Understanding real-world practices of circuit breaker labeling in residential electrical panels

Sadia Gul, University of California, Davis
Maria Kanwal, University of California, Davis
Alan K. Meier, University of California, Davis

ABSTRACT

Electrical panels are central to residential electrification because their capacity and configuration help determine whether additional electric appliances can be safely added. However, beyond capacity and available breaker spaces, circuit breaker labeling is also critical for safety, maintenance, and load planning.This study examines how circuits in electrical panels in U.S. single-family homes are labeled and how observed practices compare with the circuit identification qualities emphasized in NEC 408.4(A).

Data was collected through a nationwide online survey in which participants submitted photographs of electrical panels and circuit directories. Of the 452 survey submissions, 428 included complete panel photographs suitable for evaluating individual breaker labels, and 394 provided sufficient panel door documentation for evaluating door circuit directories. The analysis evaluated labeling formats, coverage, legibility, and specificity.

Findings show wide variation in labeling practices, including incomplete, generic, or illegible markings. A door circuit directory was identified in 65% (n=256) of the directory analysis sample, whereas individual breaker labeling was identified in 44% (n=188) of the individual breaker analysis sample. Door circuit directories remained the primary form of circuit identification, but their usefulness often varied because of partial coverage and mixed specificity. Individual breaker labeling was less common overall, but when present, 66% of panels had all or most breakers labeled, and the labels were generally legible. Overall, these findings underscore the need for improved labeling practices and closer attention to the completeness, legibility, and distinctiveness of circuit descriptions to support safe maintenance, troubleshooting, and future panel modifications.

Introduction

Residential electrification is an increasingly important component of building decarbonization efforts, driven by the growing adoption of electric vehicles, heat pumps, and other electric end-use appliances that replace fossil-fueled equipment. Meeting these growing demands requires not only sufficient electrical capacity but also an empirical understanding of existing residential electrical infrastructure, including service ratings and available breaker positions that may constrain the addition of new electric loads. Recent research has begun to quantify the distribution of panel ratings and breaker space in single-family homes across the United States, identifying panel capacity as a potential constraint in large-scale electrification efforts (Gul and Meier 2025; Fournier et al. 2024). However, while these studies have improved understanding of panel capacity limitations, they have largely centered on amperage ratings and available circuit space rather than on how circuits are identified and documented within the panel.

While capacity and breaker availability are important indicators of electrification readiness, electrical panels also play a critical operational role within residential buildings. Beyond distributing power, the panel functions as the central point for circuit identification, enabling occupants, electricians, and inspectors to locate and isolate specific circuits during routine maintenance, troubleshooting, renovations, and emergency situations. Accurate circuit labeling is therefore essential for safely de-energizing equipment, replacing devices, upgrading appliances, and responding to electrical faults. When circuit documentation is incomplete, unclear, or outdated, users may rely on trial and error methods to determine which breaker controls a given load, increasing the likelihood of confusion, delays, and unintended exposure to energized conductors. This operational opacity can create maintenance challenges and complicate the long-term management of residential electrical systems. Panel labeling therefore serves not only a technical function, but also important operational and safety functions within residential buildings.

Circuit identification is not merely a matter of convenience but is explicitly addressed in National Electrical Code. The National Electrical Code (NEC), widely adopted across U.S. jurisdictions, requires that each circuit and circuit modification be "legibly identified as to its clear, evident, and specific purpose" (NEC 408.4(A))(Gunther 2024). The NEC specifies that a circuit directory must be provided and located on the face or inside of the panel enclosure, so that circuit descriptions are accessible at the panel. While the core requirement for clear and specific identification has remained consistent throughout recent editions, 2023 NEC provides additional direction concerning the identification of spare or unused overcurrent devices and states that circuit descriptions should not be based on transient conditions. Through these requirements, the NEC establishes minimum expectations for the clarity and accessibility of circuit identification within panelboards.

