# The Selection and Use of Resistive Loads -

# When Should I Choose Water vs. Air Cooling?

Resistive loads, also called dummy loads or dummy antennas, continue to grow in size and capacity as the transmitters used in broadcasting and scientific pursuits increase in power. The selection of a dummy load, formerly considered a per forma matter, has now become an important part of the process of engineering a new facility.

For powers above the 5KW average level there are really only two choices of cooling medium: air or water. The poor thermal capacity [specific heat] of oil renders it unsuitable for all but a few minor applications. So the engineer really has to choose between a load which is cooled by direct application of water to one or a few resistors or a load which has numerous resistors which are cooled by forced air.

From the standpoint of simplicity, reliability and ease of maintenance, the direct air-cooled load is far superior to water-cooled loads. It is a simple device in its conception and manufacture: there is a container full of resistors, a fan to move air and a control system for the fan. Maintenance is limited to minor cleaning, lubricating the fan and, possibly, replacing fan belts. Unattended operation is the norm and extremes in ambient conditions cause little concern.

The downside of air-cooled loads is that they are usually limited to frequencies below 220MHZ. The size of the resistive element is simply too large to allow broadband operation as the enclosure dimensions approach the value of one-quarter wavelength at the operating frequency.

Of course, this limitation grows even greater as power is increased and more resistors are required. From a practical size and construction standpoint, we have found that 75KW is the maximum rating which can be economically achieved in a load capable of operation at 220MHZ.

Thus, above 220MHZ, the water-cooled load enters the picture. These loads are deceptively simple! They usually consist of one resistor housed in a plastic water jacket which is contained in a tapered line section. There are some exceptions to that rule, but that is the norm. They are marvels of efficiency, using 8 gallons per minute of water to dissipate 25KW of heat. All this in a package about the size of a man's shoe! But, they must have coolant or they are quickly destroyed. Even a few seconds without coolant while power is applied will cause complete internal destruction. Also, since they are cooled with water, which freezes, some method of freeze protection must be provided.

As transmitter power [RMS value] passes 75KW or the frequency of interest exceeds 220MHZ, we must take a careful look at ambient conditions, frequency of interest, budget and how the load is to be used.

First, let's consider the case of higher frequencies. There are many high power applications in the 220-890MHZ band. We have found few applications where an air-cooled load exhibited the desired return loss for useful operation above 220MHZ, so we must conclude that direct water-cooled loads are the only way to go in this frequency range. We have developed water-cooled loads capable of dissipating from five to 100KW from 50HZ to 890MHZ, others which are good for 125KW to 200KW from 50Hz to 450MHZ and a 300KW load for 50HZ to 277MHZ. Just as with air-cooled loads, the finite size of the resistive element limits the frequency response as power capability is increased.

Second, consider the 50-220MHZ range. This is the crossover range. If an air-cooled load is available, it certainly should be specified. If the power is more than 75KW or there is a hard requirement for harmonic attenuation, then a water-cooled load is probably the only possibility.

Third, let's consider the short wave bands. We have developed both air and water-cooled products for high power shortwave [2-26MHZ] applications. Each is unique to the customer and beyond the scope of this article.

And that brings us to the medium wave and VLF bands. For medium wave and very low frequency applications, resistor elements are easily combined to

provide much higher power capability than any single-element device could achieve. In one application, six loads are used in parallel to dissipate 1,500KW of power.

Our Model 58450 uses this approach. We have combined two loads [nominally 250KW each] in a cabinet, provided pumping capability and controls and used a dry cooler located outside of the building to dissipate the heat generated by the loads. This approach requires careful attention to many design factors, but has proven to be durable and economical, as well as intrinsically safe.

I haven't mentioned problems such as lack of space, lack of water, severe ambient conditions and remoteness of sites. Each condition requires consideration and complete specifications make the job much easier.

When Should I Choose Water vs. Air Cooling? That was the question we started with. The answer is: When I've considered all of the operating and storage requirements of the site and determined that a water-cooled load is required.

About the author:

Commander James L. Keyes is a retired Naval Officer who spent much of his 26-year career involved in avionics and Command and Control Communications. He is an accomplished pilot with more than 120 combat missions in helicopters. His assignments ranged from Destroyer Anti-Submarine Helicopter [DASH] development to support and operation of the TACAMO system, used to communicate with submerged submarines of the U.S. Strategic Deterrent Force.

Following retirement, Commander Keyes moved to Yellville, Arkansas, where he has been involved in design and manufacture of resistive loads for Altronic Research, Inc. since 1986.