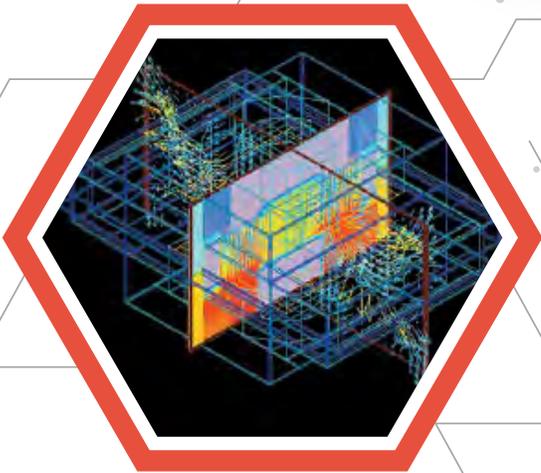


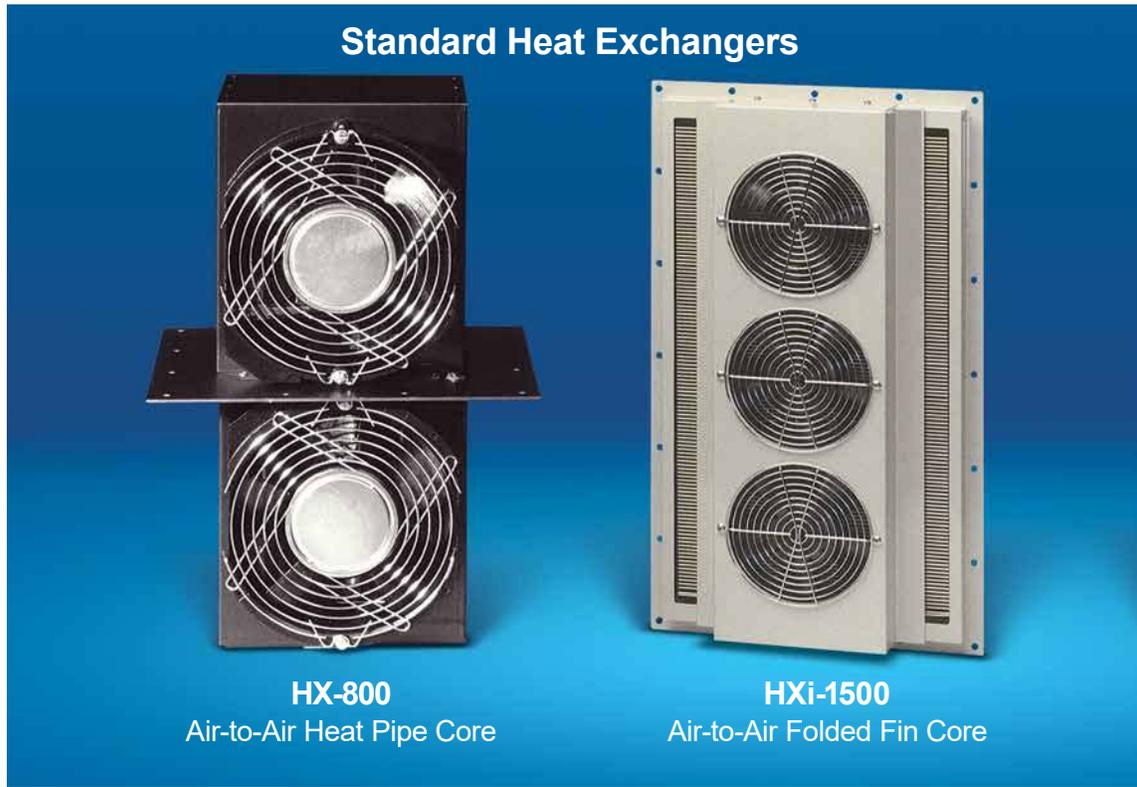
**HEAT EXCHANGERS AND  
ENCLOSURE COOLING**



One Company, Many Solutions

### HEAT EXCHANGERS: PROTECTING PERFORMANCE

You need the thermal protection that keeps increasingly miniaturized, specialized, high-performance electronics running smoothly. And you want the design flexibility that makes performance possible. Boyd Corporation gives you both. Our wide array of heat exchangers provide compact, high-efficiency cooling that lets you reliably isolate cabinet electronics from the external environment. You can choose from proven, dependable standard or custom air-to-air or powerful liquid-to-air thermal solutions. Our versatile air-to-air heat exchangers can be tailored to a wide range of applications. Where heat dissipation needs are too great for natural or forced-air convection, or remote heat dissipation is required, you can rely on closed-loop liquid-based cooling technology. Both solutions are backed by Boyd Corporation's engineering excellence and custom capabilities.



### SOLUTIONS FOR PRACTICALLY ANY APPLICATION

We know how to support your design ideas by solving the toughest thermal challenges. We also offer the engineering skill and experience to partner with you and extend your capabilities to meet the most exacting requirements.

#### Markets Served

- Telecommunications
- Computer
- Medical
- Food & Beverage
- Industrial
- Military & Aerospace
- Transportation