While the NEC establishes requirements for circuit identification, the practical implementation of panel labeling begins at installation and is shaped by installation practices, inspection processes, and later panel modifications. Electricians are responsible for installing panelboards, completing circuit directories, and updating labels when circuit modifications are made, typically in accordance with adopted NEC provisions and local jurisdictional amendments. Electrical inspectors review installations for compliance with applicable code requirements prior to approval. In residential applications, manufacturers commonly provide pre-printed directory cards or labeling templates within panel enclosures; however, the completion and ongoing maintenance of circuit descriptions remain the responsibility of the installer and, over time, may also depend on subsequent alterations performed by homeowners or contractors. As a result, the clarity and durability of circuit labeling in existing homes may reflect a combination of initial installation practices, inspection oversight, and later modifications. This makes existing residential panels a useful setting for examining how code expectations are reflected in observed labeling practice over time.

Accurate circuit identification is closely linked to safe electrical work practices. Federal occupational safety regulations require that equipment be properly de-energized before servicing and that the de-energized condition be verified (OSHA 1910.333, n.d.), underscoring the importance of reliably identifying the correct circuit before work is performed. In residential contexts, unclear or incomplete breaker descriptions may increase reliance on trial and error methods to isolate circuits during maintenance, renovations, or appliance replacement. While labeling deficiencies are not independently documented as a primary cause of electrical injuries,

ambiguous circuit documentation can introduce uncertainty during circuit isolation and complicate safe work procedures.

Although circuit identification is required by code and central to safe panel operation, relatively little is known about how residential panel directories and breaker labels are completed in practice. Most discussions of electrical infrastructure focus on system capacity or compliance at the time of inspection, while the condition, clarity, and coverage of circuit documentation within existing homes have received limited systematic examination. In particular, there is limited large-scale photographic evidence describing how circuit directories are filled out, how consistently breakers are labeled, or how labeling formats vary across installations. To address this gap, this study conducts a structured analysis of door circuit directories and individual breaker labels in single-family homes, documenting patterns in labeling coverage, legibility, specificity, repeated entries, and physical format. By providing empirical documentation of residential labeling practices, this work contributes evidence to inform discussions of implementation consistency and potential opportunities to strengthen guidance and professional practice. The following sections describe the data collection and coding framework, present findings for the two forms of circuit identification, and discuss their practical implications for residential panel labeling practices.

Methodology

This study builds upon our previously published nationwide survey of single-family homes that examined electrical panel capacities and electrification readiness. While that earlier work provided insights into panel ratings, breaker position availability, and appliance configurations, it also revealed limitations in the completeness of submitted panel photographs. In particular, many participants submitted partial images of electrical panels that did not clearly show the interior door area, where circuit directories and related labeling information are typically recorded. As a result, the first-phase dataset did not permit a systematic evaluation of residential circuit labeling practices.

To address this limitation, a second phase of data collection was designed with enhanced photographic requirements that explicitly targeted both the panel interior and associated labeling areas. This paper focuses exclusively on the second-phase dataset and examines residential panel labeling practices using NEC 408.4(A) as an interpretive benchmark, particularly its requirement that circuit identification be legible and sufficiently clear, evident, and specific.

Data collection was conducted between March and December 2025 using the Prolific research platform. Participants living in detached and attached single-family homes were recruited from the four U.S. Census regions to improve geographic diversity. The survey collected information on housing characteristics, major appliances, and residential electrical infrastructure, accompanied by photographic documentation of electrical panels and associated labeling systems. The final second-phase dataset contained 452 survey submissions. Although responses were collected across all four Census regions, the sample should not be interpreted as nationally representative of the U.S. single-family housing stock.

Participants were instructed to upload (1) a complete image of the electrical panel showing all breakers and empty positions, (2) a close-up image of the main service disconnect, and (3) a clear image of the circuit directory or door label when present. Participants were also instructed to ensure that panel photographs were sufficiently clear to capture any labels placed beside individual breaker positions. All submissions were manually reviewed for image completeness, clarity, and internal consistency before coding.

