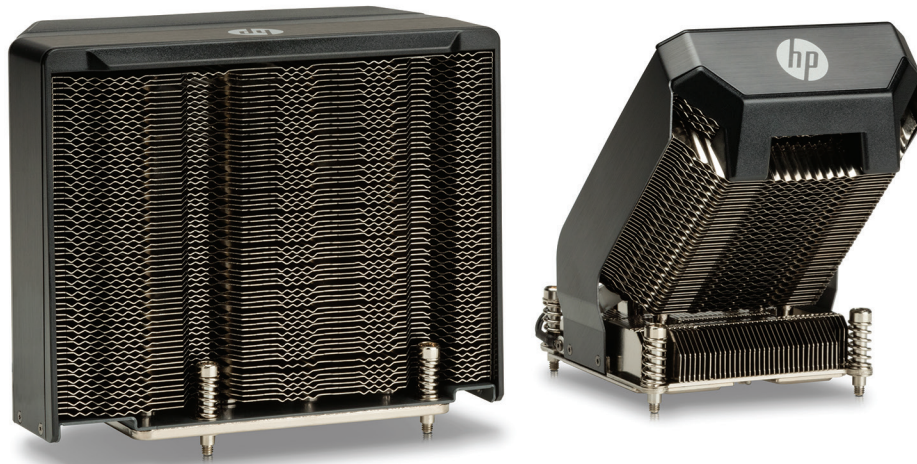


# HP Z Cooler

HP Z440 & Z840 Workstations



## What is the HP Z Cooler?

The HP Z Cooler uses 3D Vapor Chamber technology and HP's innovative Staggered Hex Fin Heat Exchanger to dissipate processor heat faster and more efficiently than ever before on the HP Z440 and HP Z840 Workstations. This increased efficiency translates into impressive system acoustics with full processor performance.

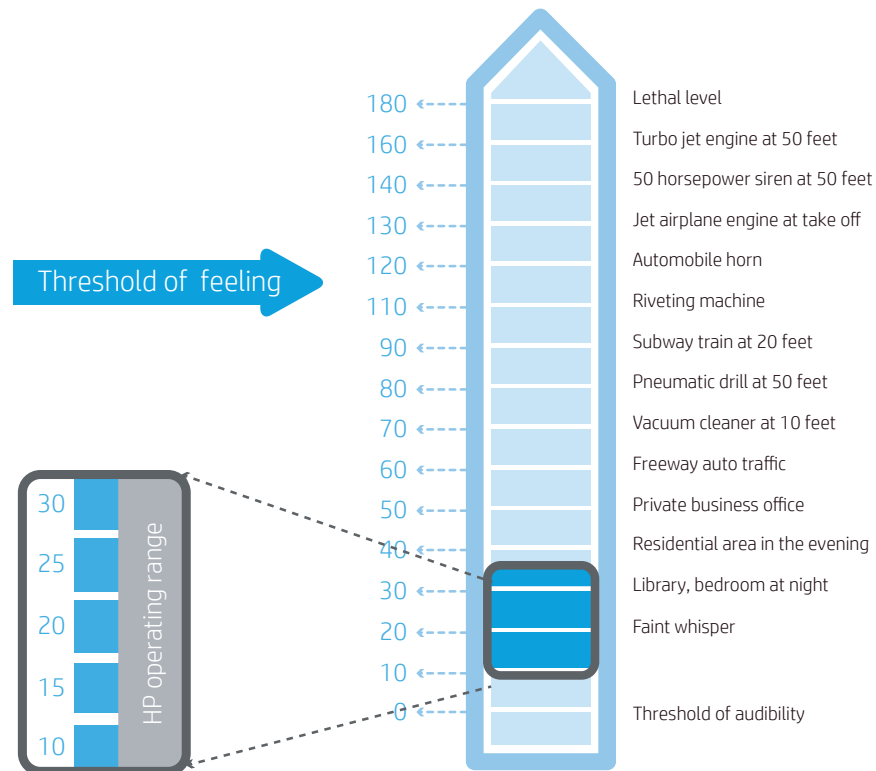
## What is acoustic noise?

Acoustic noise is unwanted vibration audible to the human ear. Many workstation components emit acoustic noise when operating. The demand for cooling requirements continues to rise as processors become more powerful, driving acoustic noise levels higher. Several studies have shown that acoustic noise disrupts the work environment, resulting in decreased user productivity.