#### Common Applications

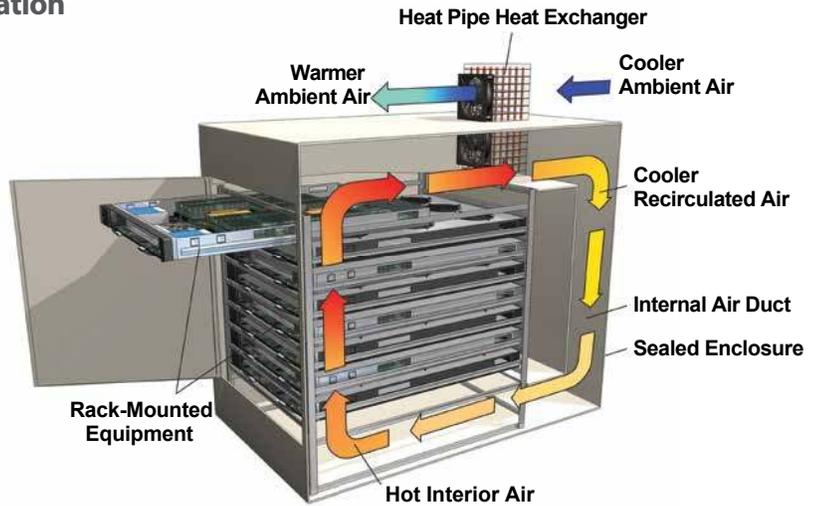
- Cabinets, Enclosures & Shelters (Indoor & Outdoor)
- Automation & Process Control Cabinets
- Data Center & Central Office Network Rooms
- Industrial Drive & Power Supply Cabinets
- Radio Base Stations & Shelters
- CNC Machine Electronics Cabinets
- Digital Advertisement Boards
- Kiosk Display Systems
- Medical & Test Equipment
- Energy Recovery HVAC
- Military Enclosures & Shelters

### YOUR COOLING OPTIONS ARE COVERED

Whether your project requires air-to-air, liquid-to-air, direct-air-cooling or conductive technologies, Boyd Corporation can provide a solution that handles the temperature ranges of practically any application.

#### Enclosure Cooling-Effects of Temperature Variation

- At High Temperatures
  - I/C Device Behavioral Changes (Erratic Output)
  - Silicone Material Properties Begin to Change
- At Low Temperatures
  - I/C Device Behavioral Changes (Erratic Output)
  - Cooling Below the Dew Point Leads to Condensation (Corrosion & Electrical Shorts)
  - Shorter Battery Life
- Negative Results
  - Catastrophic Failures
  - Degradation of Material Properties
  - Decrease in Mean Time Between Failure (MTBF)



Closed-loop air-to-air heat exchanger enclosure cooling

Heat exchangers can be extremely effective, more energy-efficient, low-cost and easily adaptable thermal solutions for enclosure cooling.

#### System Characteristics

Heat Exchanger Type	Technology Description	Heat Dissipation Level	Environment Type	Typical Applications	Cools Below Ambient	Cools Above Ambient	Closed Loop
Air-to-Air Heat Exchangers	Closed loop, no liquids.	Moderate	Cool air environment with moderate heat load Dirty or corrosive air locations.	<ul style="list-style-type: none"> <li>• Indoor or outdoor</li> <li>• Telecommunications</li> <li>• Light-duty mfg.</li> </ul>		X	X
Liquid-to-Air Heat Exchangers	Close coupled liquid cooling.	Highest	Very hot environments with high-heat load Extremely dirty/dusty air locations.	<ul style="list-style-type: none"> <li>• Extreme conditions where air conditioners would be subject to failure</li> <li>• Automotive mfg.</li> <li>• Machine tool packaging</li> <li>• Paper mill</li> </ul>	X		X
Filter, Fans, Blowers, Impellers or Direct-Air-Cooling Systems (DACS)	Forced, fresh air open loop.	Low to moderate	Cool, clean air environment	<ul style="list-style-type: none"> <li>• Industrial mfg.</li> <li>• Outdoor telecom</li> <li>• Data networking</li> </ul>		X	
Conductive (No Cooling Unit)	Passive heat radiates through enclosure walls.	Very low	Cool air environment (<78°F/25°C)	Where enclosed components operate within recommended temperature range		X	Per enclosure rating

### HX™ SERIES COMPACT AIR-TO-AIR HEAT EXCHANGERS

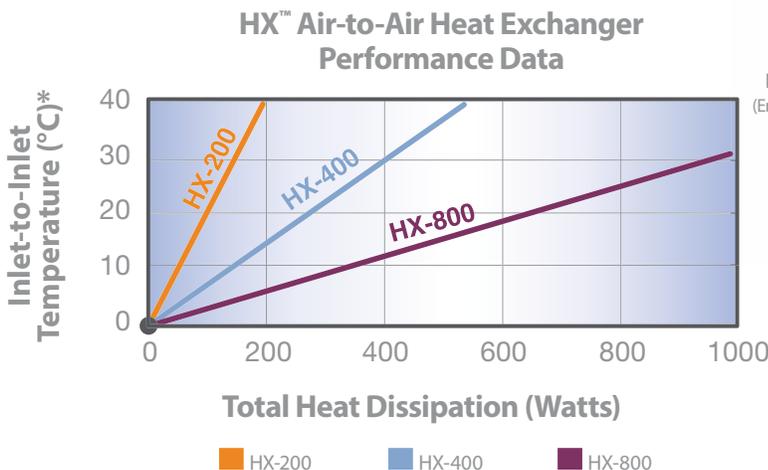
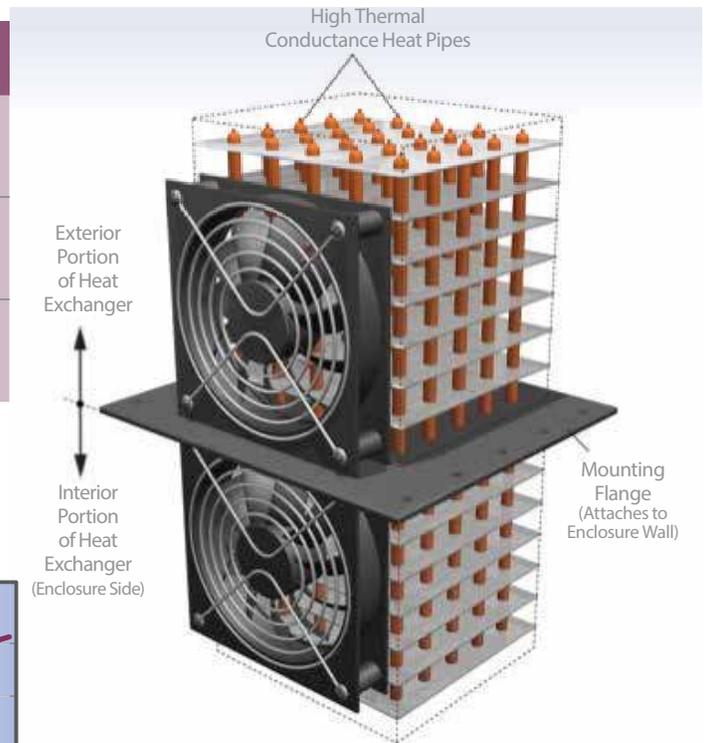
When you need reliable and efficient cooling for high-heat loads in enclosed electronic equipment or demanding outdoor applications, the Boyd Corporation HX™ Series air-to-air heat exchanger delivers. HX™ Series heat exchangers use two-phase heat pipe technology to create an efficient and cost-effective heat transfer system. This maintenance-free cooling solution is also designed to ensure your enclosures remain contaminant free, and maintain NEMA 4 and NEMA 12 (IP66 and IP55) integrity.

