The following information may be helpful in selecting and using cooling system parts for conversion purposes. You should keep in mind that there are so many variables involved with the process of cooling an engine that it's impossible to use hard and fast rules, but if you apply the following principles, you will be able to make the right decisions to add to the reliability and longevity of your vehicle. Overheating should not be a problem on a conversion if some basic principles are followed.

Engine Condition and Tuning

An often-overlooked area is the condition of the engine itself. Mechanically it must be sound and the water jackets of the block and head(s) must be free of contaminants and build-up that could act as an insulator, preventing proper heat transfer to the cooling media. A good flush of the cooling system and engine with the right detergents is a good way to eliminate this possibility. Engine compression, timing (both ignition and camshaft), as well as induction tract air leaks, thermostat (or the lack of one) are also among a few of the many cooling issues related to the engine itself that get overlooked too often.

The Radiator

Most people realize that radiator size is relative to good cooling. What may not be realized is that the core area in square inches is much more important than core thickness. As a general rule, it takes a minimum of fifty square inches more core area than displacement in cubic inches of the engine to be cooled.
As an example, a 283 c.i.d. Chevy V8 requires 283 square inches of core area plus at least fifty additional square inches of core, for a total of 335 sq. in. This could be an 18"x19" core (342 sq. in.) or any other height by width combination to end up with the number of square inches needed. The actual size or configuration be it cross flow or vertical flow, is not quite as important as long as it will fit the area available and is large enough for the engine. Some contend that cross-flow radiators with the inlet and outlet on opposite sides offers some benefit, but again, size is the chief concern. Cross-flow radiators do have one advantage in that the velocity of the fluid will have less of a pushing effect on the radiator cap, allowing it to better stay seated.
Many times a radiator will be found that has the proper core size but the mounting will be too wide or too tall, etc. The mounting flanges can often be trimmed or otherwise modified to work. Often, the radiator can also be turned around in its mountings to change the front to back location of the flanges. Sometimes a radiator may be found that is the proper size but one or both hose fittings may not be correct for the engine. A good radiator shop can do these types of modifications. However, be sure you don't end up with both hose fittings on the same side of the radiator or hot coolant will simply circulate and not pass through the core. This is an often-overlooked item that can cause overheating on a conversion.

Materials

The materials used to build the radiator are an important factor. Copper/bronze cores are the most common, but aluminum units are slowly supplanting them, especially where more rigorous cooling requirements exist. Heat transfers through different materials at different rates. Aluminum has some of the most impressive transfer capabilities of the common metals. Generally, an aluminum radiator with its high level of thermal conductivity will cool better with less core area. Plastic units, for the discussion of different conversions, are mostly worthless. They usually don't have the strength or cooling capacities required. Some radiators employ plastic tanks with a metallic core, and prove difficult with which to work.

The Radiator Cap and Cooling System Pressure

The cap of the radiator acts as a filling location, but is also a safety valve for the cooling system. The cap should be located at the absolute highest point in the cooling system to allow for the release of air and for proper filling. As mentioned earlier, the location of the cap and configuration of the radiator has some import. A cross-flow radiator is less likely to push the cap open prematurely by the pressure of the flowing fluid instead of the excess pressure of the cooling system itself. This brings us to our next topic... Pressure.
One very effective way of raising the boiling point of a fluid is to place it under pressure. Vehicle cooling systems' operational temperatures vary. "Running hot" in one system's application may be normal temperature to another. In other words, an open (or non-pressurized) cooling system will, of course, boil at 212 degrees Fahrenheit at sea level. This same system will be normal at 195-220 degrees F. with a 15-16 pressure cap and 50:50 mix of glycol coolant and water. A higher pressure in the cooling system offers a higher boiling point. In a sealed cooling system, the

pressure the hot coolant creates itself performs this pressurization function automatically. Higher coolant pressures also transfer heat from the cylinder heads more efficiently. But cooling systems can only withstand so much pressure, and a relief valve built into the cap provides this function. Naturally, you will want to use a radiator cap with the highest pressure rating that the radiator is designed to accept. As a general rule, standard systems operate at 15-21 PSI, performance radiators operate at 22-24 PSI, and professional racing radiators will go as high as 29-31 PSI. The coolant will typically only build to 16-18 PSI, due to expansion up to 200 °F. However, if the engine does overheat due to external factors, the pressure inside the cooling system could reach as high as 28 PSI. Once the radiator cap has opened and vented coolant, it is a slippery slope. The engine will not cool down until the engine has been turned off! It is recommended that for certain applications, moderate pressures be used. Higher-pressure systems become increasingly difficult to service the further away from civilization you travel.

As mentioned earlier, the location of the cap is important. It should always be located at the highest point of the cooling system; this includes the engine itself. This allows for any air in the system to rise to the cap area where it can be released, preferably to an overflow reservoir. The cap area should also see the lowest velocities within the system, further allowing the coolant to de-aerate near the cap. This is also the part of the system where the pressure is lowest, which is crucial. You only want excess heat pressure to open the cap, not the flow of the coolant. This is why thermostat housing style caps are not recommended.

