

## Thermal Profiles of Electric Motors and Their Relationship to Electric Motor Testing: *A Study in Progress*

**In reality every individual motor has its own unique operational characteristics, but should operate within a set of normal parameters established by industry standards.**

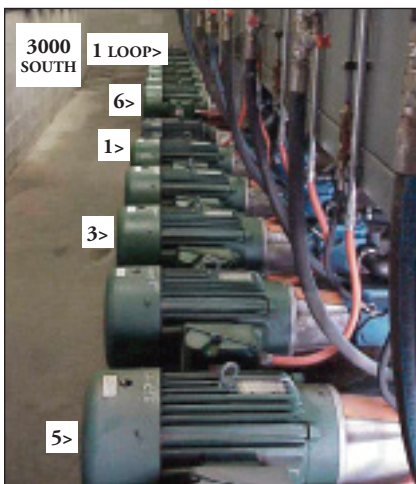


Figure 1: 3000-gallon (far end) and 1500-gallon (near end)—South side from far end:  
#1 Loop Pump then #1-6 Pumps;  
#2 not running.  
From middle:  
#3 Loop then #1-5 Pumps;  
#1 not running,  
#6 not shown

Data first collected (sometimes called baseline) is very useful for comparison to future data for trending and analysis. This helps confirm anomalies that may indicate deteriorating equipment and can also be used to help determine severity.

When inspection programs are created, inspectors normally do not have the luxury of being able to collect their baseline data on all new equipment operating within normal parameters. Usually the equipment has been in operation for years and may or may not be operating normally. This creates a situation where the first data collected, reflecting years of previous operation, may become baseline used for future comparison and trending. This could affect analysis and interpretation in a way that may indicate less severity than it actually may be. An understanding of, and experience with, electric motors will also be invaluable in analyzing this type data. This study began with a supposition and question: How can thermal profiles of motors be used to reinforce the findings of possible anomalies detected by online and offline testing and vice versa, especially in the relationship of operating temperatures versus percent of full load amps.

This study was performed on twenty-one motors. Eighteen of them are identical motors in identical service with the same model number and sequential serial numbers. This created a unique situation where motor data could be compared and analyzed. In reality every individual motor has its own unique operational characteristics, but should operate within a set of normal parameters established by industry standards. With these variations of operational characteristics in mind it was assumed these motors, with sequential serial numbers, would provide data similar enough to make valid comparisons.

Eighteen of the motors are 30 horsepower with 286TC frames. The other three motors are 20 horsepower with 256TC frames. All have hydraulic pumps bolted and direct coupled to the motors.

There are twelve hydraulic pumps and two re-circulating or loop pumps on a 3,000-gallon tank. There are six hydraulic pumps and one re-circulating pump on a 1,500-gallon tank.

The 3,000-gallon tank has seven hydraulic pumps on the south side and seven hydraulic pumps on the north side. South side pumps are numbered #1 Loop and #1–6 Hydraulic Pumps (Figure 1). North side pumps are numbered #2 Loop and #7–12 Hydraulic Pumps (Figure 4, next page).

The 1,500-gallon tank has seven pumps on the south side only. These pumps are numbered #3 Loop and #1–6 Hydraulic Pumps (Figure 1).

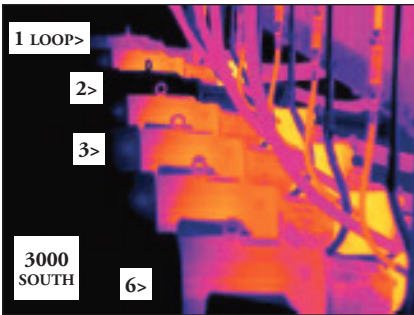


Figure 2: 3000-gallon (South side). From far end: #1 Loop Pump then #1-6 Pumps; #2 not running.