You can also take advantage of the capillary action of heat pipes to design custom systems that work in any orientation, including against gravity, or systems for extremely space-constrained applications. HX™ Series heat pipes are manufactured to function in freeze-thaw conditions. Design flexibility and application versatility are integral to the HX™ concept. Multiple packaging options are available for various applications, and product design can easily be scaled to fit any thermal capacity.



### HX™ Series Performance Data

Model	Performance	Weight
HX-200	4.8 W/°C	2.7 lbs.
HX-400	13.2 W/°C	6.8 lbs.
HX-800	32.0 W/°C	15.1 lbs.

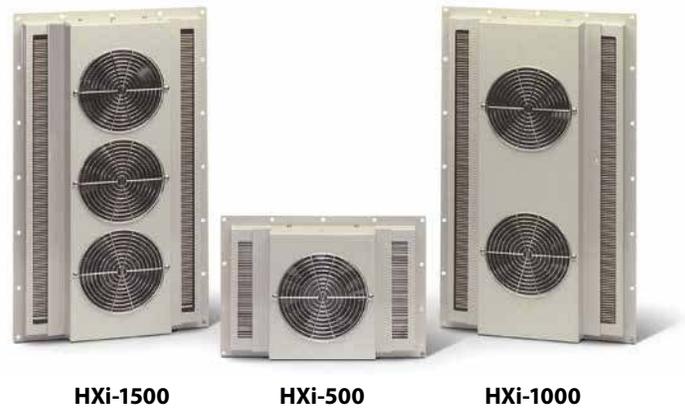


\* Inlet-to-inlet: Inlet air temperature to the heat exchanger on the inside of the enclosure minus the inlet air temperature on the outside of the enclosure.

### HXi™ SERIES LOW-PROFILE AIR-TO-AIR HEAT EXCHANGERS

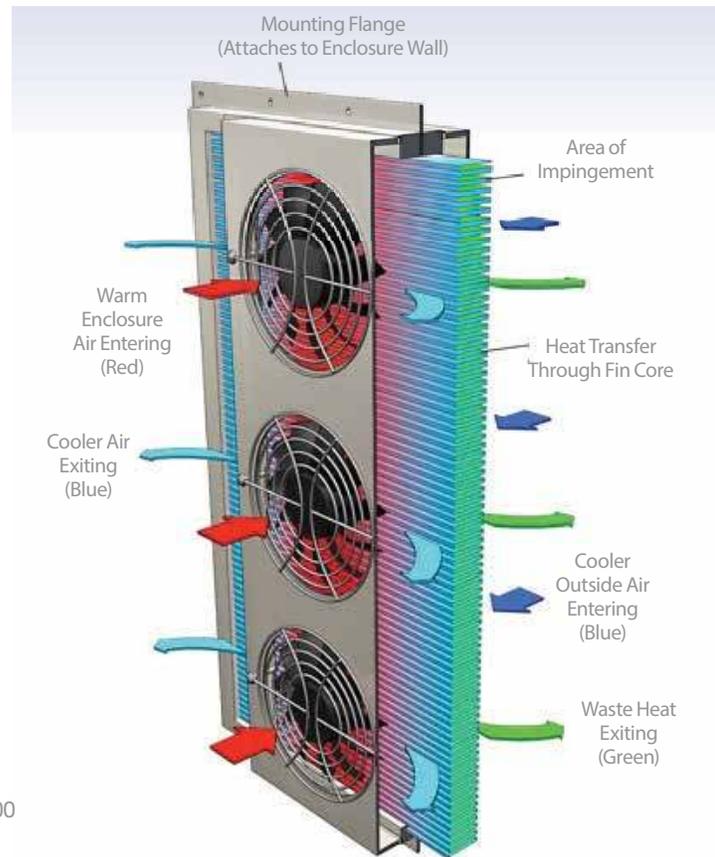
For high-heat transfer performance with indoor and outdoor electronic enclosures, rely on Boyd's HXi™ Series. These versatile heat exchangers give you compact size and significantly improved heat transfer performance, even at high-heat loads, through double-sided impingement cooling technology. The HXi™ Series heat exchanger can dissipate twice the heat load of most conventional heat exchanger technologies of similar size, so you can have both higher performance and lower fabrication costs.

Standard units are available with 2, 4 or 6 fans, and custom optional features such as alarms and temperature controls are also available. The HXi™ Series is UL recognized and meets Telcordia GR-487-CORE, NEMA 4 and NEMA 12 (IP66 and IP55) requirements.

