

Illustrative photo: an arc flash suit beside a switchboard.

NLC ACADEMY · EPISODE 35

Faster clearing, less energy.

We found no cal/cm² value in the Saudi regulations we searched; it usually comes from the client's specification. On one illustrative 380 V board, cutting the clearing time from 0.5 s to 70 ms takes the incident energy from 17.7 to 2.5 cal/cm².

THE SAUDI LAYER FIRST

Saudi rules set duties; we found no cal/cm² value in them

Labour Law 121-123, MHRSD OSH regulation
employer duties: protect, inform, PPE, training

NCOSH high-risk occupations regulation
lists panel assemblers; names the hazard as shock

SBC 401-2024, an IEC 60364 based code
no arc-flash entry in the contents we read

SAIS, formerly HCIS, Decision 327
names NFPA 70; NFPA 70E not found in it

Saudi Arabian Grid Code, May 2024
maximum and minimum fault data owed to users

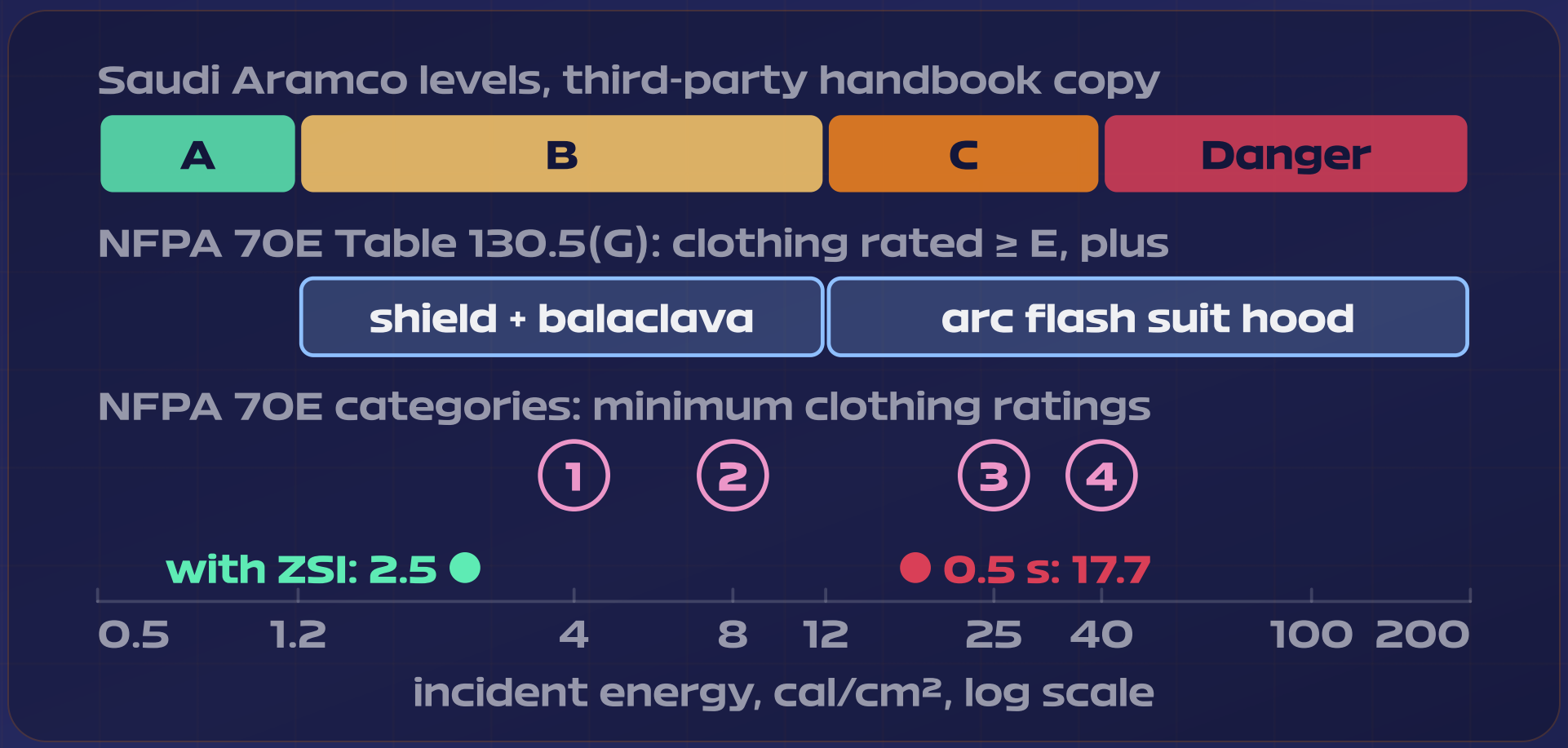
Saudi Aramco Safety Handbook (copy)
contract: cal/cm² levels, third-party copy

no value found · supplies an input · contract value

In the documents we searched, not finding a value is not proof that no duty applies. The general duties bind every employer. The cal/cm² figures we found come from contracts: Saudi Aramco documents, or a specification that imports NFPA 70E and IEEE 1584. [7]