To characterize residential panel labeling practices, we developed a structured manual coding framework based on a visual review of submitted photographs. Labeling was evaluated for two forms of circuit identification: door circuit directories (DCDs) and individual breaker (IB) labeling. For this study, a DCD was defined as the designated area on the interior side of the panel door used to document the purpose of each breaker position. It could take the form of a pre-printed directory card, a table integrated into a manufacturer provided label, or another designated space for recording circuit descriptions. The main evaluation categories are summarized in Table 1.

Table 1: Summary of the panel labeling evaluation framework.

Evaluation category	Variables	Purpose
Presence and format	Labeling presence; directory or label type	Determined whether circuit identification was present and documented its physical format.
Coverage and readability	Coverage status; writing method; legibility	Evaluated how completely breaker positions were labeled and whether recorded circuit descriptions could be read from the submitted images.
Description quality	Specificity; repeated identical entries; abbreviation use; spare breaker labeling	Assessed whether circuit descriptions were clear, distinct, and informative, and whether spare or unused breaker positions were explicitly identified.

Door circuit directories and individual breaker labels were treated as distinct but potentially coexisting approaches to circuit identification, since some panels included one, the other, or both. For each submission, we first assessed whether the panel photograph was complete and whether labeling information was visible either on the panel door or adjacent to breaker positions. Panels with incomplete or unclear documentation were excluded from analyses that required direct observation of the relevant labeling features. Consequently, the analytical sample size varied according to the form and characteristic of labeling being evaluated.

Door circuit directory analysis

For door circuit directories, the principal analytical sample was limited to submissions that included (1) a complete panel photograph and (2) either a separate image of the panel door interior or a panel photograph in which the door interior was visible. This filtering produced a DCD analytical sample of 394 panels. Within this sample, we coded whether a circuit directory was present and, when present, classified its physical format, coverage, writing method, legibility, abbreviation use, specificity, repeated identical entries, and spare breaker labeling. Cases in which the door area contained only manufacturer information rather than an identifiable circuit directory were coded as having no door circuit directory present. Cases in which directory presence could not be determined reliably because the submitted photographs did not show the directory area with sufficient clarity were coded as unknown.

Directory format was classified into categories such as manufacturer provided circuit directory labels, printed sheets, sticker systems, handwritten directories, and mixed formats.

Coverage was coded as all breakers labeled, most breakers labeled, some breakers labeled, barely labeled, none, or unknown/not assessed. Legibility was coded as fully legible, mostly legible, or compromised. The compromised category included cases in which a substantial portion of the recorded entries could not be interpreted reliably because the writing was only partly readable or effectively illegible. Specificity was coded as mostly specific, mixed specificity, mostly generic, or non-informative, based on readable entries only. Repeated identical entries captured cases in which the same generic descriptor appeared across multiple breaker positions, and abbreviation use distinguished among no abbreviations, self-explanatory shortened forms, explained abbreviations, and unexplained abbreviations. Spare breaker labeling was coded separately where applicable.

Not all DCD variables were evaluated using the same denominator. Directory presence was assessed using the full DCD analytical sample (n=394), whereas directory characteristics were evaluated only where a true circuit directory was determined to be present (n=256). Legibility was assessed only for directories containing at least some recorded entries (n=226). Specificity, repeated identical entries, and spare breaker labeling were evaluated using the subset of directories in which all or most breaker positions were labeled (n=169), because these directories contained sufficient information for meaningful assessment.

Individual breaker labeling analysis

In addition to door circuit directories, the study also evaluated labels placed beside individual breaker positions. Because this form of labeling depends on visibility of the panel interior rather than the door, the IB analysis used 428 submissions containing complete panel photographs. Within this subset, we coded whether individual breaker labeling was present and then evaluated the type, coverage, legibility, abbreviation use, specificity, and repeated identical entries of the observed labeling.

