

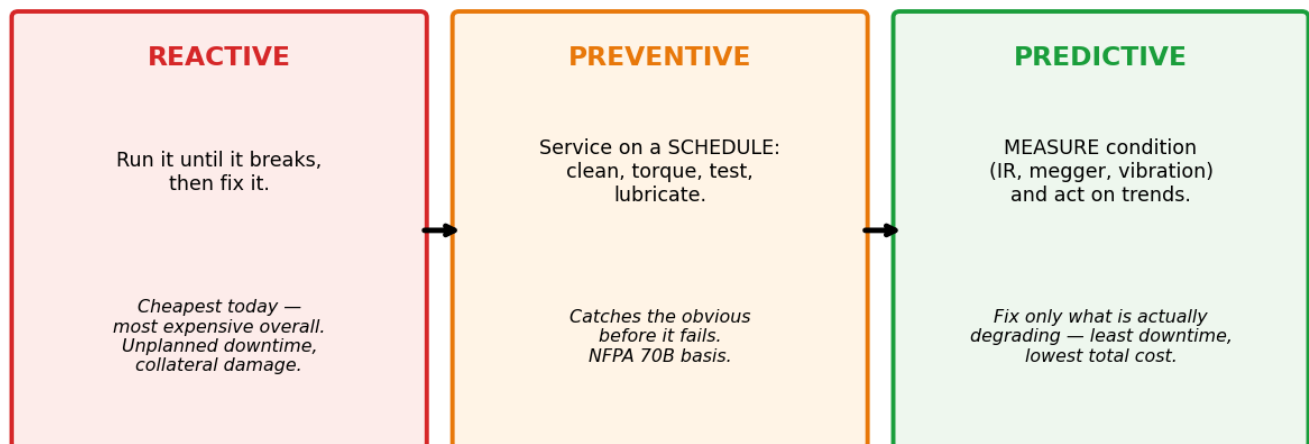
Module 2.8 — Preventive & Predictive Maintenance

Find the warning before the failure: the NFPA 70B program and its intervals, step-by-step PM for panels, switchboards, transformers and motors, predictive tests with pass/fail numbers, and the life-safety tests.

Why this module. Most electrical failures give a warning first: a connection runs hot for weeks, insulation resistance drifts down for years, a battery's internal resistance creeps up. Maintenance work is about finding those warnings on a schedule and fixing them during a planned shutdown instead of during an outage. This module covers the three maintenance strategies, the NFPA 70B program and its intervals, step-by-step PM for panelboards, switchboards, dry-type transformers, and motors, the predictive tests with their pass and fail numbers, the life-safety tests the inspector and insurer ask for, and the records that tie it together.

Part A — Three Ways to Maintain

THREE WAYS TO MAINTAIN — and why the last two win



Reactive costs the most over time; preventive catches the obvious on a schedule; predictive measures condition and fixes only what is degrading.

Strategy	What triggers the work	Example	Where it fits
Reactive (run to failure)	A failure	Replace a burned lug after an outage	Cheap, redundant, non-critical loads such as a single lighting circuit
Preventive (time-based)	The calendar	Annual clean, inspect, and exercise breakers	Everything without monitoring data
Predictive (condition-based)	A measured condition: infrared temperature rise, megohm trend, battery ohmic value, ultrasound	An IR scan finds a 20 °C rise on one phase lug, so a repair is scheduled	Critical gear and gear with baseline readings

The current standards blend the last two. NFPA 70B sets each interval from an equipment condition assessment, so measured condition drives how often the preventive work happens. NFPA 70B-2026 also accepts continuous monitoring: Eaton's summary of the 2026 changes says permanently installed temperature sensors can now satisfy the thermal-inspection requirement.

NFPA 70E-2024 205.4 (205.3 in the 2021 edition) puts the duty in one sentence: "Electrical equipment shall be maintained in accordance with manufacturers' instructions or industry consensus standards to reduce the risk associated with failure." Its Informational Note 2 adds that noncontact diagnostics such as infrared and ultrasound "can assist in the identification of electrical anomalies." NEC 2026 110.17 says servicing "shall be performed by qualified persons" in accordance with the original equipment manufacturer's instructions. IEEE 3007.2 is the IEEE recommended practice on the same subject; you will hear it named but will not need a copy.

