Benchmarking Electric Utility Standards

Service Quality, Reliability, and Technical Standards

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PSC

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Executive Summary

Properly defined service quality, reliability, and technical standards for electric distribution utilities help ensure the safety, quality, and dependability of state energy supplies. For Michigan, the Michigan Public Service Commission (MPSC) outlines such standards. However, these standards require thoughtful review and appropriate updates to ensure utilities are held to applicable criteria. Michigan now has an opportunity to update the rules that have governed service quality and reliability for more than 15 years. To achieve its ambitious energy goals, the state must update its policies, regulations, and rules concerning the electric industry to ensure the safety, reliability, and resilience of the electric distribution grid.

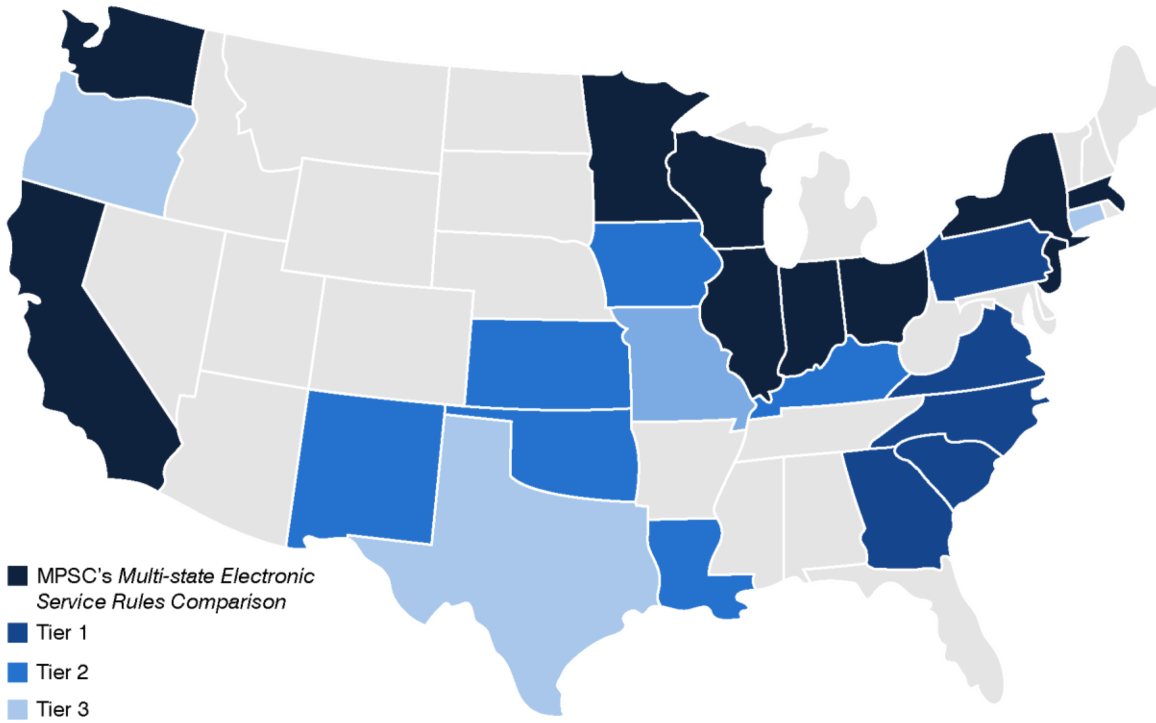
In a comprehensive review of Michigan's energy system, conducted in September 2019, the MPSC concluded that Michigan's *Service Quality and Reliability Standards for Electric Distribution Systems* and *Technical Standards for Electrical Service* have been left unchanged long enough, determining that updates are necessary to enable the state and its electric utilities to integrate emerging technologies, incorporate evolving state policy goals, and address shifting customer preferences. Following the release of the *Michigan Statewide Energy Assessment: Final Report*, the MPSC created two dockets that established workgroups—led by MPSC staff and coordinated by the MI Power Grid initiative—to investigate and recommend updates to these rules. As part of this effort, MPSC staff are coordinating two separate workgroups: The Technical Standards for Electric Service workgroup (case number U-20630) and the Service Quality and Reliability Standards for Electric Distribution Systems (case number U-20629) workgroup.

Study Approach

To support this effort, Public Sector Consultants (PSC) reviewed service quality, reliability, and technical standards for 25 peer states across the country, and benchmarked Michigan's rules against these states, identifying common and best practices as well as providing potential considerations to inform Michigan stakeholders. This effort synthesizes essential information for stakeholders to consider in the development of new standards that support targeted outcomes for electric service providers and promote improved customer experience.

The first step in this effort was to identify potential states for analysis. PSC undertook a detailed comparison of states' performance on commonly reported electric reliability indices as well as on a number of other characteristics to identify peer states. In total, PSC identified 25 states (Exhibit 1). A full breakdown of the selection methodology is provided in Appendix A.

EXHIBIT 1. Benchmarked States



MPSC's *Multi-state Electric Service Rules Comparison*	California, Illinois, Indiana, Massachusetts, Minnesota, New Jersey, New York, Ohio, Washington, and Wisconsin
Tier 1	Georgia, North Carolina, Pennsylvania, South Carolina, and Virginia
Tier 2	Iowa, Kansas, Kentucky, Louisiana, New Mexico, and Oklahoma
Tier 3	Connecticut, Missouri, Oregon, and Texas

As this study intended to compare rules and/or standards for electric distribution utilities, PSC reviewed relevant administrative rules, codes, and regulations for selected states. The basis for this research were Michigan's service quality, reliability, and technical standards contained in the Michigan Administrative Code for Licensing and Regulatory Affairs filed under the MPSC. Service quality and reliability standards are provided in Rules 701 through 752, while technical standards are outlined in Rules 101 to 804.

PSC's research revealed that states use several different terms to label the rules that govern their operation of electric utilities. These include administrative code; administrative rules; code of regulations; and codes, rules, and regulations. Not only do these rules have different names, they also vary in terms of organization, content, and level of detail. PSC identified several practices for how states establish their rules/standards and distinguished three common approaches. PSC has attempted to label these approaches throughout this report and group states to support comparative analysis.

One approach is to employ administrative rules for outlining required practices, as Michigan primarily does. Another approach is to use the administrative rules process for outlining required practices; however, these rules are less substantial or less detailed regarding electric utilities. In some cases, states rely on its own statutes and other regulatory proceedings to define acceptable practices for electric distribution utilities. The third approach is to use administrative rules for electric utilities in a limited manner. Moreover, states' use of comparable rules, standards, statutes, or regulatory action were not readily available. PSC categorized these different approaches into three groups (Exhibit 2).

EXHIBIT 2. State Groupings

Group Number	Description	States
Group One	Details comprehensive administrative rules	Illinois, Indiana, Iowa, Kentucky, Michigan, New Jersey, New Mexico, Pennsylvania, Texas, and Wisconsin
Group Two	Includes substantive, but less detailed, administrative rules that are augmented by other statues and proceedings	California, Connecticut, Kansas, Massachusetts, Minnesota, Missouri, New York, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, Virginia, and Washington
Group Three	Has limited administrative rules	Georgia and Louisiana

Note: Michigan is included in group one for comparison purposes.

While states' approaches to setting administrative rules vary, PSC observed that rules are generally used to establish baseline performance requirements for utilities, not to meet specific performance improvement objectives. In some cases, standards provide a broad outline for state regulators to exercise oversight of utility planning and other efforts to drive performance, but these practices are not commonly articulated at the statewide level. This can likely be attributed to administrative rule update processes, which are subject to several stages of review and scrutiny, making these rules less flexible than other regulatory approaches.

A complete overview of these groupings and states' approaches to setting rules for electric utilities is provided in Appendices C and D.

Key Findings

This study intended to identify common themes and best practices from the 25 benchmarked states to help guide Michigan's efforts in updating its service quality, reliability, and technical standards.[1] Through this comparative analysis, PSC benchmarked state standards and helped contextualize potential changes for stakeholder consideration. Key findings are presented in the following section and are organized into two parts. The first part focuses on service quality and reliability, while the second centers on technical standards, which mirrors the organization of Michigan's rules.

Service Quality and Reliability Standards

Service quality and reliability standards are fundamental to ensure the safe, consistent operation of the electric grid. Though almost all states maintain these types of rules and/or standards, there is a significant degree of variability among them. PSC observed a number of differences in Michigan's approach to these

[1] It is important to note that the key findings and suggestions in this report are PSC's and not the views of its clients—DTE Energy, Consumers Energy, and the Michigan Electric and Gas Association.

standards, as well as potential ways the state could update and improve them (detailed below). A complete inventory of state standards and discussion of their diverse approaches is included in the "Service Quality and Reliability" section of this report.

PSC observed that, overall, states appear to be using their own rules/standards to dictate baseline service quality and reliability performance levels that utilities must maintain. By design, statewide standards do not lend themselves to utility-specific applications or guideline establishment for improving performance. The rulemaking process also makes statewide standards less flexible than other options to address utility performance. One way to evaluate the effect of Michigan's rules is to review utilities' annual performance reports and identify persistent performance issues, which could indicate a need to address related standards.

Performance Standards During Service Disruptions

Michigan's service quality and reliability standards define unacceptable levels of performance for electric utilities during service disruptions and include requirements for planning and preparing for these disruptions, remedying them, and responding to downed power lines. While the majority of states examined share Michigan's broad requirement that utilities must operate the electric grid within defined parameters, the remaining components of Michigan's performance standards are unique from the other states.

Michigan's Rule 22 specifies required response times for utilities in the event of a service disruption and prescribes practices for addressing circuits that experience frequent outages. Within this rule, Michigan outlines separate requirements under both normal and catastrophic conditions. These requirements are one of the most noteworthy differences between Michigan's standards and those of the 25 benchmarked states. Not only were Michigan's required service restoration timelines unique, but its use of term "catastrophic condition" also did not appear in any other state standards.

Instead of requiring utilities to meet specific outage restoration times, the majority of state standards require utilities to restore service as soon as possible and subsequently report their reliability performance using standard industry reliability indices, such as the System Average Interruption Duration Index (SAIDI), the System Average Interruption Frequency Index (SAIFI), or the Customer Average Interruption Duration Index (CAIDI). These indices are not entirely different from Michigan's performance standards, as they still track utilities' response to service disruption and restoration; however, these standards enable comparison among states over time in way that Michigan's standards do not. Though Michigan utilities already report performance on common reliability indices, this reporting is not dictated by state standards nor is it tied to specific performance objectives.

Additionally, any reliability performance measure used to track outage frequency and customer experiences should be used to focus investment on certain the areas of the grid that are most impacted by service interruptions. **Michigan's current reliability performance standards are inconsistent with common practice and industry-standard measurements**, which raises the question of whether Michigan should update its existing performance standards to align with other states' (MPSC case number U-12270).

Wire-down Responses

Utilities' response to downed wires is another element of Michigan's performance standards where its approach is an outlier. In this instance, **Michigan's standards set a more prescriptive approach to wire-down response and does not prioritize planning and preparation to the extent found in the overwhelming majority of benchmarked states.** PSC reviewed relevant standards for electric utilities in 48 states and found that only Massachusetts established specific requirements for downed-wire response. While Michigan's standard maintains various requirements for these responses depending on the location, Massachusetts' establishes three different priority levels and bases response times on this prioritization. The more common approach to ensuring public and employee safety in the event of downed wires is to require utilities to have emergency response plans that identify how they will operate during emergency conditions and how they will coordinate with first responders.

Unacceptable Service Quality Levels of Performance

In addition to defining service quality levels during outages, Michigan's standards also include requirements for utilities related to answering customer calls, responding to customer complaints, reading meters, and installing a new service. Again, this case illustrates that **Michigan's standards are among the most prescriptive in this study**. In fact, Michigan was one of only five states with a standard for average customer call answer time and one of three with a standard for call blockage. While Michigan's call answer requirement was not the most restrictive, examination of different state standards raises questions about whether customer call answer time is the best metric for ensuring customer satisfaction. Recognizing that answer times and blockage factors are only one aspect of effective communication between utilities and customers, Massachusetts repealed its call answer standard in 2015 to enable utilities to define more comprehensive ways of providing customer service, which includes digital outage centers, social media, and other channels. Michigan utilities have consistently met state standards for call answer and blockage factors during the 15 years the MPSC has collected this performance information (MPSC case number U-12270).

Michigan's meter reading requirements represent another example of how the state's service quality and reliability standards are some of the most detailed of the benchmarked states. Only Minnesota has a similar standard that specifies the percentage of meters that utilities must be read during a given year. **The more common approach to ensuring meters are read and that customer bills are accurate is for utilities to make reasonable efforts to read a meter and work with customers if the equipment is inaccessible**. Michigan electric utilities have read more than 95 percent of meters on average every year from 2005 to 2018 and—with the advent of advanced infrastructure—meter reading will only become easier for utilities to conduct (MPSC case number U-12270). Given Michigan's historic performance and other state examples, the need for a specific meter reading threshold should be considered to ensure it is necessary and aligns with state policy goals.

Financial Incentives and Penalties

Part four of Michigan's *Service Quality and Reliability Standards* outlines available incentives for electric utilities when they exceed service quality and reliability standards. These standards clearly define required performance levels for utilities and establish processes for the MPSC to authorize incentives. **PSC was unable to identify similar standards in any of the other states examined**. **The four states that do allow incentives do not address them through administrative rules; instead, they handle these incentives through regulatory proceedings and apply them on a more limited basis**, such as ongoing efforts in several states to address financial incentives and penalties through performance-based ratemaking.