IB label type was classified into categories such as paper labels with handwritten entries, direct marker writing, printed stickers, tape-only labels, pencil based labels, and mixed approaches. Coverage, legibility, abbreviation use, specificity, and repeated identical entries were coded using criteria parallel to those applied to door circuit directories. Label type and coverage were evaluated for the 188 panels where IB labeling was present. Legibility, abbreviation use, specificity, and repeated identical entries were evaluated for the 185 panels containing at least some recorded breaker level labeling.

All coding was conducted manually from photographs using predefined category definitions developed for this study. The coding framework was designed to characterize observable labeling practices rather than to verify whether recorded circuit descriptions correctly identified the connected circuits or loads. The goal of the coding framework was not to make formal determinations of NEC compliance, but to characterize how residential labeling practices compare with the practical labeling qualities emphasized by NEC 408.4(A), namely the completeness, legibility, and specificity of circuit identification. Results were summarized using counts and percentages, with denominators adjusted to reflect the photographs and labeling characteristics that could be evaluated.

Results and Discussion

The labeling analysis was conducted on the survey submissions with sufficient photographic documentation of the electrical panel and associated labeling area. Of the 452

survey submissions, 428 included a complete photograph of the electrical panel and formed the analytical sample for individual breaker labeling. Evaluation of door circuit directories required both a complete panel photograph and either a separate photograph of the panel door interior or visibility of the door interior within the panel photograph, resulting in a smaller analytical sample of 394 submissions. The two analyses therefore used different sample sizes because individual breaker labels could be evaluated from the panel face, whereas door circuit directories required visibility of the door labeling area.

A door circuit directory was identified in 65% (n=256) of the 394 panels in the DCD analytical sample, while 27% (n=106) showed no identifiable directory on the door interior. In the remaining 8% (n=32), the presence of a directory could not be determined reliably because the submitted photographs did not show the directory area with sufficient clarity.

Among the 256 panels in which a door circuit directory was identified, the dominant format was a manufacturer provided circuit directory label that included a pre-printed grid or table for documenting breaker positions. This format was observed in 88% (n=224) of panels. Other formats were much less common and included printed sheet directories in 9% (n=22), adhesive sticker systems, handwritten sheet directories, and mixed directory formats together accounted for approximately 4% (n=9). The directory format could not be determined for one panel. Representative examples of these directory formats are shown in Figure 1.

