



Quality Motor Rewinding an Energy Efficiency Measure

Regional Technical Forum Submittal

May 22, 2007

Table of Contents

Executive Summary.....	3
Introduction	3
Background	3
Calculating Motor Energy Use and Savings.....	4
kWh Savings Table	5
Table 1: Deemed Green Motor Practices Protocol Electrical Savings	5
Application and Commitment.....	5
Worthwhile and Necessary	6
Acknowledgments.....	6
Contact.....	6
ATTACHMENTS.....	7
GREEN MOTORS PRACTICES GROUP.....	8
ANNUAL MEMBER COMMITMENT	8
Annual Member Commitment Attachment A	9
Annual Member Commitment Attachment B.....	9
Annual Member Commitment Attachment C.....	9
Table 2: Rewinding NEMA Premium® motors	10
Table 3: Rewinding Epact motors	11
Table 4: Rewinding standard motors.....	12
Mission.....	13
Vision.....	13
Strategy.....	13
Tactics	13
GMPG Officers	14
GMPG Member Roster.....	14
GMPG Member Roster (cont)	15
Incentive Sample Form	16

Executive Summary

- The Green Motors Practices Group (GMPG) is requesting Regional Technical Forum (RTF) approval of deemed savings for motors rewound by participating members and adding this resource to the list of eligible energy efficiency measures;
- NEMA Premium® motor purchases have been incentivized with similar savings and so should efficient motor repair/rewinding offering similar kWh savings;
- Many new energy efficient motors installed under regional efficiency programs are now reaching the end of their life and need repair;
- Green Motor Practices Group members and EASA's process protocol can maintain or slightly improve original motor efficiency during repair/rewinding and save energy.

Introduction

Energy efficiency organizations have long encouraged NEMA Premium® motor purchases with incentives. It's now time to recognize quality rewind practices that will maintain those efficiencies as an equally valuable energy efficiency measure. The Green Motors Practices Group (GMPG)/RTF approval is intended to provide utilities and BPA in the Pacific Northwest with the ability to acquire and enhance this cost effective resource across the Northwest region.

The RTF's approval of the energy efficient rewind practices of GMPG members will hopefully lead to the use of uniform program specifications throughout the region—bolstering the bottom line of industrial firms and local motor service centers that support them.

Background

There is a widely prevalent but incorrectly held belief that rewound motors always lose efficiency. In February of 2000 a DOE publication stated, "You should generally subtract two points from motor efficiency on smaller motors (≤ 40 HP) and subtract one point for larger motors." Not everyone read what the same document goes on to say, "Shops with the best quality-control practices can often rewind with no significant efficiency degradation."¹ Motor Master+ was updated in 2005 with about one-half of these deductions for rewound motors:

- **Deduct 1% efficiency for motors 40 HP or less;**
- **Deduct 0.5% efficiency for 50 HP and larger motors** ².

Reinforcing the above defaults in 2003 EASA/AEMT released "The Effect of Repair/Rewinding on Motor Efficiency" decisively proving:

- **No losses in motor efficiency provided processes are controlled;**
- **If processes are not controlled larger motors (75-150 HP) lost on average 0.6% efficiency**³.

¹ Energy Management for Motor Driven Systems, published by Office of Technologies Energy Efficiency and Reliable Energy, US Department of Energy, see Motor Load and Efficiency Estimation Techniques page 5-7

² Motor Master 4.0 Users Guide, produced by Washington State University Cooperative Energy Program see Page 27 numbered bullet 2

³ The Effect of Repair Rewinding on Motor Efficiency, published by the Electrical Apparatus Service Association, Inc. and the Association of Electrical and Mechanical Trades, see Part 1 page 1-5, group A, B, C1, and C2

This EASA/AEMT study in conjunction with EASA’s “Guidelines for Maintaining Motor Efficiency During Rebuilding” is used by the Green Motors Practices Group (GMPG) and is the basis of our RTF request for approval. The nonprofit GMPG was incorporated in 2006 and is operated by motor service industry leaders aided by the Industrial Efficiency Alliance requiring member motor service centers to:

- Sign a commitment to provide energy efficient system services—including **efficiency retention or improvement in the repair/rewind process**;
- Members agree to recommend replacement or repair/rewind on the basis of total cost of ownership;
- Motor repair/rewind procedures are in accordance with EASA’s “Guidelines for Maintaining Motor Efficiency During Rebuilding” and the EASA/AEMT Study;
- Organization and personnel are made available for training, GMPG inspection, and process review;
- When failure event damages may impact motor efficiencies, customers are made aware of the economic consequences;
- Non-compliant motor service center members have six months to comply or be removed⁴.