WHAT ARAMCO WRITES

Aramco's handbook copy uses energy levels, not categories



1. A third-party copy of the Safety Handbook, 5th ed., sets levels from each label's energy: A up to 1.2; B above 1.2 up to 12; C above 12 up to 40 cal/cm²; above 40, no energized work. [7]

2. NFPA 70E Table 130.5(G) breaks at the same 1.2 and 12 and adds face, head, hand, hearing and foot protection. Categories 1 to 4 are clothing ratings of 4, 8, 25 and 40: a different scale. [8]

Not a controlled copy: no revision date is printed, and which level owns exactly 1.2, 12 or 40 is not confirmed. G.I. 2.721, which it cites, was not available. Use the client's current controlled revision.

WHO OWNS WHAT

Four documents, four jobs, none of them Saudi

NEC 110.16
installation code
2023: label ≥ 1000 A
2026: content listed

NFPA 70E 130.5
employer's standard
one method, not both
the label's content

IEEE 1584-2018
a Guide: the sums
energy and boundary
no PPE advice at all

IEEE 1584.1-2022
the study's scope
what a study delivers
1584.2: data checklists

Saudi project: applies where the contract names it

1. NEC 110.16 says which equipment is marked; its 2026 text also lists the content. NFPA 70E 130.5 sets the assessment and, in 130.5(H), the label content. [8][9]
2. IEEE 1584-2018 is a Guide: it computes energy and boundary and, by its scope, gives no PPE recommendation. IEEE 1584.1-2022 sets what a study should deliver. [10]

IEEE 1584 calculates; it does not require a label.

BEFORE ANY PPE

De-energize first. PPE is the last control

1. **Electrically safe work condition**
   the default: NFPA 70E-2024 110.2
2. **Energized work only if justified**
   infeasible, or de-energizing adds hazard
3. **Permit, qualified persons, safe practices**
   energized electrical work permit, 130.2
4. **Two assessments: shock and arc flash**
   130.4 and 130.5, each on its own
5. **PPE last, by one method**
   130.7: clothing, face, hands, hearing, feet

Having PPE never justifies energized work

1. Energized work needs its own justification, a permit and qualified persons. PPE limits burn injury at the working distance; it does not stop blast, fragments or noise. [8]
2. Use one PPE method per piece of equipment: incident energy analysis or the category tables, not both. A computed 6 cal/cm² is not "category 2". [8]

WHAT THE MODEL NEEDS

Eight inputs per location, plus clearing time, in a tested range

Voltage
three-phase AC, 50 or 60 Hz. Saudi 60 Hz is inside the range; no frequency correction. [10]

208 V to 15 kV

Bolted fault current
0.5 to 106 kA at 208 to 600 V; 0.2 to 65 kA at 601 V to 15 kV. Two separate ranges. [10]

two ranges

Electrode configuration
VCB, VCBB, HCB, VOA or HOA: vertical or horizontal bus, in a box or in open air. [10]

5 types

Gap and enclosure
gap 6.35 to 76.2 mm up to 600 V, 19.05 to 254 mm above; box height and width up to 1244.6 mm, opening up to 1.549 m². [10]