Michigan's standards also provide a structure for penalties if a utility does not meet required performance criteria for service restoration or frequency of interruptions on the same circuit. While referred to as "penalties," a review of Michigan's standards suggests that a more appropriate name would be "customer bill credits," as Rules 44, 45, and 46 detail the availability and amount of customer credits utilities must provide if they fail to meet established service restoration thresholds. Just as none of the states examined in this analysis rely on performance standards like Michigan's, **state practices for customer bill credits also differ from Michigan.** PSC found only one state with a standard relating to customer bill credits: Illinois. Unlike Michigan, Illinois' standard does not specify different bill credit options, amounts, or their distribution process; instead, it includes a more general requirement for utilities to "compensate customers for damages, such as spoiled food" in the case of an outage lasting more than four hours (State of Illinois n.d.b). PSC did find other examples of customer bill credits (e.g., in Washington); however, these credits are not provided in statewide standards and are, instead, detailed in individual utility filings related to customer service guarantees.

A review of state standards for customer bill credits also demonstrates that Michigan's service quality and reliability standards are substantively different from the benchmarked states. In the case of customer bill credits, statewide standards may not be the most appropriate mechanism for establishing bill credit procedures. Throughout this analysis, there are clear opportunities for Michigan to learn from other states to modernize and streamline its standards to ensure customer protections, utility flexibility, and the continued, safe, and reliable operation of the electric grid.

Technical Standards for Electric Service

Michigan's *Technical Standards for Electric Service* establishes key parameters for how state utilities operate, requirements for meter testing and accuracy, the electric grid's operational characteristics, engineering and maintenance, service provision for customers, and record keeping and reporting. PSC's analysis highlights various differences between Michigan and other states' standards. Overall—despite a few instances—Michigan provides more specificity in its standards as well as more prescriptive requirements for utilities than benchmarked states. Discussion of the key findings and notable differences from the benchmarking analysis is provided below.

Records and Reports

Records and reporting requirements are common throughout all states' standards for electric utilities. For Michigan, however, the notable difference is a specific requirement related to the retention and availability of technical standard records. **PSC observed that the most common state practice was to have an overarching requirement for record retention and availability, rather than a standard pertaining to a specific section of their rules**. Given that Michigan's requirement for technical standards records (found in Rule 203) specifies individual records required, it is plausible that this standard could be eliminated if Michigan had a high-level rule that requires records related to any standard be maintained in a manner that enables examination by state regulators.

While Michigan's technical standard reporting requirements are defined broadly, it also provides a list of documents and information that utilities must submit with regular frequency. Most of these requirements cover commonly reported elements of utility operation and regulation—like current tariffs, meter and service standards, and descriptions of service territories—but Michigan also includes reporting requirements that are not found in other states. For example, Michigan requires utilities to submit annual construction budgets that detail all major changes to generating or transmission facilities. PSC was unable to identify similar information requirements in any of the 25 states examined. **This raises the question of whether regulators require this information or if the information is simply provided through other means, such as rate cases or other planning efforts.** This observation is not intended to diminish the need for this information or its importance, but rather to question whether including this requirement in technical standards is appropriate. The other required document—not commonly included in state standards—is monthly electric service reports. Only one state, Iowa, had a similar requirement. Similar to PSC's observation of construction budgets, this requirement does not seem to align with the other document requirements found in Rule 203, as evidenced by the lack of similar standards in other states.

Michigan is one of the first states to have a requirement related to security reporting and cybersecurity. Rule 205 was adopted in 2019 and established the framework for utilities to notify state regulators of their ongoing cybersecurity efforts. While Michigan's standard is largely informational in nature and does not include specific requirements for cybersecurity practices, it is an outlier in this study. Only Oklahoma and Pennsylvania mention this topic in their standards, but they do not have similarly detailed reporting requirements. Instead, they provide a framework for developing and implementing utilities' own cybersecurity plans and seek rate relief for their efforts. Most states have opted to address this issue through dedicated regulatory proceedings rather than statewide standards. This choice reflects the developing nature of cybersecurity practices and the highly sensitive nature of these efforts. **As cybersecurity continues to emerge as an important element of grid reliability and resiliency, Michigan must ensure that its standard can adapt and serve as a foundation for necessary improvements as they are implemented.**

Meter Requirements

PSC observed that requirements governing electric meters are some of the most uniform standards across its review. This is because accurate metering is essential to monitoring grid operation and ensuring customers are charged fairly for their consumption. **Despite the ubiquity of metering infrastructure, there are still notable differences in how states establish these requirements.** Michigan's technical standards include two separate parts related to metering. Part three provides meter requirements, while part six outlines equipment testing and accuracy. Though there are distinct elements addressed in each part, they share a central topic and overlap on certain elements. This raises the question of whether the current organization could be updated to streamline metering standards.

One potential approach to determine how parts three and six could potentially align is through the combination of Rules 303, 304, and 615. Rule 303 requires utilities to record and retain meter reading data; Rule 615 outlines metering equipment and testing records that must be maintained; and subsequently, Rule 304 requires utilities to have a meter data collection system. While the individual components of Rules 303 and 615 are different, the underlying requirement for utilities to maintain this data is the same. The point of comparison between the two data sets is that all meter reading information must be recorded with identification of the meter. Functionally, **these data sets could be combined for the sake of data collection and retention and then be reported, as needed, for meter reads or equipment records.** This would be in line with practices observed in a number of benchmarked states. Rule 304 requires utilities to retain certain information, which implies that utilities have some form of data collection and management system already in place. As such, this rule could potentially be eliminated. Additionally, PSC could not identify any states that have a standard for meter data collection systems, which suggests that this standard may be unnecessary.

The other element of metering equipment standards worth highlighting is how states address metering inaccuracies and provide billing adjustments for customers. **PSC observed that the majority of**

states maintain standards for addressing billing adjustments, which largely contain similar provisions as Michigan's. Consistently, states use the same qualifying conditions to determine if meters should be tested for inaccuracy and whether subsequent billing adjustments are necessary.

PSC noted various timing differences in state billing adjustment standards once a utility deems a meter inaccurate. States generally provide a formula for calculating the period of a billing adjustment based on an administratively set cap as well as the last point a meter was known to be working. Michigan allows adjustments for up to six years—the longest time frame PSC identified—with the most common period being one to two years. The other aspect with variation between states was whether utilities were required to adjust bills for current or previous customers. Michigan was one of five states that requires utilities to try to communicate billing adjustments with former customers. One practice, observed in Washington and New Mexico, that Michigan has not adopted was utilities' ability to choose not to collect an underbilled amount if a meter has unregistered customer consumption.

Customer Relations

Michigan's customer relations standards address requirements for utilities that provide temporary electric service in the case of existing facility extensions, new service extensions, and requirements that customers do not tamper with utility-owned equipment, such as meters. The two standards related to the extension of utilities' facilities and service illustrate two distinctly different approaches to how Michigan's standards are written. Rule 410 establishes requirements for utilities when investment in new service exceeds what is provided in normal rates and requires the customer to pay incremental costs for charges incurred. **Though this rule does not detail the specific requirements for determining excess costs, it does require utilities to submit a plan for state regulator review. This standard aligns with a number of other states.**

On the other hand, Rule 411 provides detailed requirements for extension of electric service to new customers. **No other benchmarked state has a standard that provides the same level of detail for extending utility service as Michigan.** While Minnesota's comes the closest, it does not stipulate requirements related to customer proximity to an existing provider or allow customer preference to be a deciding factor. Several states have standards to prevent duplication of service, but, in general, service extension provisions found in peer states more closely resemble Rule 410, providing broad guidance for utilities and enabling state regulators to make the ultimate decision on extension. This might not be a feasible model for Michigan, given PA 69 of 1929, but it is worth noting that Michigan's rules are some of the most comprehensive.

Engineering

Clearing vegetation from power lines is one of the most effective ways utilities can manage major causes of electric grid disruptions. Michigan and half of the states included in this analysis have a standard that requires utilities to have a line clearance programs. In this case, **Michigan's standard is less detailed than other states, and—in lieu of state-specific detail—references the National Electric Safety Code (NESC) standard**; however, the NESC standard only goes so far in defining practices for vegetation management. There are a number of states that provide greater detail for vegetation management programs, including requirements that utilities assess the results of their plans, target improvements to the most affected areas of the grid, and work with communities to ensure vegetation management receives customer buy-in. Michigan should consider ways to align vegetation management program standards with desired outcomes for customers in a way that provides flexibility for utilities to tailor their planning for meeting system needs.

Metering Equipment Inspections and Tests

The most prominent aspect of Michigan's meter equipment inspection and test standards is the number of explicitly referenced meter types and associated equipment. This is where the organization of Michigan's standards stands out, which raises questions about whether the state could reorganize its standards to streamline and simplify this rule set. PSC found that a number of states take a higher-level view of meter equipment testing.

Service Quality Standards

Service quality standards for electric utilities govern core operating characteristics of the electric grid, like frequency and voltage. Due to the grid's interconnected nature, these standards are often established by regional or national entities responsible for operating the interstate grid. **Michigan is not alone in having standards for operating frequency or service voltage; in fact, PSC found that the majority of benchmarked states have similar standards.** Several states have opted to approach these standards differently, allowing utilities to operate in accordance with other approved standards. Michigan could consider incorporating similar standards for all aspects of this section without risking substantive change to existing ones. This could potentially alleviate the need to address standards due to future changes and improve consistency among states.

Safety

Part eight of Michigan's technical standards addresses the safe operation of the electric system. Rule 802 requires utilities to comply with the Michigan Occupational Safety and Health Act (MIOSHA) as well as relevant federal health and safety laws and regulations. Only four states have similar requirements. This is likely due to the fact that these guidelines are already articulated in other applicable statutes or regulations. **If Michigan utilities are already subject to MIOSHA, as well as federal rules and regulations, then Michigan should consider removing Rule 802, as it does not articulate any additional standards for utilities to comply with.**

Michigan Performance Standards

Michigan's *Service Quality and Reliability Standards* establishes clear measures for utility performance. State utilities are required to report on 15 different performance measures, all of which were established in 2005; since then, utilities have consistently reported on them. These standards are fairly unique to Michigan in what they require utilities to measure and report.

PSC compiled all of the performance reports filed during 2005 to 2018 and analyzed the impact of these performance standards on service quality and reliability. Annual performance reports are filed in MPSC case number U-12270. In the last 15 years, 20 utilities have filed these reports. This number has since declined after two events: When We Energies and the Wisconsin Public Service Corporation became Upper Michigan Energy Resources in 2017, and when Cloverland Electric Cooperative and Edison Sault Electric Company merged in 2010. Additionally, there were several instances where utilities' annual reports were not contained in the annual report proceeding. The following reports were not found: Alger Delta's 2017 report, Cherryland Electric Cooperative's 2007 report, and Cloverland Electric Cooperative and Edison Sault Electric Company's 2016 report.

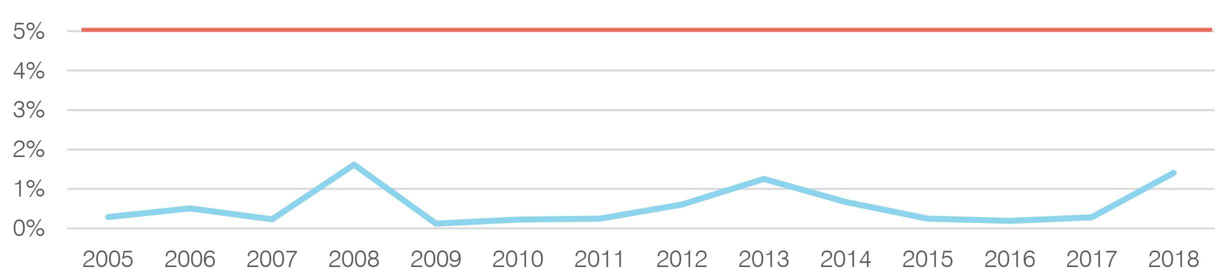
The intent of this analysis is not to evaluate individual utility performance, but rather to determine how well these standards have been adhered to, how and if performance has changed over time, and if there are opportunities to revise standards for the advancement of state goals. PSC calculated weighted averages for utility performance based on 2018 customer counts obtained from the U.S. Energy Information Administration. In the case of utilities that merged during the reporting period, customer counts were obtained from the year prior for distinct utilities; 2018 customer counts were used for the period after. The weighted averages ensure reported performance truly indicates customer experience.

Overall, Michigan utilities have successfully met established performance metrics. PSC identified only two metrics where utility performance has not consistently met statewide standards. Utilities' service restoration under normal conditions is one case where performance has fell below the standard in several years; however, in the past two years, performance has rebounded. While utilities across the state met standards for service restoration during catastrophic conditions consistently, in 2017, statewide performance was below this standard, resulting in a significant spike in customer credits issued for that year. Of all credits issued under catastrophic conditions from 2005 to 2018, 78 percent were issued in 2017; 2017 was also one of two years where utilities did not meet the statewide threshold for wire-down relief—only the second time in 15 years. In both instances where wire-down relief performance was below the standard, utilities exhibited lower-than-average restoration response in catastrophic conditions.

Call Blockage Factor

A call blockage factor measures the percentage of customer calls that go unanswered. When this factor exceeds 5 percent, the MPSC requires a detailed explanation. Overall, utilities complied with this requirement, as electric providers reported a weighted average of 0.56 percent between 2005 and 2018. When considering only investor-owned utilities, the average call blockage factor was 0.41 percent. Though many utilities kept these factors below 5 percent, 13 exceeded the call blockage factor for a given year, with 2008 yielding the highest average at 1.62 percent. Several electric cooperatives did not provide their call blockage factors because reporting was either omitted, or the utility noted that the requirement was waived (Exhibit 3).

