EXAIR® WHITE PAPER

Total Cost of Ownership Comparison of Popular Electronic Enclosure Coolers.

Home of Intelligent Compressed Air® Products

Read this white paper to:

Gain an understanding of the differences between common industrial cooling methods

Determine your best solution based on key factors

Which cooling solution is best for your company and your electronics?

The costs associated with down time and repairs on sensitive electronics that fail due to heat or environmental contaminants, is an unnecessary burden. There are various methods used in industry to dissipate heat loads within an electrical cabinet. Knowing the best option to handle difficult environments, while offering a low total cost of ownership and optimal functionality, will help keep production running while saving money.

EXAIR has engineered a solution that will work in every environment and save you time and money. Read on to see how an EXAIR Cabinet Cooler® System beats the alternatives when comparing purchase cost, installation time, maintenance, and operation cost.

Sources of Heat

There are two main heat sources that add up to make the total heat load:

1) **What is inside the cabinet and**
2) **The environment surrounding the cabinet.**

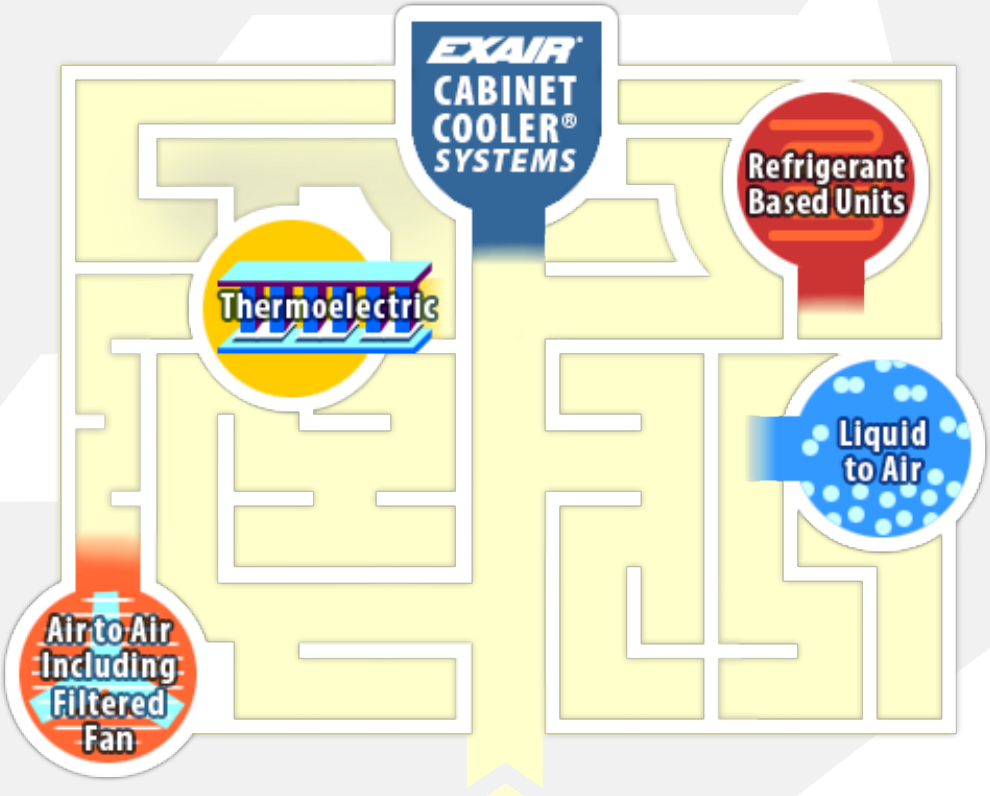
Internal Heat sources such as AC Drives, Servers and Power Supplies generate heat. Ironically, that same equipment can be damaged by the very heat it is creating.

External Heat sources are mainly dictated by the environment in which the enclosure is located. These sources include Engine Rooms, Industrial Ovens and even solar heat, if the enclosure is located outdoors or in direct sunlight.

At higher temperatures, the efficiency of equipment decreases and may cause component damage or failure. For example, a modern variable-frequency drive (VFD) typically has an efficiency of 93-97% and is designed for operation below 95°F. For every degree increase above the maximum intended operating temperature, efficiency is derated by 2%. This is in addition to the risk of equipment failure.

What are the Popular Options?

1. Air to Air Heat Exchangers (including Filtered Fan)
   learn more on ***Page 05***
2. Liquid to Air Heat Exchangers
   learn more on ***Page 06***
3. Thermoelectric Coolers
   learn more on ***Page 07***
4. Refrigerant Based Air Conditioners
   learn more on ***Page 08***
5. EXAIR Cabinet Cooler® Systems
   (Vortex Tubes) *learn more on* ***Page 09***



How Are we Going to Compare Them?

To fully explore our five options we will focus on five key factors.

1. Initial Unit Cost:
   What is the initial purchase cost?
2. Installation:
   How many hours will it take to install?
3. Maintenance:
   How many hours a year will you spend performing maintenance on the "cabinet cooling" solution?
4. Operation/Performance:
   How much does the solution cost to operate, considering the electricity usage / compressed air usage? And how well does it perform?
5. Total Cost of Ownership:
   Finally we are going to add all of that up to calculate an estimated yearly cost of ownership.