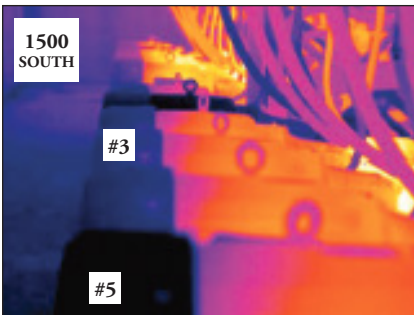


Figure 3: Near End, 1500-gallon, South side. From middle: #3 Loop then #1-6 pumps; #1 not running, #6 not shown.

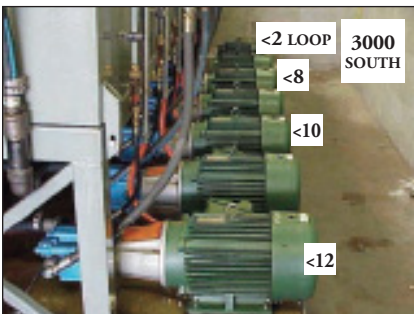


Figure 4: 3000-gallon tank - North side. From far end: #2 Loop then #7-12 Pumps.

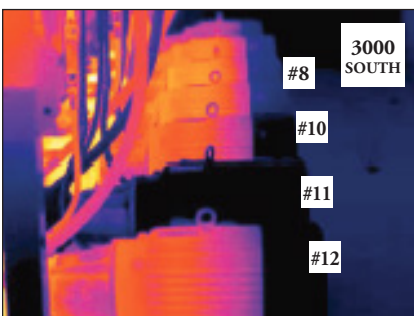


Figure 5: 3000-gallon - North side. From far end: #2 Loop then #7-12 Pumps, #11 not running.

Normally five hydraulic pumps plus the loop pump are running simultaneously in each set of seven. The remaining hydraulic pump in each set of seven is normally on standby. Valves on each pump manually control motor loading and hydraulic flow/pressure.

The motors are relatively new and apparently in good condition. Thermal profiles were taken of the motors along with online and offline motor circuit test results. The thermal profiles appeared typical of running motors in good condition. Drive end motor bearings could not be viewed due to the pumps being bolted directly to the Cflange of the motors. The fan shrouds on the opposite ends also shielded the opposite end bearing profile. The online and offline tests showed the motors to be operating normally except in one category of testing. This anomaly was present in all the motors and will be discussed briefly at the end of this paper.

Initial comparisons were made between the thermal profiles and the percent of full load amp data. Percent of full load amps, along with the other test data, was gathered with online testing at the time the thermal profiles were taken. Future plans, as time permits, include comparing the other online and offline testing data to thermal profiles for possible trending and analysis.

Below are thermal profiles of four motors that represent all the motors in the study. The four were selected because they provided the widest range of differences and similarities. Table 1 contains the temperatures and percent full load amps of the four motors found in Figures 6, 7, 8 and 9 (next page).

Figure Number	Tmax DegC	%FLA	X-Axis Reference
6	94	84%	1
7	81	74%	2
8	69	70%	3
9	75	73%	4

Table 1

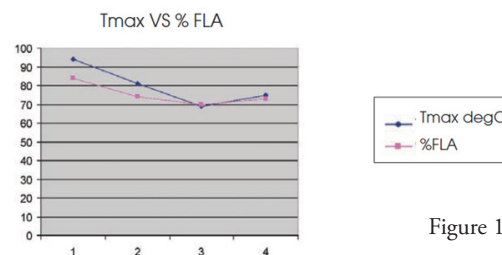


Figure 10

Figure Comparison	T% Difference	% FLA Difference	X Axis Reference Point
6 to 7	13.83%	10%	1
8 to 9	8.00%	3%	2
6 to 9	20.21%	11%	3
7 to 8	14.81%	4%	4
6 to 8	26.60%	14%	5
7 to 9	7.41%	1%	6

Table 2

When Table 1 is charted, it is evident that as percent of full load amps increase operating temperature increases.

Table 2 contains the motor temperature differences, calculated as a percent, and the percent of full load amps difference.

When table 2 is charted, it reinforces the relationship of temperature and percent of full load amps.

In Figure 11 (next page) one can see a definite correlation between percent of full

