LOCOMOTIVE COOLING WATER TEMPERATURES

An engineman's guide to proper control of engine cooling systems and maintaining optimum cooling temperatures during standard operation of locomotives.

This document is intended as a guide and reference of locomotive engine cooling water temperatures. All attempts shall be made to make clear the various key temperatures, when and how they should be achieved, as well as the various terms used throughout the document. The astute engineman reading this document may note that certain themes, subjects and terms are repeated throughout. This is quite intentional, and serves to increase exposure of subject material for attempted retainment by the subject. In addition to cooling water temperatures, there will be included a section regarding the draining of the air reservoirs on page four [4].

Terms, Definitions, and Explanations

During the course of this document there will be some terms used which may cause confusion as to what they infer. To avoid undue confusion said terms shall be listed and defined below, and some may include exceptions and/or informative additions on a case by case basis as they apply to certain locomotives. There will also be a basic overview of how the diesel prime mover and it's cooling system work. The engineman should come to know these terms and the applicable definitions, as well the various important differences between locomotives for which exceptions may apply.

- Load: Increasing the amount of work required of an engine.
  This is more or less when you place the locomotive in "run" and apply power via the throttle whilst a direction is selected with the reverser. Placing the controls in such a manner means there is a draw on the main generator and therefore the prime mover must work harder. On 1857 it would simply be putting the loco Run on/off switch to the "on" position.

- Idle: The running of an engine at its lowest set RPM and lowest set fuel-rack position.
  To mean in the case of our diesel-electric locomotives, the prime mover turning at low RPM which is controlled by how much fuel is injected, which is controlled by the governor. The majority of the time when the engine is idling, the system is not under load, though some locomotives may output amperage from the main generator when put into the initial throttle setting without increasing RPM.

- Throttling up under load: Increasing engine speed above an idle RPM while there is an applied load.

- Throttling up out of load: Increasing engine speed above an idle RPM while not being under any load.
  The increase of engine RPM correspondent to an increase of throttle position, while the directional control is set to neutral.

- Light engine: The movement of a locomotive or locomotives in consist, while not moving any cars etc.

- Condensate: The accumulation of condensation and vapor.
  In the case of the locomotives air system, the water vapor and condensation in the pipes and air reservoirs.

Overview of the Diesel Engine Cooling System

A basic understanding of how the diesel prime mover and it's cooling system work together will help the engineman understand the importance of the cooling system and why it is imperative to be within a certain temperature range.

The diesel-electric locomotive uses a diesel engine connected to a generator in order to produce traction. This is the diesel prime mover. For the scope of this document things shall be kept brief and simplified.

Engines produce heat while operating. This heat is a result of the combustion process, as well to some extent the friction of the engine's moving parts. In order to dissipate this heat, a cooling fluid is circulated through the engine to the radiators. The cooling system also circulates coolant trough an oil cooler to maintain proper lubricating oil temperature.

The mention of lubrication here does have a direct relation to our main subject of cooling. Lubricating and cooling systems are an integral part of engine operation. Lubrication lessens friction, and the cooling system maintains the optimum temperature of not only the engine but the lube oil as well. Lubricating oil works best within a certain temperature range. When cold, the oil is more viscous (thicker), and doesn't lubricate as well. This makes it harder for the moving parts of the engine to operate, and the oil itself is harder to circulate throughout the system and exerts a higher pressure as it does so. As oil warms up it thins out (becomes less viscous). If too hot, the oil can become thin enough to blow past/out of where it is needed, and in some cases can blow past the piston rings. Ring blow-by results in excessive oil in the combustion chamber, which produces increased carbon buildup. It also fills the exhaust headers and manifolds with oil, which when combined with the increased carbon can become dangerous as a fire hazard over time. Increasing engine speed while outside of the optimum temperature range not only requires the engine and it's parts to work harder, but can also be harmful and cause damage.

Engine Cooling Water Temperatures

The following section shall list the key water temperatures that the engineman should be mindful of. The temperatures listed are important as that certain actions may or may not be taken until corresponding temperatures are reached. For the most part, these are constant amongst all of our locomotives currently operating, but there are a few case by case things that must be taken into account. Under normal conditions, such as RALs or Caboose Train operations, the locomotive should be at certain key temperatures. Failure to do so causes undue wear and tear of the engine. The four key temperatures are as stated below:

1. The locomotive should be idled to a minimum of 100-110 degrees F before being throttled up. This may take as little as thirty minutes, to as long as sixty or more minutes, depending on the ambient temperature and locomotive. After the above temperature(s) have been reached, it may be permissible for the engine to be throttled up *out of load*.

2. At 120 degrees F, the locomotive may be placed under load and used in light engine, light use.

3. At 140 degrees F, the locomotive has reached the lower limit of "normal operating temperature range" which for most of our locos ends at 180 degrees (140-180 F). At this point the loco may be used for normal use.

4. At about 180 degrees F, the water temp is at the far end of the operating range. On locomotive with manually controlled cooling (1100 and 1857), the shutters should be opened at this temperature. The shutters should be left opened until the water temp reaches about 160 degrees F at which point they should be closed. Letting the engine cool down to 140 degrees F is not necessarily detrimental, but it is not recommended either and should be avoided when possible. *Do not cool the engine down to 120 F while running*.

* **Any failure of the temperature regulating systems should be reported to the proper authority. Any tinkering of such control systems, especially on 1857, should be done only by qualified and informed individuals.**

The Air System and Draining of Condensate

Another important part of a properly operating locomotive is the air system. Compressed air plays a vital role in just about everything, from the brakes to the pistons that open and close the radiator shutters, to actuating control and power contactors, down to the windscreen wipers. All these components are supplied from an extensive system of piping and tubing that all eventually can be traced back to the main reservoir tanks. For this reason, the main reservoir tanks will be the focus of the draining of condensates and other contaminants.

Upon start up of the locomotive, one must open the drains on the main reservoir tanks in order to drain any condensate from them. This is a part of the inspection checks and more than highly recommended (mandatory). The draining of the main reservoir tanks upon shut down is somewhat situational. If the loco is not going to be used again for a considerable amount of time then the tanks should be blown down (tank drains left open and all air let out). If the loco is going to be used again relatively soon, one should at least open the drains to check for any accumulation of condensates. If the locomotive is left running but your are out of the seat and have ample time (such as engineer swap, between RALs, etc) you should check the reservoirs for condensate.

Accumulation of condensate is natural, but can be kept to a minimum by following these procedures. When the reservoirs are not drained enough excess condensate accumulates, which causes lots of problems because many of the controls of the locomotives are air-controlled. Air pistons in the contacts and relays gum up and/or rust, lines clog with gunk and/or rust, and in the winter the air lines freeze.