

Critical Safety Review of NFPA 70B Article 7.4 Infrared Thermography

Subject: NFPA 70B Article 7.4, as currently written, requires an annual “covers-off while energized” infrared (IR) scan; a practice that exposes personnel to unnecessary risk of electrical shock and arc flash, while also driving unsustainable costs.

This review presents a safer and more practical alternative: a two-step workflow. First, perform a non-invasive surface IR scan to identify potential anomalies. Second, conduct targeted deenergized maintenance or, where justified, enhanced scanning with covers removed. This approach maintains diagnostic effectiveness while significantly reducing exposure risk and overall cost.

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1. Primary Safety Risk of Energized Cover Removal per NFPA 70B Article 7.4

- **Electrical Shock & Arc Flash Hazard:** Removing dead-fronts or covers on energized panelboards, switchboards, MCCs and the like exposes personnel to live parts and dramatically increases electrical shock & arc flash risk.
- **Manufacturer Instructions:** UL 67 (panelboards), UL 891 (switchboards) and UL 845 (MCC's) are evaluated and listed with covers in place. Most manufacturer instructions clearly state: *“De-energize before removing covers or servicing equipment.”* Conducting IR scans with covers removed while energized is contrary to both listing intent and manufacturer guidance.
- **Real-World Cost:** A single serious electrical shock or arc flash injury can cost a facility hundreds of thousands of dollars to millions of dollars in medical expenses, lost time, insurance claims, OSHA fines, and long-term reputational damage. At \$400 per scan on 72million pieces of electrical equipment would cost up to ~\$28.8billion, annually!

2. Limitations of NFPA 70B Article 7.4 (2023, as written)

- **Impractical Requirements:** The article does not explicitly recognize non-invasive IR inspections with covers in place. Its current language implies “qualified persons in PPE” are required for every IR task, even simple external surface

scans. This interpretation discourages adoption of safer, lower-risk practices and increases cost.

- **Work Hot Permits & Electrical Safety Program:** Article 7.4 underemphasizes the need for IR inspections to be formally integrated into a facility's Electrical Safety Program and/or Electrical Maintenance Program, including hot-work permits, one-line diagrams, and panel schedules. Without this framework, safety and compliance gaps remain.

3. Safer Two-Step IR Inspection Method (Risk-Based) proposed

A structured two-tier process aligns safety with reliability:

1. **Standard Test: Non-invasive IR inspection with covers in place.**
 - Detects most meaningful anomalies (loose connections, overloaded circuits, failing devices).
 - Requires only standard PPE (gloves, safety glasses, cotton shirt).
 - Enables frequent, lower-cost, trendable inspections by trained technicians.
2. **Enhanced Test: Energized inspection with covers removed.**
 - Reserved only for flagged equipment that shows abnormal heating trends.
 - Must be performed by qualified persons, under full NFPA 70E requirements, PPE, and permits.
 - In certain obvious circumstances, to prioritize a localized panel deenergized outage and promptly address the panel's problems without waiting for additional "covers removed" IR testing.

This two-step test approach reduces unnecessary live electrical exposures and aligns with other risk-based maintenance principles to reduce risks.

4. Technical Surface IR Notes

- **Surface vs. Internal Temperatures:** While readings taken at the surface cover temperatures may read lower or less precise than internal covers-off temperature readings, they still show relative anomalies, this is the key diagnostic indicator.

- Validation Testing: Controlled shop tests (heat gun, soldering iron, hair dryer, set on terminals) confirm that an IR scan can detect anomalies through the covers reliably.
- Tools: Spot IR thermometers are excellent for “doors open, covers in place” scans when target size > spot size. Thermal imagers are ideal for broader coverage but must respect arc flash boundaries (often ≥ 12 in). This also brings in the assumption that the facility has performed a complaint Arc Flash Study.

5. Strategic Plant-Level Cost Considerations

- Cost Control: At approximately ~\$400 per panel per year for third-party services, full NFPA 70B-compliant scans are most often unsustainable. A hybrid model (in-house surface scans + targeted third-party enhanced inspections) improves safety and reduces cost (a win win).
- Maintenance Integration: IR results should feed directly into work orders, reliability tracking systems, and predictive maintenance databases, not sit in standalone reports.
- Trend Monitoring: Frequent in-house surface scans create a thermal history, allowing better decision-making before failures escalate.