EXHIBIT 3. Weighted Average Call Blockage Factor, All Utilities, 2005–2018

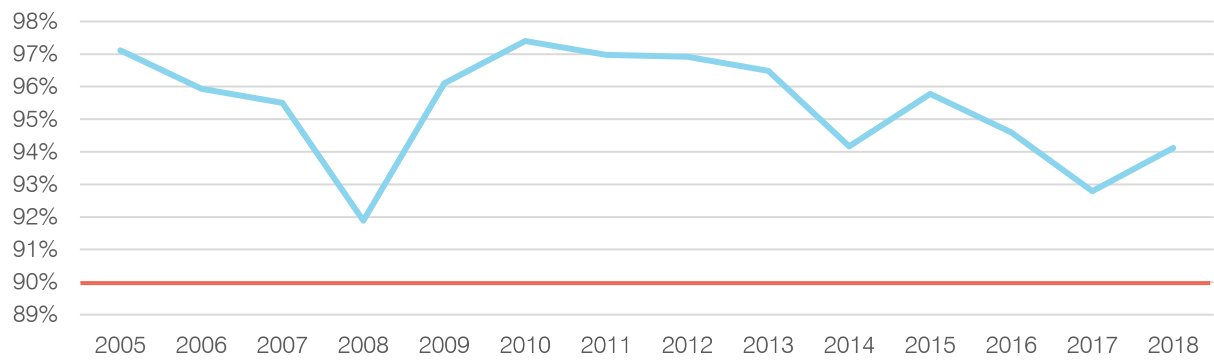


Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Complaint Response Factor

A complaint response factor is the percentage of customer complaints that utilities respond to within three business days. Michigan's standard requires that 90 percent of complaints receive a response within this same time frame. Electric providers have consistently performed well above this metric. From 2005 to 2018, electric utilities reported a weighted average response rate of 95.41 percent. When only accounting for investor-owned utilities, this average was 95.44 percent. The range in utility performance has not varied much from year to year: 2008 represented the lowest weighted average at 91.9 percent, and 2010 represented the highest end at 97.4 percent. For individual Michigan utilities, they did not meet the complaint response factor five times since 2005 (Exhibit 4).

EXHIBIT 4. Weighted Average Complaint Response Factor, All Utilities, 2005–2018

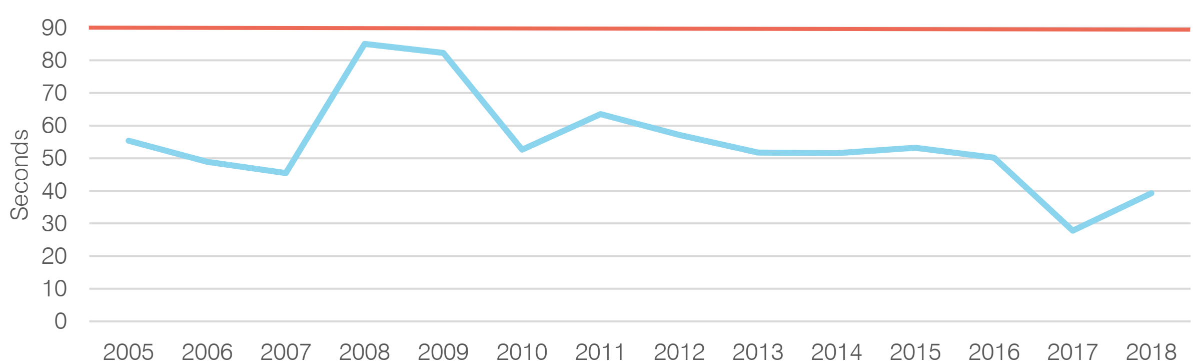


Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Average Customer Call Answer Time Factor

The average customer call time factor measures how quickly electric providers respond to customer calls. The standard is 90 seconds or less. From 2005 to 2018, electric providers answered calls at an average of 54.6 seconds, which is well below the 90-second standard. Investor-owned utilities reported a slightly higher number at 56.9 seconds. In this same time frame, electric providers failed to meet this standard only six times. As for electric providers' highest- and lowest-performing years, 2017 had the lowest average call answering time at 27.8 seconds and 2008 had the highest at 85.1 seconds (Exhibit 5).

EXHIBIT 5. Weighted Average Customer Call Answer Time Factor (in Seconds), All Utilities, 2005–2018

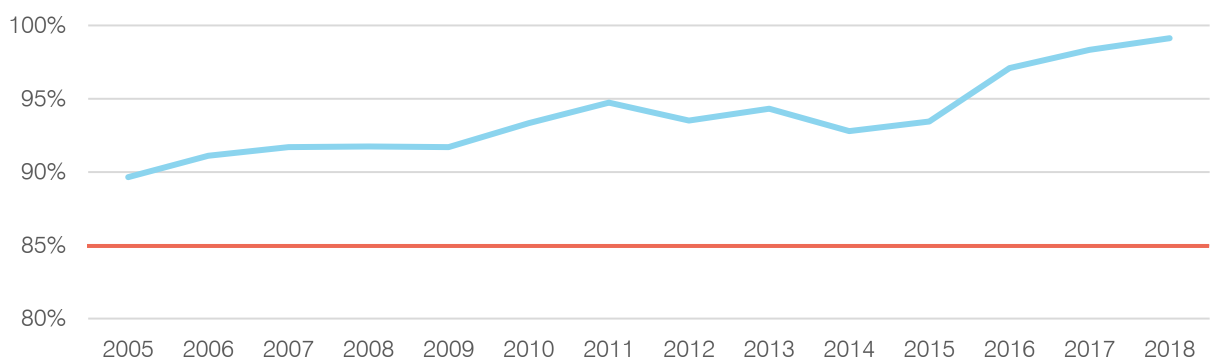


Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Meter Reading Factor

The meter reading factor is the "percentage of meters read within an approved billing period" (MPSC n.d.a, 2). To be considered compliant, an electric utility must have a metering reading factor of at least 85 percent. PSC's review of these factors from 2005 to 2018 revealed that electric providers reported a weighted average rate of 93.8 percent. For investor-owned utilities, this average was 93.7 percent. Electric providers failed to meet this standard just nine times during this time frame. The high- and low-performing years for these factors were both significantly above the required standard: In 2005, electric providers' lowest combined average was 89.7 percent, and in 2018, it was 99.1 percent (Exhibit 6).

EXHIBIT 6. Weighted Average Meter Reading Factor, All Utilities, 2005–2018

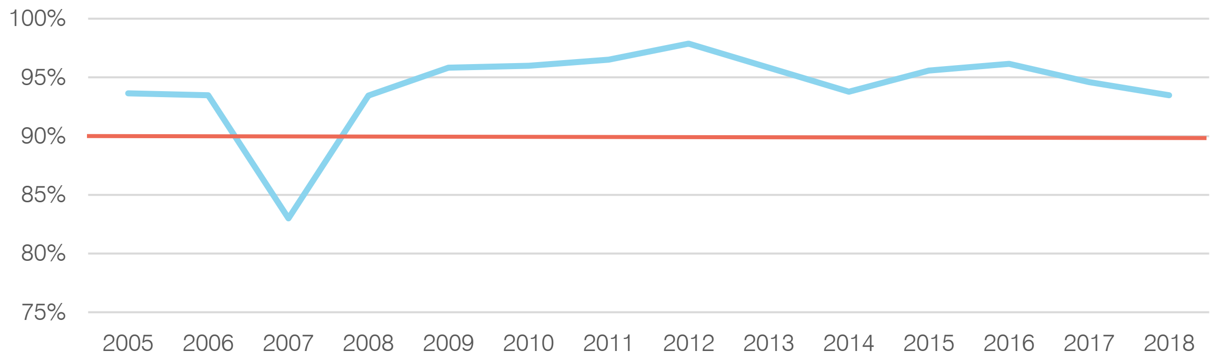


Source: PSC analysis of annual performance reporting in MPSC case number U-12270

New Service Installation Factor

The new service installation factor measures how long it takes utilities to complete new service hookups. Electric providers must complete 90 percent of these hookups within 15 business days to comply with the standard. Except for 2007, from 2005 to 2018, electric providers met this standard. The weighted average during this time frame was 94.2 percent. For investor-owned utilities, this average was 94.1 percent. Electric providers only failed to meet this standard twice. Electric providers' highest- and lowest-performing years were also well above the standard. The year with the lowest-weighted average was 2007, with 83 percent of installations completed within 15 business days. The highest new service installation factor occurred in 2012, with a weighted average of 97.8 percent (Exhibit 7).

EXHIBIT 7. Weighted Average New Service Installation Factor, All Utilities, 2005–2018

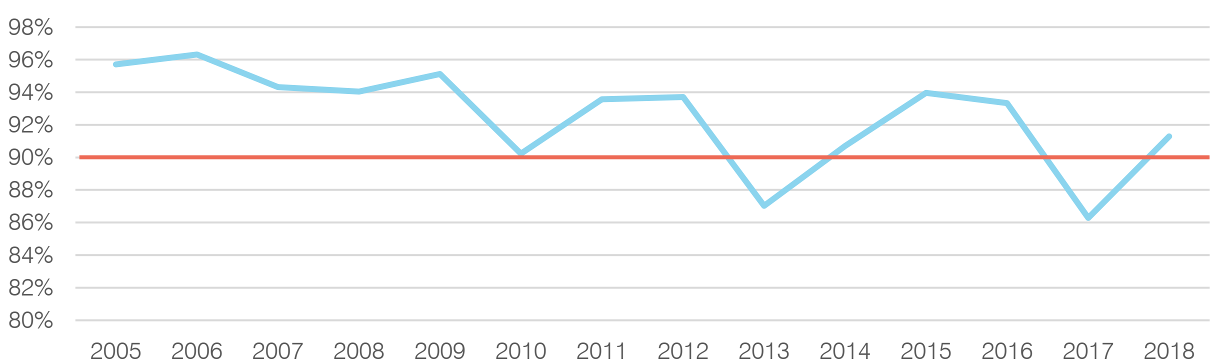


Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Wire-down Relief Factor

The wire-down relief factor measures how quickly electric providers respond to downed-wire reports and requests from nonutility employees guarding a downed wire. Electric providers must respond to these requests within 240 minutes in metropolitan areas and 360 minutes in nonmetropolitan areas 90 percent of the time. Overall, utilities have met Michigan's standard for the 2005–2018 period, with a weighted average of 92.5 percent. The weighted average for investor-owned utilities during this same period was 92.3 percent. There were 18 instances where utilities failed to meet this standard for a reporting year. In 2013 and 2017, the weighted statewide average for wire-down response fell below Michigan's standards (Exhibit 8).

EXHIBIT 8. Weighted Average Wire-down Relief Factor, All Utilities, 2005–2018



Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Service Restoration Factor

The service restoration factor measures how quickly electric providers restore service in various weather conditions. Michigan's standards require utilities to measure their service restoration factor separately for catastrophic conditions, normal conditions, and all conditions.

Catastrophic Conditions

The MPSC defines catastrophic conditions as weather conditions that cause 10 percent or more of utility customers' service to be interrupted or if the government (local, state, or federal) declares the weather event as an emergency. Under these circumstances, it is expected that 90 percent of all customers' service be restored within 60 hours of the event. From 2005 to 2018, the average restoration factor during catastrophic conditions was 95.4 percent; 2017 was the only year where the statewide weighted average restoration factor was less than the 90-percent threshold, registering at 85.3 percent. In all, utilities failed to meet the service restoration standard for catastrophic conditions eight times during this time frame.

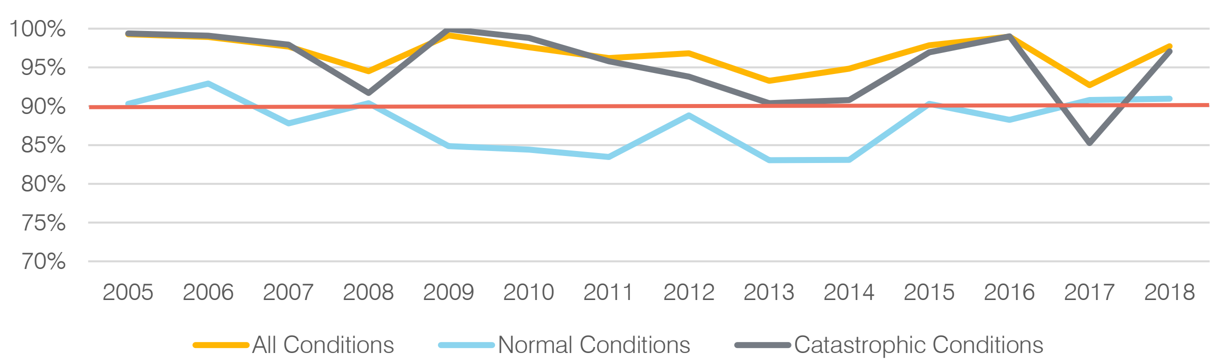
Normal Conditions

The MPSC defines normal conditions as weather that does not cause the circumstances articulated in its description of catastrophic conditions. In these situations, the MPSC expects that 90 percent of all customers' service be restored within eight hours of service interruption. Overall, Michigan utilities have not met this standard, with a weighted average restoration factor of 87.8 percent for 2005 to 2018. Utilities failed to meet this standard in eight out of 15 years and failed to meet the service restoration standard for normal conditions 23 times.

All Conditions

The MPSC defines all conditions as an "amalgamation of data from both normal conditions and catastrophic conditions" (MPSC n.d.a, 3). When considering data derived from both normal and catastrophic weather conditions, the electric provider must restore service to 90 percent of all customers in 36 hours. Michigan utilities have met this standard every year from 2005 to 2018. The weighted average in all conditions was 96.8 percent, and utilities failed to meet this standard for all conditions four times (Exhibit 9).

