ZS, AND THE PROSPECTIVE EARTH FAULT CURRENT

WHY MULTIPLY BY CMIN?

ZS = ZE + (R1 + R2)

What it's for: the total earth fault loop impedance of the circuit, once R1 + R2 is known. That needs **Ze** too.

$$Zs = Ze + (R1 + R2)$$

All in ohms. Simple: add the two sides of the loop together to get the whole.

We don't install Ze, the DNO does. You get Ze in three ways:

- **Measurement**: on site, with an earth fault loop impedance tester,
- **Enquiry**: phone the DNO and ask, or
- **Calculation**. In a question, Ze is usually just **given** in the scenario.

3 for a full design.

ANOTHER EXAMPLE: ADD A ZE TO THE RADIAL FROM SECTION 7

```
Ze (TN-C-S, given)      = 0.35 Ω
R1 + R2 (section 7)     = 0.40 Ω
Zs = 0.35 + 0.40        = 0.75 Ω
```

PROSPECTIVE EARTH FAULT CURRENT AND CMIN

What it's for: once you know Zs you can work out the **prospective earth fault current (PEFC)**: how many amps would flow if there were an earth fault at that point of the circuit. It's just Ohm's law, with one extra factor.

$$PEFC = (U_0 \times Cmin) \div Zs$$

U_0 = 230 V · Cmin = **0.95** for UK public LV supplies (Reg 411.4.4 Note 1) · Zs in ohms · PEFC in amps

Cmin is the minimum voltage factor (Reg 411.4.4, p.73). It allows for the supply voltage varying with time and place, and for low-voltage supplies it is **0.95**: 230 × 0.95 = **218.5 V**. Generated voltage isn't a steady, smooth 230 V. It goes up and down all the time. BS 7671 Appendix 2 (p.436) gives the UK's permitted range: 230 V **+10 % / −6 %**, so **216.2 V to 253.0 V**. In the UK we design with 218.5 V.

WORKED EXAMPLE: WHY CMIN MATTERS

```
Zs = 5 Ω
Without Cmin:  230 ÷ 5   = 46 A
With Cmin:     218.5 ÷ 5 = 43.7 A     (230 × 0.95 = 218.5 V)
Difference:                2.3 A less fault current
```

2.3 A might not sound much, but a protective device needs **enough current** to operate quickly (next section). Less current means it takes longer, so things stay live longer. By designing with the **worst case** (the lowest voltage), you know it can't get any worse.

ANOTHER EXAMPLE: PEFC FOR ZS = 0.75 Ω

```
PEFC = (230 × 0.95) ÷ 0.75
     = 218.5 ÷ 0.75
     = 291.3 A
```

The **maximum Zs** formula uses the same $U_o \times$ Cmin: Zs × Ia ≤ $U_o \times$ Cmin, printed at **Reg 411.4.4 (p.73)**.

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