Air to Air Heat Exchangers

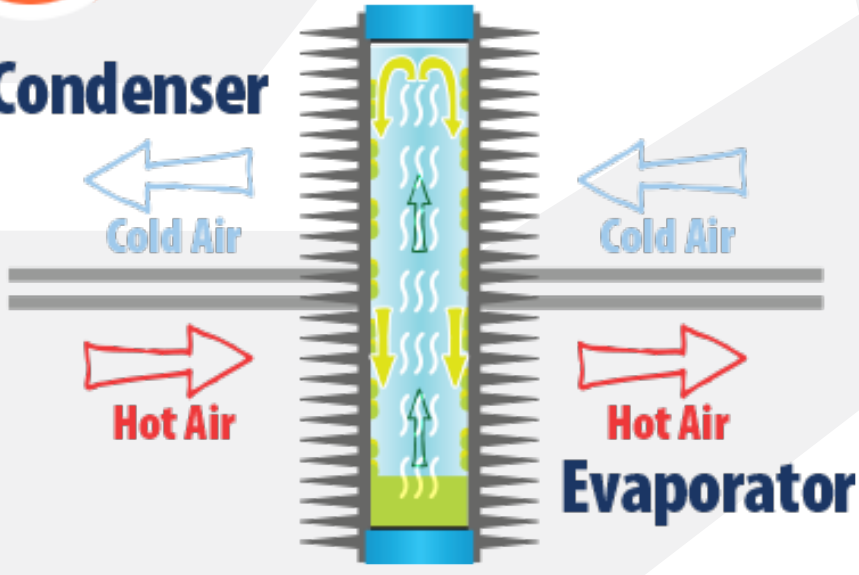
Pros:
Inexpensive; lower maintenance costs

Cons:
Cannot cool below ambient temperature; has moving parts that can fail

Heat pipes in Air to Air heat exchangers cool enclosures by using evaporative cooling to transport thermal energy from one place to another via the evaporation and condensation of a coolant. Heat pipes transfer heat through a "phase change" of the coolant, similar to a compressor based conditioner, except that they have no moving parts other than fans.

The lower section of the heat pipe assembly is in contact with heated air from the electrical enclosure. That heat causes the refrigerant to change phase (vaporize). That vapor flashes to the top of the pipe which is in contact with the outside air. When the outside air temp is lower than the enclosure temp, the refrigerant vapor gives up heat to the outside air and returns to a liquid. The liquid falls to the bottom and the cycle starts again, as long as there is a negative temperature differential between the outside air and the enclosure.

Air to Air heat exchangers cannot cool the enclosure lower than the ambient air temp. So the ambient temperature needs to be temperature controlled. And the circulation fans are a wear item that can lead to a failure and cabinet overheating.