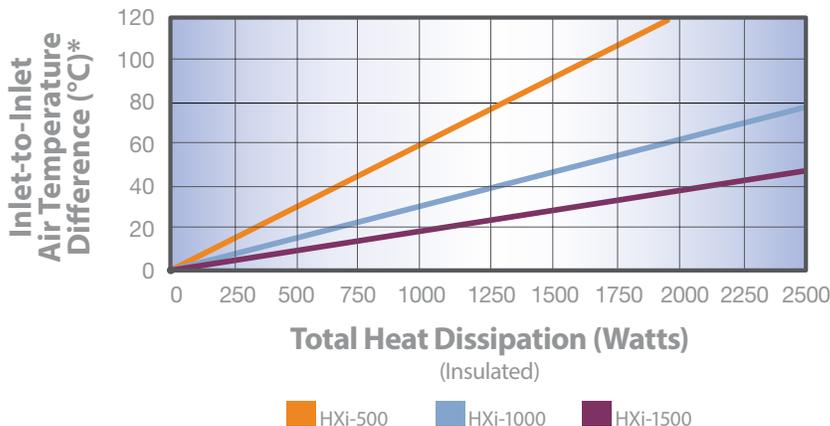


### HXi™ Series Performance Data

Model	Performance	Weight
HXi-500	16 W/°C	15 lbs.
HXi-1000	33 W/°C	20 lbs.
HXi-1500	52 W/°C	25 lbs.
HXi-1500+	Per Customer Requirement	



HXi™ Low-Profile Air-to-Air Heat Exchanger Performance Data\*



\* Inlet-to-inlet: Inlet air temperature to the heat exchanger on the inside of the enclosure minus the inlet air temperature on the outside of the enclosure.

### HX® Series Heat Exchangers

Aluminum construction. Configurations fit top, side, back or door mounting positions (see page 7 for flange view).

Model	Performance	Sold Without Fans	12 VDC 6.3 Watts	24 VDC 5.3 Watts	48 VDC 5.8 Watts	115 VAC 50–60 Hz 18 Watts	230 VAC 50–60 Hz
HX-200	4.8 W/°C	S01497-010*	F13587-000	F01559-000	F13021-000	F00097-000	Custom
Model	Performance	Sold Without Fans	12 VDC	24 VDC 14.4 Watts	48 VDC 2.0 Watts	115 VAC 50–60 Hz 29 Watts	230 VAC 50–60 Hz 29 Watts
HX-400	13.2 W/°C	S00534-010*	Custom	F13209-000	F01462-000	F00102-000	F00103-000
Model	Performance	Sold Without Fans	12 VDC 53 Watts	24 VDC 41 Watts	48 VDC 40 Watts	115 VAC 50–60 Hz 82 Watts	230 VAC 50–60 Hz 84 Watts
HX-800	32.0 W/°C	S00535-010*	Custom	F10240-100	F10240-000	F00107-000	F00108-000

\* Performance for heat exchangers sold without fans cannot be guaranteed since the air flow rate is unknown.

### HXi® Series Heat Exchangers

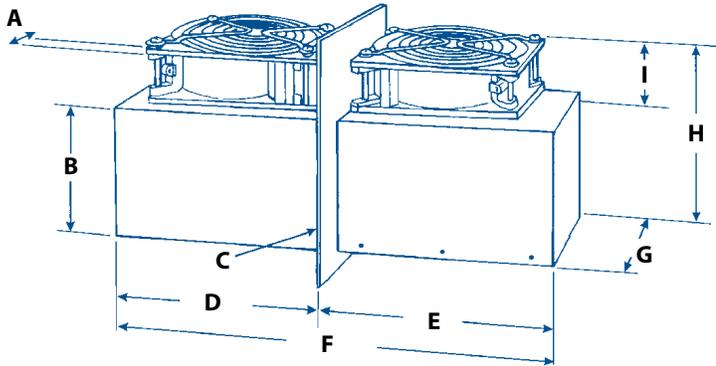
Aluminum construction. Configurations fit side, back or door mounting positions (see page 7 for flange view).

Model	Performance	12 VDC 53 Watts	24 VDC 41 Watts	48 VDC 40 Watts	115 VAC 50–60 Hz 82 Watts	230 VAC 50–60 Hz 84 Watts
HXi-500	16 W/°C	F02507-000	F02522-000	F01423-000	F01458-000	F02516-000
HXi-500 w/Alarm	16 W/°C	—	F17697-200	F01781-000	—	—
Model	Performance	12 VDC 106 Watts	24 VDC 82 Watts	48 VDC 80 Watts	115 VAC 50–60 Hz 163 Watts	230 VAC 50–60 Hz 168 Watts
HXi-1000	33 W/°C	F02508-000	F02523-000	F01609-000	F01459-000	F02517-000
HXi-1000 w/Alarm	33 W/°C	—	F17697-100	—	—	—
Model	Performance	12 VDC 159 Watts	24 VDC 123 Watts	48 VDC 120 Watts	115 VAC 50–60 Hz 245 Watts	230 VAC 50–60 Hz 250 Watts
HXi-1500	52 W/°C	F02509-000	F02524-000	F01416-000	F01460-000	F02518-000
HXi-1500 w/Alarm	52 W/°C	—	F17697-000	—	—	—
HXi-1500+ Not UL Approved, No Finger Guards	73 W/°C	—	—	F17624-400	—	—

#### CORPORATION

### STANDARD HEAT EXCHANGER PARAMETERS

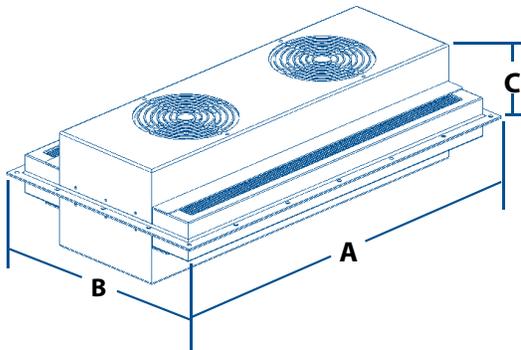
#### HX™ Series



	HX-200	HX-400	HX-800
<b>A</b>	.25" (6)	.25" (6)	25" (6)
<b>B</b>	2.125" (54)	3.75" (95)	5.875" (149)
<b>C</b>	4.5 sq" (114)	6.75 sq" (171)	10.00 sq" (254)
<b>D</b>	4.075" (104)	6.1" (155)	7.4" (188)
<b>E</b>	4.075" (104)	6.1" (155)	7.4" (188)
<b>F</b>	8.25" (210)	12.3" (312)	14.9" (378)
<b>G</b>	3.25" (83)	5.25" (133)	6.5" (165)
<b>H</b>	3.85" (98)	5.25" (133)	8.125" (206)
<b>I</b>	1.5" (38)*	1.25" (32)*	2.0" (51)*

( ) = millimeters \* May vary depending on voltage.

