

Guide to

Effects of current on human beings and livestock —

Part 2: Special aspects relating to
human beings

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National foreword

This Published Document, which has been prepared under the direction of the General Electrotechnical Engineering Standards Committee, is identical with the Report of the International Electrotechnical Commission, IEC Publication 479-2:1987 *“Effects of current on human beings and livestock. Part 2: Special aspects relating to human beings”*. Although the content of the IEC Publication is not judged suitable for publication as a British Standard, its status in the IEC of “Basic safety standard” (see IEC Guide 104:1984 “Guide to the drafting of safety standards, and the role of committees with safety pilot functions and safety group functions”) is likely to result in many references to it being made in other IEC standards concerned with safety and it is therefore thought to be of interest to members of appropriate Technical Committees and to those concerned with development of products. In particular, the number of experiments on which the data in IEC 479 were based was statically small and there may have been a bias in respect of age, health and racial characteristics. The most conservative figures in IEC 479 cover 95 % of the adult population so, where safety of persons is a consideration, a substantial safety factor should be applied. Attention is drawn to the introduction in PD 6519-1 which indicates ways in which the PD should be used.

PD 6519 is published in two Parts. The other Part is:

— *Part 1 General aspects*

Terminology and conventions. The text of IEC 479-2 has been approved as suitable for publication as a Published Document without deviation. Some terminology and certain conventions are not identical with those used in British Standard publications; attention is drawn especially to the following.

Cross-references^a

International standard	Corresponding British Standard
IEC 50	BS 4727: Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms
IEC 50(551):1982	Part 2:Group 02:1983 Power electronics terminology (Technically equivalent)
IEC 50(801):1984	Part 3:Group 08:1985 Acoustics and electroacoustics terminology (Technically equivalent)

^a Undated in the text.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Chapter 4: Effects of alternating current with frequencies above 100 Hz

1 General

Electric energy in the form of alternating current of higher frequencies than 50/60 Hz is increasingly used in modern electrical equipment, for example aircraft (400 Hz), power tools and electric welding (mostly up to 450 Hz), electrotherapy (using mostly 4 000 Hz to 5 000 Hz), switching mode power supplies (20 kHz to 1 MHz).

Little experimental data is available for this chapter, so that the information given herein should be considered as provisional only but may be used for the evaluation of risks in the ranges of frequencies concerned (see bibliography). Attention is also drawn to the fact, that the impedance of human skin decreases approximately inversely proportional to the frequency for touch voltages in the order of some tens of volts, so that the skin impedance at 500 Hz is only about one tenth of the skin impedance at 50 Hz and may be neglected in many cases. This holds even more true for higher frequencies. The impedance of the human body at such frequencies is therefore reduced to its internal impedance Z_i (see Chapter 1).

2 Scope

This chapter describes the effects of sinusoidal alternating current within the frequency ranges:

- above 100 Hz up to and including 1 000 Hz (see Clause 4);
- above 1 000 Hz up to and including 10 000 Hz (see Clause 5);
- above 10 000 Hz (see Clause 6).

3 Definitions

In addition to the definitions given in Part 1, the following definition applies:

3.1

frequency factor F_f

ratio of the threshold current for the relevant physiological effects at the frequency f to the threshold current at 50/60 Hz

NOTE The frequency factor differs for perception, let-go and ventricular fibrillation.

4 Effects of alternating current in the frequency range above 100 Hz up to and including 1 000 Hz

4.1 Threshold of perception

For the threshold of perception the frequency factor is given in Figure 9.

4.2 Threshold of let-go

For the threshold of let-go the frequency factor is given in Figure 10.

4.3 Threshold of ventricular fibrillation

For shock-durations longer than the cardiac cycle, the frequency factor for the threshold of fibrillation for longitudinal current paths through the trunk of the body is given in Figure 11.

For shock-durations shorter than the cardiac cycle no experimental data is available.

5 Effects of alternating current in the frequency range above 1 000 Hz up to and including 10 000 Hz

5.1 Threshold of perception

For the threshold of perception the frequency factor is given in Figure 12.

5.2 Threshold of let-go

For the threshold of let-go the frequency factor is given in Figure 13.

5.3 Threshold of ventricular fibrillation

Under consideration.

6 Effects of alternating current in the frequency range above 10 000 Hz

6.1 Threshold of perception

For frequencies between 10 kHz and 100 kHz the threshold rises approximately from 10 mA to 100 mA (r.m.s. values).

For frequencies above 100 kHz the tingling sensation characteristic for the perception at lower frequencies changes into a sensation of warmth for current intensities in the order of some hundred milliamperes.

6.2 Threshold of let-go

For frequencies above 100 kHz there is neither experimental data nor reported incidents concerning the threshold of let-go.

6.3 Threshold of ventricular fibrillation

For frequencies above 100 kHz there is neither experimental data nor reported incidents concerning the threshold of ventricular fibrillation.

6.4 Other effects

Burns may occur at frequencies above 100 kHz and current magnitudes in the order of amperes depending on the duration of the current flow.

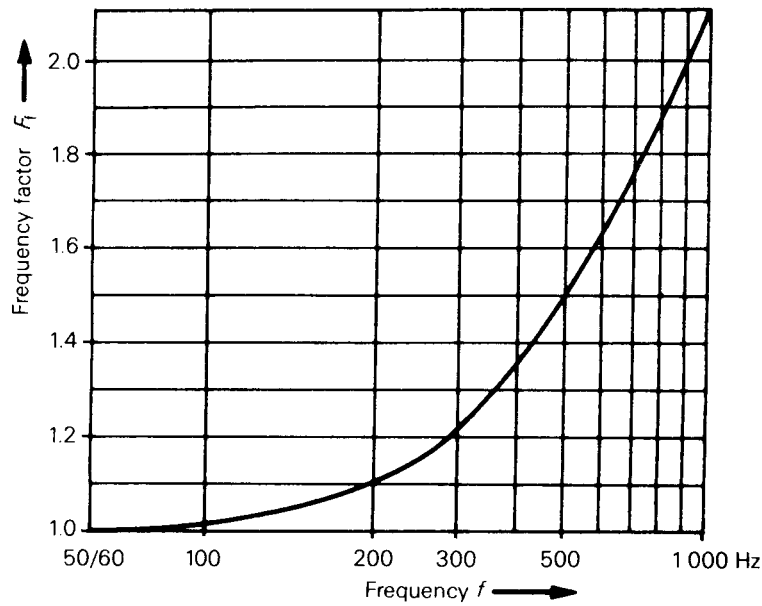


Figure 9 — Variation of the threshold of perception within the frequency range 50/60 Hz to 1 000 Hz

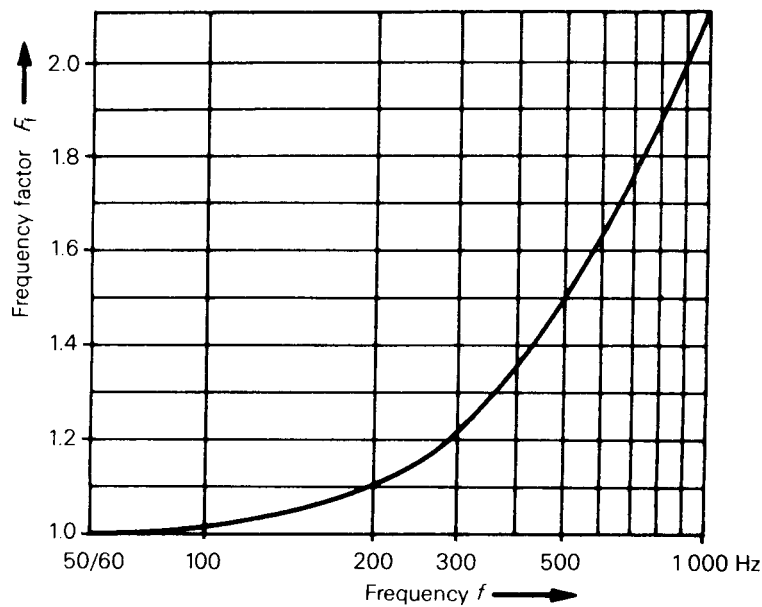


Figure 10 — Variation of the threshold of let-go within the frequency range 50/60 Hz to 1 000 Hz