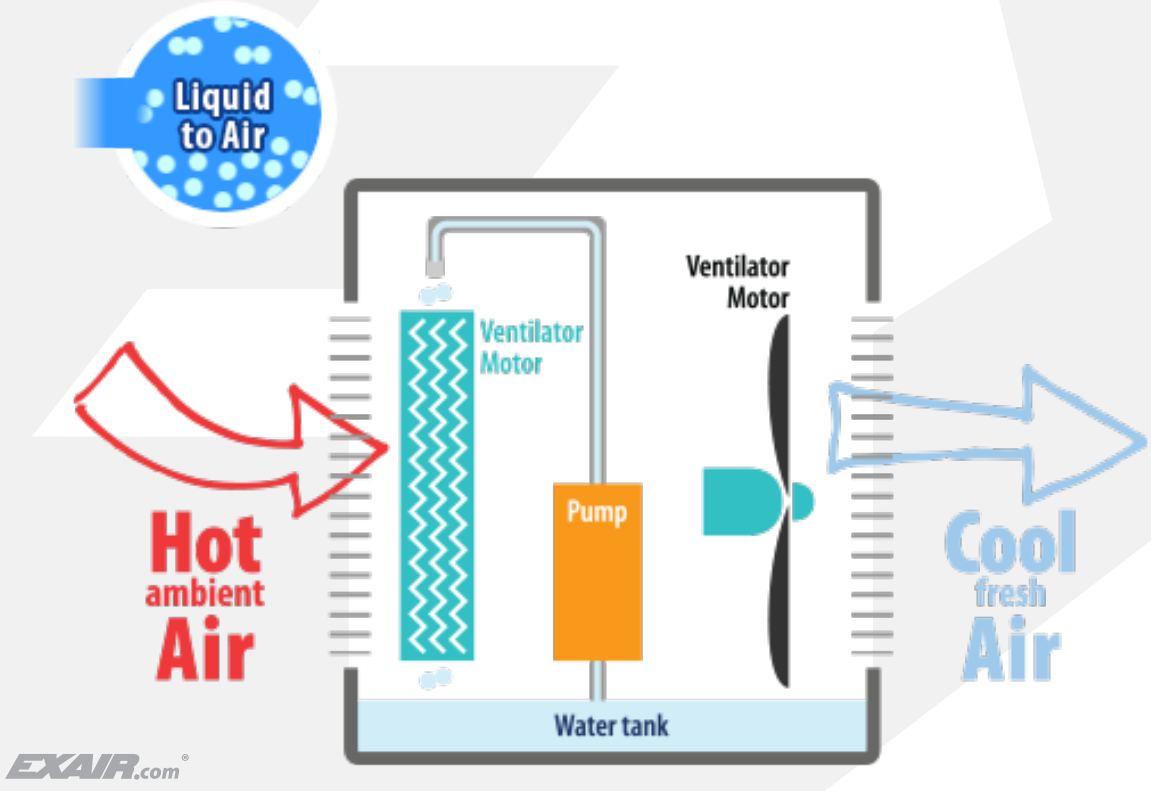
Liquid to Air

Pros:
Inexpensive; higher heat removal than Air to Air

Cons:
Requires a cold liquid source; has moving parts that can fail; increased maintenance cost

Liquid cooling is usually turned to when Air to Air doesn't have the required heat removal. Due to the cooled liquid, Liquid to Air can get below ambient temperature unlike Air to Air.

With Liquid to Air cabinet cooling the air within the cabinet is cooled by flowing a cold liquid through the heat exchanger and distributing the air within the cabinet via the heat exchanger's fan. The cabinet cooler may receive the cold liquid from facility water, a recirculating chiller or another heat exchanger. Water inlet temp is assumed to be 68°F (20°C) in most cases. So some sort of secondary service is needed to provide that cold liquid.



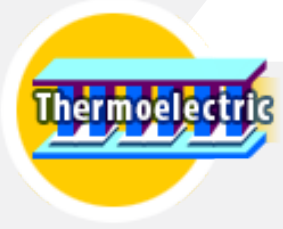
Thermoelectric

Pros:
Many input power options; mount in any orientation

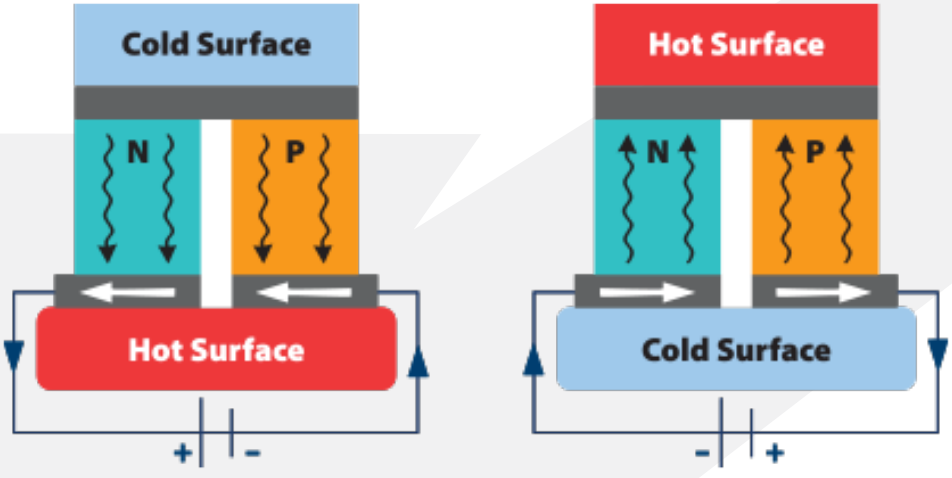
Cons:
Inefficient; cooling capacity is limited

The underlying phenomenon behind thermoelectric cooling systems is known as "The Peltier effect". This effect is harnessed by using two elements of a semiconductor material, upon application of a direct current (DC) power source, the device transfers heat from one side to the other. The side the heat is taken from becomes cold, and fans blow air against the cold surface distributing cold air around the cabinet.

The major disadvantage of the Peltier effect is that it is inefficient. The flowing current itself tends to generate a significant amount of heat, which then gets added to the overall heat dissipation.



The Peltier effect is a temperature difference created by applying a voltage between two electrodes connected to a semiconductor material. This phenomenon can be useful when it is necessary to transfer heat from one medium to another on a small scale.