Green Motors Practices Group members are committed to these standards for motor rewinds to maintain motor efficiency and provide the best value to their customers.

Calculating Motor Energy Use and Savings

$$\text{Annual Energy (kWh)} = \frac{\text{Horsepower} \times 0.746 \times \text{Operating Hours} \times \text{Motor Loading}}{\text{Efficiency}}$$

Where:

- Horsepower and 0.746 kW/hp are given
- Assumed Operating Hours to be as follows per Year⁵

Size Category	Hours	Size Category	Hours
1-5 HP	2,745	101-200 HP	5,200
6-20 HP	3,391	201-500 HP	6,132
21-50 HP	4,067	501-1,000 HP	7,186
51-100 HP	5,329	1,000 plus HP	7,436
		All Motor Sizes	5,083

- Assumed Motor Loading to be 68.2%⁶
- Efficiency =
 1. If Standard⁷, Epact⁸, NEMA Premium⁹ or Green Motors Practices rewind then efficiency will be based on appropriate published tables without adjustment¹⁰

⁴ Green Motors Practices Group application and commitment documents, see Attachments of this submittal

⁵ United States Industrial Electric Motor Systems Market Opportunities Assessment, published by US Department of Energy December 1999, Motor Challenge, see Section 1, page 42

⁶ Achieving More With Less: Efficiency and Economics of Motor Decision Tools (2006), Prepared By Advanced Energy, see Motor Load Conditions page 29

⁷ Standard Table, USDOE, Attachment C, Average Efficiencies for Standard Efficiency Motors at Various Load Points

⁸ Motor Efficiency Tables, Washington State University Cooperative Energy Program

⁹ NEMA Premium® Efficiency Table, Product Scope and Nominal Efficiency Levels

¹⁰ The Effect of Repair Rewinding on Motor Efficiency, published by the Electrical Apparatus Service Association, Inc. and the Association of Electrical and Mechanical Trades, see Part 1 page 1-5, group A, B, C1, and C2

2. If non-controlled rewind of motor ≤ 40 HP then reduce efficiency by 1%. If 50 HP or greater then reduce efficiency by 0.5%. ¹¹

kWh Savings Table

The following Table and the Attached Tables are calculated using the above formula, assumptions, and efficiency qualifications:

- Table 1 is a simple average of kWh savings over all RPMs and Enclosures from Tables 2, 3, and 4;
- Attached Tables 2, 3, and 4 assign kWh savings based on *efficiency retention* using controlled repair/rewind processes;
- 36% of industrial and commercial motors are custom¹² and must be repaired/rewound as replacements are difficult to find; Green Motors Practices reaches those motors;
- Replacing standard and Epact with NEMA Premium® motors is best, but controlled repair processes net similar savings.

Table 1: Deemed Green Motor Practices Protocol Electrical Savings

HP	Average kWh saved	HP	Average kWh saved
1	16	60	856
1.5	25	75	1097
2	33	100	1456
3	48	125	1771
5	80	150	2116
7.5	146	200	2809
10	196	250	4136
15	291	300	4952
20	385	350	5732
25	573	400	6542
30	686	450	7349
40	909	500	8165
50	573		

See Attached Tables 2, 3, and 4 for specific kWh savings rather than the above simple average abbreviations

Application and Commitment

The current Green Motors Practices Group commitment document is attached for review; for additional information visit www.greenmotors.org.

¹¹ Motor Master 4.0 Users Guide, produced by Washington State University Cooperative Energy Program see Page 27 numbered bullet 2

¹² The Blue Book, page 77, Table 3-9: OEM Restrictions on Equipment with Installed Motors Restrictions, Percent Reporting Replacement motors available only through OEM 22%, Replacement only through one manufacturer 14%

Worthwhile and Necessary

- The Green Motors Practices Group is active in the market and ready to expand; however the market needs encouragement as quality repair/rewind processes cost more;
- Motor consumers, Pacific Northwest utilities, and BPA need to ensure efficiency retention and capture the significant energy savings through Green Motors Practices repair/rewinding protocol;
- As NEMA Premium® motors become more prevalent, continuing to replace with another NEMA Premium® or an Epact motor makes less sense from a cost, from an energy and also from an environmental standpoint;
- Motor rewinding has long been and will remain a large part of the motor industry;
- Currently eleven northwest motor service centers are members – about 20% of the rewind market;
- Green Motor Practices for motor repair are cost effective compared to new energy efficient motors (Not all motors can be replaced with NEMA Premium®—making efficient repair the best option);
- Green Motors Practices Group members are offering these services and serve a significant portion of the regional market (The group is growing);
- RTF approval hopefully would lead to uniform utility program specification for efficient motor rewinds throughout the Northwest;
- Uniform specifications would bolster the bottom-line for northwest commercial, agricultural and industrial facilities and encourage local motor service centers that support them.