6. Suggested NFPA 70B Article 7.4 code policy language

“Infrared thermography is a diagnostic tool to be used in a two-tiered approach. Non-invasive infrared inspections (covers in place) shall be performed by qualified IR technicians and performed in accordance with Table 9.2.2 frequencies and facility condition assessments. Enhanced energized inspections requiring cover removal shall be performed only after non-invasive inspection indicates abnormal condition or when equipment criticality and risk assessment justify such energized examination. All enhanced IR examinations shall be performed by licensed electricians and shall comply with NFPA 70E, manufacturer instructions, and site hot-work controls; de-energization for inspection/repair is preferred where feasible.”

7. Bottom Line for Stakeholders:

- Engineers: Recognize that electrical equipment listings do not support energized cover removal. Advocate for safer IR inspection methods that align with NFPA 70E, manufacturer instructions and industry best practices.
- Technicians: Perform non-invasive scans first, escalate with electricians performing enhanced testing only when justified, and always work within PPE and safety program requirements.
- Plant Managers: Balance cost, compliance, and risk. One serious electrical incident can outweigh the cost of years of preventive IR programs. Support safer two-step policies & procedures to protect both people and assets.

Closing Review Notes:

An experienced engineer has a duty to be critical of an NFPA code article by examining its intent, comparing it with other industry safe practices and standards.

NFPA 70B Article 7.4 provides valuable guidance but leaves ambiguity around safe, non-invasive IR practices. A solution-oriented, industry proven risk-based (tiered safety hierarchy) approach, while aligned with manufacturer listings, NFPA 70E, and real-world reliability needs, should drive needed code revisions. This dialogue strengthens the standard and supports both safety and practicality for the personnel & at the facility level.

NFPA 70B Article 7.4 currently omits stating what specific voltages are within and outside the scope of the NFPA 70B Article 7.4. What about medium voltage gear, energized and under normal loads, is this equipment intended to be safely IR scanned with covers off, with or without infrared (IR) windows?

NFPA 70B Article 7.4 currently doesn't mandate what level of qualified person can perform these covers-off while energized IR scans, nor how many are needed to perform the IR testing steps; work hot permit, establish safety barrier, cover removal & testing steps and putting equipment back in working order.

NFPA 70B Article 7.4 currently doesn't address activating safety mechanisms where present, like ERMS, Zone selective interlocking or Arc Quenching Switchgear.

NFPA 70B Article 7.4 currently omits stating what specific electrical equipment falls under the scope of Article 7.4. One solution is to copy the list of electrical equipment which require an Arc Flash Label per NEC 110.16 (NFPA70E); switchboards, switchgear, panelboards, industrial control panels, motor control centers and

transformers, disconnect switches, enclosed breakers, and external variable frequency drives. Incredibly, that's approximately 72million pieces of electrical equipment purportedly scheduled for an energized IR scan annually (frequency per NFPA 70B Table 9.2.2); **impossible to say whether this many covers-off energized tasks can be accomplished safely.**

And at \$400 per IR scan; that's a whopping \$29billion additional maintenance expenditure annually! For costs reference; currently, total "electrical contractors / facility maintenance" U.S. \$30billion electrical maintenance in commercial/institutional buildings in 2023; effectively doubling annual electrical maintenance costs? **Not economically feasible.**

How many switchboards, switchgear, panelboards, industrial control panels, motor control centers and transformers, disconnect switches, enclosed breakers, and external variable frequency drives are there in use within the US (non-residential U.S. stock); an estimated 72million pieces of electrical equipment.

- Panelboards (distribution/load centers); ~25 million
- Switchboards; ~800k
- Switchgear; ~1.0 million
- Motor Control Centers; ~250k
- Industrial Control Panels; ~4 million
- Transformers; ~20 million
- Enclosed disconnects / enclosed breakers; ~20 million
- External / standalone Variable Frequency Drives (VFDs) ~1.5 million

About the Author:

Dennis Zimmer is a professional electrical engineer with more than 35 years of experience in Manufacturing, MEP, AE, Facility Engineering and Controls across commercial, manufacturing, mixed-use, institutional, and industrial projects. Dennis has served as a principal engineer, middle manager, and business owner. Over the course of his career, Dennis has held P.E. licenses in 15 states.

He has also been accredited by WA L&I to perform electrical field evaluations for over 7 years and has additional Machine Safety & Risk Assessment certification.

His passion is mentoring engineers in technical mastery, business acumen, and leadership excellence.

Thank you, Dennis

