prerequisite Parameter	Cooling Need of the Application Area Segment Wise				
			Reliability (24X7)	Temp. Control	Humidity Control	Power Saving	Air Quality
Control Room & VFD Room	>90% sensible load due to critical equipment, machine heat load, high temperature due to heat dissipation by equipment	Generally, 25+/-1 °C with less than 60% RH and high efficiency filtration					
UPS Room, IT Room, EPBAX Room	>95% sensible load due to only equipment heat load gain and need higher air volume to remove heat	Generally, 25+/-1 °C with less than 60% RH and high efficiency filtration					

High *Moderate* *Low*

Challenges:

- These application needs year around continuous cooling support to reduce equipment failure and fail-safe operation.
- Deployment of comfort units leads to removal of a high amount of sensible load simultaneously injecting an extra amount of latent heat which needs to be removed by deploying a standalone dehumidifier. It results in unorganized and frail system architecture and escalates the TCO.

Vertiv Solutions:

Application Area	Cooling Load (Approx.)	Recommended Type of Cooling Unit
Control Room & VFD Room	Typical 6 to 10 TR	Frontal bottom & top flow-based Liebert DM is good solution. Along with 24x7 continuous cooling, less no of floor standing units, energy efficient refrigerant, BMS compatibility are provided by Liebert DM units.
UPS Room & Battery Room, EPBAX Room	4 ~ 8 TR depends on sizes of UPS & heat dissipation	Multiple wall-mounted Precision AC solutions are preferred; SRC-G wall mounted & ceiling mounted configurations are good to go; N+1 configuration to be chosen for uptime solution.
Small Server Room	Typical 2 to 5 TR	Small DX solution. SRC-G (wall mounted).

Note5:

- Kindly refer to all pointers of Note1.
- Control rooms and EPBAX rooms are very critical rooms in the refinery segment. Apart from sensible cooling of 24x7 basis, precision control of the inside environment, and air filtration is one of the very important factors.
- Both Liebert DM & Liebert SRC-G are effective small critical room cooling units; but for a small rooms like battery room and small IT room wall-mounted precision unit (Liebert SRC-G) is more suitable.

ROI Calculation

Although initial equipment costs may favor comfort cooling units, it is not a feasible solution for precision cooling needs in the long run. However, Liebert Thermal Management solutions not only provide optimal overall cooling but are also highly economical when energy costs and service life of the equipment are considered making them a vital cog in the wheel from the user perspective. Due to basic engineering, design, and varied equipment, only the operation expenditure will be evaluated without including the capex element The following example depicts the operating cost comparison between the two approaches:

Room conditions – 24 °C, 50% relative humidity

Compressor motors and fans – 90% efficient

Electricity costs – $0.15 kW/h

Liebert Thermal Management unit – SHR of 0.90; comfort system – SHR of 0.70

Sensible Cooling required: 6.3 kW

Operation Analysis for one year		
Parameter	**Liebert SRC-G (7 kW Capacity)**	**Comfort Air Cooling (10 kW Capacity)**
Sensible Cooling Capacity (kW)	6.3	6.3
Total Cooling Capacity (kW)	7 (6.3 Sensible + 0.7 Latent)	9.7 (6.3 Sensible + 3.4 Latent)
Unit EER	3	3
Input Power (kW)	7/3 = 2.3	9.7/3 = 3.23
Total Input Power (kW)	2.3	3.23
Cost/yr @ $0.15/kW-hr	2.3 kW X $ 0.15/kW-hr x 8760 hr -$ 3,022	3.23 kW X $ 0.15/kW-hr x 8760 hr -$ 4,244
Savings = $ 1,222 by Liebert SRC Unit		

Key Features and Benefits of Liebert DM

- **Capacity:** 7, 12, 17, 22, 27 kW (in greater India region, for 22 & 27 kW capacity & configuration, please contact the Vertiv local representative)
- **All five models come in the same platform**
- **Applicable for small technological room applications**
- Highly Efficient refrigerant (R410A) is now a standard offering (for refrigerant option, in greater India region please check with the Vertiv local representative)
- **More variants are available i.e., downflow & up-flow**
- Scroll compressor
- **User-friendly controller & 7” touch screen**
- Metallic construction structure
- Evaporator cooling coils with hydrophilic coated
- Direct driven centrifugal fan is standard; EC fan is offered on request (for 7 & 12 kW)
- **Easy maintenance – easy access from front & side**
- Heater & Humidifier are in-built options that can be offered

- Water-cooled version, water leak detector, energy-saving card, etc can be offered on request
- Washable Nylon filters are being offered.

Key Features and Benefits of Liebert SRC-G

- Higher airflow > 255 CMH/kW
- Liebert SRC uses an environment-friendly refrigerant (R410A)
- High sensible cooling ensuring SHR > 0.9
- Can sustain high ambient temperatures of up to 48 °C
- Metallic structure provides rigidity and longevity
- Energy-efficient 'EC fans' for much lower power consumption
- Advanced 'Controller' with a completely user-friendly interface
- Configured with an RS485, using MODBUS-RTU communication protocol up to 8 units are interlinked for a synchronized operation in sequencing & standby modes
- Equipped with a highly efficient compressor (Scroll for 7 & 11 kW & Rotary for 3 kW)
- Liebert SRC series comes in a range of 3 kW (1 Ph), 7 kW (1 Ph & 3 Ph), and 11 kW (3 Ph) (all are CE certified & higher capacity models will be available soon)
- Robust design.

Conclusion

Business-critical technological rooms have unique environmental requirements and, as a result, necessitate cooling systems that can match these requirements. Liebert SRC-G & Liebert DM support all typical IT & small industrial applications namely comprising of 2-5 racks with a capacity of 1 kW/rack to 3 kW/rack. Such applications are widely deployed in Banks, Healthcare, Government Institutes, Energy Sector, and Transportation Segments. Apart from detailed applications mentioned in this paper, there are many other domains such as Steel plant, textile industry, laser cutting tool room, rubber industries, food & beverages, etc. where small critical room cooling plays a pivotal role. Over and above, Liebert SRC-G & DM are also suitable for UPS and Battery room (in every industry & domain) which is essentially established as a power backup solution for the above-stated business segments.

Vertiv thermal management solution truly provides all critical segments with an end-to-end wise cooling solution. Vertiv does have numerous solutions for medium & large data centers, both in DX & CW mode. Also, for high computing & high density, Vertiv offers XD solution, row-based solution, and even innovative liquid cooling solution. But while it comes to very small critical rooms which are the backbone of the entire mission-critical system, Vertiv acts as the true architect of continuity and offers a handful of small room cooling solutions.

Vertiv.com | **Asia Pacific**