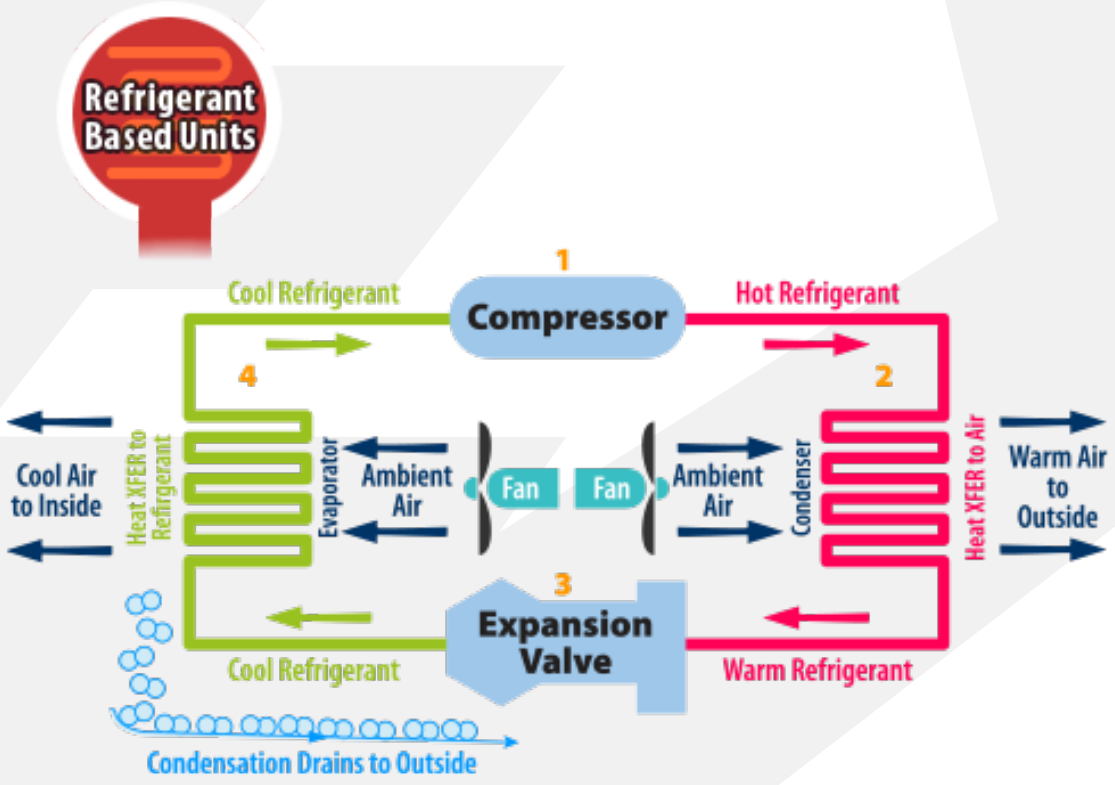
Refrigerant Based Units

Pros:
High cooling capacity

Cons:
Uses a chemical refrigerant; high maintenance cost; long installation time

All air-conditioning systems utilize a specific material to undergo a phase change process. That material, also known as a refrigerant, is contained within tubing which runs throughout the air conditioning system.

Refrigerant cooling systems are capable of higher cooling capacities, but come with higher maintenance costs, due to the amount of moving wear components.

