

1C.2.1—Voltage Level and Range

Asset Management Department

Date: 8 Jun 04

© 2004 by PacifiCorp. All rights reserved

Contents

SECTION	PAGE
1 Scope	1
2 General	1
3 Voltage Ranges	2
3.1 Range A (Favorable Zone)	2
3.2 Range B (Tolerable Zone)	2
3.3 Voltage Unbalance	3
4 Handbook Issuing Department	4

TABLES	PAGE
Table 1 - Service Voltage Ranges	3
Table 2 - Utilization Voltage Ranges	3

1C.2.1—Voltage Level and Range

1 Scope

The purpose of this document is to state PacifiCorp's ranges for service voltage. Recommended ranges of utilization voltages are also given. The voltage levels presented apply to sustained or steady-state voltages only. These levels do not apply to the momentary voltage excursions that may result from such causes as switching operations, motors starting, fluctuating loads, and so forth.

2 General

For any specific nominal voltage, the operating voltages on a power system will differ from that nominal value due to voltage drop in the system as well as changes in the system's operating condition. It is important that the design and operation of power systems and accompanying utilization equipment be coordinated with respect to these voltage variations so that the performance of customer equipment will be satisfactory throughout a range of the actual voltages encountered on the system.

PacifiCorp's voltage ranges are based upon *Voltage Ratings for Electrical Power Systems and Equipment*, American National Standard ANSI C84.1-1989. ANSI C84.1-1989 was prepared by the National Electrical Manufacturers Association (NEMA) with participation by the Edison Electric Institute (EEI) and others.

Some of the stated purposes of ANSI C84.1-1989 are:

1. To promote standardization of nominal system voltages and ranges of voltage variations for operating systems
2. To promote standardization of equipment voltage ratings and tolerances
3. To promote coordination of relationships between system and equipment voltage ratings and tolerances
4. To provide a guide for future development and design of equipment in order to achieve the best possible conformance with the needs of the users

In ANSI C84.1, it was noted that some utilization equipment had nameplate voltages that were not consistent with reliable operation. The recommendation was made that the voltage ranges for which equipment is designed should be changed as needed in order to be in accordance with the ranges shown in Table 2 and that the voltage ratings in each class of utilization equipment should be either the same as the nominal system voltages or related to the nominal system voltages by the approximate ratio of 115 to 120.

3 Voltage Ranges

Voltage is divided into two ranges: A and B. Each voltage range is listed for two locations: service and utilization. Service voltage is measured at the point of delivery; utilization voltage is measured at the terminals of the utilizing equipment. These are detailed in Table 1.

The difference between service and utilization voltage allows for voltage drop in facility wiring between the point of utility delivery and the utilization equipment. The National Electrical Code (NEC), in Articles 210-19(a), 215-2(b), and 310-15, recommends that voltage drop in branch circuits (sub panel to utilization equipment) be less than three percent. It also recommends that feeder (between main panel and subpanel) voltage drop be less than three percent, with the combined voltage drop of branch plus feeder being less than five percent.

3.1 Range A (Favorable Zone)

Voltage range A is the favorable zone, where voltage level is near optimal.

3.1.1 Service Voltage

PacifiCorp's supply systems are designed and operated so that most service voltage levels are within the limits specified for range A. The occurrence of service voltages outside these limits is to be infrequent.

3.1.2 Utilization Voltage

Customer systems are to be designed and operated so that, with service voltage levels within range A limits, most utilization voltage levels will also be within the limits specified for range A.

Utilization equipment shall be designed and rated to give fully satisfactory performance throughout this range.

3.2 Range B (Tolerable Zone)

Voltage range B is the tolerable zone, where voltage level is acceptable but not optimal.

Range B includes voltage levels above and below range A limits that necessarily result from operating conditions. Although such conditions result in a practical system, they should be limited in extent, frequency, and duration. Within a reasonable time, corrective measures should be taken to upgrade voltage levels that lie in range B to those of range A.

In some cases, sustained voltage levels will fall outside range B. In these instances, utilization equipment may not operate satisfactorily and protective devices may need to operate to protect equipment. Such cases should be considered temporary and subject to immediate improvement.

Table 1 - Service Voltage Ranges

Nominal Service Voltage	Range B Minimum	Range A Minimum	Range A Maximum	Range B Maximum
% of Nominal	91.7%	95%	105%	105.8%
Single-Phase				
120/240, 3 wire	110/220	114/228	126/252	127/254
Three-Phase				
240/120, 4 wire	220/110	228/114	252/126	254/127
208Y/120,4 wire	191/110	197/114	218/126	220/127
480Y/277,4 wire	440/254	456/263	504/291	508/293
2.4 to 34.5 kV % of Nominal	95%	97.5%	105%	105.8%
Above 34.5 kV	<i>See Engineering Handbook 1B.3., Section 3.5</i>			

Table 2 - Utilization Voltage Ranges

Nominal Service Voltage	Range B Minimum	Range A Minimum	Range A Maximum	Range B Maximum
% of Nominal	88%	91.7%	105%	105.8%
Single-Phase				
120/240, 3 wire	106/212	110/220	126/252	127/254
Three-Phase				
240/120, 4 wire	212/106	220/110	252/126	254/127
208Y/120,4 wire	184/106	191/110	218/126	220/127
480Y/277,4 wire	424/245	440/254	504/291	508/293
2.4 to 34.5 kV % of Nominal	86.7%	90%	105%	105.8%

3.3 Voltage Unbalance

The above voltage limits still apply to all phases of a 3-phase system, even in the presence of voltage unbalance. If an electric supply system is operating near the upper or lower limits of the ANSI C84.1-1989 voltage ranges, each individual phase voltage should be within the listed limits.


4 Handbook Issuing Department

The Asset Programs Documentation Department of PacifiCorp is responsible for issuing this document. Comments and suggestions are welcome. Additional copies may be obtained from:

Asset Programs Documentation, Lloyd Center Tower
825 NE Multnomah, Suite 1600, Portland, Oregon 97214
Telephone: (503) 813-5293 Fax: (503) 813-6804

This Engineering Handbook document was developed by PacifiCorp for use in its operations and is the property of PacifiCorp. No other use is intended. These materials may not be reproduced except in support of PacifiCorp projects.

Approval records are on file in Asset Policy Documentation. Publication and use of this document is authorized by the Standards Engineering Manger and the Director of Asset Programs.

Approved: 
Gail Shaw
Standards Engineering Manager