EXHIBIT 9. Weighted Average Service Restoration Factor, All Utilities, 2005–2018

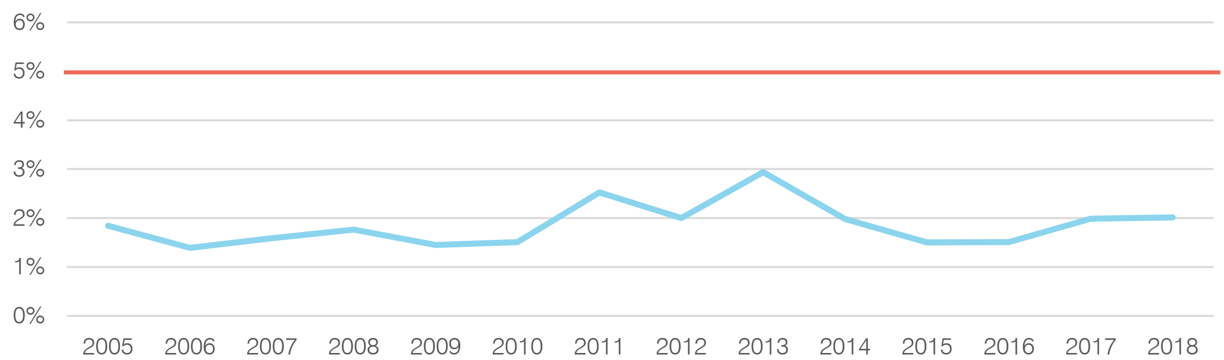


Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Same-circuit Repetitive Interruption Factor

The same-circuit repetitive interruption factor measures the number of interruptions that ten or more people on a circuit experience in all conditions. Electric providers must have less than 5 percent of their circuits experience five or more repetitive interruptions within 12 months in order to comply with this standard. Michigan electric providers have been well below this goal of 5 percent: From 2005 to 2018, PSC calculated the weighted average at 1.86 percent. When just considering investor-owned utilities, the weighted average was slightly higher at 1.92 percent. The same-circuit repetitive interruption factor was not achieved six times between 2005 and 2018 (Exhibit 10).

EXHIBIT 10. Weighted Average Same-circuit Repetitive Interruption Factor, All Utilities, 2005–2018



Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Customer Credits: Catastrophic Conditions, Normal Conditions, and Same-circuit Interruptions

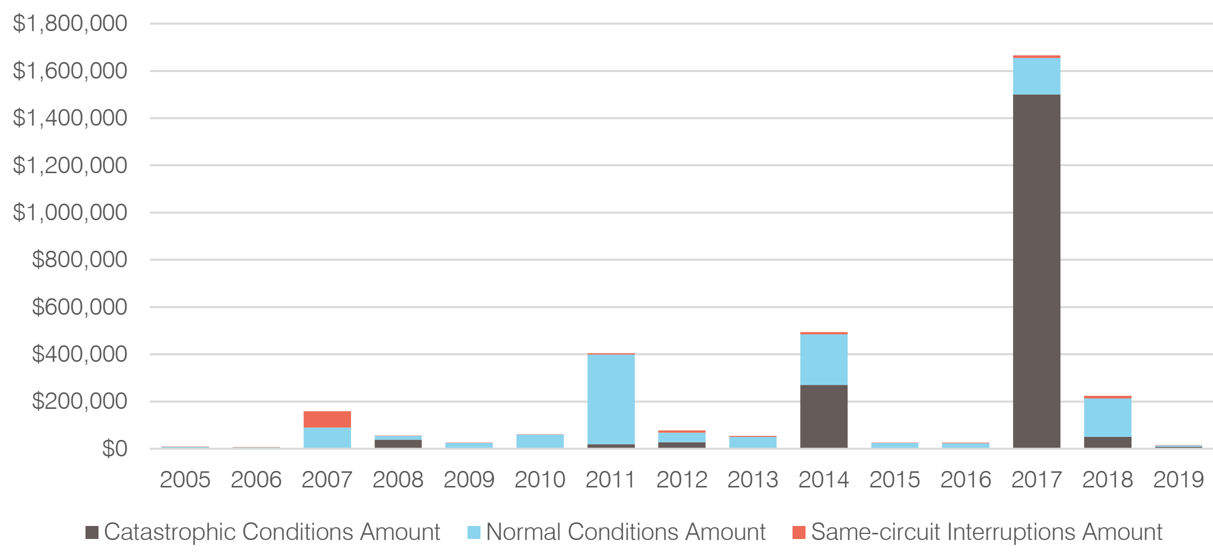
From 2005 to 2018, Michigan electric providers issued 132,229 credits to customers at a value of $3,287,953 for failing to meet the state's performance standards during catastrophic and normal conditions and for same-circuit repetitive interruptions. To receive credits, customers must submit an application to their utility. The vast majority of issued credits were due to service restoration failures, with failures during normal and catastrophic conditions representing 50,160 and 76,926 credits, respectively. This is reflected in the total amount of credit issued as well, with only $126,335.34 in credits issued for same-circuit repetitive interruptions. Summaries of customer credits issued are provided in Exhibits 11 and 12.

EXHIBIT 11. Customer Credits: Catastrophic Conditions, Normal Conditions, and Same-circuit Interruptions, 2005–2018

	Number of Credits	Amount
Customer Credits for Catastrophic Conditions	76,926	$1,913,266
Customer Credits for Normal Conditions	50,160	$1,248,352
Customer Credits for Same-circuit Interruptions	5,143	$126,335
Total	**132,229**	**$3,287,953**

Source: PSC analysis of annual performance reporting in MPSC case number U-12270

EXHIBIT 12. Customer Credits, 2005–2018



Source: PSC analysis of annual performance reporting in MPSC case number U-12270

Service Quality and Reliability Standards

Part One: General Provisions

- R 460.701: Application of Rules
- R 460.702: Definitions
- R 460.703: Revision of Tariff Provisions

Part Two: Unacceptable Levels of Performance

- R 460.721: Duty to Plan to Avoid Unacceptable Levels of Performance
- R 460.722: Unacceptable Levels of Performance During Service Interruptions
- R 460.723: Wire Down Relief Requests
- R 460.724: Unacceptable Service Quality Levels of Performance

Part Three: Records and Reports

- R 460.731: Deadline for Filing Annual Reports
- R 460.732: Annual Report Contents
- R 460.733: Availability of Records
- R 460.734: Retention of Records

Part Four: Financial Incentives and Penalties

- R 460.741: Approval of Incentives by the Commission
- R 460.742: Criteria for Receipt of an Incentive
- R 460.743: Disqualification
- R 460.744: Penalty for Failure to Restore Service After an Interruption Due to Catastrophic Conditions
- R 460.745: Penalty for Failure to Restore Service During Normal Conditions
- R 460.746: Penalty for Repetitive Interruptions of the Same Circuit
- R 460.747: Multiple Billing Credits Allowed
- R 460.748: Effect in Other Proceedings

Part Five: Waivers and Exceptions

- R 460.751: Waivers and Exceptions by Electric Utilities
- R 460.752: Proceedings for Waivers and Exceptions

Part One: General Provisions

Rule 460.701: Application of Rules

Michigan Standard

Rule 1: "(1) These rules apply to electric utilities as defined by R 460.702(k).

(2) These rules do not relieve an electric utility that is subject to the jurisdiction of the public service commission from any of its duties under the laws of this state, including all of the requirements of R 460.3101 to R 460.3908" (MPSC n.d.a, 1).

The first rule identifies which rules govern utilities. These rules are applied to all electric utilities in Michigan, as defined by state statute. This includes a "person, partnership, corporation, association, or other legal entity whose transmission or distribution of electricity the commission regulates" but does not include a "municipal utility, affiliated transmission company, or independent transmission company" (State of Michigan 2004b).

Benchmarked State Standards

Similar to Michigan—where some utilities are subject to state regulation—the other states in this analysis maintain their own rules for determining which electric utilities are required to abide by service quality and reliability standards. Broadly, states with these standards apply them to all utilities subject to state regulation; however, the type of utilities that fall into these categories vary.

Rule 460.702: Definitions

Because every state examined provides its own definition for electric utility standards, PSC determined that analyzing these definitions would not provide revelatory information for this report and has thus omitted comparison of these definitions. When a term's definition has bearing on the application of rules, this report will provide that information.

Rule 460.703: Revision of Tariff Provisions

Michigan Standard

Rule 3: "Not more than 30 days after the effective date of these rules, an electric utility subject to the commission's jurisdiction shall file any revisions of its tariff provisions necessary to conform with these rules" (MPSC n.d.a, 3).

Michigan's third rule for electric distribution systems specifies how and when utilities must implement service quality and reliability rules. Utilities have 30 days to implement changes to their existing tariffs in order to comply with this standard.

Benchmarked State Standards

While it is not common for the benchmarked states to have established time frames for utilities to update tariffs/plans, they do require utilities to comply with other rules and standards. Of the 25 states examined, only Massachusetts and Missouri specify timelines for utilities to adopt rules and practices consistent with new standards.

- **Massachusetts**: Gives utilities 45 days to file their service quality plans consistent with associated guidelines (MDPU 2015).
- **Missouri**: Requires utilities to revise their tariffs within 90 days of the commission's approval of changes (State of Missouri 2019).

Other states have general requirements for utilities to adopt, maintain, revise, or rescind standards in order to comply with new or revised rules. For example, the State of Washington specifies that "tariff provisions filed by utilities must conform with these rules . . . Tariffs that conflict with these rules without approval are superseded by these rules" (State of Washington 2019).

Part Two: Unacceptable Levels of Performance

Rule 460.721: Duty to Plan for Unacceptable Levels of Performance

Michigan Standard

Rule 21: "An electric utility shall plan to operate and maintain its distribution system in a manner that will permit it to provide service to its customers without experiencing an unacceptable level of performance as defined by these rules" (MPSC n.d.a, 3).

Michigan requires electric utilities to participate in and plan for the reliability of the electric system. Rule 21 provides a broad mandate for utilities to comply with state standards for service quality and reliability.

Benchmarked State Standards

Most states examined provide similar directives for system operation to ensure reliability and service quality. Examples are provided below.

- **Louisiana**: State guidelines specify that each utility must design and maintain a program to cost-effectively improve reliability and sustain that reliability over time. The goal of such programming is to limit the frequency and duration of service interruptions to meet 100 percent of customer demand (LPSC 1998).
- **Massachusetts**: State guidelines stipulate that every gas and electric distribution company must ensure adequate service to customers (Commonwealth of Massachusetts 2018).
- **New Jersey**: State guidelines specify that programs must be designed to sustain reliability and, where appropriate, improve it. Additionally, each electric distribution company must use appropriate, qualified resources to maintain minimum reliability levels for its respective operating areas (State of New Jersey n.d.).
- **New York**: State guidelines stipulate that each utility must maintain procedures to meet established service levels, that each program be cost-effectively designed to improve reliability, and that these programs must sustain that reliability over time (State of New York n.d.).
- **Oregon**: State guidelines specify that electric companies must use reasonable means in design, operation, and maintenance of its system to ensure reliable service to each customer, including programs to minimize service interruptions (State of Oregon n.d.).
- **Pennsylvania**: State guidelines note that reliable electric service is essential to the health, safety, and welfare of residents (Commonwealth of Pennsylvania n.d.).
- **South Carolina**: State guidelines specify that every electrical utility shall furnish adequate, efficient, and reasonable service (State of South Carolina 2019).

A few states did not include statements related to ensuring reliability, including Indiana, which does not define unacceptable performance as Michigan does. Similarly, Georgia does not have any rules or standards related to this measure.

Rule 460.722: Unacceptable Levels of Performance During Service Interruptions

Michigan Standard

> **Rule 22:** "It is an unacceptable level of performance for an electric utility to fail to meet any of the following service interruption standards:
>
> a) Considering data derived through the amalgamation of data from both normal and catastrophic conditions, an electric utility shall restore service within 36 hours to not less than 90 percent of its customers experiencing service interruptions.[2]
>
> b) Considering data including only catastrophic conditions, an electric utility shall restore service within 60 hours to not less than 90 percent of its customers experiencing service interruptions.
>
> c) Considering data including only normal conditions, an electric utility shall restore service within eight hours to not less than 90 percent of its customers experiencing service interruptions.
>
> d) Considering data derived through the amalgamation of data from both normal and catastrophic conditions, an electric utility shall not experience five or more same circuit repetitive interruptions in a 12-month period on more than 5 percent of its circuits" (MPSC n.d.a, 3–4).

Rule 22 specifies how utilities must perform when responding to electric service interruptions and includes four performance standards:

1. Service restoration under normal and catastrophic conditions
2. Service restoration under catastrophic conditions
3. Service restoration under normal conditions
4. Same-circuit outages

Minimizing the frequency and duration of service interruptions is a primary goal for utilities and regulators. However, Michigan prescribes different performance standards for restoring utility service, depending on the extent of an outage. Under catastrophic conditions, utilities must have 90 percent of customers restored within 60 hours; during normal conditions, 90 percent of customers need to be restored within eight hours (MPSC n.d.a).

In Michigan, conditions are classified as catastrophic when inclement weather results in a service interruption for 10 percent of a utility's customers or when local, state, or federal government declares a state of emergency. Additionally, Michigan's standard also reviews repeat outages on the same circuit during a 12-month period to ensure utilities are working to address areas where outages occur more frequently.

[2] Catastrophic conditions means either of the following: 1) Severe weather conditions that result in service interruptions for 10 percent or more of a utility's customers or 2) events of sufficient magnitude that result in issuance of an official state-of-emergency declaration by the local, state, or federal government (MPSC n.d.a).