Acoustic noise is generated by multiple components within a workstation, such as hard disk drives (HDDs), optical disk drives (ODDs), liquid cooling pumps, fans, and blowers. Fans and blowers are often significant producers of acoustic noise. Workstations commonly contain multiple fans and blowers with various functions. Some may be used to exhaust air from the interior of the chassis while others may provide cooling for graphics cards, memory, and processors. The speed at which a fan or blower operates depends upon the cooling requirements. To remove excess heat, fan speeds are increased causing a corresponding increase in acoustic noise.

The typical operating range for HP Z440 and HP Z840 Workstations is 10 dBA to 35 dBA. The scale in Figure 1 shows the decibel level for some common sounds. Through many generations of workstation development, HP has discovered that customer objections to acoustic noise begin to occur when the decibel level exceeds 35 dBA. Because of this, HP strives to keep the operating acoustic level of our workstations below the 35 dBA level.

Figure 1. Decibel levels of common sounds



#### Why did HP choose to develop the HP Z Cooler?

Many industry and ergonomic studies have shown that high acoustic levels have a negative effect on worker productivity. The HP Z Cooler works to provide extremely efficient removal of heat from the Central Processing Unit (CPU) using new HP innovations and available cooling technology. Please see “How does the HP Z Cooler work?” below. Efficient heat removal translates to lower acoustic levels associated with the cooling of the CPU. Over time, CPUs have increased in performance and have also increased the amount of heat they generate. CPUs have progressively become more difficult to cool while maintaining a low acoustic output. HP focuses on providing high levels of user productivity during the workstation design process. Low acoustic noise output is a key factor in enabling high user productivity. The HP Z Cooler is an example of HP’s commitment to user productivity.

In addition, studies have shown certain kinds of acoustic noise are more distracting than others, especially higher frequencies and irregular modulations. When a workstation executes a heavy cyclic processor workload, the fan(s) may ramp up and down rapidly with the workload, creating these irregular modulations. The improved ability of the HP Z Coolers to efficiently remove CPU heat helps to reduce these bothersome changes in fan speed, delivering a pleasant user experience even under the most demanding processor use.

#### Does the HP Z Cooler lower the acoustics of the entire system?

The purpose of the HP Z Cooler is to cool the CPU component while reducing the acoustic levels produced from cooling the CPU. If cooling the CPU creates the dominant acoustic level, reducing the CPU acoustic level will lower the total acoustic output of the system. If the graphics cards or spinning hard drives create the dominant acoustic level, reducing the CPU acoustic level will not lower the entire system acoustics.

#### Will the HP Z Cooler enable the processors to be overclocked?

The design objective and purpose of the HP Z Cooler is to lower the system acoustic level. The HP Z Cooler enables maximum processor performance at the processor’s rated frequency. HP does not promote operating the processors at greater than their rated frequency.

#### Which HP Z Workstation platforms support the HP Z Cooler?

The HP Z Cooler is offered as a Configure to Order (CTO) component on the Z440 and Z840 platforms.

**Why isn't the HP Z Cooler offered on the HP Z640?**

Due to the internal chassis layout and interference with the 2nd CPU riser connector and riser when installed, the HP Z640 cannot physically accommodate the HP Z Cooler (Z440 version) that would be required to achieve desired acoustic improvements.

**How do I order the HP Z Cooler?**

The HP Z Cooler is offered as a CTO component on the Z440 and Z840 platforms. The HP Z Cooler can be configured with all processors available on the HP Z440 and HP Z840. The HP Z Cooler can be used in both single and dual processor Z840 workstations.

To order the HP Z Cooler with the Z440, select the following CTO item:

- N3R51AV HP Z Cooler

To order the HP Z Cooler with a single processor Z840, select the following CTO item:

- N3R52AV HP Z Cooler 1 CPU

To order the HP Z Cooler with a dual processor Z840, select the following CTO item:

- N3R53AV HP Z Cooler 2 CPU

For customers that order the HP Z Cooler with a single processor Z840, there is an After Market Option (AMO) to add a 2nd processor along with the HP Z Cooler. To order the 2nd processor HP Z Cooler as an AMO, select the following AMO item along with the 2nd processor that matches the processor currently configured in the system:

- N3R54AA HP Z840 HP Z Cooler

**What are the benefits of the HP Z Cooler?**

The primary value of the HP Z Cooler is in the reduction of acoustic levels associated with cooling the CPU, the typical primary source of system acoustic noise. Lowering system acoustic levels enhances end-user productivity. The HP Z Cooler employs a single hermetically-sealed 3D Vapor Chamber unit with no pumps or hoses, so it has the simplicity and reliability of traditional heat pipes with better thermal performance than a liquid cooling system.