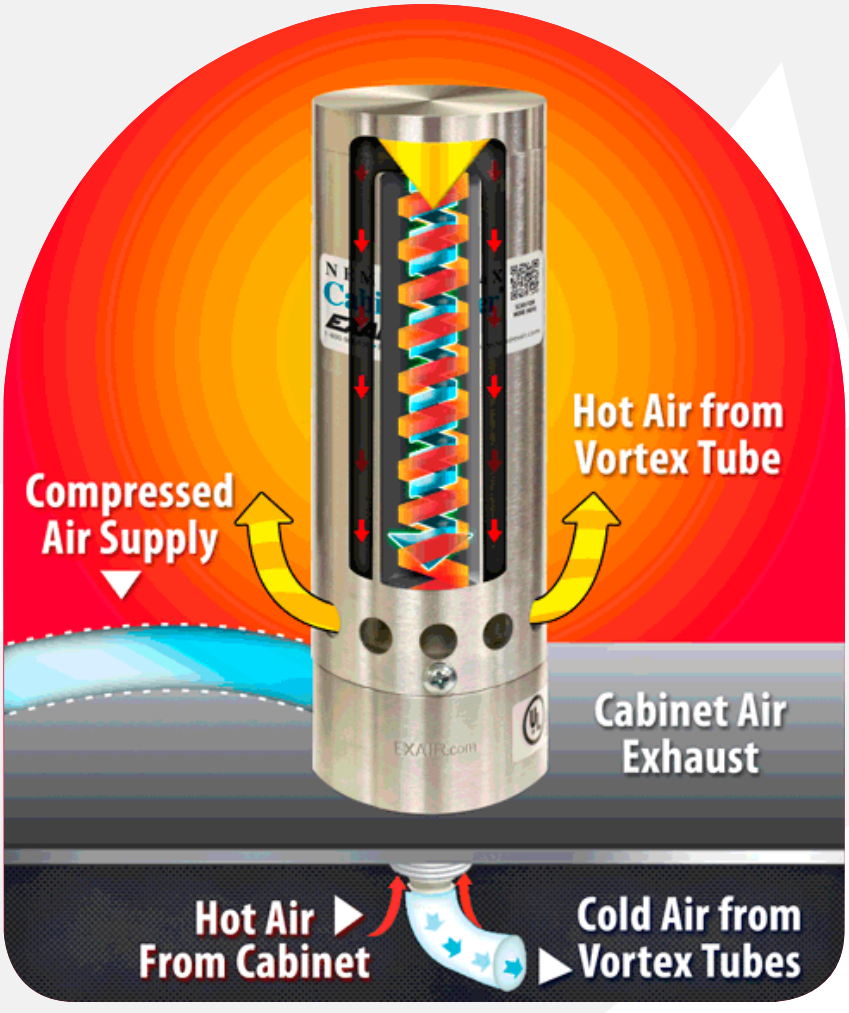


EXAIR Cabinet Cooler® Systems

Pros:
Low maintenance; small footprint; low cost; withstands harsh environments

Cons:
Requires compressed air

Compressed air enters the vortex tube powered Cabinet Cooler and is converted into two streams, one hot and one cold. Hot air from the vortex tube is muffled and exhausted through the vortex tube exhaust. The cold air is discharged into the cabinet through the included cold air distribution kit. The displaced hot air in the cabinet rises and exhausts to atmosphere through the cabinet cooler body. The control cabinet is both cooled and purged with cool, clean air. Outside air is never able to enter the control panel.



Total Cost of Ownership

Cabinet Cooler® Systems cost less to purchase, need less time to install, require no maintenance and perform better than the alternatives.

First, the upfront purchase price of the cooling solution is spread over the manufacturers expected service life time. This is the yearly cost.

Using the recommended installation hours with a service rate of $65.00/hr, the installation cost is spread over the manufacturers expected service life.

The next expense going into the total operation cost is the electricity draw. Calculate that off the running Watts (W=AxV), 5 Hr/day, 5 days/week, 39 weeks/year @ $.085 per Kilowatt hour. This is the yearly operation cost.

Then all of those are totaled up to get the Total Cost of Ownership per year. (This does not include production downtime for repairs.)

	Air to Air Heat Exchanger 3300 BTU/hr, 120VAC, 0.6 amps	Liquid to Air Heat Exchanger 8300 BTU/hr, 120VAC, 0.3 amps	Thermoelectric 1370 BTU/hr, 230VAC, 60Hz, 10.8 amps	Refrigerant Based 1513 BTU/hr, 460VAC, 60HZ., 2.0 amps	EXAIR Cabinet Coolers NEMA 12 1,700 BTU/hr, 120VAC with Thermostat Control
Initial Unit Cost	$1,450.00 (10 year Life) 2018 Price $145.00/year	$1,275.00 (10 year Life) 2018 Price $127.50/year	$4,450.00 (10 year Life) 2019 Price $445.00/year	$3,290.00 (5 year life) 2018 Price $658.00/year	$770.00 (20 Year Life) 2019 Price $38.50/ year
Installation	3 Hours Minimum Install time x $65.00/ hr ÷ 10 years = $19.50/year	3 Hours Minimum Install time x $65.00/ hr ÷ 10 years = $19.50/year	3 Hours Minimum Install time x $65.00/ hr ÷ 10 years = $19.50/year	3 Hours Minimum Install time x $65.00/ hr ÷ 5 years = $39.00/ year	1 Hr Installation Time x $65.00/hr ÷ 20 yr = $3.25/year
Maintenance	3 hours/year x $65.00/hr = $195.00/ year	4 hours/year x $65.00/hr = $260.00/ year	4 hours/year x $65.00/hr = $260.00/ year	6 hours/year x $65.00/hr = $390.00/ year	No Maintenance, No Downtime
Operation	5 Hr/day, 5 days/week, 39 weeks/year @ $0.085/kWh= $5.97/year	5 Hr/day, 5 days/week, 39 weeks/year @ $0.085/kWh= $2.98/year	5 Hr/day, 5 days/week, 39 weeks/year @ $0.085/kWh= $205.86/year	5 Hr/day, 5 days/week, 39 weeks/year @ $0.085/kWh= $76.25/ year	5 Hr/day, 5 days/week, 39 weeks/year @ $0.25/1000 cu. ft of air = $366.11/year Electricity= $0.60/Year
Total Yearly cost of Ownership	$365.47/year (Not including downtime for repairs)	$409.98/year (Not including downtime for repairs)	$930.36/year (Not including downtime for repairs)	$1,163.25/year (Not including downtime for repairs)	**$408.46 / year**

Total Cost of Ownership continued

As you can see, EXAIR Cabinet Cooler® Systems come in at the 2nd lowest cost of ownership. But if you factor in the cooling limitations Air to Air and filtered fans have, and the nearly zero downtime for repairs, EXAIR's Cabinet Cooling solution is the best overall solution to protect your expensive electronics.

Since a Cabinet Cooler® System does not rely on ambient air, it can cool under harsher conditions and higher ambient temperatures, without losing performance, like a heat exchanger.