#### HXi™ Series



	HXi-500	HXi-1000, 1500	Custom
<b>A</b>	10" (254)	24" (610)	Custom Sizes Available
<b>B</b>	14" (355)	14" (355)	
<b>C</b>	6.87" (174)	6.87" (174)	

( ) = millimeters

### CUSTOM DESIGNS AND ENGINEERING

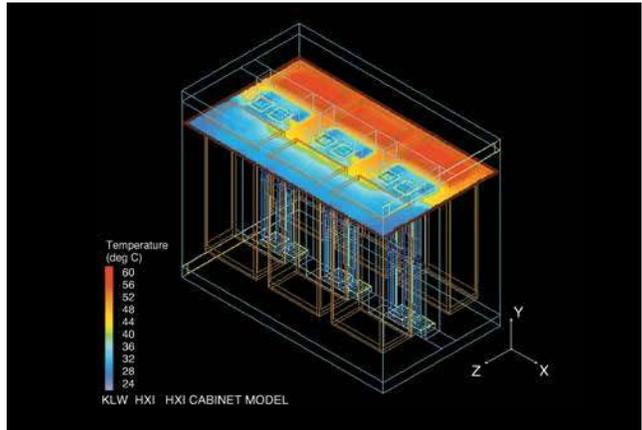
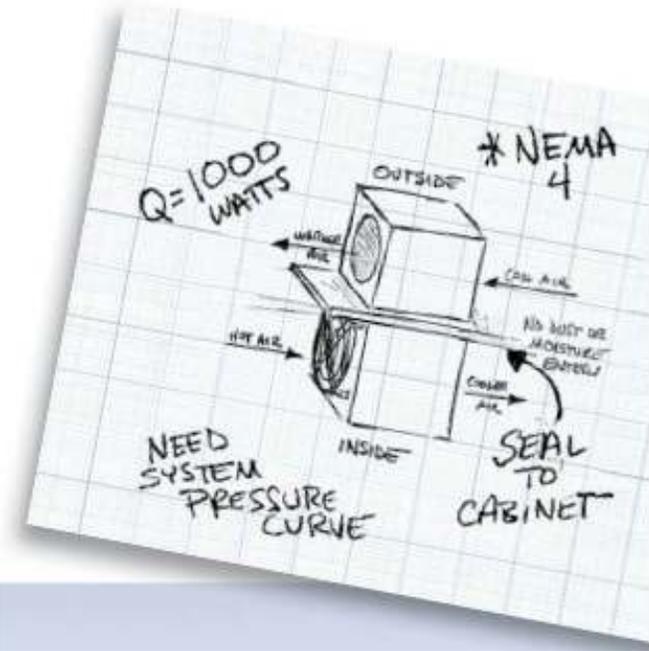
Partner with Boyd Corporation and create great custom designs.

Turn your thermal challenge into an opportunity to create an exciting new generation of electronic devices by collaborating with a dedicated, specialized Boyd Corporation engineering team. When our standard heat exchangers don't meet your needs, our team of engineers will collaborate with you and your team to develop a custom design to cool your project.

#### Our Outcome-Driven Project Cycle



NEXT GENERATION TECHNOLOGICAL ADVANCEMENT



#### Thermal Modeling

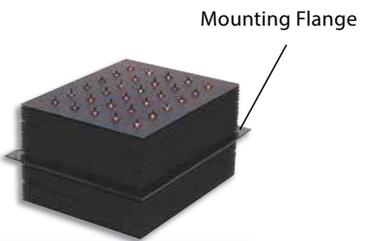
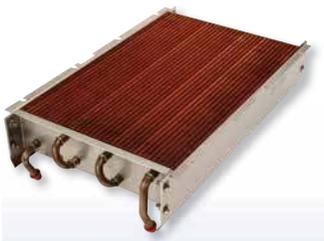
Boyd Corporation can provide a computer-generated model of how your heat exchanger will operate in your application. We can utilize CFD (computational fluid dynamics) such as FloTHERM® and CD-adapco STAR-CCM+ to model the performance of your heat exchanger.

#### Custom Heat Pipe Core Only Designs

Heat pipe core units can be a flexible thermal management system used to interface with duct work and other customized heat exchanger applications. Fin stacks can be tailored to accommodate different air velocities in the ambient and internal loops. All heat pipe core units can provide a NEMA 4 and/or NEMA 12 compliant seal to separate the two air streams. Boyd's engineering team can design the appropriate heat pipe core for each customer's application.

#### Custom Solutions

Custom heat exchangers are an important part of our product mix. As a heat transfer specialist, Boyd Corporation will design a custom heat exchanger system to meet your special requirements. We are dedicated to designing and delivering the custom thermal solutions that OEM customers need.