Benchmarked State Standards

While none of the benchmarked states approach service restoration performance as Michigan does, most do differentiate between major and minor interruptions. California is the only state that specifies the duration of service restoration, requiring utilities to do so in less than 9.5 hours following a major outage (CPUC n.d.).[3] New Jersey does not specify a certain length of time, but it does require utilities to begin restoration "within two hours of notification by two or more customers or identification by their outage management system of any loss of electric service" (State of New Jersey n.d.). This standard does not apply during major events.[4]

Instead of specifying the duration of restoration efforts for each outage, most states take a different approach to setting reliability performance thresholds, requiring utilities to annually report on several reliability indices. These indices include the following, ordered by most commonly used:

- The System Average Interruption Frequency Index (SAIFI)
- The System Average Interruption Duration Index (SAIDI)
- The Customer Average Interruption Frequency Index (CAIFI)
- The Customer Average Interruption Duration Index (CAIDI)
- The Momentary Average Interruption Frequency Index (MAIFI)

These indices provide consistent electric service reliability measures and are the most common way that states monitor electric reliability and service restoration. Nearly three-quarters of the states examined in this study use some combination of these indices to document their performance related to service interruptions and restoration, with SAIDI, SAIFI, and CAIDI as the most common. Missouri requires utilities to provide CAIFI performance data, while Oregon and California require utilities to report their MAIFI performance.

Most of the states examined define reliability reporting requirements and performance standards through the promulgation of rules and standards. However, several states—including Connecticut, Kansas, Massachusetts, and Virginia—have established performance standards and reliability reporting requirements through regulatory proceedings overseen by state utility regulators.

Though using reliability indices for reporting is common, it is not always linked to performance. Several states include general statements related to prompt service restoration, but they are not tied to specific performance objectives. Examples include:

---

[3] California maintains separate definitions for major outages and measured events. A major outage is "when 10 percent of the electric utility's serviceable customers experience a simultaneous, nonmomentary interruption of service. For utilities with less than 150,000 customers within California, a major outage occurs when 50 percent of the electric utility's serviceable customers experience a simultaneous, nonmomentary interruption of service" (CPUC n.d.). A measured event is "major outage, resulting from nonearthquake, weather-related causes, affecting between 10 percent (simultaneous) and 40 percent (cumulative) of a utility's electric customer base. A measured event is deemed to begin at 12:00 AM on the day when more than 1 percent (simultaneous) of the utility's electric customers experience sustained interruptions. A measured event is deemed to end when less than 1 percent (simultaneous) of the utility's customers experience sustained interruptions in two consecutive 24-hour periods (12:00 AM to 11:59 PM); and the end of the measured event in 11:59 p.m. of that 48-hour period (CPUC n.d.).

[4] New Jersey defines major events as either: "(1) a sustained interruption that affects at least 10 percent of customers in an operating area. A major event shall be deemed to extend to those other operating areas of that electric distribution company that are assisting the affected areas; (2) an unscheduled interruption resulting from action taken at the direction of an independent system operator to prevent uncontrolled or cascading interruption of service or to maintain adequacy and security of the electric system; (3) an outage that is outside the control of the electric distribution company and results in a state of emergency declaration; (4) when a company is providing mutual aid to another distribution company or utility" (State of New Jersey 2008a).

- **Illinois**: When interruptions occur, utilities must reestablish service as soon as possible and in a time consistent with general safety and public welfare (State of Illinois n.d.b).
- **Kentucky**: When interruptions occur, utilities must reestablish service in the shortest possible time (State of Kentucky 2019).
- **New Mexico**: When interruptions occur, service must be reestablished within the shortest time possible, with regard to safety (State of New Mexico n.d.).
- **Oregon**: When interruptions occur, each electric company must reestablish service with the shortest possible delay consistent with the safety of its employees, customers, and the public (State of Oregon n.d.).
- **Texas**: When interruptions occur, the utility must reestablish service in the shortest possible time (PUCT 2019).

Three states—Indiana, Georgia, and South Carolina—do not specify reliability or service restoration reporting or standards.

Rule 460.723: Wire-down Relief Efforts

Michigan Standard

Rule 23: "(1) It is an unacceptable level of performance for an electric utility to fail to respond to a request for relief of a nonutility employee guarded downed wire at a location in a metropolitan statistical area within 240 minutes after notification at least 90 percent of the time under all conditions.

(2) It is an unacceptable level of performance for an electric utility to fail to respond to a request for relief of a nonutility employee guarded downed wire at a location in a nonmetropolitan statistical area within 360 minutes after notification at least 90 percent of the time under all conditions" (MPSC n.d.a, 4).

Michigan has a specific standard related to downed-wire response, but an overwhelming majority of states do not. Instead, these states often take two common approaches:

- File emergency response plans that dictate their performance in case of outages and restoration practices
- Adopt the National Electrical Safety Code (NESC)

The NESC is established by the Institute of Electrical and Electronics Engineers (IEEE) and is revised every five years to account for technological changes. These standards provide guidelines for the safe installation, operation, and maintenance of electric infrastructure (IEEE n.d.).

A survey of state adoption of the 2017 NESC revealed that 29 states adopted this code. Of these states, 17 automatically adopt the most recent version, Florida and Nevada adopt the most recent version only after it has been reviewed, and several states have adopted older versions (Exhibit 13).

EXHIBIT 13. NESC Adoption

NESC Version	Number of States	States
1997	1	Kansas
2002	2	Illinois, Hawaii
2007	2	Indiana, Arizona
2012	11	Colorado, Delaware, Idaho, New Hampshire, New Jersey, Oklahoma, Ohio, Texas, Virginia, Washington, Wisconsin
2017	29	Alabama*, Alaska, Arkansas*, Connecticut*, Florida^, Iowa, Kentucky*, Maine*, Maryland*, Michigan, Minnesota*, Mississippi*, Missouri, Montana*, Nebraska, Nevada^, New Mexico*, New York*, North Carolina*, North Dakota, Oregon, Pennsylvania, Rhode Island*, South Carolina*, Tennessee, Utah, Vermont, West Virginia*, Wyoming*
None adopted	6	California, Georgia, Louisiana, Massachusetts, District of Columbia, South Dakota

* Automatically adopts newest version of the NESC
^ Adopts the newest version of the NESC following review
Source: IEEE 2019

The NESC provides a framework for how employees should respond to downed wires. The NESC's rule 421 outlines general operating routines, including downed-wire cases:

> "An employee, finding crossed or fallen wires that are creating, or may create, a hazard, shall remain on guard or adopt other adequate means to prevent accidents. The proper authority shall be notified. If the employee is qualified, and can observe the rules for safely handling energize parts by the use of insulating equipment, this employee may correct the condition" (IEEE n.d.).

This rule does not specify acceptable performance levels relative to guarding or reporting downed wires and, thus, is not subject to enforcement in the way Michigan's standard is.

Benchmarked State Standards

PSC reviewed published standards for electric utilities in the contiguous 48 states. Of those, 46 do not have such standards—only Massachusetts and Michigan do. Massachusetts requires electric distribution utilities (EDUs) to ensure downed-wire incidents do not pose a threat to public safety and that they measure and report their response for the following three categories:

- **Priority one: Life-threatening or imminent danger**. Downed-wire calls require a response from the nearest trained resource.
- **Priority two: Hindering emergency operation**. The next-available trained resource will respond to downed-wire calls.
- **Priority three: Nonthreatening electrical hazard**. Downed-wire calls must be met with capable resources (MDPU 2014).

This standard requires EDUs to "meet an average response time of one hour for 98 percent of priority-one downed-wire calls" and "an average response time of two hours for 95 percent of priority-two downed-wire calls” (MDPU 2014). Failure to meet these standards results in a penalty, which is a based on a predetermined allocation for individual metrics.

Additionally, Massachusetts stipulates that EDUs report the following data for downed wires:

- Date and time call received
- Priority level
- Date and time the first company resource arrived on the scene
- Time between call received and first company resource arrived on the scene
- Date and time of repair

Utilities can exclude certain data from performance calculations, including emergency calls from individuals other than municipal officials, emergency calls involving a facility that belongs to a telephone or cable company—as long as the EDU coordinates with these companies—and instances when emergency response is delayed due circumstances beyond their control (MDPU 2014).

Emergency Preparedness, Planning, and Reporting

The other common practice observed with downed-wire relief standards was that states require utilities to report on their emergency response or preparedness plans. In many cases, these plans are specific to an individual utility. A few examples of these requirements are provided below.

- **Connecticut** requires companies to file individual emergency response plans every two years. These plans are subject to regulatory review and must include the following:
  - Estimates concerning potential damage and service outages prior to any emergency
  - Damage and service outage assessments after any emergency
  - Restoration management after any emergency, including access to alternate restoration resources via regional and reciprocal aid contracts
  - Planning for at-risk and vulnerable customers
  - Policies concerning communication with state and local officials and customers, including individual customer restoration estimates and the timeliness and utility of such estimates
  - Need for mutual assistance during any emergency (State of Connecticut n.d.)
- **Delaware** requires each electric distribution company to meet service reliability and quality performance objectives and submit an annual report to the Delaware Public Service Commission. Each company establishes their own performance objectives that support electric reliability performance maintenance and represent expected performance, accounting for new construction projects, quality and maintenance programs, planned actions, and any resource or time limitations (State of Delaware 2006).
- **Florida** requires utilities to file annual distribution reliability reports. These reports document distribution performance and provide status updates on storm preparedness initiatives. In 2019, Florida Power and Light reported its plan to increase restoration training and assistance programs, including training local governments about how to report downed power lines (FPL 2019).
- **Minnesota** requires utilities to file an annual safety report that includes injuries and property damage resulting from downed wires or other electrical system failures. Additionally, EDUs must report any remedial actions taken as a result of these impacts (State of Minnesota 2009).

- **Ohio** requires electric utilities to submit emergency plans for service restoration that must include policies and procedures for responding to customer outages, restoring service, and developing specific response plans for downed-wire situations (State of Ohio 2017).
- **Texas** requires electric utilities to file emergency operations plans with the Public Utility Commission of Texas that detail service restoration priorities, how to identify and respond to severe weather, staffing plans, and a list of emergency operations personnel (PUCT 2019).
- **Washington** requires EDUs to track electric service reliability and file an annual report with the Washington Utilities and Transportation Commission. Annual reporting must be consistent with monitoring and reporting plans filed with the commission and compare baseline reliability statistics (State of Washington 2019).
- **Wisconsin** requires EDUs with more than 25,000 customers to have procedures for tracking response times during emergencies related to wire contacts, dig-ins, and downed wires. The Public Service Commission of Wisconsin requires reports to include the following information:
  - The date and time the call was received
  - The caller's identity
  - The identity of the person receiving the call
  - The location and nature of the problem, incident, or accident
  - The time the utility responder arrived at the location
  - The total time to respond
  - The final disposition or resolution of the problem

Wisconsin's standard recognizes that major storms may impact compliance and requires EDUs to demonstrate they have made reasonable efforts to give priority response to requests from first responders (State of Wisconsin 2000).

Rule 460.724: Unacceptable Service Quality Levels of Performance

Michigan Standard

Rule 24: "It is an unacceptable level of performance for an electric utility to fail to meet any of the following service quality standards:

a) An electric utility shall have an average customer call answer time of less than 90 seconds.

b) An electric utility shall have a call blockage factor of 5 percent or less.

c) An electric utility shall have a complaint response factor of 90 percent or more within three business days.

d) An electric utility shall have a meter reading factor of 85 percent or more within the approved period, including customer reads.

e) An electric utility shall complete 90 percent or more of its new service installations within 15 business days" (MPSC n.d.a, 4).

Service quality and performance are important to maintain, even when the power is on. Rule 24 establishes standards for these items, apart from outages, and outlines five performance measures:

1. Customer call answer time
2. Customer call blockage factor
3. Customer complaint resolution factor
4. Meter reading factor
5. New service installations

As each of these measures are unique, the following discussion will address each one individually.

Benchmarked State Standards

Customer Call Answer Time

Michigan's performance standard for customer call answer time is less than 90 seconds on average (MPSC n.d.a). Out of the 25 states examined, only five have established performance measures for customer phone calls.

- **Illinois**: The state requires an average of 60 seconds (State of Illinois n.d.b).
- **Kansas**: The state has a three-tiered system, with each tier corresponding to a potential penalty that increases as the percentage of calls answered in 20 seconds decreases. Penalties are triggered when less than 66 percent of customer calls are answered within 20 seconds. The maximum penalty is enforced when less than 58 percent of calls are answered within 20 seconds (Akin 2017).
- **Massachusetts**: The state previously required an average call answer time of 20 seconds but removed this requirement in 2015, as utilities began using more direct, comprehensive methods for capturing customer satisfaction (MDPU 2015).
- **Minnesota**: The state requires at least 80 percent of calls to be answered within 20 seconds (State of Minnesota 2009).
- **North Carolina and Virginia**: Both states require utilities report their average answer time, but specific standards relating to this performance were not identified (NCUC 2019; Commonwealth of Virginia n.d.).
- **Ohio and Wisconsin**: Both require calls to be answered within 90 seconds (State of Wisconsin 2019; State of Ohio n.d.).

Wisconsin's standard also includes requirements for how utilities can prioritize calls during emergency events, ensuring customers have the option to speak to a live agent, and exceptions to these rules in case of severe weather events (State of Wisconsin 2000).

Customer Call Blockage Factor

Michigan requires utilities to maintain a call blockage factor of less than 5 percent.[5] Only Illinois and Kansas have similar service quality provisions. Illinois' provision applies to electric utilities statewide and requires abandon rates to not exceed 10 percent (State of Illinois n.d.b). Kansas' abandoned call rate

[5] Call blockage factor refers to the percentage of calls that do not get answered. This is calculated by multiplying the remainder obtained by subtracting the number of answers from the number of calls, multiplying by 100, and then dividing that value by the total number of calls (MPSC n.d.a).

performance measure only applies to one utility and is tied to a three-tiered penalty structure if the rate exceeds 4 percent (Akin 2017).