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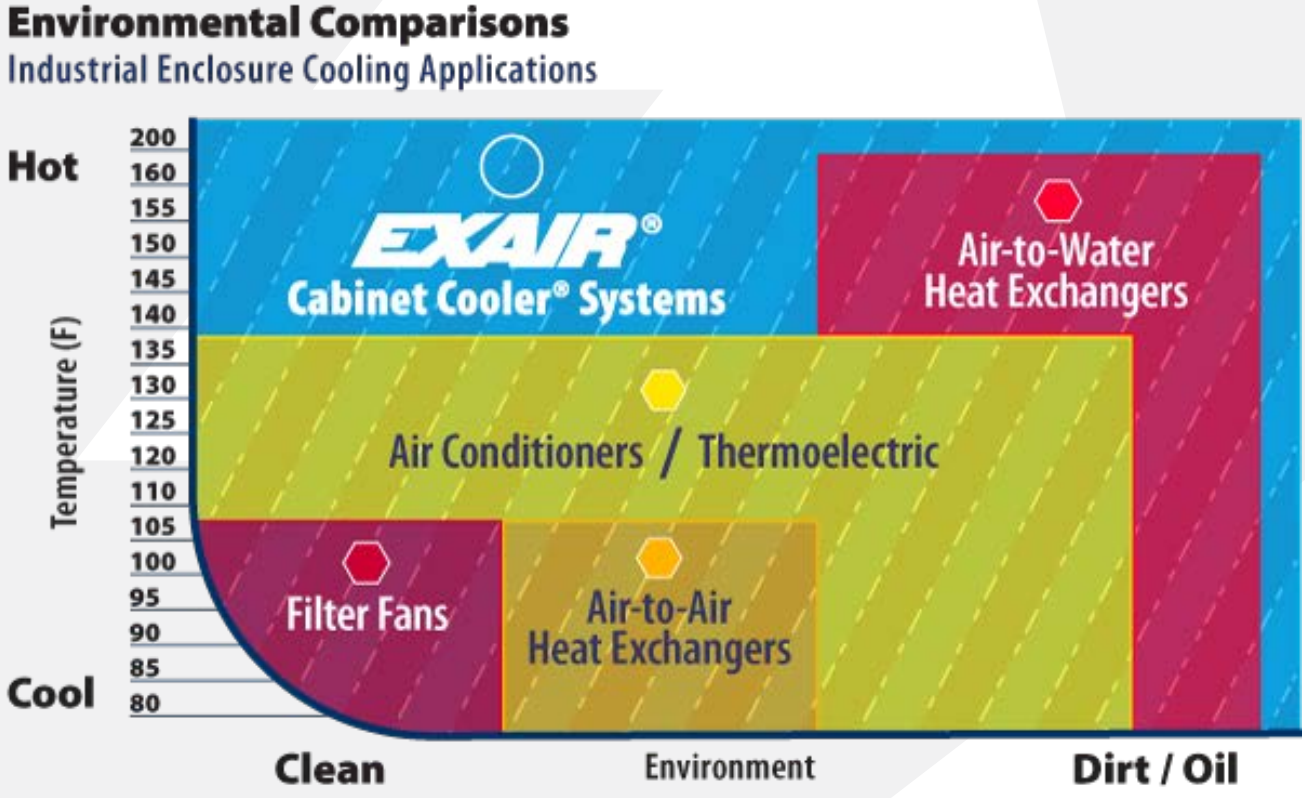
Here is a visual chart to explain the temperature and environmental conditions each of the cooling systems perform the best in.

EXAIR Cabinet Coolers exceed Btu/Hr characteristics of most alternatives, they exceed the maximum operating temperature of most and withstand the harshest conditions while still producing a very low total operating cost.



EXAIR Cabinet Cooler® Systems

Stop electronic control downtime due to heat, dirt, and moisture!

EXAIR Cabinet Cooler® systems maintain NEMA 4, 4X, and 12 integrity.

All Cabinet Coolers are CE and cULus LISTED compliant!

EXAIR's compressed air operated Cabinet Cooler Systems are a low cost, reliable way to cool and purge electronic control panels. There are no moving parts to wear out and no filters to replace, eliminating the need for constant monitoring.

NEMA Type 12 (IP54) and NEMA 4 and 4X (IP66) models are available that are very compact and mount in just minutes through an ordinary electrical knockout.

Available in a wide range of cooling capacities, they range from 275 Btu/hr. for our smallest system, up to 5,600 Btu/hr. for our largest Dual System.

Thermostat control systems are the most efficient way to operate a Cabinet Cooler as they limit compressed air use by operating only when the temperature inside the enclosure approaches critical levels. Continuous Operating Systems are recommended when constant cooling and constant positive pressure inside the panel is required.

Cabinet Coolers mount to the enclosure through a drilled hole or standard electrical knockout.

EXAIR Cabinet Coolers Systems are also UL Listed and CE compliant.

The NEMA Type 12 Cabinet Coolers may be mounted on the top or side of the panel, while NEMA Type 4 and 4X Cabinet Coolers must be mounted on the top of the panel or on the side of the panel in the vertical position to maintain their NEMA integrity.

If there is a need to mount a NEMA 4 or 4X cabinet cooler to the side of a cabinet, we do offer a side mount kit to make this possible without impacting the NEMA integrity of the cabinet.

Thermostat Controlled Systems

Systems with thermostat control include a Cabinet Cooler, thermostat, solenoid valve, cold air distribution kit and filter.

