

I C.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. These levels do not apply to 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 voltage(s) on a power system will differ from the 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 voltage variations, to ensure that the performance of customers' equipment will be satisfactory throughout a range of actual voltages.

PacifiCorp's voltage ranges are based on ANSI C84.1, *Voltage Ratings for Electric Power Systems and Equipment (60Hz)*. This document is intended to reflect the requirements of the current ANSI C84.1 standard. ANSI C84.1 was prepared by the National Electrical Manufacturers Association, with participation by the Edison Electric Institute and others. (If statements or references in this document vary from national standards, the national standards shall apply.)

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

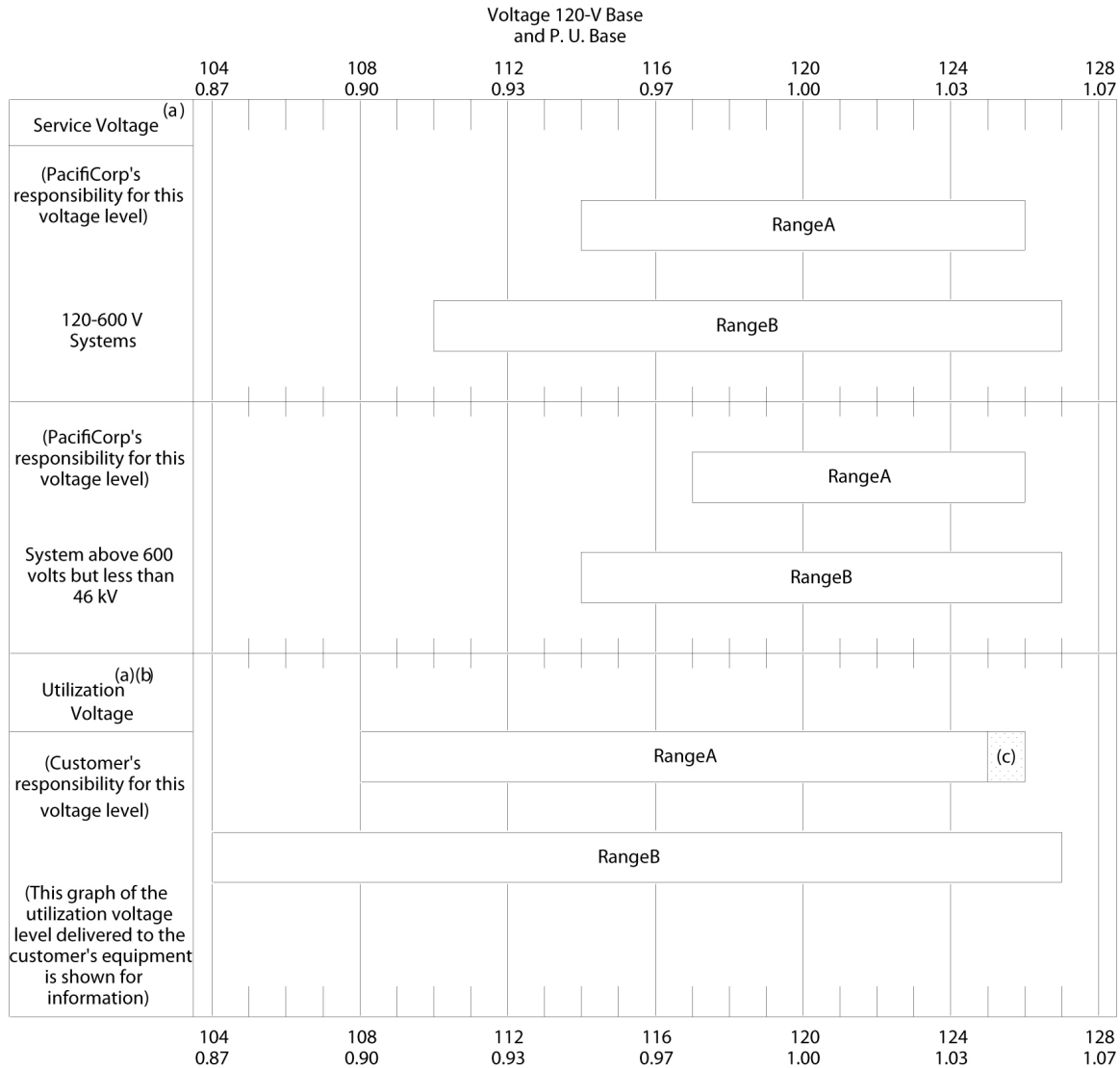
1. To promote standardization of nominal system voltages and ranges of voltage variations for operating systems
2. To promote standardization of equipment voltage ratings and tolerances
3. To promote coordination of relationships between system and equipment voltage ratings and tolerances
4. To provide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

ANSI C84.1 (2011 edition) notes that some utilization equipment has nameplate voltages inconsistent with reliable operation. Voltage ranges for which equipment is designed should be changed as needed to be in accordance with the ranges shown in Table 2 of this document. Voltage ratings in each class of utilization equipment should be the same as the nominal system voltage, or related to the nominal system voltages by an 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 illustrated in Figure 1 and detailed in Table 1 and Table 2 of this document.

**Figure 1—Illustration of Voltage Ranges Consistent with ANSI C84.1
(See Tables 1 and 2 of this document for voltage range values.)**



NOTES

- a. The difference between minimum service and minimum utilization voltage is intended to allow for voltage drop in the customer's wiring system.
- b. The customer is responsible for the utilization voltage level delivered to their equipment.
- c. For 120 volt nominal systems, maximum utilization voltage would not be expected to exceed 125 volts. This also scales up to other nominal voltages through 600 V.

Table 1—Service Voltage Ranges

Nominal Service Voltage	Range B Minimum	Range A Minimum	Range A Maximum	Range B Maximum
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	See Engineering Handbook Section 1B.3.			

Table 2—Utilization Voltage Ranges

Nominal Service Voltage	Range B Minimum	Range A Minimum	Range A Maximum	Range B Maximum
Single-Phase				
120/240, 3-wire	104/208	108/216	126/252	127/254
Three-Phase				
240/120, 4-wire	208/104	216/108	252/126	254/127
208Y/120, 4-wire	180/104	187/108	218/126	220/127
480Y/277, 4-wire	416/204	432/249	504/291	508/293
2.4 to 34.5 kV % of nominal	86.7%	90%	105%	105.8%

The difference between service and utilization voltage allows for voltage drop in facility wiring between the point of utility delivery and the utilization equipment. National Electrical Code (NEC) Articles 210-19(a), 215-2(a), and 310-15 recommend less than three percent (< 3%) of voltage drop in branch circuits (from the sub-panel to utilization equipment). NEC also recommends less than three percent (< 3%) of feeder voltage drop (between the main panel and subpanel), with the combined voltage drop (of branch and feeder) being less than five percent (< 5%).

3.1. Range A (Favorable Zone)

Voltage range A is the “favorable” zone, in which the 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 steady-state service voltages outside these limits shall be infrequent.

3.1.2. Utilization Voltage

Customer systems shall be designed and operated such that service voltage levels are within range A limits and most utilization voltage levels are 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, in which the 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 reasonable timeframes, corrective measures should be taken to upgrade voltage levels in range B to those in 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. Such cases should be considered temporary and subject to immediate improvement.

3.3. Voltage Imbalance

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

4. Regulatory References

4.1. California

Standard service voltages for California are listed in rule number 2 of the *General Rules and Regulations, Description of Service*, for Pacific Power.

4.2. Idaho

Standard service voltages for Idaho are listed in section 3 of the *General Rules and Regulations, Description of Service*, for Rocky Mountain Power.

4.3. Montana

Standard service voltages for Montana are listed in section 3 of the *General Rules and Regulations, Description of Service*, for Pacific Power.

4.4. Oregon

Oregon Administrative Rules, Public Utility Commission, Chapter 860, Division 23 (Service Standards), Section 860-23-0020 (*Quality of Electric Service*) requires a “set of normal standard voltages,” maintained so as to “not normally vary more than plus or minus five percent [5%] of the standard at the service entrance.” Voltage surveys and recorded results are also required. Standard service voltages are listed in Rule 3 of the *General Rules and Regulations, Description of Service*, for Pacific Power, under Public Utility Commission Order No. 34.

4.5. Utah

Utah Public Service Commission Rules R746-310-4, *Station Instruments, Voltage and Frequency Restrictions and Station Equipment* (effective 9/1/12) refers to ANSI C84.1.

4.6. Washington

Washington UTC Rules relating to electric company operations: WAC 480-100, Section 191373 (for standard voltage and permissible variation) requires that “standard voltages” are adopted and filed. These rules also state that the variation in voltage shall not be more than five percent (5%) above or below the standard voltage adopted, and the total voltage variation shall not exceed eight percent (8%). Standard service voltages are listed in Section 3 of the *General Rules and Regulations, Description of Service*, for Pacific Power.

4.7. Wyoming

Wyoming Public Service Commission *Rules of Practice & Procedure*, Section 314 (P.S.C Wyoming No. 14, R6 -1), refers to ANSI C84.1. Standard service voltages are listed in Rule 6 of the Rates and Rules, Description of Service, for Rocky Mountain Power.

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