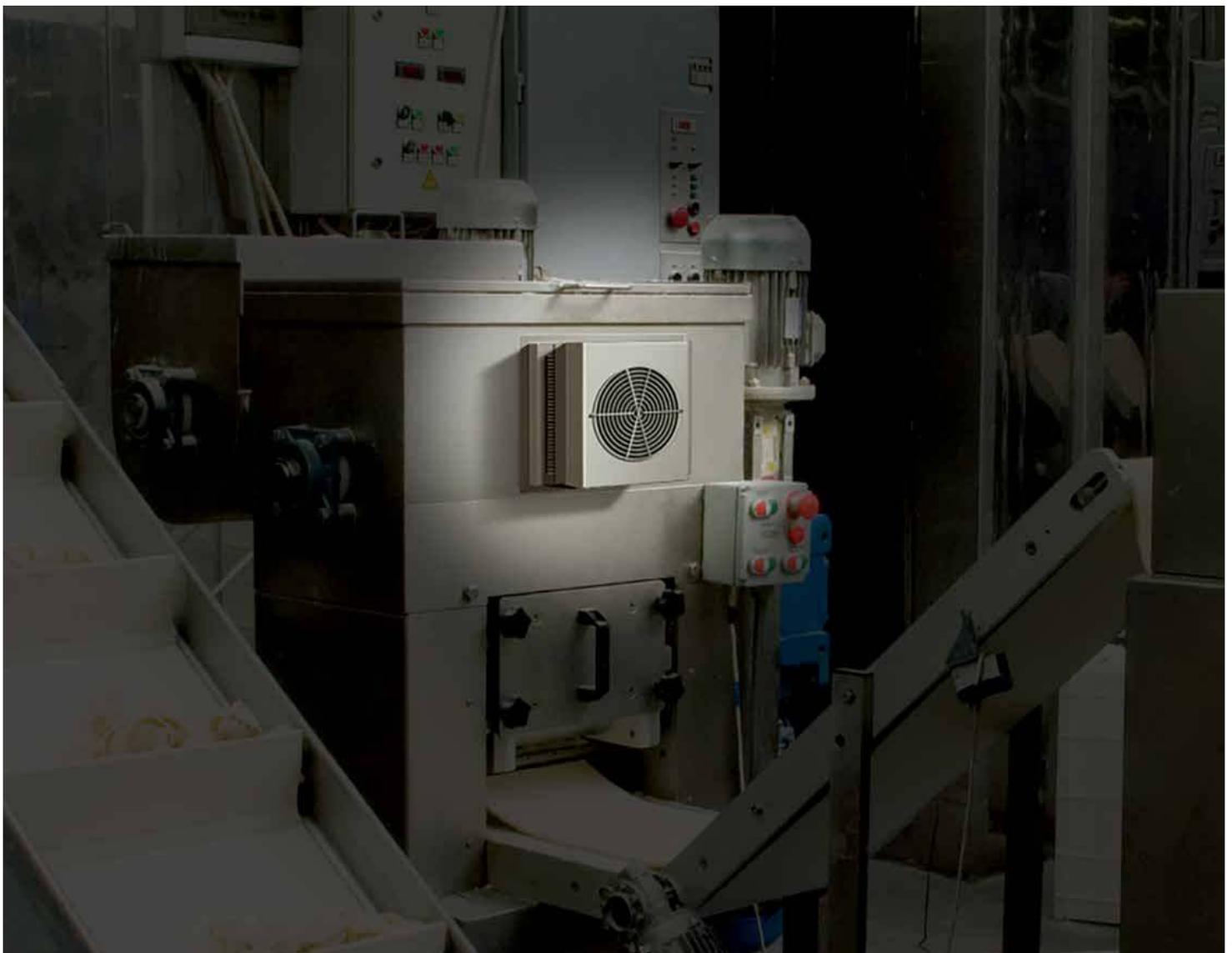


## STAINLESS STEEL HEAT EXCHANGERS

Many industries, such as food-and-beverage and pharmaceutical, have chosen stainless steel as the standard material choice for their applications. With its corrosion-resistant properties, stainless steel can be steam cleaned, providing a hygienic, antibacterial surface which gives it a modern and attractive appearance. Because of these attributes, stainless steel is often the best value option when considering the total life of your application.

### Boyd Corporation Stainless Steel Heat Exchangers Product Offering

- For NEMA 4X environments including corrosion-resistant applications
- Type 304 or 316 stainless steel housings
- Surface mount on outside of enclosure
- VAC or VDC fan configurations



## SPECIAL CONFIGURATIONS HX™ FLUSH-MOUNT

Heat pipe heat exchangers are an easily adaptable technology for custom applications. Whether mounted externally, partially recessed or captured within duct work, the heat pipe heat exchanger is a reliable and highly efficient heat transfer mechanism that can maintain NEMA 4 and NEMA 12 enclosure integrity.

Designed to provide a thermal performance of 12W/°C, this unit uses the flexibility of heat pipe heat exchanger technology to accommodate different mounting configurations.

The product design can easily be scaled to larger or smaller capacity configurations and can be equipped with either AC or DC fans.

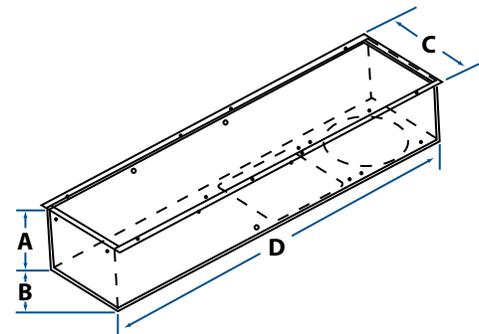
\* This heat exchanger is custom designed for a specific application and all data is for reference only.



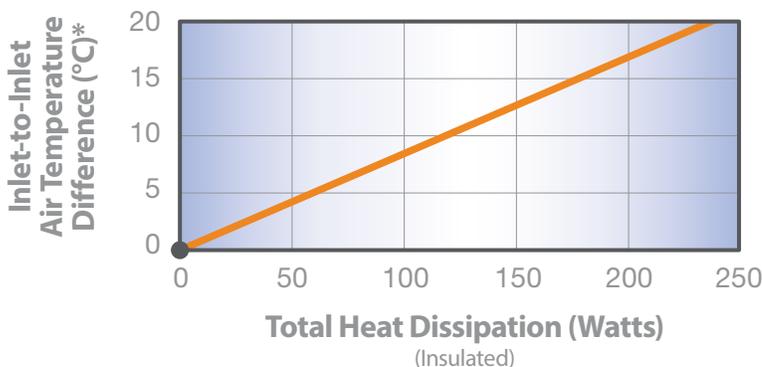
### HX™ Flush-Mount Dimensions\*

A	4.00"	(101.60)
B	5.75"	(146.05)
C	6.25"	(158.75)
D	22.50"	(571.50)

( ) = millimeters



### HX™ Flush-Mount Air-to-Air Heat Exchanger Performance Data



\* Inlet-to-inlet: Inlet air temperature to the heat exchanger on the inside of the enclosure minus the inlet air temperature on the outside of the enclosure.