Customer Complaint Resolution Factor

Michigan requires utilities to have a complaint response factor of 90 percent or more within three business days. While none of the other states examined provided a similar response factor, several do have certain time requirements for utilities when responding to complaints. For example, Ohio utilities are required to provide customers with a status report within three business days of receiving a complaint. For Wisconsin, its response rate is targeted at 48 hours, or four hours if there is an emergency situation. Other states with clear time frames include Minnesota (five days), Illinois (14 days), and Texas (21 days) (State of Minnesota 2009; State of Illinois; n.d.b; PUCT 2019).

A number of other states include provisions for responding to complaints without specifying a time frame:

- **Connecticut**: The utility shall conduct a prompt, complete investigation of customer complaints and advise the complainant thereof (State of Connecticut Public Utilities Regulatory Authority n.d.).
- **North Carolina**: Each utility will conduct a full, prompt investigation of all customer complaints, either directly or through the commission or public staff (NCUC 2019).
- **Oklahoma**: Each utility must conduct a full, prompt investigation of every customer complaint, either directly or through the commission (State of Oklahoma 2019).
- **Pennsylvania**: Public utilities must conduct a full, prompt investigation of complaints made by its customers, either directly to the utility or through the commission (Commonwealth of Pennsylvania n.d.).
- **Virginia**: Every public utility shall establish procedures that ensure prompt, effective handling of all customer inquiries, service requests, and complaints (Commonwealth of Virginia n.d.).

Meter Reading Factor

Michigan utilities are required to read 85 percent of meters, which includes customer-conducted reads, during a prescribed period. Minnesota was the only other state included in this analysis that has a similar standard:

> "Utilities shall attempt to read all meters on a monthly basis, unless otherwise authorized by the commission. Utilities are assumed to be in compliance with this standard if they read at least 90 percent of all meters during the months of April through November and at least 80 percent of all meters during the months of December through March. Utilities shall contact any customer whose bill has been estimated for two consecutive months and attempt to schedule a meter reading." (State of Minnesota 2009)

The other benchmarked states had clear rules for when a utility can estimate a customer's bill versus obtaining an actual meter read; however, there were no provisions dictating the number of reads a utility needed to make during a given period. Instead, states' rules provided guidelines for how frequently a customer's bill could be estimated.

- **Connecticut**: When a company issues estimated bills to a customer for two consecutive billing periods, the company shall send a notice to the customer, emphasizing the importance of obtaining an actual reading in order to prevent error and hardship (State of Connecticut Public Utilities Regulatory Authority n.d.).

- **Illinois**: If a utility issues two consecutive estimated bills to a customer, the utility shall contact the customer to determine and resolve the issue, so it may obtain an actual or customer-conducted reading (State of Illinois n.d.b).
- **Indiana**: A utility may estimate a customer bill only for good cause. Good cause refers to the following situations:
  - Customer-requested bill estimate
  - Inclement weather
  - Labor or union disputes
  - Inaccessibility of a customer's meter, if the utility has made a reasonable attempt to read it
  - Other circumstances beyond the control of the utility, its agents, and employees (State of Indiana 2020).
- **Iowa**: If an actual meter reading cannot be obtained, the utility may provide an estimated bill without reading the meter or supplying a meter reading form to the customer. Only in unusual cases, or when approval is obtained from the customer, shall more than three consecutive, estimated bills be provided (State of Iowa 2020).
- **Massachusetts**: A company shall make an actual meter reading at least every other billing period (Commonwealth of Massachusetts n.d.).
- **New York**: Utilities are required to make a reasonable effort to obtain an actual reading. If six months go by without one, then the utility can work directly with the customer to obtain it (State of New York n.d.).
- **Oklahoma**: Each service meter shall be read monthly at least ten times a year, weather permitting, on approximately the same day of each meter reading period. The utility may, if specified and approved in its tariffs, delegate the reading to the consumer; however, the reading must be verified by the utility every six months (State of Oklahoma 2019).

New Service Installations

The fifth component of Michigan’s Rule 24 establishes a 90-percent threshold for new service installations that must be completed within 15 business days. Ohio and Oklahoma are the only two states in this analysis with a similar performance metric that specify the percentage of connections within a prescribed time frame.

Ohio requires utilities to complete 90 percent of new service installations within three business days after the utility has been notified that the location is ready for service and no construction is required. If a customer schedules service more than three business days out, then the utility shall complete installation on the date scheduled. If the meters are able to start and stop remotely, then service should be activated within one business day. If the service location requires new construction (excluding primary line extensions), then 90 percent of service installations should be completed within ten business days or by the requested installation date if made more than ten days out (State of Ohio n.d.).

Oklahoma’s standards require 95 percent of installation—when no line extension construction is required—to be filled within five business days. Service must be installed within ten business days after the utility is notified that the location is ready for service or it will constitute a failure to serve. When a location requires new construction, the application for new service shall be filled within 90 days 95 percent of the time and shall not exceed 180 days (State of Oklahoma 2019).

Many other states require utilities to connect service within a prescribed period, but they do not specify the percentage of instances for which this must occur. These state provisions include the following:

- **Illinois**: Approval or rejection of the application, including notification to the applicant, shall be accomplished within two business days after the applicant sends all required information. Absent any delays caused by construction or other equipment work required, an electric, water, or sewer utility shall activate service for a successful applicant at the earliest possible date, but no more than four days after the approval of the application, unless the applicant requests a later activation date (State of Illinois n.d.b).
- **Kentucky**: The utility must reconnect existing service within 24 hours or by the close of the next business day. For new service installation, utilities have up to 72 hours, or close of the next business day, to connect a customer, as long as the cause for refusal or discontinuance of service has been corrected and the utility's tariffed rules and regulations have been met (State of Kentucky 2019).
- **New Jersey**: New customer installations must happen within three to ten business days (State of New Jersey n.d.).
- **New York**: Utilities must respond to new service requests within five business days and inform consumers if additional information is needed (State of New York n.d.).
- **Texas**: Applications for new electric service—not involving line extensions or construction of new facilities—shall be filled within seven working days after the applicant has met the credit requirements and complied with state and municipal regulations. Requests for new residential service that require construction, such as line extensions, shall be completed within 90 days or within a time period agreed to by the customer and electric utility if the applicant has met the credit requirements (PUCT 2019).
- **Washington**: Utilities will switch on power within one business day of the customer request for service except when construction is required before the service can be energized, when the customer does not provide evidence of completed inspections, when payments to the company have not been received, and when service has been disconnected for nonpayment or theft (State of Washington 2019).

Several states do not have statewide standards for new service installations, including Indiana and Oregon. Massachusetts and Minnesota do require utilities to keep service call appointments and report on the calls met. Similarly, North Carolina requires utilities to report on the number of new service installations made each year and the average number of days in construction. Iowa, South Carolina, and Virginia require utilities to create specific schedules for rates and new installations as part of their tariffs.

Part Three: Records and Reports

Rule 460.731: Deadline for Filing Annual Reports

Michigan Standard

Rule 31: "Not more than 120 days after the end of the calendar year in which these rules became effective, an electric utility shall file an annual report with the commission regarding the previous calendar year. For subsequent calendar years, an electric utility shall file its annual report not more than 75 days after the end of the year" (MPSC n.d.a, 4–5).

Benchmarked State Standards

The timing for states' annual report filings vary across utilities. Some dates are tied to the calendar year, while others adhere to a different annual reporting schedule altogether. For Michigan, annual reports are required around March 25 (approximately 75 days after the end of the year). Timing for states' annual service quality and reliability reporting is detailed below.

EXHIBIT 14. State Filing Dates

Filing Date	State
February 14	Texas
February 15	Louisiana
March 1	Massachusetts, North Carolina*, and Oklahoma
March 25	Michigan^
March 31	Kansas#, New York, and Ohio
April 1	Minnesota
April 30	Pennsylvania
May 1	Iowa, Oregon, and Wisconsin
May 31	New Jersey
June 1	Illinois
July 1	California
At least once per year	Washington

* Within 60 days of the end of the calendar year
^ Within 75 days of the end of the calendar year
# Within 90 days of the end of the calendar year
Note: Connecticut, Indiana, Georgia, South Carolina, Kentucky, New Mexico[6], Missouri, and Virginia[3] are not required to submit reports.

[6] Required reporting at state regulatory agency's discretion.

Rule 460.732: Annual Report Contents

Rule 32: "The annual report of an electric utility made pursuant to these rules shall contain all of the following information:

a) The call blockage factor. If the call blockage factor is more than 5 percent, then the annual report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

b) The complaint response factor. If the complaint response factor is less than 90 percent within three business days, then the annual report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

c) The average customer call answer time. If the average customer call answer time is 90 seconds or more, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

d) The meter reading factor. If the meter reading factor is less than 85 percent, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

e) The new service installation factor. If the new service installation factor is less than 90 percent completed within 15 business days, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

f) The wire-down relief factor. If the wire-down relief factor is less than 90 percent within 240 minutes within metropolitan statistical areas, or less than 90 percent within 360 minutes in nonmetropolitan statistical areas, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

g) The service restoration factor for all conditions. If the service restoration factor for all conditions is less than 90 percent of customers restored within 36 hours or less, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

h) The service restoration factor for normal conditions. If the service restoration factor for normal conditions is less than 90 percent of customers restored within eight hours or less, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

i) The service restoration factor for catastrophic conditions. If the service restoration factor for catastrophic conditions is less than 90 percent of customers restored within 60 hours or less, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

j) The same-circuit repetitive interruption factor. If the same-circuit repetitive interruption factor is more than 5 percent of circuits experiencing five or more same-circuit repetitive interruptions within a 12-month period, then the report shall contain a detailed explanation of the steps that the electric utility is taking to bring its performance to an acceptable level.

k) A description of all catastrophic conditions experienced during the year.

l) The number and total dollar amount of all customer credits provided during the year, broken down by customer class, for its failure to restore service to customers within 120 hours of an interruption that occurred during the course of catastrophic conditions.

m) The number and total dollar amount of all customer credits provided during the year, broken down by customer class, for its failure to restore service to customers within 16 hours of an interruption that occurred during normal conditions.

n) The number and total dollar amount of all customer credits provided during the year, broken down by customer class, for same-circuit repetitive interruptions.

o) A summary table indicating whether the electric utility complied or failed to comply with each of the standards established by these rules" (MPSC n.d.a, 5–6).

Rule 32 outlines the 15 service quality and reliability measures that utilities are required to report on in their annual reports. These are detailed in the MPSC's Service Quality and Reliability Standards for Electric Distribution Utilities.

Benchmarked State Standards

Given that Michigan's service quality and reliability standards differ substantively from many of the benchmarked states, PSC anticipated that Michigan's annual reporting requirements would also differ. Similar to Michigan, 15 states have standards that detail the necessary elements to include in their annual reports, which are consistent with other provisions of their service quality and reliability standards.[7] While these states annually report on service quality and reliability, there are significant differences in how they approach this process.

For example, New Jersey requires companies to annually report their performance on state performance standards—SAIFI and CAIDI. They must also compare this to the previous year and summarize their performance from the past ten years, identifying overall trends and major causes of outages. New Jersey's annual reports go beyond reliability performance tracking and must include summaries of other utility programs aimed at reliability improvements, including inspection and maintenance programs, new reliability programs, programs for poor-performing circuits, power quality programs, stray voltage programs, technology initiatives related to improving reliability, employee training programs, vegetation management activities and planned work, and tree hazard information (State of New Jersey n.d.).

Additionally, California's rule also outlines reporting requirements for service quality and reliability, but includes fewer reporting parameters. The required elements are:

- Each utility must report SAIDI, SAIFI, system MAIFI, and information about any group of customers commonly served by a circuit that experience at least one five-minute outage per month on a rolling annual average basis, after exclusion of major events.

[7] These states are California, Illinois, Iowa, Louisiana, Massachusetts, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Washington, and Wisconsin.

- Each utility must also report and identify the ten largest outage events and indicate whether any of them were excluded from the reported indices. For each major event excludable under the standard above, the utility will report the total number of customers affected, the number of customers without service at periodic intervals, the longest customer interruption, and the number of people used to restore service.
- Utilities must record information about SAIDI, SAIFI, and system MAIFI on a circuit level. They must provide this information upon request to any interested person over time periods no smaller than one month.
- Utilities will use their best efforts to normalize historical data over the last ten years to the reliability measures and provide that information with each annual report (CPUC 1996).

Other states—like Iowa, Pennsylvania, and Wisconsin—exempt certain utilities from filing annual service quality and reliability reports based on the number of customers served. The exemption threshold for Wisconsin and Pennsylvania is 100,000 customers or fewer; for Iowa, it is 50,000 or fewer. Another approach to annual service quality and reliability reporting is to require certain utilities to file reports, as is the case in North Carolina (State of Iowa 2020; Commonwealth of Pennsylvania n.d.; State of Wisconsin 2019; NCUC 2019).

In New Mexico and Virginia—which do not have a specific requirement for annual reports—utilities still must be able to supply information requested by state regulators as it pertains to their operations, including service quality and reliability.

Rule 460.733: Availability of Records

Michigan Standard

Rule 33: "(1) An electric utility shall make available to the commission or its staff, upon request, all records, reports, and other information required to determine compliance with these rules and to permit the commission and its staff to investigate and resolve service quality and reliability issues related to electric distribution service.

(2) An electric utility shall make records, reports, and other information available to the commission or its staff within five business days, preferably in an electronic format available through the Internet, accessible with standard browser software, identification, and password or as soon thereafter as feasible" (MPSC n.d.a, 6).