**What new HP innovations does the HP Z Cooler bring to market?**

To improve the cooling efficiency provided by the baseline 3D Vapor Chamber technology, HP developed two innovations that significantly improve the cooling efficiency of the HP Z Cooler: the Hex Fin Heat Exchanger and Staggered Fin Edge design.

**Hex Fin (Honeycomb) Heat Exchanger**

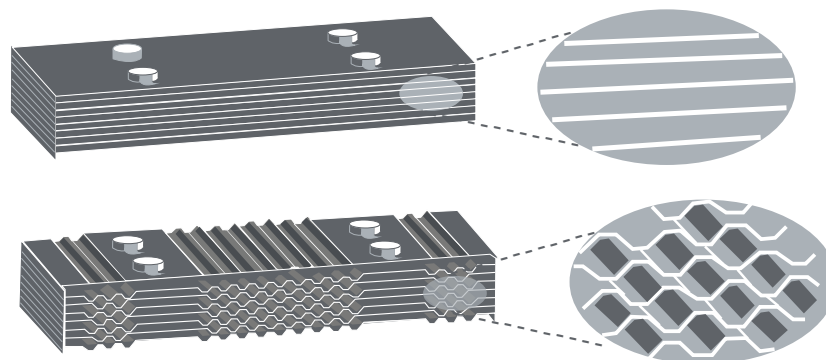
After heat has been removed from the processor, it needs to be transferred to the surrounding air so it can be removed from the chassis; this is done via a heat exchanger. In a traditional processor cooler, the heat exchanger is a series of flat parallel metal plates known as a "fin stack."

In a pump-driven liquid cooling system, the heat exchanger looks like a miniature automobile radiator with alternating rows of liquid tubes and tightly spaced fins.

The efficiency of heat transfer into the ambient air depends highly upon the airflow through the heat exchanger and the surface area available for heat transfer. These factors tend to work against one another in that adding fins to increase surface area also increases the airflow resistance (impedance), thereby reducing the total airflow.

In order to optimize the balance between surface area and airflow, a new HP innovative fin design has been created. The HP Z Coolers use specially designed fins with an alternating pattern that forms a series of hexagonal "tubes" similar to a honeycomb (see Figure 2).

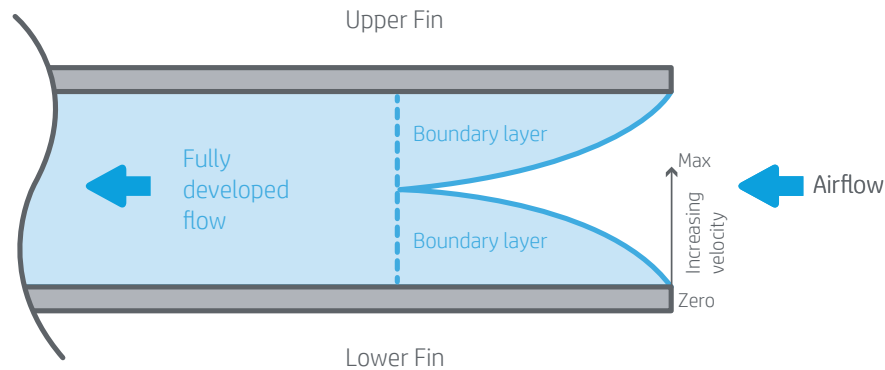
**Figure 2.** Flat fin stack vs. hex (honeycomb) fins