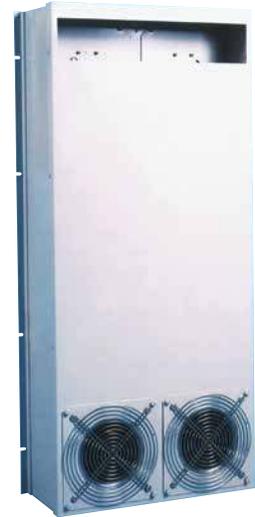
## SPECIAL CONFIGURATIONS

### HXc™ SERIES AIR-TO-AIR COOLING: CROSS-FLOW HEAT EXCHANGER\*

For applications exceeding 2000 W, Boyd Corporation recommends its high-capacity, custom-designed, cross-flow heat exchanger called HXc™. Based on the use of highly effective, cross-flow plate heat cores, the HXc™ units are space efficient and can be easily customized for today's OEM applications. These units can be equipped with such features as alarms, heaters and temperature controls. HXc™ units can be manufactured to meet Bellcore GR-487-CORE and NEMA 4 (IP66 and IP55) requirements.

Constructed from aluminum with optional epoxy coated aluminum plates, the Boyd Corporation cross-flow system is designed for high efficiency while occupying minimum space. The plates are smooth, allowing dirt to pass through the channels without clogging and fowling the exchanger.

Custom-designed for the HXc™ Series is the efficient and cost-effective answer to large-scale/high-power enclosure cooling for communications and industrial applications.

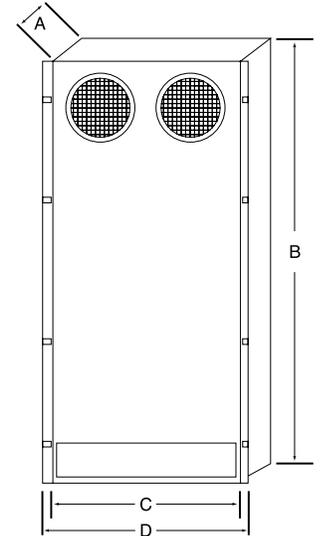


\* This heat exchanger is custom designed for a specific application and all data is for reference only.

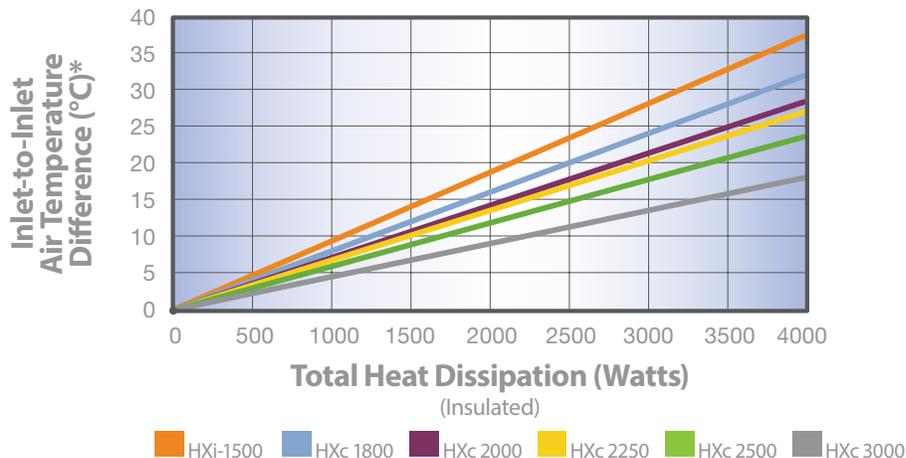
### HXc™ Series — Cross-Flow Heat Exchanger\*

Model	Perf W/°C	Fan Diameter (inches)	Depth A (inches)	Height B (inches)	Width C (inches)	Flange Width D (inches)	Est. Weight (lbs.)
HXc-1500	700	3.54	1.16	3.54	2.36	8.11	15.7
HXc-1800	700	3.54	1.02	3.54	1.97	9.57	17.44
HXc-2000	700	3.54	1.16	3.54	1.97	9.88	17.44
HXc-2250	1400	4.75	1.00	10.50	1.75	13.00	24.25
HXc-2500	1400	4.75	1.00	7.50	1.75	13.00	21.25
HXc-3000	1000	2.90	2.90	7.50	3.75	13.00	24.30

\* Non-Insulated Unit



HXc™ Air-to-Air Cross-Flow Heat Exchanger Performance Data\*



\* Inlet-to-inlet: Inlet air temperature to the heat exchanger on the inside of the enclosure minus the inlet air temperature on the outside of the enclosure.

## ACCESSORIES AND OPTIONS

### VARIABLE SPEED CONTROLLERS

#### Intelligent Fan Controllers

Strategically placed thermocouples monitor internal thermal conditions (heat generated by electronics and sun). Set the fan speed to provide "just enough" cooling at the lowest possible noise levels — and save energy in the process).

An intelligent fan controller provides the ability to manually set and change fan speeds as the system is tested and tuned. This allows the manufacturer to accurately validate how the system performs and simulate the conditions to collect and report on the data needed by site planners.

#### Energy and Noise Control

- Fan speed throttle
- Measures cabinet temperature
- Accepts supply voltage of 10 VDC to 75 VDC or AC
- UL, CSA and CE Compliant/Recognized

### EMI/RFI GASKETS AND FILTERS

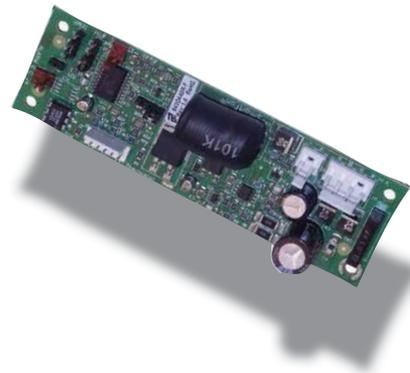
A neoprene gasket that maintains the NEMA rating of the enclosure is supplied with each standard heat exchanger. EMI/RFI gaskets and filters are available for custom designs only when requested. Boyd can also conduct testing to confirm performance.