Acknowledgments

We would like to thank the Strategic Energy Group's Steven Scott for his review and suggestions.

Comments or Questions Contact

Green Motors Practices, Dennis Bowns, 5201 W. Overland Rd., Boise, ID 83705
Phone: 208-322-6999, E-mail: greenmotors@cs.com

ATTACHMENTS

GREEN MOTORS PRACTICES GROUP

ANNUAL MEMBER COMMITMENT

As a member of the Green Motors Practices Group (GMPG), if _____ service center agrees to complete the following high-level service goals/tasks:

Adopts and publishes a company-wide shop practices policy, and communicates it effectively with stakeholders (customers, employees, investors, service center suppliers);

Commits to include in their shop practices and policies to actively support customer/client motor driven system efficiency and reliability improvements;

Agrees to promote continuous energy improvement by customers/clients;

Identifies primary person to work with the GMPG to prepare and implement a marketing plan that includes life-cycle cost analysis;

Identify shop (internal) personnel to work with GMPG and staff to support shop practices, continuous energy improvement, and key performance indicators as outlined in EASA's Tech Note 16 as modified from time to time by EASA.

Agrees to random inspection by a Group representative (see attachment A);

Agrees to inform customers and exclude in writing motors that may not sustain reliability and/or efficiency and should not be considered for repair as a compliant product of the GMPG (Attachment B);

Agrees that Sales and Shop-floor Champions will participate in and document eight-hours annually of Professional Development (e.g. EASA chapter meetings, EASA International Conference breakout sessions, Industrial Efficiency Alliance Training);

Submits Information Request Forms, submits shop equipment digital images, supplies copies of current calibration certification, and documents Professional Development to the Group;

...In turn, the Green Motors Practices Group (GMPG) will provide to members:

Website listing recognizing compliant GMPG Membership;

GMPG public relations marketing and co-operative marketing materials;

Members license to display GMPG name and logo on advertisement copy and associated materials (e.g. stationary, business cards) see Attachment C;

The GMPG will maintain the integrity of the Group by notifying members that do not adhere to the standards set forth that their status as a GMPG member may be revoked. If corrective action has not been taken within six months of notification recognition and license to use GMPG branding privilege will terminate.

Service Center President/Owner

Dennis Bowns
Green Motors Practices Group,
Executive Director

Service Center Shop Manager
(Must be an employee)

Execution date / /2007
Renewal date July 1, 2008

Annual Member Commitment Attachment A

Random inspections by a Group representative shall be done by a Group approved individual with sufficient GMPG training and may not be currently employed in the motor service industry or considered biased by GMPG or by the service center being inspected. Inspections shall be by appointment at a mutually agreed place, date, and time. Focus shall be limited to equipment and methods as described or may impact EASA's Tech Note 16 "Guidelines for Maintaining Efficiency During Rebuilding".

Annual Member Commitment Attachment B

If a motor has sufficient damage or other circumstances that may cause loss of efficiency or reliability when rebuilt the customer shall be notified prior to repair. If the repair or rebuilding process continues to completion it shall be noted on service records and the customer's invoice that the motor may not comply with GMPG standards. The intent is to allow necessary exceptions, at the discretion of the motor service center and customer (?), based on the condition of the equipment, by identifying product or products that may not comply with GMPG standards and that have been excluded.

Annual Member Commitment Attachment C

Only members in good standing have license to use and display the Green Motors Practices Group name and logo and in addition the limited license requires specific application use approval.