Benchmarked State Standards

State regulatory agencies have broad authority to review documents, records, reports, and other information regarding utility operations. While Michigan's Rule 33 expressly identifies issues related to service quality and reliability, none of the states examined have a specific rule applying to the availability of records for service quality and reliability. Examples of states' general records availability rules include:

- **New Jersey**: Each public utility must notify state regulators where its required records are kept. These records shall be open for examination upon reasonable notice during normal business hours (State of New Jersey n.d.).
- **New Mexico**: The commission may require utilities to produce or provide access to any materials (books, records, etc.) when necessary (State of New Mexico n.d.).
- **Ohio**: Each electric utility must provide access to its records to the staff upon request (State of Ohio 2017).
- **South Carolina**: All records required by these rules or necessary for their administration, shall be kept within this state, unless otherwise authorized by the commission (State of South Carolina 2019).
- **Virginia**: At each office of the public utility or licensee where records are kept or stored, such records are required to be preserved, filed, and currently indexed so they may be readily identified and made available to commission representatives (Commonwealth of Virginia n.d.).

Michigan's standards require records be made available within five business days following a request. Several states also prescribe these time frames: Iowa and Texas require records be provided within 15 days of a request; in Illinois, utilities have 30 days (State of Iowa 2019; PUCT 2019; State of Illinois n.d.b).

However, several states do not specify a time frame at all. Instead, they enable state regulators to request information during normal business hours, after reasonable notice has been provided, or during all reasonable hours, as North Carolina and South Carolina.

There are a number of states that do not have statewide standards for the availability of records, including California, Connecticut, Georgia, Kansas, Minnesota, Missouri, and Oregon.

Rule 460.734: Retention of Records

Michigan Standard

Rule 34: "An electric utility shall preserve, in detail, all records required by these rules for the previous 24 months and shall preserve, in summary form, all records for not less than four years, unless otherwise ordered by the commission" (MPSC n.d.a, 6).

Benchmarked State Standards

Rule 34 details how electric utilities must handle records related to service quality and reliability standards. PSC could not identify any other states with these exact rules. Instead, PSC found that most states have record retention standards, but these broadly apply to utilities. Several states have rules governing the retention of records relating to service interruptions, but this is only a portion of what is included in Michigan's.

Texas requires utilities to maintain interruption records for five years, including such information as the type of interruption, the cause, the date and time, the duration, the number of customers affected, the substation identifier, and the transmission line or distribution feeder. Illinois, New Jersey, Ohio, and Oregon each have similar provisions for electric interruption records and require them to be maintained for five, six, three, and seven years, respectively. Louisiana explicitly requires electric interruption records be maintained, but it does not indicate for how long (State of Illinois 2019; State of New Jersey n.d.; State of Ohio n.d.; LPSC 1998).

The other states examined have adopted national standards for records retention. Minnesota and Pennsylvania's records retention policies conform with the most recent version of the National Association of Regulatory Utility Commissioners' Regulations to Govern the Preservation of Records of Electric, Gas and Water Utilities.

California, Connecticut, Georgia, Kansas, and Missouri have no specific retention policies in their published rules.

Part Four: Financial Incentives and Penalties

Rule 460.741: Approval of Incentives by the Commission

Michigan Standard

Rule 41: "(1) The commission may authorize an electric utility to receive a financial incentive if it exceeds all of the service quality and reliability standards adopted by these rules.

(2) A request for approval of an incentive mechanism shall be made in either of the following proceedings and shall be conducted as a contested case under chapter four of 1969 PA 306, MCL 24.271 et seq. (a) A rate case proceeding. (b) A single-issue proceeding filed specifically to address adoption of an incentive program.

(3) An electric utility shall not file an application seeking approval of an incentive mechanism until it has exceeded all of the service quality and reliability standards adopted by these rules continuously for a period of not less than 12 months" (MPSC n.d.a, 6–7).

None of the states in this analysis have standards or rules similar to Rule 41. The only states that provide incentives for service quality and reliability performance are Kansas,[8] Louisiana,[9] Massachusetts,[10] and New York.[11] These incentives were not authorized or prescribed through the rulemaking process; instead, they were developed through other regulatory proceedings and applied on a more limited basis to utilities.

Rule 460.742: Criteria for Receipt of an Incentive

Michigan Standard

Rule 42: "(1) If an electric utility qualifies for implementation of a previously approved incentive mechanism, it shall file an application seeking authority to implement the incentive mechanism at the same time that it submits the annual report required by R 460.732.

(2) An electric utility shall not apply for a financial incentive approved by the commission unless all of the following criteria were met during the previous 12 months:

a) All required reports have been filed in a timely manner.
b) All required reports fully comply with the requirements as determined by the commission.
c) The electric utility's performance shall have exceeded all of the individual service quality and reliability standards.

[8] Service quality and reliability performance standards in Kansas were established as a part of the settlement agreement from the merger of Kansas City Power and Light Company, Westar Energy, Inc., and Kansas Gas and Electric Company (Akin 2017).

[9] Established through a Louisiana Public Utilities Commission General Order issued on April 15, 1998 (LPSC 1998).

[10] Established through Massachusetts Department of Public Utilities Order in Case 12-120-D issued on December 18, 2015 (MDPU 2015).

[11] Established through New York Public Service Commission Order in Case 02-E-1240; effective October 12, 2004 (State of New York 2004).

d) The electric utility shall have fully responded to any inquiries about the content of the reports made by the commission or its staff in a timely manner" (MPSC n.d.a, 7).

None of the states included in this analysis have established criteria for receipt of service quality and reliability performance incentives.

Rule 460.743: Disqualification

Michigan Standard

Rule 43: "An electric utility shall be disqualified from receiving an incentive if the commission issues an order finding that the electric utility engaged in any type of anticompetitive behavior within the 12-month period preceding the filing of an application pursuant to R 460.742(1)" (MPSC n.d.a, 7).

None of the states included in this analysis have established criteria for disqualification from receiving service quality and reliability performance incentives.

Rule 460.744: Penalty for Failure to Restore Service After an Interruption Due to Catastrophic Conditions

Michigan Standard

Rule 44: "(1) Unless an electric utility requests a waiver pursuant to part five of these rules, an electric utility that fails to restore service to a customer within 120 hours after an interruption that occurred during the course of catastrophic conditions shall provide to any affected customer that notifies the utility of the interruption with a bill credit on the customer's next bill. The amount of the credit provided to a residential customer shall be the greater of $25 or the customer's monthly customer charge. The amount of the credit provided to any other distribution customer shall be the customer's minimum bill prorated on a daily basis" (MPSC n.d.a, 7–8).

In Rule 44, the state establishes parameters for issuing customer bill credits when utilities do not restore service within 120 hours of the interruption due to catastrophic conditions. These bill credits are determined by utilities' performance and Rule 22's definition of unacceptable performance levels. If a utility violates this standard, customers are eligible to receive a credit on their monthly bill.

Benchmarked State Standards

While Michigan measures service restoration based on a utility's performance for individual events, the common practice for benchmarked states is to measure service quality and reliability performance with reliability indices (e.g., SAIDI, SAIFI, CAIDI). As such, none of the states examined prescribe statewide rules for customer bill credits based on the duration of a service interruption or specify the provision of customer bill credits for prolonged outages during catastrophic conditions.

- **Washington:** Enables utilities to establish customer bill credits when prolonged outages occur. A Pacific Power customer experiencing an outage of more than 24 hours is eligible for a $50 bill credit and an additional $25 for every 12 hours the power is out (Pacific Power and Light Company 2011). Avista Utilities has also adopted rules governing service quality that includes bill credits if the company does not meet its customer service guarantees (Avista 2015). However, these are not statewide standards, and Washington does not have any explicit rules dictating the amount or type of penalties related to service quality and reliability performance.

While standards related to customer bill credits are not common, several states have prescribed other forms of penalties for utilities that do not meet service standard requirements.

- **Illinois:** Requirements for transmission and distribution reliability allow for penalizing utilities if 30,000 customers experience an interruption lasting longer than four hours that results in a 50 percent reduction in voltage or total loss of power transmission. In these cases, utilities must compensate customers for damages, such as spoiled food. Power surges are also subject to reimbursement for customers (State of Illinois n.d.a).
- **Louisiana**: The state caps annual fines at $500,000 for failing to meet minimum performance levels in a reporting year (LPSC 1998).
- **Massachusetts**: The state has a structure for utilities to be fined when they violate reliability standards. The Department of Public Utilities can assess up $250,000 in penalties for each day a utility violates established reliability standards. The total penalties for a related series of events is $20 million. State regulators have to consider four elements when establishing a penalty: the violation's magnitude, whether the penalty is appropriate to the company's size, whether the company attempted to comply in good faith, and how much control it had over the contributing circumstances. Massachusetts also describes that any penalty levied by the department will be credited back to the company's customers, as determined by the department (Commonwealth of Massachusetts 2018).
- **New Jersey:** Service standards allow for up to a $25,000 penalty for each violation of a service standard and for each day it is violated. These penalties are assessed by the state's public utility board (State of New Jersey n.d.).
- **Ohio**: Utilities can face a $10,000 fine for each violation and each day the violation occurs (State of Ohio 2017).
- **Texas**: Fines for utilities are based on different classes of defined violations. Class-A violations deal with electric service quality and reliability standards and can be charged up to $25,000 per day if state regulators determine that the violation of standards has caused more than $5,000 in economic harm (PUCT 2019).

Rule 460.745: Penalty for Failure to Restore Service During Normal Conditions

Michigan Standard

> **Rule 45:** "Unless an electric utility requests a waiver pursuant to part five of these rules, an electric utility that fails to restore service to a customer within 16 hours after an interruption that occurred during normal conditions shall provide to any affected customer that notifies the utility of the interruption a bill credit on the customer's next bill. The amount of the credit provided to a residential customer shall be the greater of $25 or the customer's monthly customer charge. The amount of the credit provided to any other distribution customer shall be the customer's minimum bill prorated on a daily basis" (MPSC n.d.a, 8).

Michigan's customer compensation structure for service restoration during normal conditions is similar to the previous rule covering restoration under catastrophic conditions. In Rule 45, utilities are subject to paying customer credits if a service interruption lasts longer than 16 hours. The states examined for this study, in large part, use reliability indices to measure their performance and do not differentiate between performance in normal and catastrophic conditions as Michigan does. Additionally, as described for Rule 44, the states included in this study do not establish parameters for customer bill credits through standards. Because of this, there is no new information to present in relation to Michigan's Rule 45.

Rule 460.746: Penalty for Repetitive Interruptions of the Same Circuit

Michigan Standard

> **Rule 46:** "(1) Unless an electric utility requests a waiver pursuant to part five of these rules, a customer of an electric utility that experiences and notifies the utility of more than seven interruptions in a 12-month period due to a same-circuit repetitive interruption shall be entitled to a billing credit on the customer's next bill. The amount of the credit provided to a residential customer shall be the greater of $25 or the customer's monthly customer charge. The amount of the credit provided to any other distribution customer shall be the customer's minimum bill prorated on a daily basis.
>
> (2) Following provision of the billing credit to a customer experiencing more than seven interruptions in a 12-month period due to a same-circuit repetitive interruption, the electric utility's interruption counter shall be reset to zero to ensure that another credit to the customer will be processed only after the occurrence of another eight interruptions in a 12-month period" (MPSC n.d.a, 8).

The states examined use reliability indices to measure their performance and do not administer penalties based on individual performance measures, such as the number of interruptions on a singular circuit. Instead, states with penalties for violating reliability standards apply the same penalties to all standards. Because of this, the standards and penalties described for the previous two rules are the same for Rule 46.

Rule 460.747: Multiple Billing Credits Allowed

Michigan Standard

Rule 47: "An electric utility's obligation to provide a customer with a billing credit for one reason does not excuse the obligation to provide an additional billing credit in the same month for another reason" (MPSC n.d.a, 8).

Discussion of this rule was omitted from this analysis, as standards pertaining to customer bill credits and penalties were extremely limited.

Rule 460.748: Effect in Other Proceedings

Michigan Standard

Rule 48: "(1) The payment or nonpayment of a customer credit or an incentive award shall not affect the rights of a customer or an electric utility in any proceeding before the commission or in any action in a court of law.

(2) The finding of a violation of a service quality or reliability standard adopted in these rules shall not affect the rights of a customer or an electric utility in any proceeding before the commission or in any action in a court of law" (MPSC n.d.a, 8–9).

This standard was omitted from analysis because it does not address electric utilities' service quality or reliability performance.

Part Five: Waivers and Exceptions

Rule 460.751: Waivers and Exceptions by Electric Utilities

Michigan Standard

Rule 51: "(1) An electric utility may petition the commission for a permanent or temporary waiver or exception from these rules when specific circumstances beyond the control of the utility render compliance impossible or when compliance would be unduly economically burdensome or technologically infeasible.

(2) An electric utility may request a temporary waiver in order to have sufficient time to implement procedures and systems to comply with these rules.

(3) An electric utility need not meet the standards or grant the credits required by parts two and four of these rules under any of the following circumstances:

a) The problem was caused by the customer.
b) There was a work stoppage or other work action by the electric utility's employees, beyond the control of the utility, that caused a significant reduction in employee hours worked.
c) The problem was caused by an "act of God." The term "act of God" means an event due to extraordinary natural causes so exceptionally unanticipated and devoid of human agency that reasonable care would not avoid the consequences and includes any of the following: (i) Flood (ii) Tornado. (iii) Earthquake. (iv) Fire.
d) The problem was due to a major system failure attributable to any of the following: (i) An accident. (ii) A man-made disaster. (iii) A terrorist attack. (iv) An act of war" (MPSC n.d.a, 9).

Waivers in the case of special circumstances or severe weather are necessary so utilities are not unnecessarily burdened when compliance with service quality and reliability rules are outside of their control. As such, Michigan's Rule 51 enables the MPSC to grant temporary or permanent waivers that allow utilities to avoid penalties associated with violating service quality and reliability standards.