per location

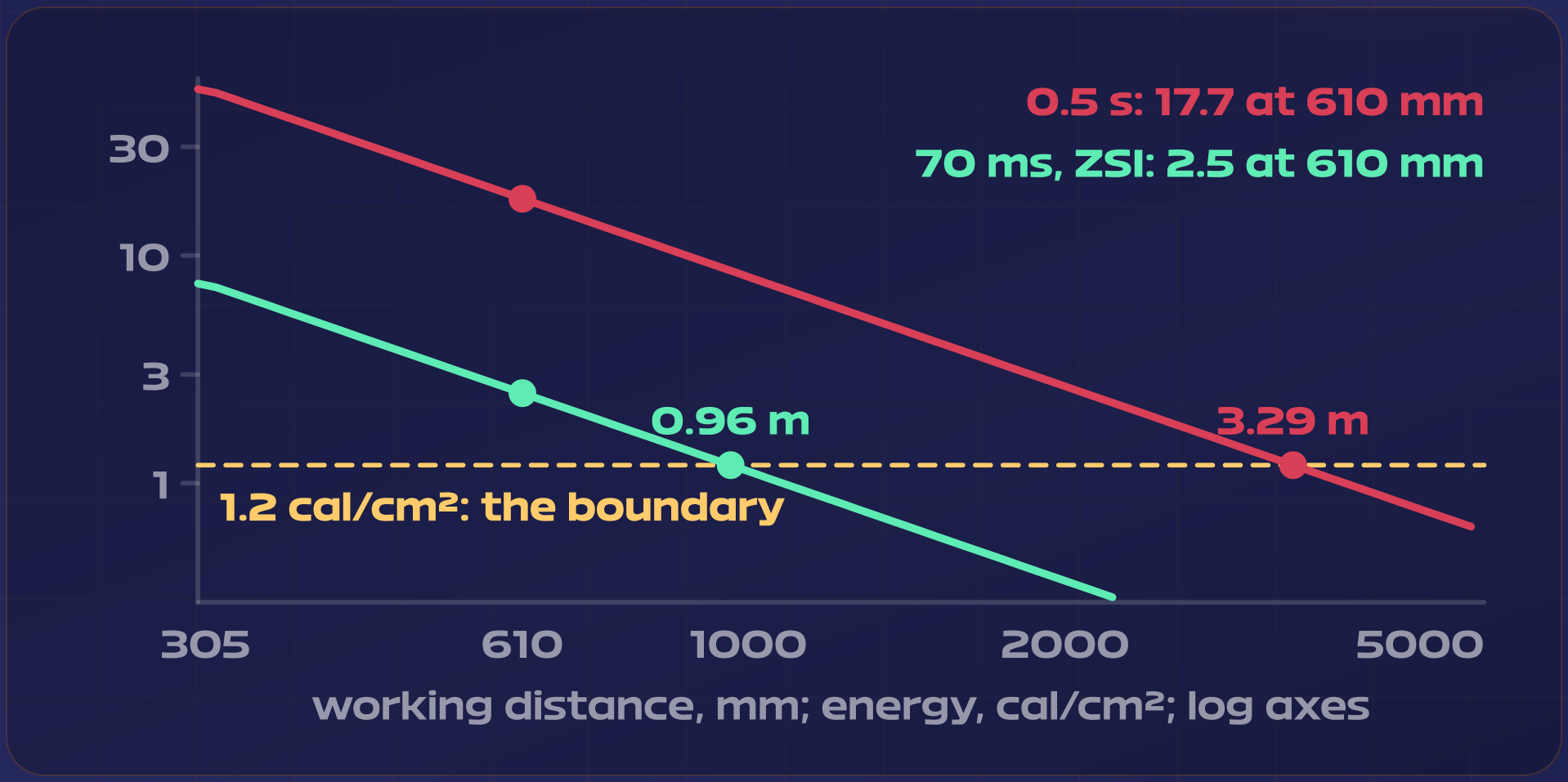
Working distance
305 mm (12 in) is the model's minimum. Nearer is outside its tested range, not a safe answer. [10]

≥ 305 mm

No input for ambient, altitude, grounding or X/R. Our code implements the IEEE 1584-2018 equations and is checked against 15 rows of a published spreadsheet export; it is not a certified tool. [10][11]

