I had a nice conversation with Paul Miglierina, at Standard-Thomson Corporation, 152 Grove Street, Waltham, MA 02254-9109 (781-894-7310). They are a division of Thomas Industrial and Automotive, and make the automotive thermostats sold under the Stant and Gates brand names. He seems to be a great guy; he has a lot of experience and is very knowledgeable about both the practical and technical aspects of how thermostats work. I actually had two conversations with him - I had to call him back to confirm some information, since I was typing at warp ten during our first conversation. He indicated he would be happy to answer any additional questions that anyone may have.

I specifically asked if I could get some detailed performance curve information – temperature versus thermostat opening position. Paul indicated that each manufacturer uses proprietary design methods, and while he would gladly discuss the general operation of thermostats, he could not provide detailed design data. Fair enough. Here is a condensed version of our conversations in a question/answer format.

George: Our group has had some discussion that thermostats are basically on-off devices. The thermostat is there only to help the engine reach operating temperature quickly. Once it opens, it's no longer a "player" in the system since the engine should reach an ideal operating temp close to 210 degrees. Do we have that correct?

Paul: Well, that's partially true. The thermostat does stay closed until the coolant temperature reaches the nominal thermostat opening temperature. After that, the thermostat also regulates coolant flow to maintain the engine temperature in the optimum range. At Standard-Thomson, we talk about four temperatures when we design and test thermostats - other manufacturers may have other terms or methods of designing and testing their thermostats. In increasing temperature order, our temperatures go like this:

Minimum opening temperature - below this temperature, the thermostat must remain closed.
Nominal temperature - the number you read on the box, or are quoted as the thermostat rated temperature.
Maximum opening temperature - at this temperature, the thermostat must be open at least a minimum amount (0.003”, 0.005”, etc.) specified by the manufacturer.
Full open temperature - the temperature at which the thermostat is at its rated full open position (0.300”, 0.400”, etc.).

The range between the minimum and maximum opening temperature is typically around 5 to 7 degrees F, although specialized thermostats for high-performance applications may have a much narrower range. All of our thermostats must begin to open within this range, or they are rejected for failure to meet quality assurance.

George: So, if we are driving down the road under normal conditions, the thermostat is in the full open position, correct?

Paul: No. We work with the OEMs to ensure that, under normal operating conditions, the thermostat is NOT at its full open position. The thermostat is designed to keep the engine

in a narrow temperature range while it is operating. Let's use an example. If we design a thermostat with a 0.300" full opening stroke, we may want it to operate at about 0.200" open stroke under normal conditions. If you start up a big hill, or start towing a load, the engine puts out more heat. We need to be able to open the thermostat more, say to 0.250", so there is more coolant flow to remove the extra heat from the engine.

George: So you design thermostats to keep engines in a narrow range of temperatures over their various operating conditions. What engine operating temperature range do you shoot for when designing a typical thermostat?

Paul: You should realize that, when we design a thermostat, we work with a large number of variables including the type of coolant, the ambient temperature and humidity, engine heat generation, radiator capacity, water pump pressure, and at least a dozen more. There is no single temperature curve for all thermostats with a nominal rating of 180 degrees, or any other nominal temperature rating for that matter. Many common thermostats are designed to regulate the coolant in the range of 205 to 215 degrees – although thermostats designed to operate outside that range are certainly not rare. As I said, the precise temperature depends on many factors. Remember that the thermostats are not fully open when they are regulating in their design range, or they wouldn't be able to regulate the engine temperature.

George: What is the typical full open temperature for a thermostat?

Paul: Again, it varies a great deal. There is no single full open temperature for all thermostats with a given nominal rating like 180 degrees. Full open temperature can range as high as 300 degrees. I'm not saying a common engine will ever run at that temperature, but the thermostat performance curve may end with the full open temperature at 300 degrees in order to get the performance we need at lower temperatures where the engine is actually operating.

George: Sorry to beat this to death, but I want to make sure I understand this clearly. If I change from a 180 degree to a 195 degree thermostat, will my engine run hotter under normal conditions?

Paul: No, that's fine. Remember that there is no single temperature curve for all thermostats with a nominal rating of 180 or 195 degrees. You could buy a 195 degree thermostat that is designed to regulate at the same temperature as your original 180 degree thermostat. In that case, you would see no difference in the engine temperature under normal operating conditions. You would, however, see that the engine gets warmer before the thermostat initially opens.

George: So, if I have a 180 degree thermostat, and I want to increase my engine operating temperature under normal driving conditions, how do I know which 195 degree thermostat to buy?

Paul: I don't think you will easily find the information you need to do what you are

asking. Performance curves for thermostats are generally proprietary information for manufacturers. Some customers probably have increased their engine operating temperature by trial-and-error, and found a part number that does what they want to do. You may get lucky on your first 195 degree thermostat purchase, and never realize that any old 195 degree thermostat may not provide the same results.

One suggestion is to try different 195 degree thermostats in your engine and monitor the normal operating temperature with an accurate temperature meter. As you mentioned, these thermostats are not expensive parts, so you could pick up a few 195 degree thermostats with different part numbers without a big dollar investment. If you have a temperature gage in your instrument cluster, you can get a very rough sense of any changes with different thermostats, but those gages are not very good for absolute temperature measurements.

The other suggestion I can make is to measure the temperature curve for a few thermostats yourself. The measuring equipment may be a cost issue, unless you have access to a lab that can do it for you. When we test our thermostats, we use carefully stirred fluid baths to make sure we don't have temperature gradients in the fluid. We also use thermocouples attached directly to the thermostat housing to get very accurate temperature measurements – you can't be off by five degrees when doing this. You also need to set up a device to measure the opening movement of the thermostat. A dial indicator is accurate enough and works well if you put together some sort of fixture to hold the thermostat and dial indicator in place. One other thing – you can't use plain water for this type of work since it boils at too low a temperature. We use fluids specifically designed to be environmentally friendly and non-toxic for our employees. I haven't looked, but an internet search would probably get you in touch with suppliers of fluids for this type of testing.

George: One final question – and this may be something you can't answer. Some of our folks have found that removing the thermostat actually causes the engine to run hotter. Most of us agree that this seems counter-intuitive, but it certainly appears to be the case. Do you have any comments on this – or should I contact a radiator manufacturer?

Paul: Well, I don't know why that occurs. Off the top of my head, it might have to do with the coolant bypass passage in the engine not being closed when the thermostat is removed. I really haven't got any other information for you on that question.