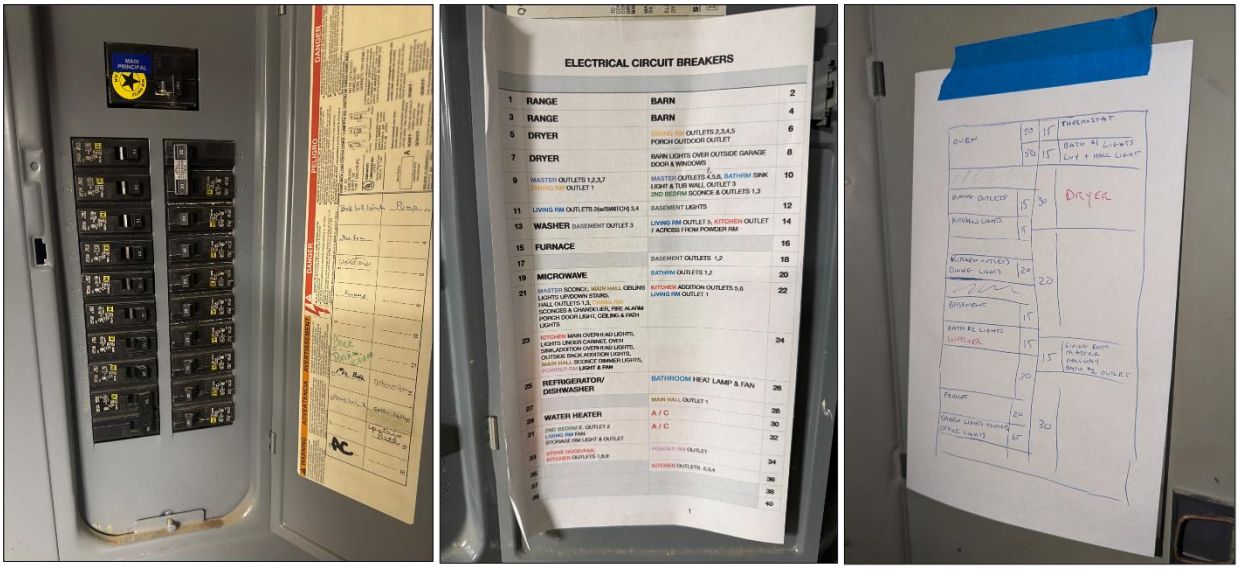

Figure 1: Examples of door circuit directory formats observed in residential panels.

Among panels with a door circuit directory, the extent to which breaker positions were documented varied considerably. Figure 2 shows the distribution of directory coverage across the 256 panel sample. About 41% (n=105) had directories in which nearly all breaker positions were labeled. A substantial share of panels had partial documentation, with 25% (n=64) having most breaker positions labeled, and about 14% (n=37) containing labels for only some breaker positions. An additional 8% (n=20) were barely labeled, 9% (n=22) contained no recorded circuit descriptions, and coverage could not be assessed for 3% (n=8).

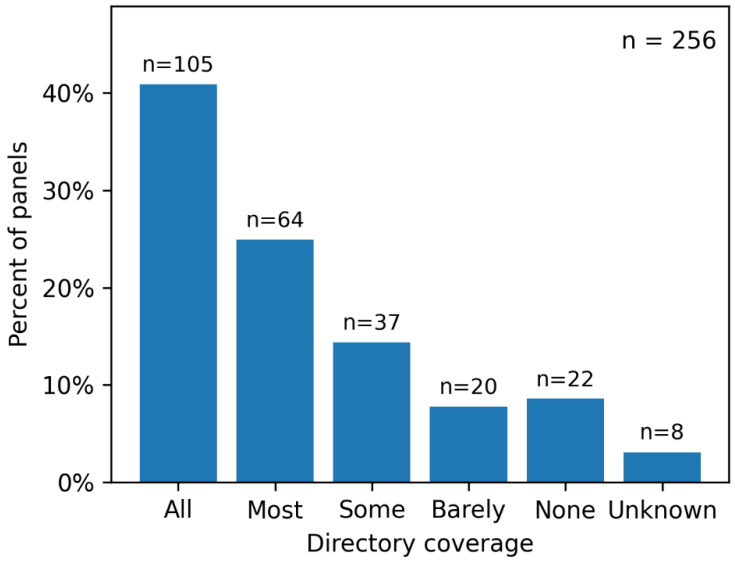

Figure 2: Distribution of door circuit directory coverage among panels with a directory present (n=256).

Legibility and writing methods were evaluated only for directories containing at least some recorded circuit descriptions. Within this subset (n=226), legibility was generally high: 54% (n=123) were classified as fully legible and 36% (n=81) as mostly legible, while 7% (n=16) were categorized as compromised. Legibility could not be assessed for the remaining 3% (n=6) because the submitted photographs did not provide sufficient visual information. Handwritten entries were far more common than printed labels, with pen or marker based entries and mixed writing methods observed more frequently than pencil or printed entries. When legibility was considered in relation to writing method, printed entries showed the most consistently clear documentation, whereas handwritten methods remained predominantly legible but displayed greater variation in legibility outcomes (Figure 3).