DISTANCE

Working distance is an input. The boundary is an output

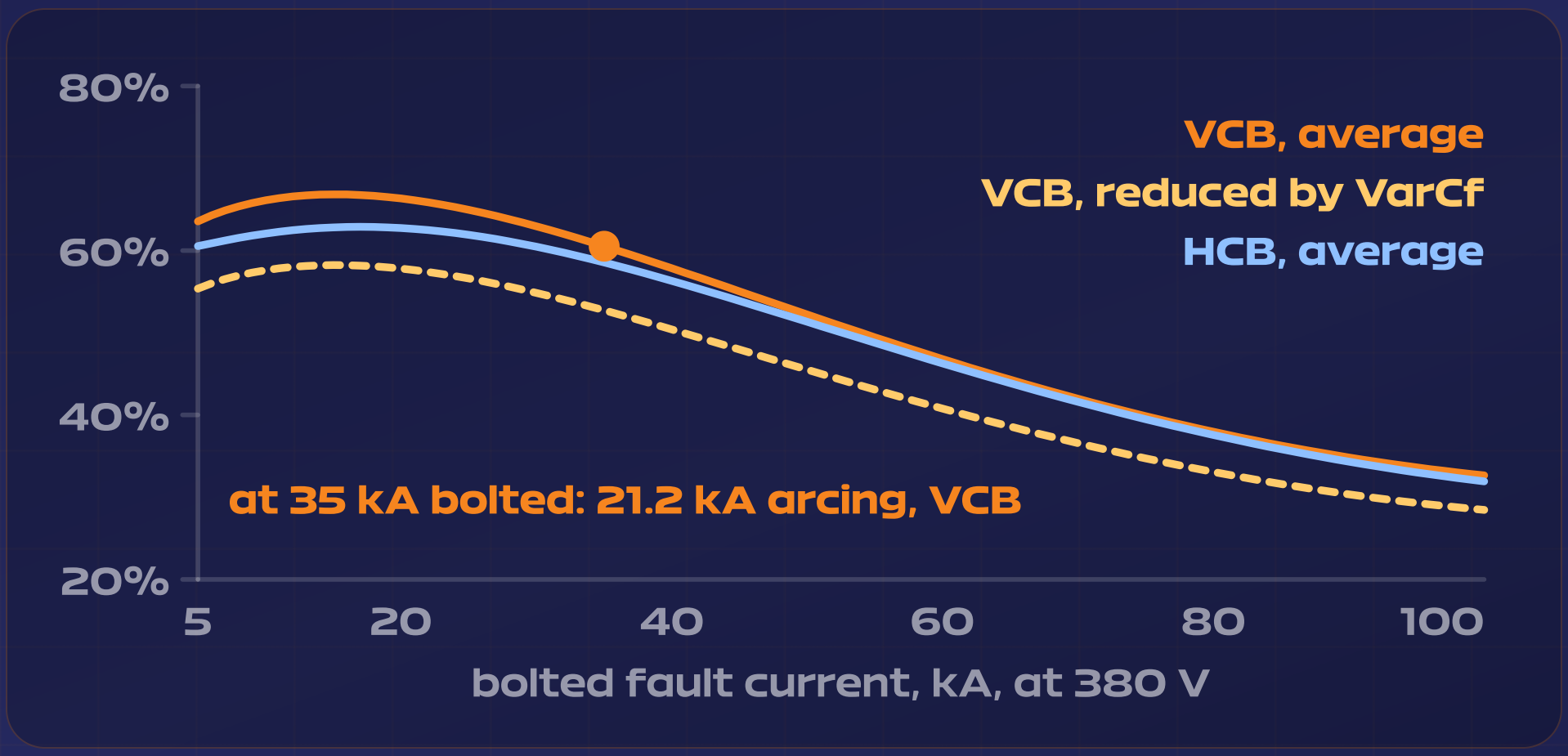


1. Baseline: 380 V, 35 kA bolted, VCB, 32 mm gap, 508 mm cube enclosure, 610 mm working distance, 0.5 s at both arcing currents: 17.7 cal/cm², boundary 3.3 m. [10][11]
2. Energy falls with distance to the power -1.6 for VCB and -2.0 for HCB. At 455 mm the same board gives 28.4. [10]

Cut the clearing time to 70 ms and the boundary moves from 3.3 m to 0.96 m. Set the working distance from the task; read the boundary from the model.

ARCING CURRENT

The arc draws less than the bolted fault current



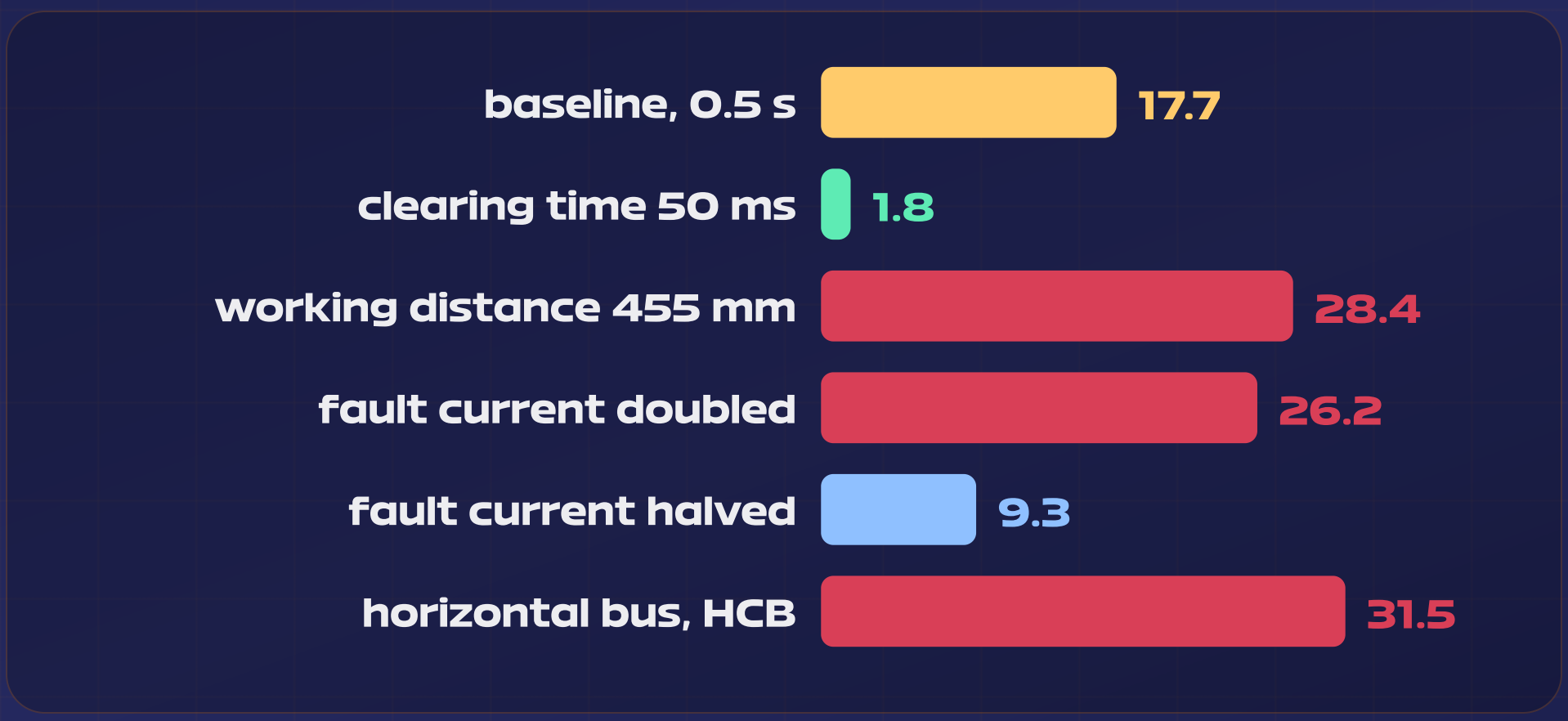
1. At 380 V the model gives 21.2 kA of arcing current for 35 kA bolted, 61%. The share falls as fault current rises, to 33% at 100 kA. [10][11]

2. IEEE 1584-2018 then reruns the same fault at a reduced arcing current, here 18.5 kA, 13% lower by VarCf, and keeps the higher energy. The 2002 edition did this below 1 kV only. [10]

Ask for both arcing currents per bus, each with its own clearing time.

WHAT MOVES THE NUMBER

On this board, clearing time moved the energy most

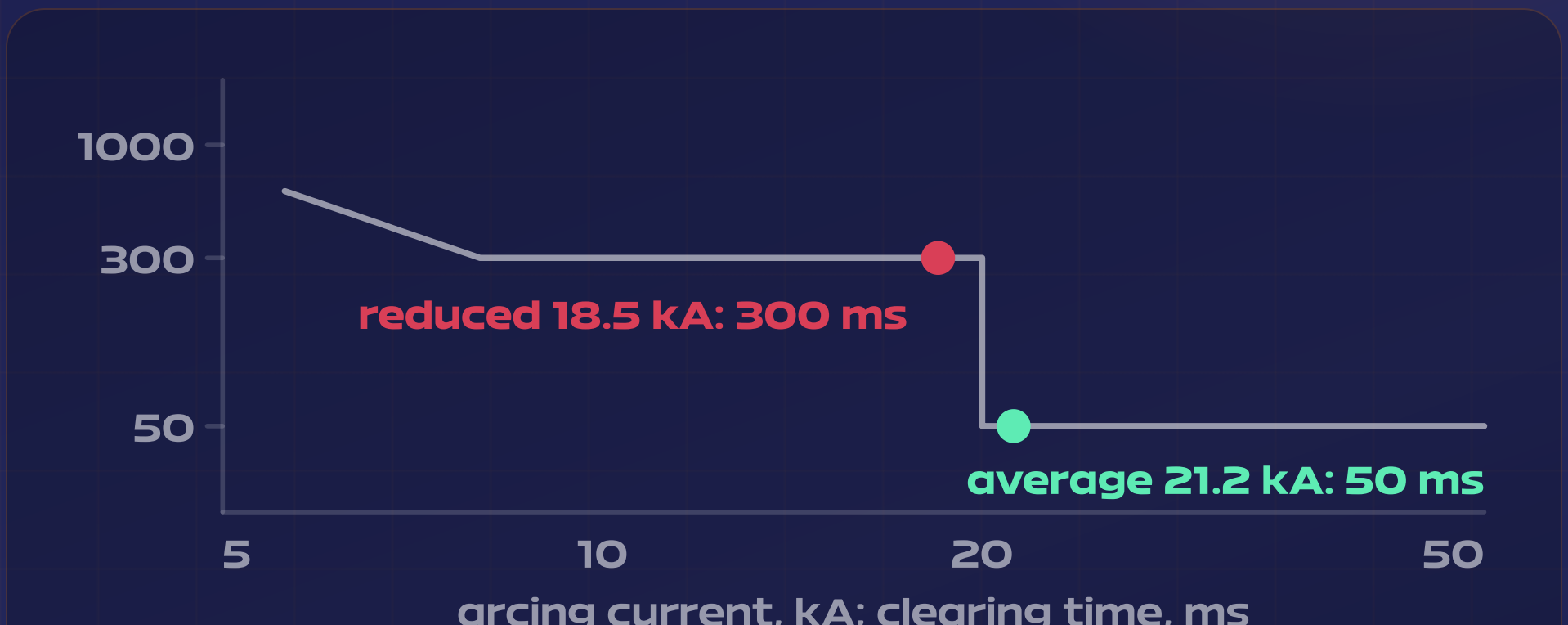


1. Energy is linear in arc duration: 0.5 s to 50 ms divides it by ten. Doubling the bolted current at the same time raised it 1.48 times here. [10][11]
2. Halving the current lowers it at the same time. On a real breaker a lower current can also trip slower, which is the next slide. [10]

SEC's public awareness page calls the clearing time the one variable that can be positively controlled. [6]

THE LOW-CURRENT TRAP

Less current, 5.3 times the energy



1.8 cal/cm²
at the average current

9.3 cal/cm²
at the reduced current

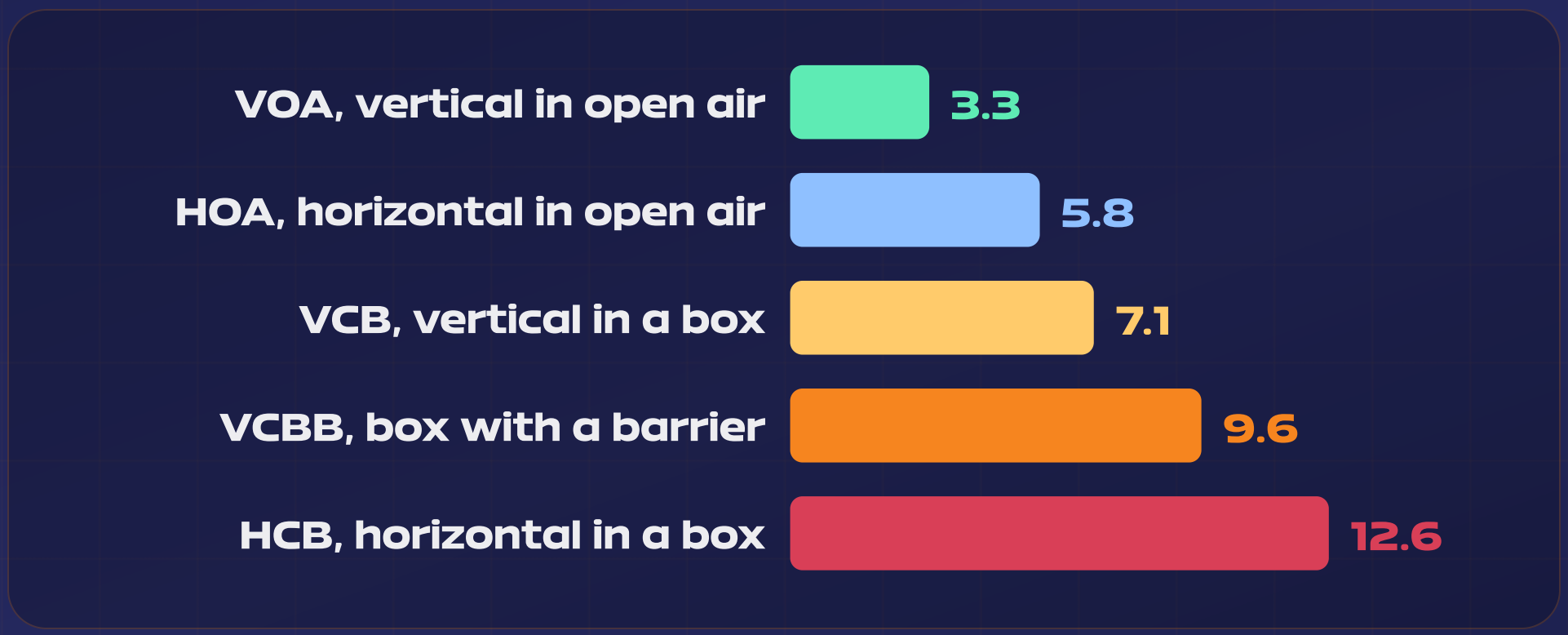
1. On an illustrative breaker, not a product curve, with a 20 kA instantaneous pickup, the average 21.2 kA clears in 50 ms: 1.8 cal/cm². The reduced 18.5 kA falls below the pickup and waits 300 ms: 9.3. [10]

2. That is one scenario: the same 35 kA fault at its reduced arcing current. A minimum network fault is a separate scenario with its own bolted current. The Grid Code owes users minimum fault data. [5][10]

Assess each fault scenario at both arcing currents, with the clearing time read at each.

AN INPUT READ ON SITE

Same board, same current, 3.9 times the energy

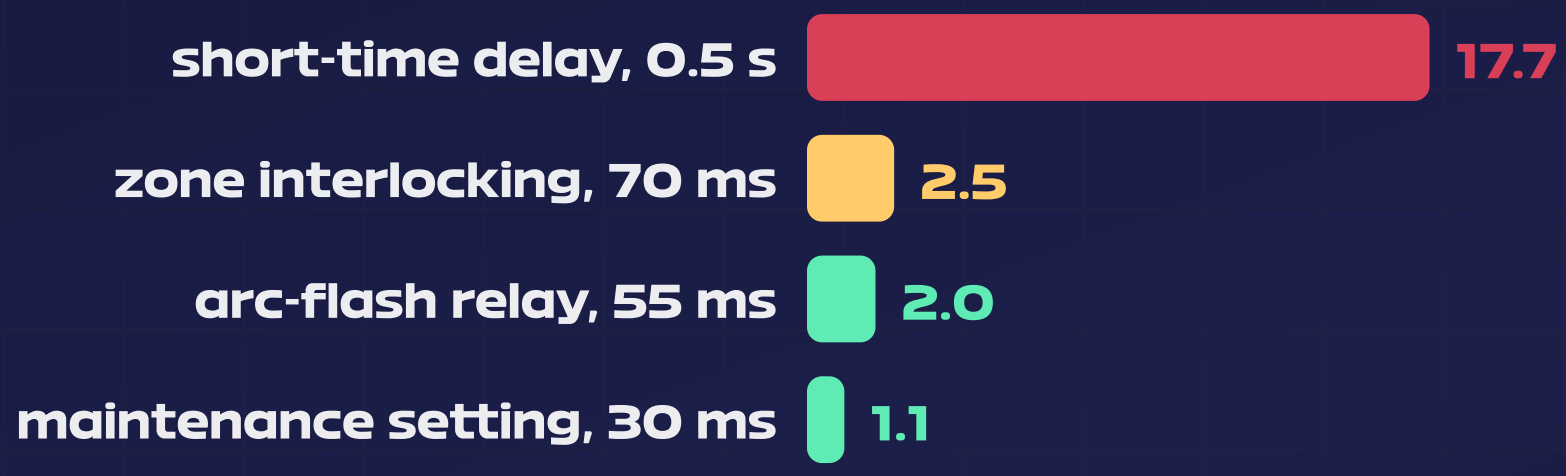


1. Held at 380 V, 35 kA and 200 ms, the five electrode configurations span 3.3 to 12.6 cal/cm². HCB, horizontal bus in a box, is 1.77 times VCB. [10][11]
2. The configuration is read off the bus inside the gear, not off a single-line diagram. IEEE 1584.2-2025 publishes the checklists for collecting it. [10]

Assume VCB on a board whose bus is horizontal and this example understates the energy by 44%.

DESIGN IT DOWN

Take time off the clock, not cloth off the shelf



remote racking
same energy; operate outside the 3.3 m boundary

arc-resistant gear
same energy; protects only in its tested door set-up

1. Zone interlocking cut a 0.5 s delay to 70 ms in a published Schneider example: 2.5 cal/cm² here. SEL quotes 2 to 5 ms for the relay; a 3-cycle breaker adds up to 50 ms. [12]
2. ABB's 2I maintenance-setting example cleared in 30 ms: 1.1 here. A maintenance switch helps only while it is on. [12]

Remote racking adds distance, cutting exposure: run it from outside the verified boundary wherever practicable. Fitting it or opening a door inside the boundary is a separate task: assess it and its PPE. [12]