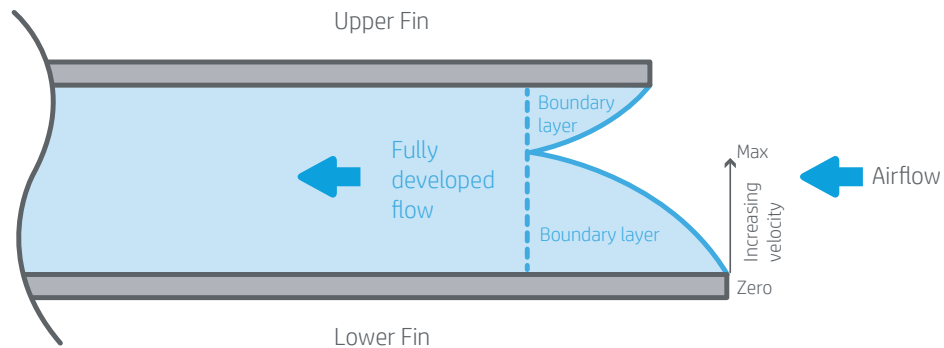
### Staggered fin edges

As air flows into the hexagonal “tubes” formed by the hex fins, boundary layers are formed along the walls of the tube. A boundary layer is a region where the velocity is less than the maximum speed of the air stream (see Figure 3). Eventually the boundary layers from each wall reach one another and the flow is considered “fully developed.” Fully developed airflow has better heat transfer. In order to encourage fully developed flow to occur sooner, the HP Z Cooler hex fins have an HP-developed staggered edge for the entrance to each tube (see Figure 4).

**Figure 3.** Boundary layer and flow formation in a normal tube



**Figure 4.** Boundary layer and flow formation in a staggered edge tube



### What is the difference between liquid cooling and the new HP Z Cooler?

Liquid cooling uses a pump to push liquid through the heat spreader that is in contact with the processor and then circulates the liquid from the heat spreader through hoses to a heat exchanger to release the heat. This is similar to how an automobile radiator works.

In contrast, the HP Z Cooler uses 3D Vapor Chamber technology that is highly efficient at removing heat and uses no pumps or hoses.

### How does the HP Z Cooler work?

- HP Z Cooler uses a 3D Vapor Chamber to draw heat from the processor
- De-ionized water in the chamber evaporates and condenses in a cyclical process

**Note:** More details on the two items above are provided under the “3D Vapor Chamber Thermal Cycle” section below

- This process heats the components in the Hex Fin (Honeycomb) Heat Exchanger
- The air travels through the heat exchanger to remove excess heat and exhaust it from the system
- Highly efficient cooling results in lower component temperatures
- Lower component temperatures result in faster cooling of components
- Faster cooling of components results in system fans having reduced cooling requirements
- Reduced cooling requirements results in fans running slower
- Fans running slower produce less noise, resulting in lower system acoustic levels

### 3D Vapor Chamber Thermal Cycle

1. The working fluid evaporates at the high temperature side of the vapor chamber, absorbing energy and creating a pressure gradient.
2. The pressure gradient causes the vapor to migrate across the vapor chamber cavity to the low temperature side. The vapor also migrates along the low pressure cavity of each heat pipe to the low temperature end.
3. The vapor condenses and is absorbed by the wick structures, releasing energy.
4. Capillary forces move the working fluid back through the wick structures to the high temperature side of the vapor chamber where the thermal cycle repeats.