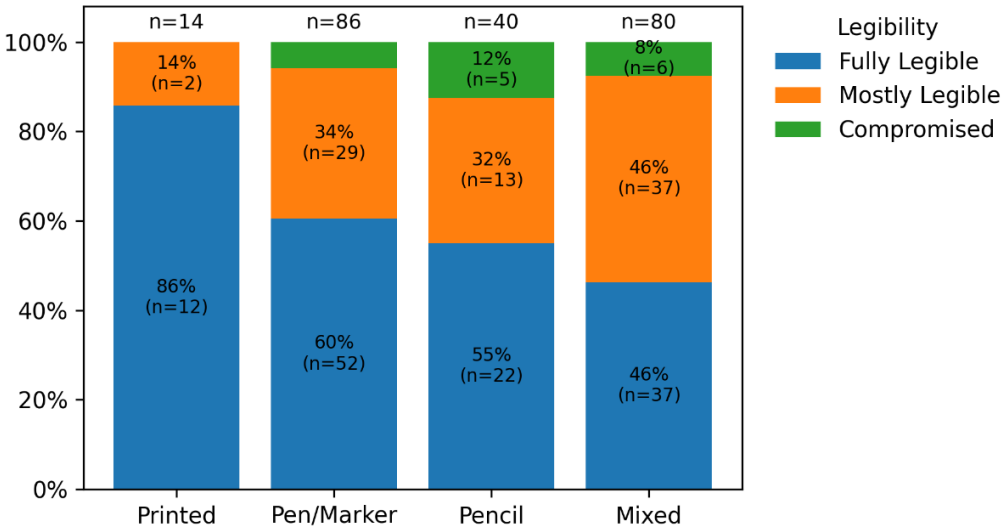

Figure 3: Door circuit directory legibility by writing method among directories with assessable legibility and writing method information (n=220).

Abbreviation use was not a dominant limitation in the analyzed circuit directories. Across the 256 panel sample, the largest shares either contained no abbreviations (35%, n=89) or used only self-explanatory shortened forms (32%, n=83). Unexplained abbreviations were present in 16% of cases (n=41), while explicitly explained abbreviations were rare (<1%, n=1). Abbreviation use could not be assessed for the remaining 16% (n=42). In many instances, shortened forms were limited to commonly recognizable terms such as AC, WH, or abbreviated spellings of words like lights, rather than less interpretable shorthand.

As many panels contained only partial or minimal circuit documentation, subsequent analyses of specificity, repeated identical entries, and spare breaker labeling were limited to the subset of directories classified as all breakers labeled or most breakers labeled (n=169). Within this more fully documented subset, mixed specificity was the most common pattern, observed in 51% (n=86) of directories. Another 39% (n=66) were classified as mostly specific, indicating that most entries identified circuits in relatively clear and distinct terms. A smaller share was classified as mostly generic (9%, n=15), while only 1% (n=2) could not be reliably assessed. These findings suggest that relatively complete circuit documentation did not always correspond to consistently specific circuit identification across breaker positions.

Repeated identical entries were also common within this more fully documented group. More than half of directories (54%, n=91) contained repeated identical labels, compared with 44% (n=75) that did not. This pattern is consistent with the high share of mixed-specificity directories, as labels such as lights, outlets, or broad room-based descriptions were often repeated across multiple breaker positions rather than differentiated more precisely. The presence of repeated identical entries could not be determined for the remaining 2% (n=3). Explicit labeling of spare breaker positions was less common, observed in only 14% of directories (n=24). These results show that the practical clarity of door mounted circuit directories depended on the completeness, legibility, and specificity of the entries provided.

To examine how the two forms of circuit identification occurred together, their presence was compared within the 394 panel sample used for the door circuit directory analysis, all of which also had complete panel photographs that allowed individual breaker labeling to be assessed. As shown in Table 2, 52% (n=204) of panels included only a door circuit directory, 22% (n=87) included only individual breaker labeling, and 13% (n=52) included both forms. Neither form was observed in 5% (n=19) of panels, while the presence of a door circuit directory could not be determined in the remaining 8% (n=32).

Table 2: Co-occurrence of door circuit directories and individual breaker labeling (n=394).