Part B — The Preventive Program (NFPA 70B)

B1. What NFPA 70B is now

NFPA 70B used to be a recommended practice that said "should." The 2023 edition made it a Standard that says "shall." The current edition is **NFPA 70B-2026**, issued November 19, 2025 and effective December 9, 2025. The 2026 edition adds continuous thermal monitoring, a new chapter on transfer switches, and an operational-technology cybersecurity risk assessment as a program element.

70B requires the equipment owner to "implement and document an overall" electrical maintenance program (EMP). The 2023 edition lists these required elements:

1. An electrical safety program that addresses condition of maintenance.
2. Named people responsible for each element.
3. A survey and analysis of the equipment to set maintenance requirements and priorities.
4. Documented maintenance procedures.
5. A plan of inspections, servicing, and suitable tests.
6. A documentation and records-retention policy covering maintenance, equipment, and personnel.

7. A process to prescribe, carry out, and document corrective measures from the data collected.
8. A design-for-maintainability process.
9. A program review and revision process that covers failures and findings.

The owner names an **EMP coordinator**. The program is audited at least every **5 years**, and the single-line diagram, short-circuit, coordination, and arc-flash studies are updated at intervals of no more than 5 years. Training records are kept for the length of employment. After maintenance, 70B-2023 calls for a **condition-of-maintenance decal** on the equipment.

B2. The equipment condition assessment (ECA)

Every piece of equipment gets rated 1, 2, or 3 in three ways: physical condition, criticality, and operating environment. **The worst of the three governs** the interval.

Rating	Physical condition (70B-2023 wording, summarized)
Condition 1	All true: like-new appearance; clean, dry, tight enclosure; no unaddressed monitoring alarm; no open predictive recommendations; last maintenance done per the program
Condition 2	Condition 1 otherwise, but any of these: results differ from past results; the last cycle needed major repair or replacement; monitoring alarms since the last assessment; open predictive recommendations
Condition 3	Changes in operation noted, or any of these: the last two cycles were missed; the last two cycles needed major repair; an active or unaddressed monitoring alarm; predictive tests found urgent actions

Criticality 3 applies wherever a failure puts people at risk. Environment 3 applies to harsh conditions the equipment is not rated for. Keep a new interval for 2 cycles before changing it. After 2 clean inspections the interval may be extended, and any extension beyond the table must be written into the program with the reason.

Intervals when the manufacturer gives none (NFPA 70B-2023 Table 9.2.2 excerpt, as printed by Eaton; the 2026 edition's table number and values were not checked for this lesson, so confirm against a 2026 copy):

Equipment	Task	Condition 1	Condition 2	Condition 3
All equipment	Infrared thermography	12 months	12 months	6 months
Molded-case, insulated-case, and low-voltage power breakers	Visual, clean, lubricate, mechanical test, electrical test	60 months	36 months	12 months
Motor control equipment	Same five tasks	60	36	12
Busways, fuses, medium-voltage power breakers	Same five tasks	60	36	12
Low-voltage ground-fault protection systems	Visual and electrical test	12 / 12	Read from the table	

SAMPLE PANELBOARD EPM CHECKLIST

TASK	FREQUENCY	METHOD
De-energize & LOTO before any hands-on work	each visit	2.1 routine
Visual: discoloration, arcing, loose parts, water	each visit	eyes
IR scan under load — find hot connections	annual	thermal cam
Torque-check breaker lugs & bus to spec	1-3 yr	torque tool
Clean interior (vacuum, lint-free — no compressed air)	1-3 yr	vacuum
Exercise / test main & key breakers	per NFPA 70B	functional
Verify directory accurate & clearances clear	each visit	110.26 / 408.4

A sample EPM checklist: tasks, frequency, method. Correction to the torque row: do not re-torque lugs and bus on a schedule. Re-torque only what the IR scan flags or what the manufacturer lists for periodic checks (Part B3).

Safety during PM. Default to de-energized work. Schneider's switchboard bulletin says to "inspect and perform preventive maintenance only on switchboards and equipment that has been de-energized and electrically isolated." Lock out and test for absence of voltage per NFPA 70E-2024 120.6 (Module 2.1). The energized parts of a PM visit are the IR scan, the ultrasonic scan, and voltage and amp readings. They need PPE per the arc-flash label; UFC 3-560-01 (para. 8-3.4) says a scan done outside the restricted approach boundary needs no energized work permit. Discharge every conductor after a megger or hipot test and barricade it while testing.

