



ANSI C84.1-2016

American National
Standard for
Electric Power
Systems and
Equipment—
Voltage Ratings
(60 Hz)





ANSI C84.1-2016

*American National Standard for
Electric Power Systems and Equipment—
Voltage Ratings (60 Hertz)*

Secretariat:

National Electrical Manufacturers Association

Approved: June 9, 2016

American National Standards Institute, Inc.

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

American National Standards Institute, Inc. (ANSI) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no warranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guideline.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health- or safety-related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires verification by the American National Standards Institute, Inc. (ANSI) that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer. An American National Standard implies a consensus of those substantially concerned with its scope and provisions. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort be made toward their resolution.

The existence of an American National Standard does not in any respect preclude anyone, whether s/he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards. It is intended as a guide to aid the manufacturer, the consumer, and the general public.

The American National Standards Institute, Inc., does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute, Inc. Requests for interpretations should be addressed to the Committee Secretariat referred to on the title page.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute, Inc., require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards can receive current information on all standards by calling or writing the American National Standards Institute, Inc.

Published by

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900, Rosslyn, Virginia 22209

© 2016 National Electrical Manufacturers Association. All rights, including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American copyright conventions.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without prior written permission of the publisher.

Printed in the United States of America

<This page intentionally left blank.>

Currently in preview, click buy full version

CONTENTS

Foreword.....	iv
1 Scope and Purpose	1
1.1 Scope	1
1.2 Purpose	1
2 Definitions	1
3 System Voltage Classes.....	2
4 Selection of Nominal System Voltages.....	2
5 Explanation of Voltage Ranges	3
5.1 Application of Voltage Ranges	3
5.1.1 Range A—Service Voltage	3
5.1.2 Range A—Utilization Voltage.....	3
5.1.3 Range B—Service and Utilization Voltages	3
5.1.4 Outside Range B—Service and Utilization Voltages	3
6 Voltage Ratings for 60-Hz Electric Equipment	4
6.1 General.....	4
6.2 Recommendation	4
Annex A Principal Transformer Connections to Supply the System Voltages of Table 1	7
Annex B Illustration of Voltage Ranges of Table 1	8
Annex C Polyphase Voltage Unbalance	9
Annex D Applicable Standards	11

TABLES

Table 1	5
---------------	---

Foreword (This Foreword is not part of American National Standard C84.1)

This standard supersedes ANSI C84.1-2011 *American National Standard for Electric Power Systems and Equipment—Voltage Ratings (60Hz)*.

With the 2016 revision, a 690/400V category has been added to the Low Voltage Class in table 1, and a paragraph discussing Conservation Voltage Reduction (CVR) has been added to Annex B.

In 1942, the Edison Electric Institute published the document *Utilization Voltage Standardization Recommendations*, EEI Pub. No. J-8. Based on that early document, a joint report was issued in 1949 by the Edison Electric Institute (EEI Pub. No. R6) and the National Electrical Manufacturers Association (NEMA Pub. No. 117). This 1949 publication was subsequently approved as American National Standard EEI-NEMA Preferred Voltage Ratings for AC Systems and Equipment, ANSI C84.1-1954.

American National Standard C84.1-1954 was a pioneering effort in its field. It not only made carefully considered recommendations on voltage ratings for electric systems and equipment, but also contained a considerable amount of much-needed educational material.

After ANSI C84.1-1954 was prepared, the capacities of power supply systems and customers' wiring systems increased and their unit voltage drops decreased. New utilization equipment was introduced and power requirements of individual equipment were increased. These developments exerted an important influence both on power systems and equipment design and on operating characteristics.

In accordance with American National Standards Institute policy requiring periodic review of its standards, American National Standards Committee C84 was activated in 1962 to review and revise American National Standard C84.1-1954, the Edison Electric Institute and National Electrical Manufacturers Association (NEMA) being named cosponsors for the project. Membership on the C84 Committee represented a wide diversity of experience in the electrical industry. To this invaluable pool of experience were added the findings of the following surveys conducted by the committee:

- a) A comprehensive questionnaire on power system design and operating practices, including measurement of actual service voltages (approximately 65,000 readings were recorded, coming from all parts of the United States and from systems of all sizes, whether measured by number of customers or by extent of service area)
- b) A sampling of single-phase distribution transformer production by kilovolt-amperes and primary voltage ratings to determine relative uses of medium voltages
- c) A survey of utilization voltage at motor terminals at approximately 20 industrial locations

The worth of any standard is measured by the degree of its acceptance and use. After careful consideration, and in view of the state of the art and the generally better understanding of the factors involved, the C84 Committee concluded that a successor standard to ANSI C84.1-1954 should be developed and published in a much simplified form, thereby promoting ease of understanding and hence its acceptance and use. This resulted in the approval and publication of American National Standard C84.1-1970, followed by its supplement, ANSI C84.1a-1973, which provided voltage limits established for the 600V nominal system voltage.