### FAN FAILURE ALARMS

Fan failure alarms are available on select heat exchanger models. These units monitor fan speed and trigger an alarm if there is a fan speed reduction or motor failure.

### HEATERS

Enclosure heaters are designed for freeze prevention and condensation protection. They are available for custom designs only.



## WARRANTIES AND CERTIFICATIONS

**Warranty:** Boyd Corporation warrants that all heat exchangers are to be free of defects in material and workmanship for a period of one year from the date of delivery. (Warranty is subject to certain conditions and exclusions.)

**UL:** UL Listed, cUL & CE.

**NEMA:** Heat exchangers are available in NEMA 12, NEMA 4, 4X and Stainless Steel.

#### Quality Accreditation and Industry Standards:

Boyd Corporation, is committed to providing customers with advanced thermal solutions that are of the highest quality, delivered in a timely manner and produced in a continuous improvement environment. This is accomplished by innovative design, development and manufacture of products that meet or exceed customer expectations for product quality, delivery and value. Advanced process controls are used with tools and techniques that allow continual improvement of our systems.

#### Related Certifications:



## FREQUENTLY ASKED QUESTIONS

**Q. Do you provide customer drawings or CAD models to help integrate heat exchangers into the design?**

Customer prints and “dummy” models, in STEP or IGES format, are available to help you allot space inside the enclosure and/or define the mounting requirements.

**Q. What is the fan life in a heat exchanger?**

With the variety of operating conditions available, it is impossible to predict fan lifespan for all applications. Fan supplier life data is available upon request. Thermostat and/or fan speed controllers can reduce runtime and/or RPMs to extend fan life.

**Q. Where are heat exchangers typically mounted in an enclosure?**

They can be mounted vertically or horizontally on the inside or outside of the enclosure. Mounting toward the top of the enclosure is typical, because that is often where the hottest air accumulates. HXi™ Series heat exchangers should not be mounted on top of the enclosure unless it is covered. Otherwise, the core of the HXi™ can fill with rain water, which would block external airflow and prevent heat exchange.

**Q. How are they installed?**

Installing the heat exchanger onto studs is recommended. Nuts and bolts can also be used, but sealing washers should be used externally for NEMA 4 applications to eliminate the possibility of water intrusion into the enclosure. Install units at least 6” from any obstructions that may impede airflow. For security reasons, install the heat exchanger from inside the enclosure to prevent external access to the mounting hardware. However, installation from outside the enclosure is sometimes required to simplify maintenance.

**Q. Are gasket and/or mounting hardware included?**

A gasket that maintains the NEMA rating of the enclosure is supplied with each standard heat exchanger. Follow the mounting methods recommended above. Installation on studs is preferred. Because Boyd Corporation does not know the specific mounting method to be used, mounting hardware is not provided.

**Q. Can the HX™ Series air-to-air heat exchangers be mounted in an upside down position?**

No, the hot side of the heat pipe heat exchanger must be level with or below the cold side. The heat pipe core is designed to work with gravity for greater heat removal efficiency. For this reason, heat pipe heat exchangers cannot be mounted to the bottom of the enclosure.

**Q. Can liquid-to-air heat exchangers be mounted at the top of an enclosure?**

No, it is not recommended. Should a leak develop, water could drip on sensitive electronics. Also, if the liquid temperature is below the dew point of the air inside the enclosure, condensation can collect and drip from the heat exchanger onto the electronics.

**Q. What about outdoor use of liquid-to-air heat exchangers?**

A non-freezing glycol/water mixture should be specified when using units in freezing temperatures.

**Q. Can altitude affect performance?**

Yes, the higher the elevation, the lower the air density, which will reduce performance. All performance values are for sea level operation

**Q. What type of routine maintenance is required?**

Maintenance depends on heat exchanger type and mounting location. The HXi™ style of heat exchangers requires very little maintenance except for fan replacement (as previously discussed). An annual check for cobwebs, insect nests and other types of blockages can maximize heat exchanger performance. HX-style heat exchangers have smaller gaps between fins, requiring more frequent checks for blockages when used outdoors or in dirty environments. With the heat exchanger turned off, foreign matter can be cleared from fins with compressed air or a hose with water. Keep air or water flow parallel to the relatively thin fins and pressure low enough to prevent damage and deformation.



## Global Presence

### Corporate Headquarters

5960 Inglewood Dr. Suite 115  
Pleasanton, CA 94588  
+1(888)244-6931

## Boyd Americas

Our highly-trained North American support teams are here to assist with your program management requirements, material selections, product design, commodity management, application engineering and raw material or finished goods testing. Our cross-functional team can be tailored to your unique needs and will closely monitor your initiatives and new programs, while ensuring tight management of new product introduction, volume production and delivery deadlines.

Alabama • Arkansas • California (4) • Connecticut • Georgia • Indiana • Juarez • Michigan  
New Hampshire • New York • Oregon • Pennsylvania • South Carolina • Tennessee • Wisconsin

## Boyd Europe

Our engineers have decades of research and develop experience to provide European customers with the highest quality custom technologies. Boyd excels in rapid prototyping and regional design services deployed for global mass production. We offer sophisticated order management that caters to your custom EDI or supply portal needs with just-in-time stocking and delivery support. Boyd delivers high touch customer service in a global environment, optimized for your complex value chains.

Italy • Germany • United Kingdom

## Boyd Asia

With operations spread across Asia, Boyd's global manufacturing footprint, engineering design centers and clean room capabilities from Class 100 to Class 100,000 provide consistent quality, speed and cost-effectiveness with centers of excellence and quality management systems to meet the unique needs of highly diversified industries, providing Asia-Pacific customers as well as global OEMs reliability throughout the product life cycle.

BacNinh • Bangalore • Chonburi • Gujarat • Gumi • New Taipei • Noida • Shanghai • Shenzhen • Wuxi