B3. STEP-BY-STEP: annual panelboard PM

1. **IR scan under load, covers off**, before any shutdown. A de-energized panel shows nothing. Load should be at least 40 percent (Part C1). Record the amps on each phase.
2. **Ultrasonic scan** of door seams and vents before opening (Part C4).
3. **Job briefing, lock out, test before touch** (live-dead-live).
4. **Clean**: vacuum and wipe with a dry lint-free cloth. No air hose: "Dust can settle inside relays and overcurrent devices" (Schneider QED-2). Keep petroleum solvents off plastic parts.
5. **Inspect** for discoloration and flaking (overheating), rodent nests, cracked or missing parts, moisture, and plating damage. Do not sand plating.
6. **Connections**: Schneider QED-2 says "Bus bar joints are maintenance-free. Do not retighten them after the pre-energizing checkout procedure is complete." Re-torque only the connections the IR scan flagged and any the manufacturer lists for periodic checks. Use a calibrated tool set to the value marked on the equipment or in its instructions (NEC 2026 110.14(D)). Blanket re-torquing over-stresses aluminum and can crack hardware.
7. **Exercise the breakers**: push-to-trip, then open and close each one 2 to 3 times, at least once a year (QED-2).
8. **Directory**: legible and specific, spares included. NEC 2026 408.4(A): "Every circuit and circuit modification shall be provided with a legible and permanent description."
9. **Working space** clear, nothing stored in it (110.26). Blank fillers in every unused space.
10. **Close up**: covers on, remove locks, re-energize in order (mains, then branches, then loads), apply the condition decal, and record the results.

B4. Switchboards and low-voltage switchgear

- **Interval**: Schneider's maximum inspection interval is **1 year**, and always after a trip.
- **Drawout breakers**: rack out to the test or disconnect position, clean, inspect the primary fingers, and lubricate only with the manufacturer's compound. Schneider names PJC7201 for bus and plug-on connections, S48899 for MasterPacT drawout connections, and SWLUB (BG20) for switch blades.
- **Trip-unit test** with the manufacturer's secondary-injection kit (Schneider names its FFTK, UTA, and S33595 kits). Schneider: "the switchboard must be de-energized."
- **Bolted pressure switches**: exercise yearly; lubricate current-carrying parts at least every year and mechanisms at least every 5 years. Fuse hardware torque is **21-30 lb-ft (28-41 N·m)**.
- **Insulators**: replace any that are cracked before re-energizing.
- **Medium-voltage vacuum breakers** (awareness): check the contact-erosion indicator, and run the one-minute AC test across open contacts only at the manufacturer's voltage. Over-voltage across open vacuum gaps can produce X-rays (GE and Eaton manuals). On SF6 gear, check the gas pressure or density gauge against the nameplate.

B5. STEP-BY-STEP: dry-type transformer PM (Eaton IOM PUB53311)

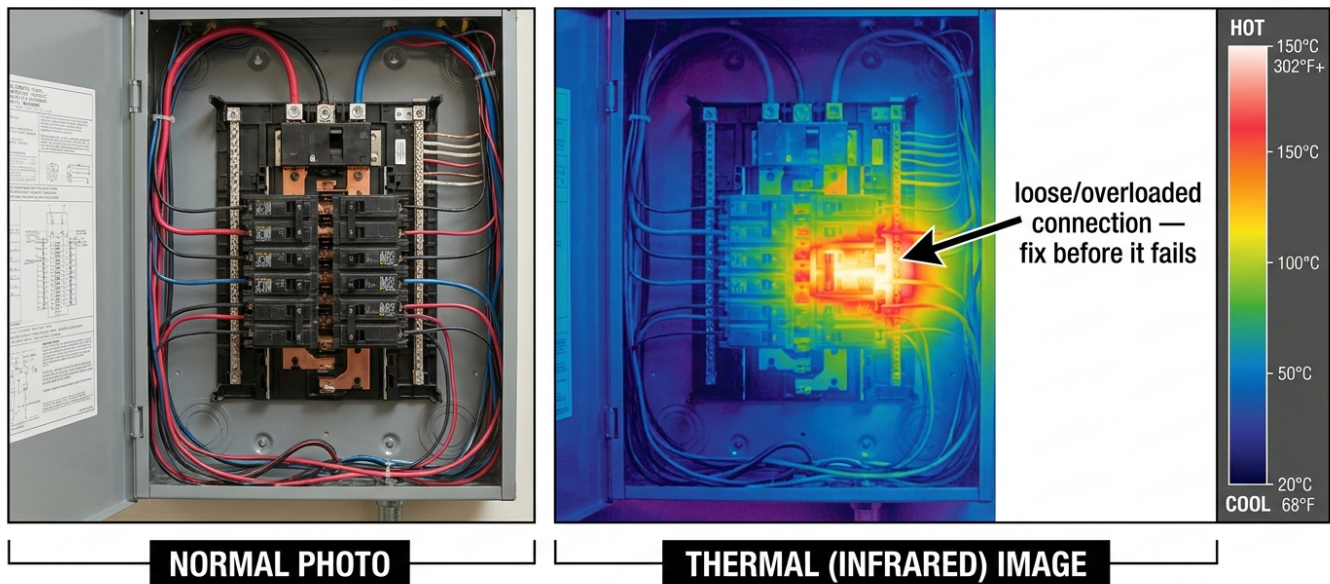
1. Scan it with IR under load first.
2. De-energize, lock out, and **let the unit cool**.
3. Remove dust from terminations and vents with a vacuum or brush. If you use dry air, protect against flying particles and damage.
4. Inspect insulators, terminals, and terminal boards for tracking, cracks, and burns.
5. Check terminal and tap connections for tightness.
6. Check the ground connections, including the X0 bond.
7. Ventilated units only: if you find moisture, dry the unit with heated air **not over 110 °C (230 °F)**.
8. Insulation test 0–600 V windings at 1,000 V dc. NETA values (as tabulated by TestGuy): **500 MΩ minimum for dry-type**, 100 MΩ for liquid-filled.
9. Touch up the paint and record the readings.

B6. Motors and MCCs

- **Megger** per IEEE 43 Table 4, corrected to 40 °C: minimum **5 MΩ** for random-wound stators and form-wound below 1 kV; **100 MΩ** for form-wound AC windings built after about 1970. Polarization index (PI = 10-minute reading ÷ 1-minute reading) at least **2.0** for Class B insulation and above, **1.5** for Class A. Skip PI when the 1-minute reading is above 5,000 MΩ.
- **Trend** each reading at the same corrected temperature. A falling trend matters more than one reading.
- **Bearings:** grease to the motor manufacturer's interval and quantity. Fluke: "Over lubrication is just as much of a problem as under lubrication."
- **Alignment and vibration** are mechanical work. Coordinate with the millwright.
- **Amp trending:** log running amps on each phase against nameplate FLA at every visit. Rising amps or growing phase imbalance become a work order.
- **MCC buckets:** de-energize and withdraw the bucket, inspect the stabs for pitting, discoloration, and spring tension, inspect the bus stab-on points, lubricate stabs only with the manufacturer's compound, check overload settings against the motor nameplate, and exercise the disconnect. Follow the MCC manufacturer's manual for the detailed steps.

Part C — Predictive: Catch It Before It Fails

INFRARED SCAN FINDS THE HOT CONNECTION



Infrared thermography — a loose connection runs hot for weeks; an annual scan finds it while everything still works.

C1. STEP-BY-STEP: infrared thermography

1. **Schedule for peak load**, or at least 40 percent load, which Fluke attributes to NFPA 70B. "Heat generated by a loose connection rises as the square of the load."
2. **PPE per the arc-flash label**. Removing covers is the risky step.
3. **Covers off**. "Don't shoot through doors." Infrared does not pass through glass or plastic shields. IR windows are the exception.
4. **Compare like with like**: emissivity at 1.0, similar parts under similar loads. Shiny metal gives false readings, so aim at insulation or black electrical tape (emissivity about 0.96).
5. **Clamp the load** on each phase so you can judge each temperature against its load.
6. **Save** an IR image and a visual image. Record ambient temperature, load, and the temperature rise (ΔT).
7. **Classify** each finding with the NETA table below, and re-scan after the repair. ASTM E1934 is the consensus guide for this work.

ΔT between similar parts, similar load	ΔT over ambient	Action (NETA MTS Table 100.18)
1-3 °C	1-10 °C	Possible deficiency; investigate
4-15 °C	11-20 °C	Probable deficiency; repair as time permits
—	21-40 °C	Monitor until corrective measures can be accomplished
Over 15 °C	Over 40 °C	Major discrepancy; repair immediately

Worked example 1. On a feeder breaker carrying about 180 A on each phase, the L1 lug reads 58 °C, L2 41 °C, and L3 40 °C. The phase-to-phase ΔT is $58 - 41 = 17$ °C, which is over 15 °C: repair immediately. Fluke's repair: the connection is "disassembled, cleaned, repaired and reassembled," then re-scanned under load.

C2. Insulation-resistance trending

Nominal rating	Minimum test voltage (dc)	Minimum insulation resistance
250 V	500 V	25 MΩ
600 V	1,000 V	100 MΩ
1,000 V	1,000 V	100 MΩ
5,000 V	2,500 V	1,500 MΩ
15,000 V	2,500 V	5,000 MΩ

Values are from NETA MTS-2019 Table 100.1 (equipment other than rotating machines); confirm against the current MTS edition.

1. Lock out and prove dead. Disconnect electronics first: trip units, surge protectors, meters, drives, and GFCI devices.
2. Apply the test voltage for one minute. Control wiring: 500 V dc for 300 V cable, 1,000 V dc for 600 V cable.
3. Record the reading and the temperature. Discharge the conductor.
4. Compare to last year. The NETA notes: "Deviations from the baseline information permit evaluation."

Worked example 2. A 480 V feeder tested at 1,000 V dc reads 2,400 MΩ this year and read 9,000 MΩ last year at a similar temperature. Both pass the 100 MΩ floor, but the reading fell $(9,000 - 2,400) \div 9,000 = 73$ percent. Investigate for moisture or damage.

C3. Contact and connection resistance (micro-ohmmeter)

NETA MTS: compare bolted-connection resistance to similar connections and investigate values that deviate "by more than 50 percent of the lowest value." For breaker poles, use the manufacturer's normal range first, then the 50 percent rule. Schneider data bulletin 0600DB1901 and NEMA AB-4 treat the 50 percent rule as a trigger to investigate, not as pass or fail.

Worked example 3 (Schneider). Three poles read 50, 60, and 76 $\mu\Omega$. The lowest is 50, and 76 is 52 percent above it, so the breaker is flagged. Poles reading 130, 180, and 150 $\mu\Omega$: 180 is 38 percent above 130, so they pass.

C4. Ultrasonic inspection

- Scan door seams and vents **before** opening, with the airborne module at **40 kHz**. Use the contact (structure-borne) probe at 25 kHz through a waveguide.
- Arcing sounds like erratic bursts, corona like a steady buzz, and tracking like a buzz with pops.
- Below about 1,000 V corona cannot form, so a buzz means loose parts vibrating at 60 Hz, or tracking.
- If you smell strong ozone, **do not open** the gear until it is de-energized.
- Ultrasound finds corona, which IR misses. IR finds resistive heating, which ultrasound misses. Use both on medium-voltage gear.

C5. Power-quality logging

Log voltage, current, harmonic distortion, and unbalance for 7 days or more at the service and at problem loads. IEEE 1159 covers monitoring practice and IEEE 519 covers harmonic limits; get the limit values from those documents, not from memory.

C6. Batteries and UPS

Interval	Valve-regulated (VRLA, IEEE 1188)	Flooded (IEEE 450)
Monthly	Float voltage, charger output, visual, room temperature, ventilation	Same, plus electrolyte level and unintended grounds
Quarterly	Every cell voltage, ohmic value, negative-post temperature	Cell voltages, representative temperatures and specific gravity
Yearly	Inter-cell connection resistance, AC ripple	Detailed visual, connection resistance, rack condition
Capacity test	At 25 percent of expected life or 2 years, whichever is less	Within the first 2 years, then at 25 percent of life

- Connection resistance more than **20 percent above** its baseline or the string average: take it apart, clean, re-torque, and retest.
- An ohmic value that changed more than **20 percent** calls for a capacity test. Replace the battery below **80 percent** capacity.
- Battery work needs eye and face protection and acid-rated gloves (NFPA 70E Article 240).

C7. Surge protective devices (SPDs)

Check the status lights at every visit. Green means protected. A red or dark light, or a red service light, means the module has reached end of life and must be replaced; there is no field repair inside the module. Press the test button if it has one and record the surge counter (Mersen STZ instructions). On unmanned sites, wire the alarm contacts to the building automation system.

Part D — Maintenance as a Service (the business angle)

What the customer receives from a PM visit is the record. The program must have a records-retention policy (70B), the inspector and insurer ask for the life-safety logs in Part E, and the next crew needs your numbers to see a trend. Write down the raw reading, not just "pass."

What each equipment record holds

Field	Example
Asset ID tied to the single-line diagram	MDP-1, T-2, MCC-A bucket 3
Nameplate data	Voltage, amps, short-circuit rating, catalog number
Condition rating and interval	Condition 2 → 36-month breaker service
Last and next due dates	Serviced 2026-04; next 2029-04
As-found and as-left readings	IR ΔT , megohms corrected to temperature, micro-ohms, trip times
Photos	IR and visual image of each finding
Open corrective items	Each with its own work order
Decal	Condition-of-maintenance decal applied and its color

The site report, in order

1. A summary table of findings ranked by NETA Table 100.18 severity.
2. Each finding with its IR and visual image, ΔT , load, and the recommended action.
3. The test data sheets (megger, micro-ohm, trip-unit, battery).
4. The life-safety test logs (generator, emergency lights, ground-fault protection).

NFPA 70B Annex E contains sample forms. Every "repair" finding gets its own work order so it is scheduled and closed out.

Part E — Life-Safety and Code-Required Tests

E1. Emergency and standby generators

NEC 2026 700.4 (700.3 in 2023) covers tests and maintenance for emergency systems. The parallel rule for legally required standby systems, 701.4, requires the system to be tested periodically on a schedule acceptable to the authority having jurisdiction (AHJ) (701.4(B)), maintained per the manufacturer's instructions and industry standards (701.4(C)), and backed by a written record of tests and servicing (701.4(D)). 701.4(K): "Means for testing legally required

standby systems during maximum anticipated load conditions shall be provided." 708.6 has the same kind of witness-test and periodic-test rules for critical operations power systems.

1. **Weekly** (Level 1 systems): inspect the generator (NFPA 110 8.4.1).
2. **Monthly**: exercise for **30 minutes or more**, either at a load that holds the manufacturer's minimum exhaust temperature or at **30 percent or more of the standby nameplate kW** (NFPA 110 8.4.2). Light loading causes "wet stacking," which is why the rule exists. Transfer the load through the ATS during the test.
3. If monthly tests cannot reach 30 percent, NFPA 110 requires an annual supplemental load-bank test. Take the steps and durations from the edition the AHJ enforces.
4. Log the date, run time, kW, exhaust temperature if read, and any alarms.

Worked example 4. A 500 kW standby generator needs at least $0.30 \times 500 = \mathbf{150 \text{ kW}}$ of load for its monthly 30-minute run.

E2. Emergency and exit lighting (NFPA 101 7.9.3)

1. **Monthly**: functional test for at least 30 seconds, with tests 3 to 5 weeks apart.
2. **Yearly**: 1½ hours on battery for battery-powered systems. The equipment must stay fully lit for the whole test.
3. **Self-diagnostic units** test themselves every 30 days but still need the monthly visual check and the annual 90-minute test.
4. Keep written records for the AHJ.

The International Fire Code is a different rule: the Minnesota Department of Health handout notes IFC 604.5 calls for a monthly 30-second test and an annual 30-minute test. Check which code your AHJ enforces.

E3. GFCI receptacles and breakers

Since June 29, 2015, UL 943 has required GFCIs to monitor themselves, but self-test cannot check the solenoid or welded contacts. UL and manufacturers recommend pressing TEST every 30 days.

1. Plug in a tester or lamp. Press TEST and confirm power is lost.
2. Press RESET and confirm power returns.
3. A device that will not reset, or shows a flashing red light, is at end of life. Replace it.

E4. Ground-fault protection of equipment (GFPE) performance test

NEC 2026 230.95(E): the ground-fault protection system "shall be performance tested when first installed on site" by a qualified person "using a test process of primary current injection," and "a written record of this testing shall be made" for the AHJ. 240.87 has a similar first-installation test for arc-energy reduction. Steps from the Eaton, Schneider, and ABB test bulletins:

1. De-energize and isolate.

2. Remove the neutral disconnect link and megger neutral to ground on the load side. It must read **at least 1 M Ω** (Schneider). Remove any downstream neutral-to-ground bonds you find.
3. Verify sensor polarity: every phase and the neutral pass through the sensor in the same direction, and **no equipment ground passes through the sensor** (ABB).
4. **Trip test:** inject 125 percent of the ground-fault pickup through one pole. The breaker must trip.
5. **No-trip test:** inject 125 percent of pickup through one pole and back through another pole or the neutral sensor. The breaker must not trip.
6. Record the settings and results for the AHJ. The test set is high-current (about 1,000 A at low voltage) with No. 2 welding-cable jumpers.

E5. Arc-flash labels

NFPA 70E-2024 130.5(G): the incident energy analysis must be updated when the system changes and "reviewed for accuracy at intervals not to exceed 5 years." 130.5(H) requires the label data to be reviewed at the same interval and the label updated if it is wrong. NEC 2026 110.16 requires the label to carry the date of the assessment, so you can see the 5-year clock at the gear. 130.5(G) also requires the analysis to consider the overcurrent device's "condition of maintenance." A breaker that has never been exercised may trip slowly, which makes the label's number too low. Report old labels and unexercised breakers to the owner.

Part F — Sample Annual PM Calendar (small commercial building)

When	Task	Basis
Weekly (Level 1 generator)	Generator inspection	NFPA 110 8.4.1
Every month	Generator 30 min at 30% kW or more with ATS transfer; emergency-light 30-second test; SPD lights; GFCI test; battery float voltage and visual	NFPA 110 8.4.2; NFPA 101 7.9.3; manufacturer; UL 943 recommendation; IEEE 1188/450
Jan / Apr / Jul / Oct	Battery cell voltages and ohmic values	IEEE 1188 quarterly
March (peak HVAC load)	IR and ultrasonic survey of all gear at 40% load or more	70B (12-month IR); Fluke
April (shutdown)	Panelboard and switchboard clean, inspect, exercise; repair IR findings; condition decals	Schneider QED-2 (1-year maximum); 70B
May	Dry-type transformer clean, inspect, insulation test	Eaton PUB53311; NETA
June	Motor megger and PI, MCC bucket and stab inspection, amp trending	IEEE 43; 70B
August (second peak)	Repeat IR on Condition 3 gear (6-month interval)	70B
September	Annual 90-minute emergency-light test	NFPA 101 7.9.3
October	Generator load bank if monthly runs were under 30%; battery connection resistance	NFPA 110; IEEE
November	Ground-fault protection check and trip-unit secondary injection per the condition rating	70B; manufacturer
December	Records review, update the maintenance database, check arc-flash label age (5 years maximum), program review	70E 130.5(G)/(H); 70B

Mistakes to avoid

Mistake	Why it matters
Re-torquing every lug and bus joint on a schedule	Schneider says bus joints are maintenance-free; over-torque stresses aluminum and cracks hardware
IR scan after the shutdown	A cold panel shows nothing. Scan first, under load
Scanning through the door or a plastic shield	Infrared does not pass through it
Scanning at light load	Heat rises with the square of the load; a light-load scan hides problems
Blowing out gear with an air hose	Drives dust into relays and breakers
Meggering with electronics connected	Damages trip units, meters, drives, and SPDs
Writing "pass" instead of the number	No trend is possible next year
Generator exercised with no load	Wet stacking; does not meet the 30% rule
Over-greasing motor bearings	Fails bearings as surely as under-greasing

Standards Checkpoints: NEC 2026 (2023 number in parentheses where it moved) and others

- **NEC 110.14(D)** terminal torque per the marked value • **110.16** arc-flash label with assessment date • **110.17** servicing by qualified persons per the manufacturer • **110.26** working space • **408.4(A)** circuit directory.
- **NEC 230.95(E)** GFPE performance test record • **240.87** arc-energy reduction test • **700.4** emergency system tests and maintenance (700.3) • **701.4** legally required standby testing and records • **708.6** COPS testing.
- **NFPA 70B-2026** (a Standard since 2023; interval table quoted here from the 2023 edition) • **NFPA 70E-2024** 205.4 maintenance duty, 120.6 lockout, 130.5(G)/(H) label review • **NETA MTS** Tables 100.1 and 100.18.
- **NFPA 110** 8.4.1, 8.4.2 generator tests • **NFPA 101** 7.9.3 emergency lighting • **IEEE 43** motor insulation • **IEEE 450 / 1188** batteries • **UL 943** GFCI.