The 1977 revision of the standard incorporated an expanded Foreword that provided a more complete history of this standard's development. The 1970 revision included a significantly more useful table 1 (by designating "preferred" system voltages), the 1977 revision provided further clarity, and the 1982 revision segmented the system voltages into the various voltage classes.

With the 2006 revision, the scope expanded to include voltages above 230 kV. This increased voltage range was previously covered by IEEE Std 1312-1993 (R2004), IEEE Standard Preferred Voltage Ratings for Alternating-Current Electrical Systems and Equipment Operating at Voltages Above 230 kV Nominal, and its predecessor, ANSI C92.2-1987. In addition, standard nominal system voltages and voltage ranges were extended to include maximum system voltages of up to and including 1200 kV.

With the 2011 revision, table 1 was modified to reflect changes in lighting characteristics. Note 1 allowed lower utilization voltages for non-lighting circuits. Modern lighting equipment does not need this special treatment. Note 1 was dropped and the table was updated with the lower voltages. This treats lighting equipment like all other utilization equipment.

Suggestions for improvement of the standard are welcome. They should be sent to NEMA, 1300 North 17th Street, Rosslyn, VA 22209.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Preferred Voltage Ratings for AC Systems and Equipment, C84. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C84 Committee had the following members:

Daniel Ward, Chairman
Khaled Masri (NEMA), Secretary

Organizations Represented

Name of Representative

Eversource Energy	Lauren Gaunt
Conrad Technical Services	Larry Conrad
Dominion Power	John Bruce
Dominion Power	Daniel Ward
Enphase Energy	John Berdiner
NRECA	Robert Harris
EPRI	Tom Key
FirstEnergy Technologies	Tim Croushore
GE Energy Management	Michelle Freeman
GW Technical Services	Gary Weidner
NorthWestern Energy	Jim Cole
NRECA	Tony Thomas
Quanta Technology	James Burke
Baldor Electric	Roger Daugherty
Siemens	Ted Olsen
Smullin Engineering, Inc.	Gary Smullin
SolarCity	Michael McCarty
T. David Mills Associates	T. David Mills
Walling Energy Systems Consulting	Reigh Walling

<This page intentionally left blank.>

Currently in preview, click buy full version

1 Scope and Purpose

1.1 Scope

This standard establishes nominal voltage ratings and operating tolerances for 60Hz electric power systems above 100 volts. It also makes recommendations to other standardizing groups with respect to voltage ratings for equipment used on power systems and for utilization devices connected to such systems.

This standard includes preferred voltage ratings up to and including 1200 kV maximum system voltage, as defined in the standard.

In defining maximum system voltage, voltage transients and temporary overvoltages caused by abnormal system conditions such as faults, load rejection, and the like are excluded. However, voltage transients and temporary overvoltages may affect equipment operating performance and are considered in equipment application.

1.2 Purpose

The purposes of this standard are to:

- a) Promote a better understanding of the voltages associated with power systems and utilization equipment to achieve overall practical and economical design and operation
- b) Establish uniform nomenclature in the field of voltages
- c) Promote standardization of nominal system voltages and range of voltage variations for operating systems
- d) Promote standardization of equipment voltage ratings and tolerances
- e) Promote coordination of relationships between system and equipment voltage ratings and tolerances
- f) Provide a guide for future development and design of equipment to achieve the best possible conformance with the needs of the users
- g) Provide a guide, with respect to choice of voltages, for new power system undertakings and for changes in older ones

2 Definitions

2.1 system or power system: The connected system of power apparatus used to deliver electric power from the source to the utilization device. Portions of the system may be under different ownership, such as that of a supplier or a user.

2.2 system voltage terms: As used in this document, all voltages are rms phase-to-phase, except that the voltage following a fault-line is an rms phase-to-neutral voltage.

2.2.1 system voltage: The root-mean-square (rms) phase-to-phase voltage of a portion of an alternating-current electric system. Each system voltage pertains to a portion of the system that is bounded by transformers or utilization equipment.

2.2.2 nominal system voltage: The voltage by which a portion of the system is designated, and to which certain operating characteristics of the system are related. Each nominal system voltage pertains to a portion of the system bounded by transformers or utilization equipment.

NOTE: The nominal voltage of a system is near the voltage level at which the system normally operates. To allow for operating contingencies, systems generally operate at voltage levels about 5–10% below the maximum system voltage for which system components are designed.