Table 2: Rewinding NEMA Premium® motors with GMPG protocol applied

HP	1200 RPM kWh Savings		1800 RPM kWh Savings		3600 RPM kWh Savings	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	18	18	17	17	16	16
1.5	25	25	24	24	24	24
2	33	33	32	32	33	33
3	49	49	48	47	47	47
5	82	80	79	79	79	79
7.5	148	146	145	144	144	143
10	195	193	190	192	190	190
15	290	287	285	285	281	283
20	383	383	377	380	375	375
25	570	570	562	562	558	558
30	684	684	670	674	666	670
40	905	905	888	888	888	888
50	559	559	552	552	550	550
60	873	873	865	865	860	860
75	1092	1092	1081	1081	1076	1071
100	1456	1448	1434	1434	1428	1428
125	1766	1749	1749	1749	1742	1742
150	2119	2099	2090	2082	2082	2082
200	2799	2787	2787	2775	2775	2764
250	4126	4091	4108	4091	4091	4074
300	4930	4909	4930	4909	4909	4889
350	5752	5728	5752	5728	5728	5704
400	6546	6546	6546	6546	6546	6519
450	7364	7364	7333	7364	7333	7333
500	8182	8182	8148	8182	8148	8148

Table 3: Rewinding Epackt motors with GMPG protocol applied

HP	1200 RPM kWh Savings		1800RPM kWh Savings		3600 RPM kWh Savings	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	18	18	17	17	-	19
1.5	25	25	25	25	26	26
2	33	33	34	34	34	34
3	49	48	49	48	50	49
5	81	81	81	81	82	81
7.5	148	146	148	146	149	148
10	193	195	195	195	197	195
15	290	290	287	287	292	290
20	383	386	383	383	386	386
25	570	570	570	565	574	574
30	679	684	679	679	689	689
40	899	899	899	899	912	912
50	559	559	559	559	563	563
60	833	833	833	833	838	838
75	1092	1092	1086	1086	1099	1099
100	1448	1448	1448	1442	1465	1456
125	1766	1766	1759	1759	1775	1759
150	2110	2099	2099	2099	2131	2110
200	2814	2799	2799	2799	2814	2799
250	4108	4126	4108	4126	4147	4108
300	4951	4951	4930	4930	4951	4930
350	-	-	-	-	-	-
400	-	-	-	-	-	-
450	-	-	-	-	-	-
500	-	-	-	-	-	-

Table 4: Rewinding standard motors with GMPG protocol applied

HP	1200 RPM kWh Savings		1800 RPM kWh Savings		3600 RPM kWh Savings	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
10	200	200	202	200	202	202
15	299	296	297	296	297	301
20	394	391	393	389	391	397
25	584	582	584	581	587	590
30	703	696	699	692	703	703
40	928	926	928	922	929	939
50	573	568	575	568	577	584
75	1111	1112	1114	1108	1127	1120
100	1476	1468	1478	1476	1483	1494
125	1795	1787	1791	1795	1814	1812
150	2142	2137	2137	2137	2168	2161
200	2826	2829	2847	2823	2859	2865
250	4192	4143	4174	4178	4228	4228
300	5014	4966	5003	4977	5009	5046
350	-	-	-	-	-	-
400	-	-	-	-	-	-
450	-	-	-	-	-	-
500	-	-	-	-	-	-

Mission

The mission of the Green Motors Practices Group is to organize, identify, and promote member motor service centers that commit to energy saving shop practices, continuous energy improvement, and motor driven system efficiency and reliability.

Vision

Green Motors Practices Group will be universally identified as energy and reliability leaders focusing on the electric motor services industry.

Strategy

- Green Motors uses its' Website to promote member service centers, continuous energy improvement concepts, and distributes practical energy related material;
- Green Motors submits documentation to the Regional Technical Form enabling electric utilities to offer motor consumers or service centers rebates or incentives based on Green Motors Practices' standards;
- Green Motors encourages excellence through continuing education by training members at several levels on in-shop practices and process controls, continuous energy improvement, and consumer motor driven system efficiency and reliability;
- Green Motors takes a proactive approach to environment issues by examining carbon emission reduction through the repair process;
- Green Motors seeks to become self-sustaining by demonstrating value to service centers and associate members.

Tactics

- Maintain the Group's Website bi-monthly in a fresh and up to date state avoiding stagnation so visitors return on a regular basis to see what's new and take advantage of the resource;
- Improve the credibility of the organization, members, and standards on an annual basis or more often when needed;
- Utilize the Industrial Efficiency Alliance by soliciting participation of staff that has experience in the Regional Technical Form and has access to developed driven systems training materials;
- Complete in-shop training materials and have the material reviewed by peers before July of 2007. Present training workshops to service centers both in person and online beginning with in-shop practices September of 2007 adding driven systems and continuous improvement late fall of 2007. Establish reasonable attendance fees or obtain subsidies from utility or utility group associate members;
- Ongoing discussion of the recycling possibilities and carbon credits/greenhouse gas emission reduction by service centers implementing Green Motors Practices with environmental groups, utilities, and EASA International;
- Complete a comprehensive business plan no later than July 2007;