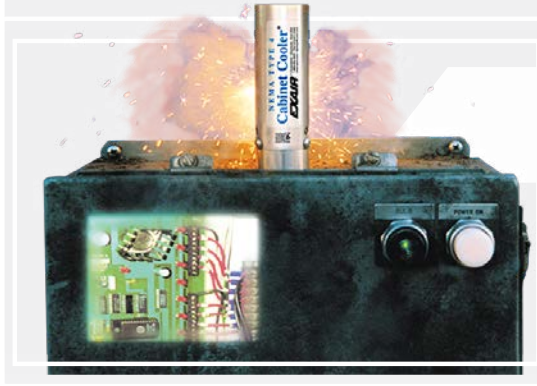
Thermostat controlled Cabinet Cooler Systems are the best option when experiencing fluctuating heat loads caused by environment or seasonal changes. Thermostatically Controlled Systems include a Cabinet Cooler, adjustable thermostat, solenoid valve, cold air distribution kit consisting of tubing and self adhesive clips to duct the cold air inside the panel and a filter separator to remove any water or contaminants from the supply.

The adjustable thermostat is a bimetal electromechanical switch, factory set to 95°F (35°C). It will normally hold a +/- 2°F (1°C) temperature inside the cabinet. Rated for 120-240VAC, 50/60 Hz or 24 VDC. The thermostats are UL recognized and CSA certified.

We also offer the ETC (Electronic Temperature Control) for providing precise temperature control via a quick response thermocouple. It can accurately maintain a constant temperature that is slightly lower than the maximum temperature rating of the electronics, allowing for just enough cooling without wasting compressed air. The temperature setting can be easily changed by a simple push of a button and the temperature is displayed on the LED readout. The control activates the included solenoid valve when the temperature setting is exceeded. The ETC is suitable for NEMA Type 12, 4 and 4X environments.

Special Cabinet Cooler® Systems

High Temperature Cabinet Cooler Systems are available for areas where ambient temperatures range from 125°F (52°C) to 200°F (93°C). Upgraded internal components are able to withstand higher temperatures like those near a boiler, oven or furnace for example. We offer systems ranging as low as 1,000 Btu/hr. up to our largest Dual System providing 5,600 Btu/hr. of cooling



Non-Hazardous Purge Cabinet Cooler Systems are the preferred choice for areas with high contaminants that may pass through conduit or small openings in the panel. The NHP Cabinet Cooler Systems apply a constant, small amount of positive pressure into the enclosure by passing 1 SCFM of air through the Cabinet Cooler when the solenoid valve is in the closed position. When the thermostat detects high temperature, the solenoid valve is energized to pass full line pressure and volume to the Cabinet Cooler, providing full rated cooling capacity for the system.

Total Cost of Ownership Comparison of Popular Electronic Enclosure Coolers

Special Cabinet Cooler® Systems continued

EXAIR's Hazardous Location Cabinet Coolers are engineered for use with purged electrical enclosures. The HazLoc Cabinet Coolers are not purged and pressurized control systems and should not be used in place of a purged and pressurized controller. They are meant for use in conjunction with a purged and pressurized control system. These systems have been approved and tested by UL for use in the following areas:

Class I Div 1 – Groups A, B, C and D
Class I areas refer to the presence of flammable gases or vapors in quantities sufficient to produce explosive or ignitable mixtures. Class I Div 1 will have ignitable concentrations of flammable gases present during the course of normal operations.

Class II Div 1 – Groups E, F and G
Class II areas are locations in which combustible dust may exist. The end user shall avoid installation of the device in a Class II environment where dust may be readily disturbed from the exhausts of the Hazardous Location Cabinet Cooler. Any dust formed in the vicinity of the cooler must be cleaned regularly.

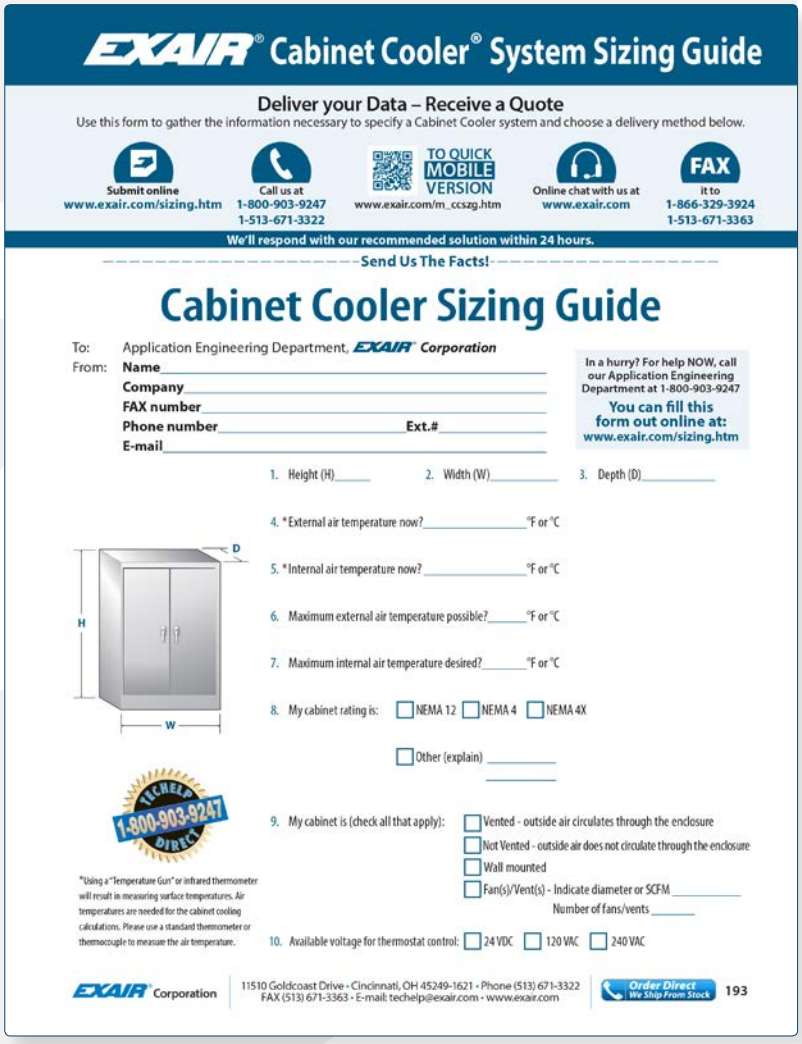
Class III
Class III areas are locations that will have ignitable fibers or flyings present. This is common within the textile industry.

The Cabinet Cooler also carries a temperature rating of T3C, meaning it cannot be installed near any materials that could autoignite at temperatures in excess of 320°F (160°C).

Let us size a Cabinet Cooler for your Application

Submit our online sizing guide at www.exair.com/index.php/cabinet-cooler-sizing-guide

Selecting the proper Cabinet Cooler System can be simplified by using our Cabinet Cooler Sizing Guide. The Sizing Guide collects all the pertinent information needed for an EXAIR Application Engineer to determine the heat load that we'll need to dissipate and ensure the most efficient cooler is chosen and the proper NEMA rating is selected to fit your particular requirement.



EXAIR® Cabinet Cooler® System Sizing Guide

Deliver your Data – Receive a Quote

Use this form to gather the information necessary to specify a Cabinet Cooler system and choose a delivery method below.

Submit online www.exair.com/sizing.htm | Call us at 1-800-903-9247 1-513-671-3322 | TO QUICK MOBILE VERSION www.exair.com/m_ccszg.htm | Online chat with us at www.exair.com | FAX it to 1-866-329-3924 1-513-671-3363

We'll respond with our recommended solution within 24 hours.

Send Us The Facts!

Cabinet Cooler Sizing Guide

To: Application Engineering Department, EXAIR® Corporation

From: Name_____

Company_____

FAX number_____

Phone number_____ Ext.#_____

E-mail_____

In a hurry? For help NOW, call our Application Engineering Department at 1-800-903-9247

You can fill this form out online at: www.exair.com/sizing.htm

1. Height (H)_____ 2. Width (W)_____ 3. Depth (D)_____

4. *External air temperature now?_____ °F or °C

5. *Internal air temperature now?_____ °F or °C

6. Maximum external air temperature possible?_____ °F or °C

7. Maximum internal air temperature desired?_____ °F or °C

8. My cabinet rating is: ☐ NEMA 12 ☐ NEMA 4 ☐ NEMA 4X ☐ Other (explain) _____

9. My cabinet is (check all that apply): ☐ Vented - outside air circulates through the enclosure ☐ Not Vented - outside air does not circulate through the enclosure ☐ Wall mounted ☐ Fan(s)/Vent(s) - Indicate diameter or SCFM _____ Number of fans/vents _____

10. Available voltage for thermostat control: ☐ 24 VDC ☐ 120 VAC ☐ 240 VAC

*Using a "Temperature Gun" or infrared thermometer will result in measuring surface temperatures. Air temperatures are needed for the cabinet cooling calculations. Please use a standard thermometer or thermocouple to measure the air temperature.

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HOME OF INTELLIGENT COMPRESSED AIR® Products

What are some typical applications that use these types of products?

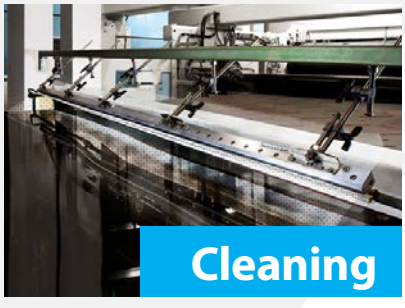
EXAIR's Intelligent Compressed Air® products excel at using compressed air safely and efficiently for applications such as blowoff, cleaning, drying, cooling, ventilating, circulating, part ejection, part manipulation and environmental separation.

Cooling

Drying

Environmental Separation

Blowoff



Cleaning

Ventilating

Part Ejection

Part Manipulation

Air Circulation

Technical Support

EXAIR has a staff of application engineers ready to assist you in selecting the appropriate model for your application.

They can be contacted at **1-800-903-9247**.

Or you can email them at **techelp@exair.com**

EXAIR.com®

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