

NEMA MG G2-2021

*A NEMA Motor and Generator (IS-MG) Section Document
Guide for Validating an Alternative Efficiency Determination Method
(AEDM)*

Published by

National Electrical Manufacturers Association

1300 North 17th Street, Suite 900

Rosslyn, Virginia 22209

www.nema.org

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Foreword

This NEMA Standards Publication is intended to provide the electroindustry industry a qualification process for validating mathematical models used for calculating the efficiency of electrical products, which are called Alternative Energy Determination Methods (AEDM). This Standard can also be used in conjunction with a semi-analytical model to combine the losses of multiple components within more complex systems. Much of the research for this Standard took place with U.S. regulators working with the NEMA Motor and Generator Section to develop methods to reduce testing while increasing the confidence of results.

Since regulating authorities typically demand reliable methods to realistically determine motor efficiency, a globally accepted consistent efficiency determination method that is science-based and not overly burdensome is needed. This Standard establishes a method for determining efficiency to be used when testing of each product shipped is not practical. It can also be used for each AEDM used by different manufacturers when it is not possible to have one global AEDM.

NEMA publications are subject to periodic review. Any comments or proposed revisions to this guide should be submitted to:

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This Standard was developed by the NEMA Motors and Generators Section. At the time of publication, the Section was composed of the following Members:

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Bluffton Motor Works—Bluffton, IN
Brook Crompton North America—Toronto, ON
Cummins, Inc.—Minneapolis, MN
GE Industrial Motors, a Wolong Company—Houston, TX
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Toshiba International Corporation—Houston, TX
Turbo-Drive Technologies—Sunnyvale, CA
WEG Electric Motor Corp.—Duluth, GA
Worldwide Electric Corporation—Rochester, NY

Introduction

The number of products covered under Minimum Efficiency Performance Standards (MEPS) is expanding every year. As a result of these expanding regulations, conformance testing is becoming extremely costly and unmanageable. Regulation, however, would not be effective without any required method of efficiency verification. With the high number of custom motor designs covered today, it became unrealistic to test everyone. Efficiency determination methods can vary widely by geography or background. This may result in different efficiency levels that disqualify or qualify the same products even though the requirements may seem identical. Without a common economical method for efficiency determination, this becomes an inconsistent and costly procedure that is passed on to the customer and could offset any energy conservation expected. Another extreme would be if every rating or model were not required to follow a specific efficiency determination method. This could result in even greater variations in actual efficiencies between manufacturers. A reliable determination method is essential to ensure MEPS conformance.

For example, performing a type test for each motor of a base rating could take more than 12 hours. If we then consider a sample of five motors tested for each base rating, it could take as much as eight working days to complete the process for each rating. The original 113 ratings identified in the 1990s covered all the power ratings, speeds, voltages, and enclosures. Thus, this testing would require over 900 working days for each manufacturer if each rating had only one base model. Since each base model must be essentially identical and might not have any differing physical or functional characteristics that affect energy consumption or efficiency, each manufacturer could have multiple models for each base rating. Today, the number of potential base models has grown to well over 10,000 and continues to grow with higher voltages, power ratings, and custom variations. There would not be enough test facilities in the world to test a sample of one manufacturer's base models. In addition, if the cost is high, then the end-users may find it more economical to repair lower efficient products than to buy new, more efficient products. This would negate any potential energy savings. Sample testing of each model of a covered product is only practical if the number of models is limited. This may exist for some serial (mass production) production products.

When the U.S. Department of Energy (DOE) evaluated the testing demand in the late 1990s, it became clear that an alternate approach, as was previously used in other DOE regulations for other products, was required. The need to establish a reasonable alternative that is not overly burdensome resulted in the development of the Alternate Efficiency Determination Method (AEDM). Yet, it was also necessary to verify the validity of the AEDM. This concept was set up for motors, but a similar procedure could be used for other products.

1 Scope

This NEMA Standards Publication establishes a qualification process for validating a mathematical model for calculating the efficiency of electrical products. This guide can be used in conjunction with a semi-analytical model to combine the losses of multiple components within more complex systems.

2 Definitions

Minimum Efficiency Performance Standard (MEPS): Regulations or Standards that specify a minimum efficiency for compliance.

Alternative Efficiency Design Method (AEDM): Use of a combination of calculated test results and a comparison with a limited number of tested models to determine a statistical correlation and high confidence of manufacturing quality control and engineering precision that reduces the number of physical samples required to be tested to estimate the efficiency of production units.

Average Efficiency: For this Standard, the sum of specific efficiency values obtained through testing divided by the number of measurements (i.e., a simple mathematical average).

Basic Model: A physical design that represents the lowest designed efficiency a manufacturer will produce.

Mathematical Model: A set of statistics, computer modeling, and equations that manufacturers use to predict the efficiency of a given design.

Nominal Efficiency: The average efficiency of a large population of any one base model.

Minimum Efficiency: The minimum allowed efficiency of a large population of any one base model.

Note: Minimum efficiency is often used in conjunction with nominal efficiency when creating MEPS.

3 Normative References

In whole or in part, the following documents are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.