

Adventech Test Report

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INTRODUCTION

Mr. Ron Ballman, Chief Executive Officer, at Adventech LLC (“**Client**”) contacted North Carolina Advanced Energy Corporation (“Advanced Energy”) to evaluate his electric motor product line for efficiency and performance. An introductory meeting was held in November to review the motors and plans of the Client. During that meeting it was noted the technology had been reviewed before by Advanced Energy dating back to 2008 when the technology had different financial support. Since that time improvements have been made and Client is seeking market penetration with the Maxeff motor brand. Three Client motors were tested at the Advanced Energy laboratory in February 2021. This report summarizes the test procedure and results.

TEST PROCEDURE

Test Setup

The test motor specifications are presented below in Table 1. Advanced Energy supplied all necessary measurement equipment. All equipment used for the testing is subject to Advanced Energy’s calibration requirements – ISO/IEC 17025 accreditation. Calibration certificates for this testing are available upon request.

Table 1: Motor Nameplate Specifications

HP	RPM	Voltage	Frame	Efficiency
40	3588	480	200L-2	95.1
45	1788	480	225S-4	95.8
45	1188	480	250M-6	95.6

Efficiency Testing

IEEE 112 Method B is the required test procedure for motor manufacturers looking to gain initial compliance to sell in the United States. It is an input-output test with segregation of losses and an indirect measurement of stray-load loss. The test includes a thermal stabilization, load points, no-load points, and various winding resistances. The IEEE 112 Method B test is beneficial in determining motor efficiency, segregated motor losses, the no-load saturation point and temperature rise by the winding resistance method. IEEE 112 Method B is specifically titled “Test Procedure for Polyphase Induction Motors and Generators.” Its scope covers motors 1.0HP and above.

Speed/Torque Performance

To effectively drive a load a motor must produce torque greater than the torque required by the load at all speeds from start to full. A motor that is unable to quickly accelerate the connected load to operating speed will generate damaging excessive heat and either fail immediately, cause the breaker, starter, or drive to trip, or experience a shortened life. A torque-speed test ensures a motor's characteristics are adequate for a specific application. Locked rotor current and torque are recorded during this test as well as breakdown torque.



Figure 1: 40HP, 2 pole motor test setup



Figure 2: 45HP, 4 pole test setup



Figure 3: 45HP, 6 pole test setup

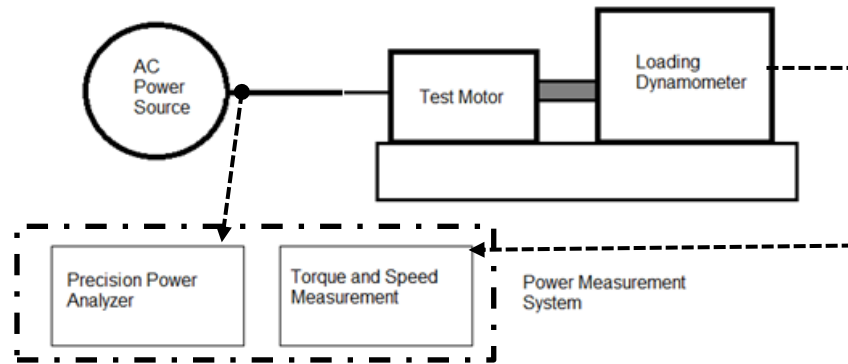


Figure 4: Schematic of the test setup

Test Results

Thermal stabilization results for each motor are shown below in Figure 5. Efficiency and power factor results at rated load are shown in Figure 6. Speed/torque results are shown in Figure 7. Raw data for each efficiency test (including extra load points) is shown in Appendix A.

Each Client motor stabilized within the limits set by its listed insulation class (Class H). Each Client motor met the minimum locked rotor and minimum breakdown torque requirements set forth by NEMA MG-1. However, each Client motor exceeded the maximum locked rotor current set forth by NEMA MG-1.

40HP, 2 pole motor	Initial	Thermally Stabilized
Ambient Temp. (°C)	21.8	22.8
Stator Winding Temp. (°C)	20.6	81.3
Resistance (Ω)	0.13619	0.16850

45HP, 4 pole motor	Initial	Thermally Stabilized
Ambient Temp. (°C)	22.0	24.0
Stator Winding Temp. (°C)	20.3	91.0
Resistance (Ω)	0.16235	0.2047

45HP, 6 pole motor	Initial	Thermally Stabilized
Ambient Temp. (°C)	21.9	23.4
Stator Winding Temp. (°C)	21.7	92.5
Resistance (Ω)	0.13297	0.16970

Motor	Temperature Rise by Resistance (°C)
40HP, 2 pole	58.3
45HP, 4 pole	62.8
45HP, 6 pole	69.0

Figure 5: Thermal stabilization results

Motor	Efficiency at Rated Load	Power Factor at Rated Load
40HP, 2 pole	93.4%	0.998
45HP, 4 pole	93.0%	0.988
45HP, 6 pole	92.6%	0.994