Figure 5. 3D Vapor Chamber operation

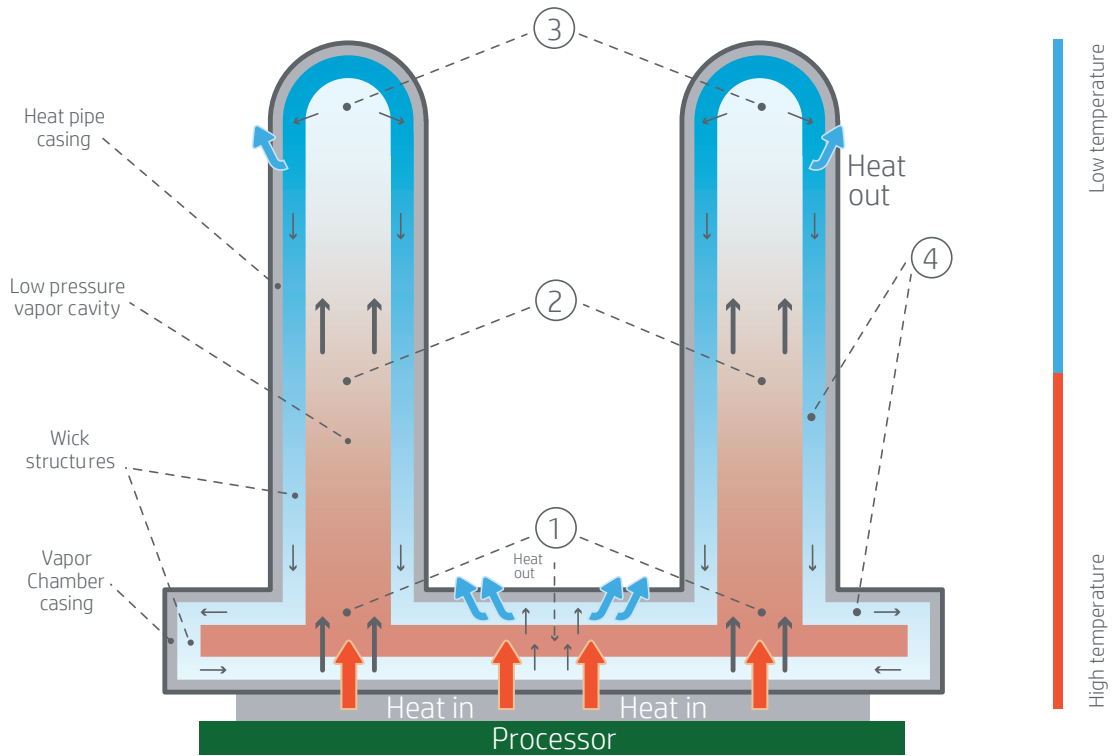
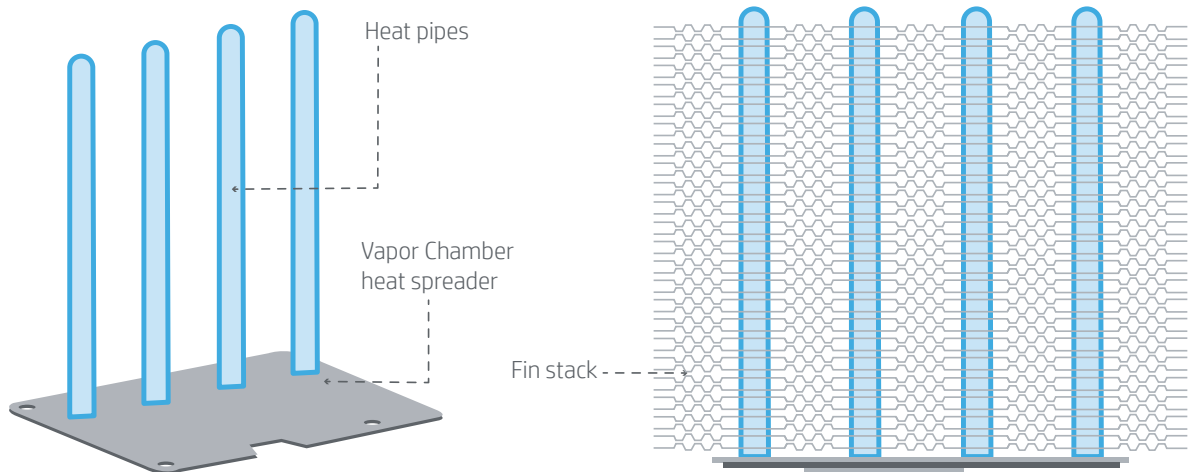


Figure 6. 3D Vapor Chamber and fin stack



### What materials and fluids are used in the HP Z Cooler?

HP is committed to engineering environmentally sustainable workstations that offer the best quality and performance on the market. The HP Z Cooler is a perfect example of this philosophy.

- The HP Z Cooler is a fully recyclable cooling solution and RoHS compliant.
- It is constructed with non-halogenated, flame retardant materials.
- It is constructed with low halogen<sup>1</sup> materials
- The working fluid is non-hazardous de-ionized water

### How do the HP Z Cooler acoustics compare to the standard cooler of the HP Z440/ HP Z840 and the solutions provided by previous platforms?

Information will be coming soon.

### Learn more about the HP Z Cooler

[White paper](#)

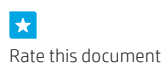
[Datasheet Z840](#)

[Datasheet Z440](#)

### Notes

<sup>1</sup> External power supplies, power cords, cables and peripherals are not Low Halogen. Service parts obtained after purchase may not be Low Halogen.

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