CONTAINMENT IS NOT ENERGY

Arc-resistant ratings hold only as tested and installed

IAC	Types	outside
IEC 62271-200	**IEEE C37.20.7**	**other door or cover open**
accessibility A, B or C and sides F, L, R as tested; doors and covers closed	Type 1 front; Type 2 front, sides, rear; Type 2B also with LV instrument doors open	not in the rating: no tested protection; the label's energy and PPE apply

A rating holds only as tested and installed: doors and covers as rated and secured, vents, ducts or plenum, current and arc duration. Type 2B adds only the identified LV control or instrument compartment doors, for people 4 in (about 100 mm) or more from the opening; not a power compartment (breaker, bus or cable) door. No rating by itself removes the risk assessment or the PPE it sets. NLC publishes its MV switchgear as IAC-AFLR, a rating with doors and covers closed. [13]

THE LABEL

Two label rules: NEC marking, NFPA 70E content

WARNING: arc flash

nominal voltage
380 V
arc flash boundary
3.3 m
energy at 610 mm
17.7 cal/cm²
assessment date
dd/mm/yyyy

one method: compliant

WARNING: arc flash

nominal voltage
380 V
arc flash boundary
3.3 m
energy at 610 mm
17.7 cal/cm²
assessment date
dd/mm/yyyy
plus PPE category 3

both: not permitted

1. NFPA 70E 130.5(H): nominal voltage, arc flash boundary, and at least one of: energy with its working distance or PPE category, not both; minimum arc rating of clothing; or a site-specific PPE level. [8]
2. NEC 110.16 (2023): warning marking, and a dated label on service and feeder equipment of 1000 A or more. 2026: voltage, boundary, energy or PPE level, assessment date. [9]

Review the assessment after any change that affects it, and at least every 5 years. Print one method's result, never an energy and a category together. [8]

ON A SAUDI SITE

Three things the study must bring from site



Illustrative photo. Arc-rated clothing limits burns; it does not stop blast, fragments or sound.

max + min
fault data
maximum and minimum, in writing, from the network

5
years to review
at most; sooner after any change that affects the study

50 °C
same cal/cm²
but a 40 cal suit at 50 °C adds heat-stress risk

A third-party copy of Aramco's handbook also lists: disconnect, test and ground at 480 V and above; remote switching, remote racking and the maintenance switch where available. Confirm against the controlled revision. [7]

THE CLAUSE TO WRITE

Five lines a tender can check

ARC FLASH STUDY AND DESIGN, SPECIFICATION

a. Arc flash risk assessment to NFPA 70E (edition stated), energy by IEEE 1584-2018, study scope to IEEE 1584.1-2022, for equipment likely to be worked on energized.
b. Per location: voltage, electrode configuration, gap, enclosure and working distance as built; maximum and minimum fault data from the network operator in writing.
c. Both arcing currents for each fault scenario, each with the clearing time read from the device curve and settings.
d. PPE by the incident energy method only: clothing, face and head, hands, hearing, feet; labels dated, reviewed after any change and within 5 years.
e. Each energy-reducing scheme functionally verified at commissioning: sensing, logic, trip path, indication and total clearing time, by manufacturer-approved procedures.

1. Each line names a document, a quantity or a test.
2. None of it permits energized work: that needs its own justification and permit. [8]

SOURCES

Where every number in this deck comes from

[1] Labour Law Arts. 121-123; MHRSD OSH Management Regulation
[2] NCOSH, Regulation on Work in High-Risk Occupations (2025)
[3] SBC 401-CR-2024 contents list; SBC 401 (2007) full text
[4] SAIS (formerly HCIS), Administrative Decision 327, 1446H
[5] Saudi Arabian Grid Code, May 2024, Schedule 12; A3.1.4.4
[6] Saudi Electricity Company, Arc Flash page (archived)
[7] Saudi Aramco Safety Handbook, 5th ed., third-party copy
[8] NFPA 70E-2024 110.2, 110.3, 130.2-130.7; 2027 changes
[9] NFPA 70 (NEC) 2023 and 2026, 110.16; 240.87
[10] IEEE 1584-2018 (range via PCIC EUR24_17); 1584.1; 1584.2
[11] arcflash_physics.py, checked vs 15 spreadsheet-export rows
[12] Schneider 0600DB0001; SEL arc-flash Q and A; ABB 1SDC007114
[13] IEC 62271-200; C37.20.7; ABB 1VAL0007; Eaton PA019003EN

We searched the documents above. Energies and boundaries come from our implementation of the IEEE 1584-2018 equations, checked against 15 rows of a published spreadsheet export; not a certified tool.

Practical electrical engineering

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Read the full episode article

https://nlc.com.sa/academy/arc-flash-ppe.html

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