Hands-On Field Exercise

- Write a one-page **EPM checklist** for a dry-type transformer using the B5 steps, the 70B intervals, and an IR row.
- **IR-scan** a loaded panel. Record load amps on each phase, the ΔT , the NETA Table 100.18 category, and the action.
- For one connection the scan flagged, find the torque value on the device label, tighten it with a calibrated tool, apply a torque stripe, and re-scan under load.

- Megger a feeder at the NETA test voltage, then compare with last year's reading and calculate the percent change.
- Run a 30-second emergency-light test on a building's units and write the log entry.
- Test 10 GFCI receptacles with the TEST and RESET buttons and log each result.
- Fill in an equipment record (Part D) for one panelboard.

Sources used in this module (public documents)

- NFPA 70, National Electrical Code 2026 (free read-only access at [nfpa.org](https://www.nfpa.org)): 110.14, 110.16, 110.17, 110.26, 230.95, 240.87, 408.4, 700.4, 701.4, 708.6. NFPA 70B and 70E information pages: [nfpa.org](https://www.nfpa.org)
- EC&M, "A New Standard for Electrical Equipment Maintenance" (Colombo, 2023): [ecmweb.com](https://www.ecmweb.com)
- NETA World, NFPA 70B-2023 Chapter 4 (Ablizard, 2023): [netaworldjournal.org](https://www.netaworldjournal.org)
- Eaton: NFPA 70B white paper WP027024EN; "For Safety's Sake" 70B-2026 updates; ground-fault test IL012125EN; dry-type IOM PUB53311; VCP-W IB131006EN: [eaton.com](https://www.eaton.com)
- Electrical Reliability Services NFPA 70B chart: [electricalreliabilityservices.com](https://www.electricalreliabilityservices.com). IEEE Electrical Safety Workshop 2023 paper 18: [electricalsafetyworkshop.org](https://www.electricalsafetyworkshop.org)
- Schneider Electric: QED-2 switchboard bulletin 80043-055-16; GFP test 80043-703-01; resistance testing 0600DB1901: [se.com](https://www.se.com)
- ABB ground-fault test bulletin 1VAL106901: [abb.com](https://www.abb.com). GE Power/Vac manual W1001486.
- Fluke thermography and motor application notes 2518864, 2563251, 3433263: [fluke.com](https://www.fluke.com)
- UE Systems ultrasound TechTrends and wave-file guide: [uesystems.com](https://www.uesystems.com)
- TestGuy NETA insulation tables: [testguy.net](https://www.testguy.net). IEEE 43, 450, 1188, 3007.2 summaries: standards.ieee.org
- Vertiv BattCon 2017 paper: [vertiv.com](https://www.vertiv.com). Eagle Eye battery white paper: [eepowersolutions.com](https://www.eepowersolutions.com)
- Mersen Surge-Trap STZ instructions INS-270386: [mersen.com](https://www.mersen.com)
- UFC 3-560-01 Electrical Safety, O&M: [wbdg.org](https://www.wbdg.org)
- NFPA 110 first-revision report; NFPA 101 7.9.3 via [up.codes](https://www.up.codes); Minnesota Department of Health emergency-lighting handout: [health.state.mn.us](https://www.health.state.mn.us)
- IAEI Magazine, UL Question Corner on self-testing GFCIs: [iaeimagazine.org](https://www.iaeimagazine.org)
- NECA NSPC 2024 arc-flash risk assessments (Dollard): [necanet.org](https://www.necanet.org). Brainfiller, date on the arc-flash label: [brainfiller.com](https://www.brainfiller.com)

End of Phase 2 (Repair). Next: Module 3.1 — The Takeoff Process.