Coolant

Water has some of the most unique physical properties of the known substances. One of these is its ability to carry heat. As such, it is the most effective media to carry the damaging heat away from the engine. The reason we add an ethylene glycol mix to the water is to eliminate the possibility of freezing of the coolant, and to effectively raise the boiling point of the coolant past water's natural limit of 212 degrees F. Like other alcohols, ethylene glycol extends the boiling and freezing points of the water to which it is added. However, when mixing the two, remember that more is not better. Any ethylene glycol concentration above 70% begins to raise the freezing point of the cooling media. What's more, ethylene glycol is significantly less effective at transferring heat. Mixtures of higher than 50% concentration are only recommended in the more severely cold climates.

With the inception of aluminum radiators and now more aluminum engines, silicates and some organic acids have been introduced into the coolant mixtures. As a rule, don't mix coolant types and brands together in your system, or the life of the media will diminish quickly. And don't rely on coolant colors alone to indicate compatibility, as different brands and different national and corporate standards do exist.

We should mention coolant disposability. Most vehicle owners have the class and responsibility in the disposal of coolant media, but some may not. Most locales have governmental and environmental information resources to assist you in finding a facility to dispose your coolant. Many parts stores and garages will also accept coolant drained from your vehicle. The thought of having that sort of foul substance percolating into you or your food's water supply should be deterrent enough.

Thermostats and Engine Temperature

Many mistakenly think that all there is to decreasing temperature of the engine is to decrease the temperature rating of the thermostat. If the cooling system cannot keep up with the heat the engine is generating, a cooler thermostat will help precious little. The second misconception that if some engine cooling is good, more must be better. Most engines run optimally at the recommended factory temperatures. Significant departures from these recommendations are most often counterproductive. The temperature is critical to the efficiency of the burn of the fuel and the tolerances of the motor itself. 180-195 degrees F is common on conventional engines. Modern motors see higher temperatures, mostly due to fuel and emissions efficacy.

Flow through the cap is important. Coolant should flow well enough to avoid the build-up of hot spots in the engine. Some caps feature ports that allow coolant to flow slightly even with the thermostat closed. While this delays the engine warming up in cold climates, it does promote better engine cooling, generally.

Airflow
The relationship of the core to the fan is quite important also. The core should be parallel to, and not more than one inch away from the fan and should be centered on the fan. The core cannot be mounted to the back of the grill as there must be space for air to spread out so it can flow through the core.

While on the subject of fans, we have finally seen electric fans become strong enough to effectively cool an engine conversion. With some good fan choices on the aftermarket, some of the cooling difficulties once experienced with mechanical fans, are now lessened. Additionally, many aftermarket electrics come with a built-in shroud and housing, further facilitating the process. Many units also carry a temperature sensor and relay to trigger the fan based on radiator heat; a convenience to the setup process. As for mechanical fans, both flex and clutch style fans are less than effective. Toss them.

It is important to note that by the time air has passed through three sets of radiator tubes it has just about reached the temperature of the coolant and additional thickness does little to improve cooling. This varies with ambient temperature and speed of airflow. It simply means that core area is much more important than core thickness. Another important factor related to airflow is mounting or carrying items on the front of the vehicle. Some vehicles have a rather limited grille opening area. License plates, oil coolers, driving lights, toolboxes, winches, etc. will usually cause enough turbulence to disrupt airflow at some speed or other and this could result in overheating. Also, the mounting of an automatic transmission cooler in front of the radiator will measurably diminish engine-cooling capacity as well. By the same token, a transmission cooler mounted behind the radiator will be subject to the heat flowing through the fins of the radiator, sometimes making it a poor location for transmission cooling purposes as well.
There may be situations that will result in less than ideal radiator to fan locations and these can be solved by shrouding the fan. Actually, a fan shroud is a good idea under any condition. This causes a vacuum, which improves airflow particularly at low vehicle speed. The best installations will have the rear edge of the shroud centered over the middle of the leading edge of the fan blades.

While on the subject of shrouds, some ask about pusher fans vs. the more conventional pullers. Pushers are measurably less effective due to the shrouding differences and the usual lack of a shroud with such scenarios. If you find yourself having to resort to a pusher type fan to even get the motor to fit, you may take it as an indication that the motor is perhaps too large or misconfigured for the vehicle being converted.

There may be many suitable radiators and fan configurations for any swap. This info should help you choose one that may be available, rather than suggesting some particular one that may be hard for you to find.

Other Considerations
Another overlooked item is the accuracy of the temperature gage. Some gages may be considerably out of calibration. Either electrical or mechanical gages can be off by 20 to 30 degrees. One should always crosscheck the temperature with a known good gauge. However, it has been our experience that the good mechanical gauge is more accurate and often preferable, though the routing of its pressure line is arguably more difficult than stringing a wire into the cab of the vehicle. One misconception should be debunked here, and that is that the temperature of the coolant media is the same as the metals adjacent to it. In fact, some spots of the engine see dramatically higher temperatures. This is why coolant flow rate is crucial. Should the coolant flow too slowly past these hot spots, it will boil and then lose is cooling capabilities, leading to a potential and dangerous chain reaction within the engine.

Again, a coolant overflow recovery system should be used on all pressurized cooling systems to make sure they stay full of coolant at all temperatures.

Conclusions
It is our hope that the cooling principles outlined in this article will assist you in putting together a quality cooling solution to your engine swap, or even just helpful for the maintenance and troubleshooting of a stock engine's cooling system. The longevity, reliability and therefore, capabilities of your are dependant upon it.