Figure 6: Efficiency and power factor results

Motor	Locked rotor (Raw)			Breakdown (Raw)			
	Voltage (V)	Current (A)	Torque (N-m)	Voltage (V)	Current (A)	Torque (N-m)	Speed (RPM)
40HP, 2 pole	433.4	380.4	200.8	449.9	258.8	312.7	3380
45HP, 4 pole	437.9	364.0	379.6	458.5	192.5	506.4	1726
45HP, 6 pole	426.8	457.7	735.9	451.8	253.1	1008.7	1138

Motor	Locked rotor (Voltage Corrected)			Breakdown (Voltage Corrected)			
	Voltage (V)	Current (A)	Torque (N-m)	Voltage (V)	Current (A)	Torque (N-m)	Speed (RPM)
40HP, 2 pole	480.0	421.3	246.3	480.0	276.1	355.9	3380
45HP, 4 pole	480.0	398.9	456.0	480.0	201.5	555.0	1726
45HP, 6 pole	480.0	514.8	931.0	480.0	268.9	1138.7	1138

Figure 7: Speed/torque performance results

Appendix A

Raw data 40HP, 2 pole											
Target Load (%)	Speed (RPM)	Torque (N-m)	Power Out (kW)	Power In (kW)	Efficiency (%)	Voltage (V)	Current (A)	Power Factor	Ambient Temp. (°C)	Stator Winding Temp. (°C)	Frequency (Hz)
200	3549	160.5	59.7	64.7	92.1	480.1	80.1	0.972	22.9	79.6	60.0
175	3557	140.1	52.2	56.2	92.9	480.0	68.9	0.981	23.0	84.8	60.0
150	3564	119.9	44.7	47.9	93.3	480.1	58.3	0.989	22.8	79.7	60.0
125	3570	99.7	37.3	39.7	93.8	480.1	48.1	0.994	22.8	81.8	60.0
115	3573	91.7	34.3	36.6	93.8	480.0	44.1	0.996	22.8	82.3	60.0
100	3576	79.6	29.8	31.8	93.6	480.0	38.4	0.998	22.9	82.2	60.0
75	3584	59.6	22.4	24.1	92.7	480.0	29.1	0.996	22.9	81.1	60.0
50	3590	39.7	14.9	16.4	91.2	479.9	20.0	0.984	22.8	79.5	60.0
25	3596	19.6	7.4	8.8	84.4	479.9	11.5	0.916	22.7	77.8	60.0
No-Load	N/A	N/A	N/A	1.4	N/A	480.1	5.4	0.309	22.9	56.5	60.0

Raw data 45HP, 4 pole											
Target Load (%)	Speed (RPM)	Torque (N-m)	Power Out (kW)	Power In (kW)	Efficiency (%)	Voltage (V)	Current (A)	Power Factor	Ambient Temp. (°C)	Stator Winding Temp. (°C)	Frequency (Hz)
200	1764	363.4	67.1	74.3	90.3	480.0	95.9	0.932	24.0	95.5	60.0
175	1770	316.5	58.7	64.2	91.3	480.0	81.2	0.952	24.1	104.2	60.0
150	1777	270.5	50.3	54.6	92.3	480.0	67.9	0.967	24.2	86.4	60.0
125	1781	224.9	41.9	45.2	92.9	479.9	55.5	0.979	24.1	89.9	60.0
115	1783	206.7	38.6	41.5	93.1	480.0	50.8	0.983	23.9	91.2	60.0
100	1786	179.5	33.6	36.0	93.3	480.1	43.8	0.988	23.9	91.2	60.0
75	1789	134.3	25.2	27.0	93.1	479.9	32.7	0.993	23.8	90.1	60.0
50	1793	89.2	16.8	18.2	92.1	480.0	22.0	0.995	23.8	88.1	60.0
25	1796	44.6	8.4	9.6	87.2	480.1	11.8	0.983	23.6	85.3	60.0
No-Load	N/A	N/A	N/A	1.2	N/A	480.0	3.1	0.470	23.2	61.3	60.0

Raw data 45HP, 6 pole											
Target Load (%)	Speed (RPM)	Torque (N-m)	Power Out (kW)	Power In (kW)	Efficiency (%)	Voltage (V)	Current (A)	Power Factor	Ambient Temp. (°C)	Stator Winding Temp. (°C)	Frequency (Hz)
200	1181	542.6	67.1	73.0	91.9	480.1	90.3	0.973	23.1	88.1	60.0
175	1184	473.8	58.7	63.5	92.4	480.0	77.9	0.981	23.1	95.6	60.0
150	1187	404.9	50.3	54.2	92.8	480.1	66.0	0.987	23.0	90.0	60.0
125	1189	336.9	41.9	45.1	93.0	480.0	54.7	0.992	23.2	92.3	60.0
115	1190	309.7	38.6	41.5	93.0	480.0	50.3	0.993	23.1	92.8	60.0
100	1191	269.0	33.6	36.2	92.8	480.0	43.7	0.994	23.1	92.5	60.0
75	1194	201.4	25.2	27.3	92.0	480.1	33.1	0.994	23.2	91.5	60.0
50	1196	134.0	16.8	18.7	89.9	480.0	22.8	0.987	23.2	89.9	60.0
25	1198	66.9	8.4	10.1	82.8	480.1	12.8	0.949	23.1	88.2	60.0
No-Load	N/A	N/A	N/A	1.7	N/A	480.0	5.1	0.411	23.2	74.6	60.0