Labeling configuration	n
DCD only	204
IB labeling only	87
Both DCD and IB labeling	52
Neither	19
Insufficient information	32
Total	394

The co-occurrence analysis showed that individual breaker labels appeared both alongside and in the absence of door circuit directories, serving as a supplementary form of circuit identification in some panels and as the primary visible labeling approach in others. In the broader sample of 428 panels with complete photographs, 44% (n=188) showed individual

breaker labeling. Within this group, the most common format consisted of paper labels with handwritten entries in pen or marker, observed in 42% of cases (n=78). Direct marker writing beside breaker positions was the second most common format, accounting for 23% of panels (n=44). Other formats were less frequent and included paper labels with pencil entries (13%, n=24), printed stickers (10%, n=19), mixed labeling approaches (9%, n=17), and tape only labels (3%, n=6). Representative examples of these labeling formats are shown in Figure 4.

Coverage of individual breaker labeling was often substantial where this labeling approach was present. Among the 188 labeled panels, 46% (n=87) had all breakers labeled and another 20% (n=37) had most breakers labeled, while 16% (n=30) labeled only some breaker positions. The remaining 18% (n=34) were barely labeled, had no labeled breaker positions, or could not be assessed. These results indicate that individual breaker labeling was most often implemented through handwritten methods and frequently provided extensive breaker level coverage when present.

Handwritten paper labels | Direct marker writing | Printed stickers | Mixed labels

Figure 4: Representative examples of individual breaker labeling formats observed in residential panels.

Legibility of individual breaker labels was evaluated only for panels with at least some recorded breaker level labeling (n=185). Most labels were legible: 69% (n=127) were fully legible and 22% (n=40) were mostly legible, while 9% (n=17) were classified as compromised. Legibility could not be assessed for one panel because the submitted photograph did not provide sufficient visual information. Across label types, most formats were fully or mostly legible. Abbreviation use was also limited: 59% of panels (n=109) contained no abbreviations, while 17% (n=31) used only self-explanatory shortened forms. Unexplained abbreviations were present in 17% of cases (n=31). As with the door circuit directories, shortened forms were often limited to familiar terms rather than obscure shorthand.

Among panels with at least some individual breaker labeling (n=185), mixed specificity was the most common pattern, observed in 46% of cases (n=85). Another 37% (n=68) were classified as mostly specific, while smaller shares were mostly generic (11%, n=21) or non-informative (4%, n=8). Repeated identical entries were present in 44% of panels (n=82), indicating that even when breaker labels were used, descriptions often combined reasonably specific labels with broader repeated terms rather than consistently distinguishing each breaker position. These findings suggest that individual breaker labeling was often readable and relatively extensive, but not always uniformly specific across all labeled breaker positions.

These findings show that variation in how residential labeling practices reflect the circuit identification qualities emphasized by the NEC lies not only in whether labels are present, but

also in how completely, legibly, and specifically circuits are identified in practice. Door mounted circuit directories remained the primary form of circuit identification in the analyzed panels, yet their usefulness often varied because of partial coverage, mixed specificity, and repeated generic entries. Individual breaker labeling was less common overall, but when present it was often extensive and generally legible, suggesting that it may function as a meaningful supplement to the traditional directory. Overall, the results indicate that residential panel labeling practices frequently provide at least some circuit information, but do not always do so in a way that consistently reflects the clear, evident, and specific identification envisioned by NEC 408.4(A). These patterns point to the need for closer attention not only to the presence of labels, but also to the quality and distinctiveness of circuit descriptions in residential electrical panels.

Implications and Recommendations

These results have practical implications for how residential panel labeling is viewed in the context of electrical maintenance, inspection, and future panel modifications. The findings suggest that the usefulness of panel labeling depends not only on whether circuit identification is present, but on whether it supports reliable circuit recognition when panels are serviced, modified, or revisited over time. In that sense, labeling quality should be understood as an operational issue as much as a documentation issue. Greater attention to labeling quality is therefore warranted both at initial installation and during subsequent panel modifications, because incomplete, overly generic, or difficult to distinguish labels may limit the usefulness of a directory even when circuit documentation is present

For inspection and code interpretation, the findings suggest that panel labeling may warrant closer attention as a practical usability issue rather than solely as confirmation that a directory is present. The observed frequency of partial directories, mixed specificity, and repeated identical entries suggests that simply confirming the presence of a circuit directory may not be sufficient to assess whether it supports effective circuit identification during maintenance or troubleshooting. Without making formal compliance determinations, the results indicate that greater emphasis on readable and distinguishable circuit descriptions may better support the intent of NEC 408.4(A) in residential practice.