GMPG Officers

President: Steve Skenzick
HPS Electrical Apparatus
3801 N.W. Stewart Pkwy.
Roseburg, OR 97470
Phone: 541-673-3162

Vice President: Owen O'Neill
Center Electric, Inc.
PO Box 111300
Tacoma, WA 98411
Phone: 253-383-4416

Treasurer: Darold Winn
Harold & Mielenz, Inc.
3531 51st Ave.
Sacramento, CA 95823
Phone: 916-422-7493

Secretary/Clerk: Kevin "Fuzz" Thurston
Electric Motor Rewind of Rupert Idaho
PO Box 609
Rupert, ID 83350
Phone: 208-436-4658

GMPG Member Roster

Company Name	Address	E-mail/Phone
Brithinee Electric	620 S. Rancho Ave Colton, CA 92324-3243	lynda_butek@mail.brithinee.com Phone 909-825-7971
Center Electric, Inc.	1212 So. 30th St. Tacoma, WA 98409 www.centerelectric.com	owen@centerelectric.com Phone 253-383-4416
CW Silver Industrial Services, Inc.	535 West 700 South Salt Lake City, UT 84101-228 www.emcsolutions.com	psellers@emcsolutions.com Phone 801-366-4100
Electric Motor Rewind of Rupert Idaho, Inc.	214 So. Hwy. 24 Rupert, ID 83350	emridaho@pmt.org Phone 208-436-4658
G.P. Electric	1020 Price St Pomona, CA 91767	gpeleco@verison.com Phone 909-865-2291
H&N Electric Pasco, Inc.	4224 East B St. Pasco, WA 99301-6418 www.hnelectric.com	hn@hmelectric.com Phone 509-547-1691
HPS Electrical Apparatus	3801 NW Stewart Parkway Roseburg, OR 97470 www.hpselectric.com	steve@hpselectric.com Phone 541-673-3162

GMPG Member Roster (cont)

Herold & Mielenz, Inc.	3531 51 st Ave. Sacramento, CA 95823 www.heroldmielenz.com	darold@heroldmielenz.com Phone 916-422-7493
K&N Electric Motors, Inc	PO Box 303 Spokane, WA 99210 www.knelectric.com	info@knelectric.com Phone 509-838-8000
Montana Electric Motors	300 Holmes Ave. Butte, MT 59701	mtelectric@in-tch.com 406-494-1645
Northwest Motor Service	1341 Industrial Way Longview, WA 98632	nwmotor@yahoo.com Phone 360-425-8700
OTS Precision Balancing	9155 S.W. Barber St Wilsonville, OR 97070 www.otswire.com	otswire@aol.com Phone 503-682-7050
Reed Electric Co.	2539 NW Vaughn St Portland, OR 97210 www.reedelectric.com	ccummins@reedelectric.com Phone 503-223-8191
S&G Electric Motor Repair, Inc.	180 Doud St. Blackfoot, ID 83221 www.sandgelectric.com	paul@sandgelectric.com Phone 208-785-5121
Sennett, Inc. dba Jim's Electric Service	515 Moore Ln. Billings, MT 59101	jimselec@juno.com Phone 406-245-5683
Western Industrial Motor & Machine, Inc.	669 Quinn, Bldg. 12 PO Box 3047 Pocatello, ID 83204 www.western-industrial.com	pete@western-industrial.com Phone 208-237-1000



Incentive Application

Service Center:

Contact:

Phone:

email:

Customer:

Invoice or Job No.

Address:

Utility:

Type:

Contact:

Incentive : \$

Completed Repair/Rewind Compliant to GMPG Standards:

Yes No Other

Responsible Employee:

Motor Information

HP	RPM	Frame	Enclosure
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Est. Annual Hrs of Operation		Est. % of Full Load	
<input type="text"/>		<input type="text"/>	

Measurement and Test Results

No Load Rotor Current			Resistance			Voltage		
Leg AB	Leg BC	Leg AC	Leg A	Leg B	Leg C	AB	BC	AC
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Core Loss		Other Measurement Readings						
Before	After	Balance	Megger		Temp	Humidity		
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>		<input type="text"/>	<input type="text"/>		

Procedures

Burn-off temp:	<input type="text"/>	°F	Non-inert	<input type="checkbox"/> Yes <input type="checkbox"/> No
Lamination Repairs:	<input type="text"/>			
Replace concentric w/Lap winding:	<input type="checkbox"/> Yes <input type="checkbox"/> No			

Green Motors Practices (or Utility) Use Only

Reviewed By:

Approved:

Yes No

Incentive: \$

Date:

Comments: