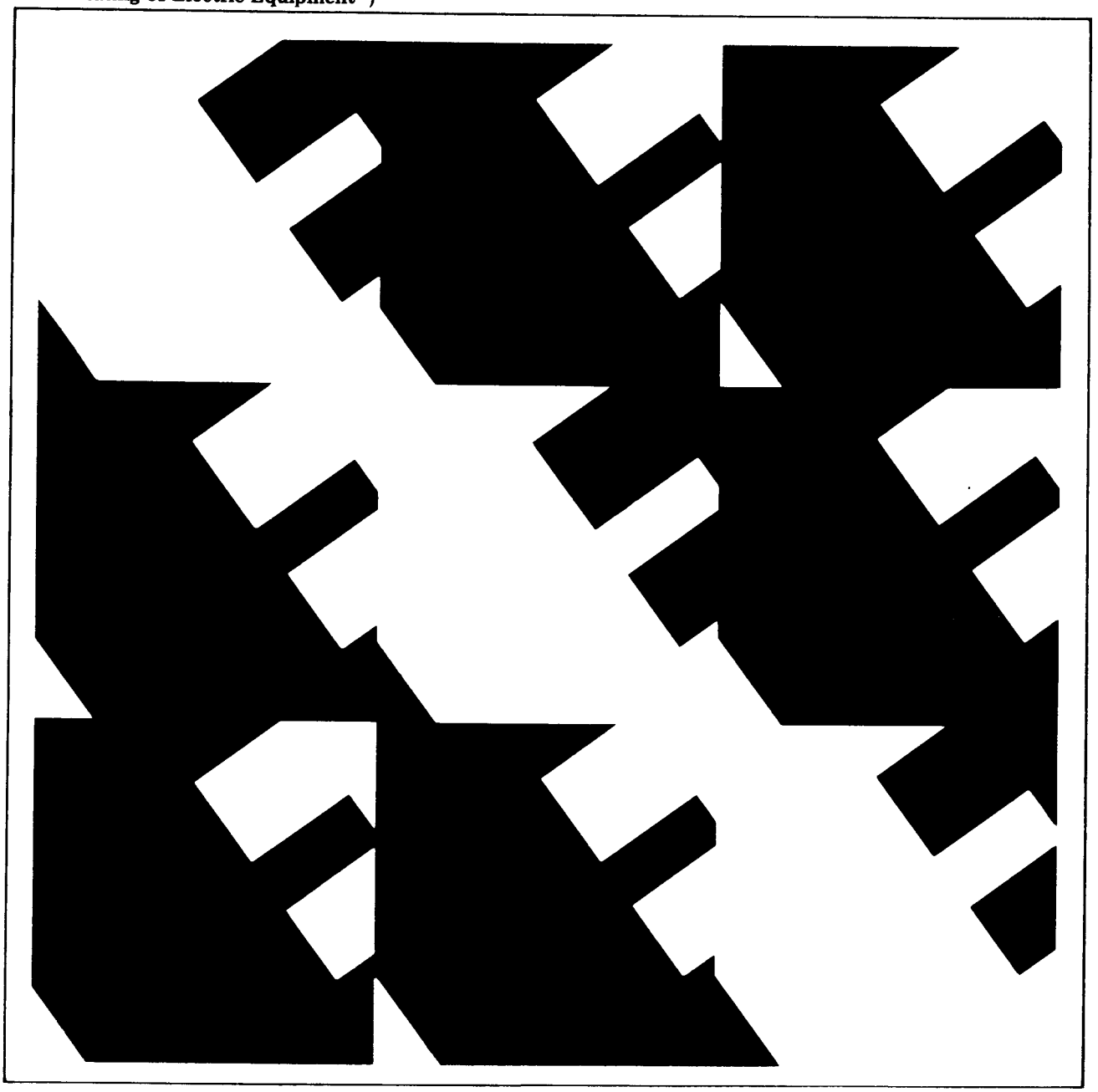
IEEE Recommended Practice for Specifying Service Conditions in Electrical Standards

(A supplement to IEEE Standards Publication No. 1
"General Principles for Temperature Limits
in the Rating of Electric Equipment")



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FOREWORD

The formulation and revision of Standards by many technical committees has resulted in nonuniformity in the treatment of service conditions. This document has been prepared as a guide for technical committees to use when Standards are being prepared or revised, with the object of obtaining consistency, as far as practicable, among the Standards for various kinds of electric equipment, which must often operate under the same service conditions.

Service conditions are specified to give the limiting conditions of operation for which standard equipment is designed. For example, ambient temperature values should be selected which, in combination with standard temperature rises, limit total insulation temperatures to suitable values. By specifying a limiting ambient value in service conditions, a readily usable simple means of stating conditions for which standard ratings are suitable is provided.

The application and operation of standard equipment under conditions more severe than the limiting ambient values specified in "Usual Service Conditions" may sometimes be justified economically. The use of standard equipment under more severe conditions and the acceptance of shorter-than-usual life or less margin of safety may be preferred to obtaining equipment specially designed for the conditions. This may apply particularly to temperatures if the excessive temperatures are of short duration or infrequent occurrence, the cumulative effects are not objectionable, and low average temperatures are prevalent. The effect of such use should be properly evaluated for satisfactory results.*

This document consists of two parts. As far as possible selections should be made from Part I for the statement of service conditions for particular equipment standards. For uniformity it is suggested that the exact wording be used where it applies. Part II covers application and testing. Selections from this part are recommended for inclusion as supplementary information to specific Standards where applicable and desirable.

* Weather Bureau records of outdoor temperatures for a number of cities of the United States show that 40°C (104°F) is seldom exceeded more than 0.5 percent of the time and that 30°C (86°F) is exceeded as much as 12 percent of the time in only a very few localities. Indoor temperatures may be higher but statistical data are meager. For more complete information regarding temperature and its effects, see IEEE Standards Nos. 1 and 96.

ACKNOWLEDGMENT

The Institute wishes to acknowledge its indebtedness to those who have so freely given of their time and knowledge and have conducted experimental work on which many of the IEEE publications are based.

This publication was prepared by the IEEE Standards Coordinating Committee No. 4, whose membership was:

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CONTENTS

IEEE Recommended Practice for

SPECIFYING SERVICE CONDITIONS in ELECTRICAL STANDARDS

PART I

97-1 Introduction. In the various Standards there will be found a number of different situations regarding usual service conditions. The following two are typical.

(a) The group where the maximum ambient temperature is specified. The Standards for bushings, fuses, lightning arresters, protector tubes, and potential devices where 40°C (104°F) ambient is used, and marine equipment where 50°C (122°F) ambient is used are typical of this group.

(b) The group where both the maximum and daily average temperatures of the cooling medium are specified. Standards for transformers, regulators, and neutral-grounding devices are typical of this group.

It is suggested that a selection of one of the following groups can be made for the statement of usual service conditions in most of the Standards for specific equipment.

97-2 Usual Temperature and Altitude Service Conditions. It is recommended that the statement of usual service conditions included in a Standard conform to the pattern covered by either Group 1 or 2 below, together with the material on unusual service conditions.

Group 1—Usual Service Conditions. Equipment conforming to these Standards shall be suitable for operation at its standard rating provided that:

(a) The temperature of the cooling air (ambient temperature) does not exceed 40°C (104°F);

(b) The altitude does not exceed 1000 meters (3300 feet).

Group 2—Usual Service Conditions. Equipment conforming to these Standards shall be suitable for operation at its standard rating provided that:

(a) The temperature of the cooling air (ambient temperature) does not exceed 40°C (104°F) and the average temperature of the cooling air for any 24-hour period does not exceed 30°C* (86°F);

(b) If water-cooled, the temperature of the cooling water (ambient temperature) does not exceed 30°C (86°F) and the average temperature of the cooling water for any 24-hour period does not exceed 25°C (77°F);

(c) The altitude does not exceed 1000 meters (3300 feet).

* For average temperature mean daily temperature as defined by the Weather Bureau.

97-3 Unusual Temperature and Altitude Service Conditions. The application of equipment at higher ambient temperatures or at higher altitudes than specified in paragraph 97-2 shall be considered as unusual.

Standard equipment may be applied at higher ambient temperatures or at higher altitudes than specified, but its performance may be affected and special consideration should be given to these applications.

97-4 Other Conditions Which May Affect Design and Application. Where other unusual conditions exist they should be brought to the attention of those responsible for the design and application of the equipment. Examples of such conditions are:

(a) damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of dust or gases, steam, salt spray, excessive moisture or dripping water, etc.;
(b) abnormal vibration, shocks, or tilting;
(c) excessively high or low temperatures;
(d) unusual transportation or storage conditions;
(e) unusual space limitations;
(f) unusual operating duty, frequency of operation, difficulty of maintenance, poor waveform, unbalanced voltage, special insulation requirements, etc.

PART II

97-5 Supplementary Information. The statements in the following paragraphs are recommended for inclusion as supplementary information in specific Standards where applicable.

97-6 Applications at Altitudes Greater Than 1000 Meters (3300 Feet)

1. Temperature. Equipment that depends upon air for its cooling medium and is designed for standard temperature rise may be used at altitudes greater than 1000 meters (3300 feet) without exceeding standard temperature limits, provided that either one of the following conditions or a combination of them prevails.

(a) The temperature of the cooling air is less than the limiting ambient temperature by an amount corresponding to the change in temperature rise due to altitude.

(b) The load to be carried is less than the rating of the equipment by an amount corresponding to the appropriate altitude correction.

Example of Condition (a) for Rotating Machine Standards. It is recognized as good practice to use machines of standard temperature rise at altitudes greater than 1000 meters (3300 feet) provided the temperature of the cooling air is not likely to exceed the following values for the respective altitudes.

Altitude	*Maximum Temperature of the Cooling Air*
1000 meters (3 300 feet)	40°C (104°F)
2000 meters (6 600 feet)	35°C (95°F)
3000 meters (9 900 feet)	30°C (86°F)
4000 meters (13 200 feet)	25°C (77°F)

Example of Condition (b) for Circuit Breaker Standards. It is recognized as good practice to use circuit breakers of standard temperature rise at altitudes greater than 1000 meters (3300 feet) provided the maximum current at which the equipment is used does not exceed the standard rating multiplied by the altitude current correction factor given in the following table.

Altitude	*Altitude Current Correction Factor*
1000 meters (3 300 feet)	1.00
2000 meters (6 600 feet)	0.99
3000 meters (10 000 feet)	0.96
4000 meters (13 200 feet)	0.90

The factors given in these two examples vary with different types of apparatus and should be considered by the committee preparing a particular Standard.

2. Insulation. The dielectric strength of equipment that depends upon air for its insulation varies with altitude. The following tabulation shows the relative dielectric strength for altitudes above 1000 meters (3300 feet) at any given temperature.

Altitude	*Altitude Correction Factor for Dielectric Strength*
1000 meters (3 300 feet)	1.00
1200 meters (4 000 feet)	0.98
1500 meters (5 000 feet)	0.95
1800 meters (6 000 feet)	0.92
2100 meters (7 000 feet)	0.89
2400 meters (8 000 feet)	0.86
2700 meters (9 000 feet)	0.83
3000 meters (10 000 feet)	0.80
3600 meters (12 000 feet)	0.75
4200 meters (14 000 feet)	0.70
4800 meters (16 000 feet)	0.65
5400 meters (18 000 feet)	0.61
6000 meters (20 000 feet)	0.56

97-7 Testing of Equipment for Altitudes Not Exceeding 1000 Meters (3300 Feet). Equipment for use at altitudes not exceeding 1000 meters (3300 feet) may be tested at any altitude not exceeding 1000 meters (3300 feet) and no altitude correction shall be applied to the observed temperature rise.

97-8 Testing of Equipment Designed for Altitudes Exceeding 1000 Meters (3300 Feet). When equipment is designed for application at high altitudes, acceptance tests may be made at any altitude less than 1000 meters (3300 feet) and altitude correction factors applied.

1. Correction of Observed Temperature Rise for Altitude. When equipment is designed for standard temperature rise at some specified altitude in excess of 1000 meters (3300 feet), the temperature rise, as determined by test at any altitude of 1000 meters (3300 feet) or less, shall be less than the standard temperature rise by the following corrections for each 100 meters (330 feet) that the specified altitude exceeds 1000 meters (3300 feet). (Correction factors selected for each type of equipment should be given here.)

2. Test Voltages at Altitudes Less than 1000 Meters (3300 Feet). When equipment that depends upon air for its insulation is designed for service at some specified altitude in excess of 1000 meters (3300 feet), the insulation test may be made at any altitude of 1000 meters (3300 feet) or less with a test voltage given by the following formula:

$$V = \frac{V_s}{A}$$

where

V = test voltage at location of test,
V_s = standard test voltage,
A = altitude correction factor for dielectric strength.

Where the test code specifies correcting dielectric test voltages for air conditions at the test location, the correction for air conditions also should be applied to this test voltage formula. Standard air conditions are:

Barometric pressure	760 mm (29.92 inches) of mercury (101 325 newtons per square meter)
Temperature	25°C (77°F)
Humidity	15.45 mm (0.6085 inch) of mercury (2058.92 newtons per square meter)