For electricians and others performing panel modifications, the findings point to the value of maintaining circuit identification in a way that remains clear after later changes or additions. Labels beside breaker positions may also serve as a useful supplement in some panels, particularly where they improve immediate circuit recognition. At the same time, these labels do not replace the broader organizational role of the door circuit directory, which remains the primary location for documenting circuit purposes.

A key limitation of this study is that the photographic analysis could evaluate the presence, coverage, legibility, and specificity of circuit labels but could not determine whether a label accurately identified the circuit or load it controlled. Verifying labeling accuracy would require detailed in-home panel audits. Labels may also reflect previous appliances or earlier household configurations and therefore may not describe current conditions. Because such discrepancies could not be identified systematically, their prevalence cannot be estimated from this dataset.

Future research could extend the photographic analysis through interviews with panel manufacturers, electrical inspectors, and electricians. These interviews could provide insight into how circuit directory formats are designed, how circuit identification requirements are interpreted during inspection, and how labels are completed and updated during installation and

later modifications. This input could inform the development and testing of model circuit directories or labeling examples that demonstrate clear, specific, and distinguishable circuit identification within existing panel labeling formats.

Overall, the study suggests that opportunities for improvement lie less in creating entirely new labeling systems than in promoting clearer and more consistent use of existing formats. In the context of ongoing residential electrification, where panel modifications, appliance replacements, and new circuit additions may become more frequent, clearer and more complete circuit identification may become increasingly important for safe maintenance, troubleshooting, and future electrical upgrades.

Conclusion

This study examined how circuit identification is implemented in residential electrical panels in U.S. single-family homes, focusing on both door circuit directories and labels placed beside individual breaker positions. The findings show that door circuit directories remain the primary form of circuit identification among the panels examined, but their usefulness often varied because of incomplete coverage, mixed specificity, and repeated generic entries. Individual breaker labeling was less common overall, but when present it was often extensive and generally legible, indicating that it may serve as a useful supplement to the traditional door directory. The results suggest that the central issue in residential panel labeling is not simply whether labels are present, but whether circuit descriptions are complete, readable, and sufficiently distinct in practice. By documenting these patterns empirically, this study provides evidence that may inform improvements in labeling guidance and inspection practices and support clearer and more consistent circuit identification during installation, maintenance, and later panel modifications.

AI-Assisted Tools Disclosure

AI-assisted tools used: OpenAI ChatGPT.
Used for: Improving clarity, and grammar, and Python code for figures.
Extent: Manuscript editing and generating code.
Human review: The authors reviewed and verified all content and remain fully responsible for the final manuscript.

References

Fournier, Eric Daniel, Robert Cudd, Samantha Smithies, and Stephanie Pincetl. 2024. "Quantifying the Electric Service Panel Capacities of California's Residential Buildings." *Energy Policy* 192 (September): 114238. https://doi.org/10.1016/j.enpol.2024.114238.

Gul, Sadia, and Alan Meier. 2025. "Assessing Electrification Readiness in U.S. Single-Family Homes Based on a Nationwide Survey of Electrical Panel Capacities." *Energy Policy* 206 (November): 114712. https://doi.org/10.1016/j.enpol.2025.114712.

Gunther, Fritz. 2024. "Requirements in Labeling Switches and Circuit Breakers in Panelboards and Switchgears in the 2023 NEC." *New York Electrical Inspection Agency*, February 5.

https://www.nyeia.com/requirements-in-labeling-switches-and-circuit-breakers-in-panelboards-and-switchgears-in-the-2023-nec/.

OSHA 1910.333. n.d. “1910.333 - Selection and Use of Work Practices. Occupational Safety and Health Administration.” U.S. Department of Labor. Accessed March 15, 2026. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.333.