The Lineman’s Gap / The PV Gap

From a field practice to a rated standard: rubbers and leathers for the hand, and what the PV worker still needs

PART 1 · THE LINEMAN’S GAP

A PRACTICE BEFORE A STANDARD

Commercial electric distribution began with Edison’s Pearl Street Station in 1882 [1], and the wires multiplied fast. Within a few years poles and wires crowded New York’s streets; after the blizzard of 1888 tore many down, the city went on to take its poles down and bury thousands of wires [2]. The men who built and kept those lines worked close to live conductors, and the cost was high: when Henry Miller and nine other linemen founded what became the IBEW in St. Louis in 1891, safety was the foremost reason [3]. Protecting the hands started the way most field safety does, as practice: rubber between the worker and the wire, leather over the rubber. In time the gear had its own makers, each with its own gloves. By 1977, three manufacturers, W. H. Salisbury among them, supplied all the linemen’s rubber gloves sold in the US, in 155 models; when NIOSH tested a sample against the national standard, most complied, but half the gloves of one model failed the electrical test and were recalled, and NIOSH warned that “strict control of the use of compliance markings is absolutely necessary” [4]. That is the gap a standard closes: one set of classes and tests that every maker builds to and every lineman can rely on [5] [6].

PROOF AND PROTECTION

Two ideas made the glove trustworthy. First, proof: every glove is electrically tested before it is first issued, and again at set intervals [7], so the barrier is verified, not assumed. Second, protection for the protector: “To protect against damage, protector gloves (made of leather) are worn over the rubber gloves,” because the sharp end of a conductor can puncture rubber [5]. The rubber holds the voltage; the leather keeps the rubber whole.

FROM PRACTICE TO STANDARD

What crews learned in the field was gradually written down. The specifications for rubber protective equipment were first developed as American Society for Testing and Materials (ASTM) standards, then adopted as American National Standards: rubber matting (J6.7-1935), line hose and hoods (J6.1 and J6.2-1950), sleeves (J6.5-1962), gloves (J6.6-1967) and insulating blankets (J6.4-1970) [5]. OSHA’s first rule for electrical protective equipment, 29 CFR 1910.137, incorporated those documents by reference. By the 1990s they were “up to a quarter century out of date,” and in 1994 OSHA rewrote the rule in performance terms drawn from the ASTM specifications [5]. Even then, the utility and union proposal OSHA started from was, in OSHA’s words, “based primarily on current industry practice” [5].

Today the path is complete. A glove is specified by ASTM D120 and its leather protector by ASTM F696 [6]. OSHA rates every glove in one of six classes, each with a maximum use voltage and a higher proof-test voltage; requires leather protectors over insulating gloves; and requires a glove to be retested before first issue, every six months, and after any use without protectors [7]. A common-sense practice became a professional habit, and the habit became rated, standardized equipment with a known limit, checked before the work begins.

Class	00	0	1	2	3	4
Max use (ac)	500 V	1,000 V	7,500 V	17,000 V	26,500 V	36,000 V
Proof test (ac)	2,500 V	5,000 V	10,000 V	20,000 V	30,000 V	40,000 V

Rubber insulating glove classes, OSHA 29 CFR 1910.137, Tables I-1 and I-4 [7]; classes as in ASTM D120 [6].

Sources, Part 1 [1] IEEE Milestone, Pearl Street Station, 1882. ethw.org [2] American Social History Project, CUNY, “The Blizzard of 1888: Building.” cuny.edu [3] P. A. Noble, “Honoring Our Linemen,” *The Electrical Worker*, IBEW, Jul 1, 2026. ibew.org [4] W. I. Cook and W. G. Fletcher, *A Report on the Performance of Linemen’s Rubber Insulating Gloves*, NIOSH Publication 77-196, July 1977. cdc.gov [5] OSHA, “Electric Power Generation, Transmission, and Distribution; Electrical Protective Equipment,” final rule, Federal Register, Jan 31, 1994. osha.gov [6] ASTM D120, Standard Specification for Rubber Insulating Gloves (ANSI webstore); ASTM F696, Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens (ANSI webstore). [7] OSHA 29 CFR 1910.137, (c)(2)(viii), Tables I-1, I-4 and I-5. osha.gov

PART 2 · THE PV GAP

THE SAME STARTING POINT

Solar put a new kind of source on roofs and in fields. “While exposed to the sun, PV systems remain energized, even after a building’s connection to the grid has been disabled” [8]. A disconnect or rapid shutdown opens the circuit downstream; it doesn’t stop the cells from making current. In the field, the options on a live module have been to wait for dark, or to break the circuit with a sacrificial connector or cutters in full PPE. Covering the panel has been a practice, the way rubber once was: in 2011, UL laid ordinary tarps over a live array, and two of four still left 1.8 to 2.1 A and over 120 V; the report noted that “more research may be needed” to find products “proven to be reliable and effective in blocking illumination” [9]. Since then, the world’s PV capacity has grown from about 96.5 GW at the end of 2012 [10] to 3 TW after a record 664 GW was added in 2025 [11], about thirty times over. Every one of those modules makes current whenever the sun is on it.

BORROWED GEAR

PV crews didn’t develop their own hand protection; they adopted the lineman’s rubber gloves as standard gear. Those classes were set long before PV, and their dc ratings don’t line up with PV’s common 600, 1,000 and 1,500 V dc system voltages: Class 00 is rated to 750 V dc and Class 0 to 1,500 V dc, and the next step, Class 1, is rated to 11,250 V dc [12]. A 1,500 V string sits right at the top of Class 0, and a 2,000 V dc system would push a worker into Class 1, a glove built for far higher voltages than the job. As PV voltages rise, the case grows for hand protection rated specifically for dc work, and for barriers that lower the hazard before the glove is ever tested.

THE FIRST PURPOSE-BUILT TOOLS

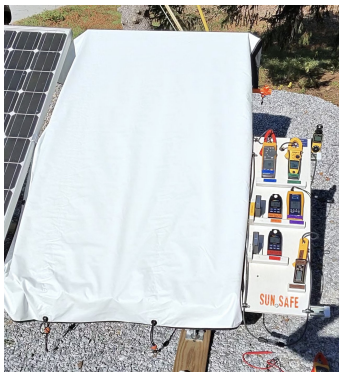
The first purpose-built answers are now appearing. PVStop, patented in 2016 and used by fire services, is a spray-on coating that blocks light from the panel [13]: in effect, the first spray. The Blackout Sheet is a reusable, multi-layer cover, tested by instrument: to our knowledge, the first blackout blanket built and measured for this job. Each fits a different need. A coating suits a fire scene; a cover that comes off by hand suits maintenance and getting an array back in service.

WHAT STILL HAS TO HAPPEN

Like the first rubber gloves, each of these is one maker’s answer, tested its own way. As the industry keeps expanding, its safety gear needs to follow the same path the lineman’s did: shared performance levels, a proof test, inspection and retest rules, and protection for the protector. The levels are starting to appear. The 2027 edition of NFPA 70E adds Article 380 for work on PV systems: above 100 V and 40 mA, controls must be chosen from the hierarchy of risk control [14] [15]. What is missing is a standard that rates light-blocking covers and coatings against levels like these.

THE GOAL

The goal is products made to shared test methods and ratings, so a worker can trust that a cover or coating, used properly together with the rest of their PPE, is designed to protect them. Like a glove proof-tested well above its use voltage, these products should be over-engineered for the edge cases, such as cloud-edge sun brighter than full sun and the largest modules on the market, so the protection holds at every level. The Blackout Sheet is one example, built and tested to its own published method and pass criteria, with limits sized for 1,400 W/m^2 design-day sun and 14 A modules. Its design levels, no more than 5 W/m^2 under the sheet and 100 mA of current, both at 1,400 W/m^2 design-day sun, are stated the same way NFPA 70E 2027 Article 380 states PV thresholds: as measurable numbers (100 V and 40 mA for shock) [14]. Every Phase 1 result also came in under 40 mA. It is meant to open the door for standards that any maker’s product can be rated against, the way any glove today is rated by class.



The Blackout Sheet over the shorted test module, instrument board alongside. Photo: Sun Safe LLC.

PHASE 1, MEASURED

Seven trials on one monofacial module (Aug 29 and Oct 22, 2026; the Oct 22 trials witnessed on site), all passed. Shorted current of 7.6–9.5 A fell to 2–11 mA with the sheet on, read on the BT270, the milliamp-resolution clamp. Optical density 2.63 (AH-Sol pair) to ≥ 3.02 (DayStar pair, a lower bound). Every result was also below the 40 mA shock threshold in NFPA 70E 2027 Article 380, which is recorded, not a Phase 1 gate.

Pass criteria: Stage 1 (S1) current < 125 mA; Stage 2 (S2) under-sheet light < 7 W/m^2 and OD ≥ 2.3; Stage 3 (S3) light from current agrees with the light meter; valid only at ≥ 800 W/m^2. Full criteria and data: sunsafepv.com/r+d.

Rubber gloves went from field practice to rated equipment over decades. PV doesn't have to wait that long. Phase 1 is a small, first step: seven trials on one monofacial module, not a listing, a standard or field instructions, and never a substitute for the PPE and procedures already required. The aim is the one the lineman's glove came to serve: a barrier you can verify before the work begins.

Sources, Part 2 [8] Namikawa, IEA PVPS T12-09:2017, p. 8. iea-pvps.org [9] Backstrom & Dini, UL, Firefighter Safety and Photovoltaic Installations Research Project, 2011, §9.1 Table 17, §9.2. fsri.org [10] IEA PVPS, A Snapshot of Global PV 1992–2012, 2013. iea-pvps.org [11] SolarPower Europe, Global Solar Market Outlook 2026–2030, Jun 22, 2026. solarpowereurope.org [12] I-CAR, "Insulated Rubber Gloves and High-Voltage Batteries," Collision Repair News, Feb 4, 2010 (ac and dc ratings by class). i-car.com [13] PVStop pvstop.com.au; Williams, US 9,455,370 B2 (2016). uspto.gov [14] NFPA 70E, 2027 revision cycle, Second Correlating Revisions SCR-1 (310.2) and SCR-13 (Article 380, 380.2). nfpa.org [15] J. Phillips, "A Review of Chapter 3: 2027 NFPA 70E Update, Part 3," *Electrical Contractor* (NECA), Sep 15, 2026. ecmag.com Phase 1 data, method and references: sunsafepv.com/r+d.