Benchmarked State Standards

The use of waivers to release utilities from compliance with rules is relatively common for the states included in this analysis. As in Michigan, waivers are subject to review of state regulatory bodies and are only granted if there is a demonstrable need. Examples of states' waiver rules include:

- **Illinois**: Utilities can file a petition for exemption or modification that presents specific reasons and facts in support of the requested exemption or modification. State regulators will consider exemptions to rules based on review of the following information: 1) whether circumstances are beyond the control of company and have made compliance extremely difficult; 2) whether a company has made a good-faith effort to comply with the rule; 3) whether the information provided is complete, timely, and meaningful (State of Illinois n.d.b).
- **Iowa**: State regulators can grant a waiver to rules when it is convinced that the rule poses undue hardship and the waiver would not impinge anyone's legal rights. Waivers can be granted with

conditions that are aimed at achieving the intended objectives of the rule in question (State of Iowa 2020).

- **Ohio**: The commission may, upon an application or a motion filed by a party, waive any requirement, other than a requirement mandated by statute, for good cause shown (State of Ohio n.d.).
- **Oklahoma**: Whenever compliance with any provision or requirement would be unduly burdensome, cause unreasonable hardship or excessive expense, or result in an unusual difficulty, the commission may, upon application of the utility or the consumer and after notice and hearing, suspend or excuse compliance with other requirements as appropriate (State of Oklahoma 2019).
- **Oregon**: For limited purposes in specific proceedings, state regulators may modify or waive any of the rules in this division for good cause shown (State of Oregon n.d.).
- **Washington**: The commission, in response to a request or on its own initiative, may grant an exemption from, or modify the application of, any of its rules in individual circumstances if the exemption or modification is consistent with the public interest, the purposes underlying regulation, and applicable statutes (State of Washington 2019).

Rule 460.752: Proceedings for Waivers and Exceptions

Michigan Standard

Rule 52: "(1) A petition for a waiver of a customer credit provision filed by an electric utility shall be handled as a contested case proceeding. The burden of going forward with a request for a waiver shall be on the electric utility. To be timely, a petition for a waiver of a customer credit provision of these rules shall be filed not more than 14 calendar days after conclusion of the outage giving rise to application of the customer credit provision.

(2) A petition for any other waiver or exception may be granted by the commission without notice or hearing" (MPSC n.d.a, 9).

Using waivers to provide customer credits is unique to Michigan's service quality and reliability standards, as is the establishment of its customer credit provisions. The second aspect of Rule 51 is much more aligned with other states' approach to issuing waivers. While the details required from a utility in a waiver application or how state regulators will interpret the application differs, by and large, decisions for granting waivers are the sole discretion of state regulators. Some states, like Washington, require a formal docket for waivers to be reviewed; however, the more common practice is for utilities to submit their rationale to the commission for review without a more involved case proceeding.

Technical Standards for Electric Service

Full list of rules provided in Appendix B.

Part One: General Provisions

- R 460.3101-3102

Part Two: Records and Reports

- R 460.3201-3205

Part Three: Meter Requirements

- R 460.3301-3309

Part Four: Customer Relations

- R 460.3408-3411.

Part Five: Engineering

- R 460.3501-3505

Part Six: Metering Equipment Inspections and Tests

- R 460.3601-3618

Part Seven: Standards of Quality Service

- R 460.3701-3705

Part Eight: Safety

- R 460.3801-3804

Part One: General Provisions

R 460.3101: Applicability; Purpose; Modification; Adoption of Rules and Regulations by Utility

Michigan Standard

> **Rule 101: "**(1) These rules apply to utility service that is provided by electric utilities that are subject to the jurisdiction of the public service commission.
>
> (2) These rules are intended to promote safe and adequate service to the public and to provide standards for uniform and reasonable practices by utilities.
>
> (3) These rules do not relieve a utility from any of its duties under the laws of the state of Michigan. (See R 460.1601(3).)
>
> (4) Each utility may adopt reasonable rules and regulations governing its relations with customers which it finds necessary and which are not inconsistent with these rules for electric service. Adopted rules and regulations must be filed with, and approved by, the commission.
>
> (5) An electric utility may petition the commission for a permanent or temporary waiver or exception from these rules for good cause shown provided that the waiver or exception is consistent with the purpose of these rules" (MPSC n.d.b, 1).

The first rule of Michigan's *Technical Standards for Electric Service* establishes which utilities are governed by subsequent rules. In Michigan, the rules established are applied to all electric utilities as defined by state statute. This includes a "person, partnership, corporation, association, or other legal entity whose transmission or distribution of electricity the commission regulates under 1909 PA 106, MCL [Michigan Compiled Laws] 460.551 to 460.559, or 1939 PA 3, MCL 460.1 to 460.10cc. Electric utility does not include a municipal utility, affiliated transmission company, or independent transmission company" (State of Michigan 2004).

Benchmarked State Standards

Similar to Michigan, where some utilities are subject to state regulation and others are not, the states examined have their own rules dictating what type of electric utilities are required to abide by service quality and reliability standards. Broadly, states with technical standards for electric service apply them to all utilities subject to state regulation in other forms, though the types of utilities in these categories vary.

While Michigan's technical standards apply to investor-owned utilities and electric cooperatives, some other states, such as Minnesota and Ohio, exempt electric cooperatives from state standards.

Other states extend their standards to include all types of utilities. For instance, the Revised Code of Washington (RCW) requires electric companies to "furnish and supply such service, instrumentalities and facilities as shall be safe, adequate and efficient, and in all respects just and reasonable" (State of Washington 2019). This applies to all electric companies in the state defined as, "any corporation, company, association, joint stock association, partnership and person, their lessees, trustees or receivers appointed by any court whatsoever . . . and every city or town owning, operating or managing any electric plant for hire within this state" (State of Washington 2019). Wisconsin also explicitly includes municipal utilities in standards related to the provision of electric service.

Texas takes a different approach than Michigan as well. Instead of defining the broad applicability of a set of rules and later noting instances where a rule does not apply, Texas defines applicability of individual aspects of its technical standards. For example, for vegetation management standards, Texas' rules state, "this section applies to an electric utility's (utility) distribution assets" (PUCT n.d.).

R 460.3102: Definitions

Every state examined provides their own definitions as they relate to technical standards for electric service. It is PSC's determination that analyzing these definitions would not provide revelatory information for the purposes of this report and thus has omitted comparison of these definitions for the purposes of this analysis.

Part Two: Records and Reports

R 460.3201: Records; Location; Examination

Michigan Standard

> **Rule 201: "**Upon a request by the commission or its designated representative, records which are required by these rules or which are necessary for the administration of these rules shall be available within the state of Michigan for examination by the commission or its designated representative" (MPSC n.d.b, 2).

The availability of records related to Michigan's technical standards is an important aspect of the MPSC's ability to provide oversight and regulation of utility service. As such, utilities are required to make records available to MPSC staff or its designated representative. The State does not provide a time period within which utilities must comply with requests to examine records.

Benchmarked State Standards

Overall, state regulatory agencies have broad authority to review documents, records, reports, and other information regarding utility operations. While Michigan's Rule 201 expressly identifies records pertaining to technical rules, none of the states examined have a similar rule applying to the availability of records for specific sections of their rules. Examples of states' general records availability rules include:

- **Illinois**: "All records that are required by this section to be preserved shall be so arranged, filed, and currently indexed by the meter service provider that they may be identified and made available upon request to representatives of the commission" (State of Illinois n.d.b).
- **Indiana**: All records required by these rules shall be preserved for at least three years except as otherwise provided. Such records shall be kept within the state at the principal place of business of the public utility, or at such other places as the utility shall designate after notification to the commission, and shall be open for examination by the commission or its representatives. Each public utility shall notify the commission of the office at which such records are kept" (State of Indiana 2020).
- **North Carolina**: "All records required by these rules shall be preserved by the utility for at least one year after they are made. Such records shall be kept within the State at the office or offices of the utility and shall be open for examination by the commission or its representatives or the public staff at all reasonable hours" (NCUC 2019).
- **South Carolina**: "All records required by these rules or necessary for the administration thereof shall be kept within this state, unless otherwise authorized by the commission" (State of South Carolina 2019).
- **Virginia**: "At each office of the public utility or licensee where records are kept or stored, such records as are herein required to be preserved shall be so arranged, filed, and currently indexed that they may be readily identified and made available to representatives of the commission" (Commonwealth of Virginia n.d.).

R 460.3202: Records; Preservation

Michigan Standard

> **Rule 202:** "Unless otherwise specified in these rules, or by other order of the commission, all records that are required by these rules shall be preserved for the period of time specified in R 460.2501 et seq. of the Michigan Administrative Code" (MPSC n.d.b, 2–3).

Rule 202 of Michigan's technical standards refers to the MPSC's *Preservation of Records of Electric, Gas, and Water Utilities* rules, which outline general practices for recording, retaining, and destroying utility records, as provided in Rule 460.2501. These rules closely resemble common practices in place for states included in this study with established record retention standards. These rules apply broadly to utility records and do not include the other rules in this section that prescribe standards for specific types of records, including Michigan's Rule 615 "Metering Equipment Records;" Rule 204 "Customer Records, Retention Period, Content;" Rule 703 "Voltage Measurements and Records;" and Rule 705 "Interruptions of Service, Records, Planned Interruption, Notice to Commission."

Benchmarked State Standards

Like Michigan, 19 of the 25 states reviewed in this analysis have standards pertaining to the retention of records for electric utilities. Standards for these states illustrate two common approaches to record retention schedules—setting state-specific retention schedules or adoption of national standards.

PSC found two different national standards that states have adopted. New Jersey, New Mexico, Pennsylvania, and South Carolina all refer to the National Association of Regulatory Utility Commissioners' *Regulations to Govern the Preservation of Records of Electric, Gas and Water Utilities*. Oklahoma, Oregon, and Iowa all refer to the rules established by the Federal Energy Regulatory Commission *Code of Federal Register* Part 125 governing "Preservation of Records of Public Utilities and Licensees."

States that establish their own record retention schedules include Connecticut, Illinois, Indiana, Kentucky, Massachusetts, New York, North Carolina, Ohio, Texas, Washington, and Wisconsin. Several states have also adopted default record retention time frames if they lack a standard for a particular record. With a longer time frame, New York requires records be maintained for six years, while Indiana, Ohio, and Washington require three years, and Texas and Oklahoma specify two years. North Carolina had the lowest retention period at one year.

Missouri has record retention standards for certain types of activities (e.g., service interruptions or meter tests) but does not have a general standard for record retention.

R 460.3203: Documents and Information; Required Submission

Michigan Standard

Rule 203: "A utility shall submit all of the following documents and information and shall maintain the documents and information in a current status:

a) A copy of the utility's tariff.
b) A copy of the utility's rules and standards that are made available to the public covering meter and service installation.
c) A copy of each type of customer bill form.
d) A list of the cities, villages, and townships that the utility serves. Upon a request by the commission or its designated representative, the utility shall also provide copies of the associated franchise information.
e) The name, title, address, and telephone number of the persons to be contacted in connection with the following matters: (i) General management duties. (ii) Customer relations (complaints). (iii) Engineering operations. (iv) Meter tests and repairs. (v) Emergencies during nonoffice hours.
f) An annual copy of the utility's construction budget, which shall be updated for all major changes to generating and transmission facilities.
g) An "Electric Service" monthly report, on forms suitable to the commission, that shows information concerning the utility's acquisition and disposition of electric energy and other information as required. The reports shall be submitted by investor-owned utilities within 50 days after the end of the quarter reported and by rural electric cooperatives within 50 days after the end of the month reported.
h) A map or maps that show the utility's operating area within this state, including generating stations and transmission lines with their voltage designations. Upon a request by the commission or its designated representative, the utility shall also make available a map or maps that show all of the following: (i) Distribution lines with the number of phases designated. (ii) State boundary crossings. (iii) Service areas" (MPSC n.d.b, 3).

Michigan's Rule 203 addresses the need for utilities to provide state regulators with up-to-date information regarding their operations, billing practices, standards for meters and service installation, and appropriate company contacts. The rule outlines the following categories of information that utilities must report on tariffs, meter and service installation standards, customer bill forms, summaries of places served, service territory maps, utility contacts, annual construction budgets, and electric service reports.

Benchmarked State Standards

None of the 25 states examined have a standard that includes all eight of the components required in Michigan's Rule 203. However, four of the states—Iowa, New Mexico, South Carolina, and Wisconsin—had standards with many shared elements. Of these states, Iowa's standard was the most similar, requiring utilities to submit documents related to six out of the eight components of Michigan's standard. South Carolina's rule includes five of the same reporting requirements. Wisconsin and New Mexico also have requirements relating to five of the components in Michigan's rule, but these requirements are spread across two or more rules. Exhibit 15 outlines how other states' standards compare with Michigan.

EXHIBIT 15. Required Documents and Information

Document Required	Michigan	Iowa	New Mexico*	South Carolina	Wisconsin*
Tariff	✓	✓	✓	✓	✓
Meter and Service Installation Standards	✓	✓	✓	✓	✓
Customer Bill Form	✓	✓	✓	✓	✓
Summary of Places Served	✓				✓
Service Territory Maps	✓	✓	✓	✓	✓
Utility Contacts	✓	✓	✓	✓	
Annual Construction Budget	✓				
Electric Service Report	✓	✓			

* Indicates that requirements are contained in more than one rule.
Sources: MPSC n.d.b; State of Wisconsin 2019; State of South Carolina 2019; State of New Mexico n.d.; State of Iowa 2020

Each of these state standards also include requirements not found in Rule 203. For example, New Mexico's standard outlines other records and reports required, such as meter testing reports and continuity of service plans. Wisconsin's rule also requires utilities to submit their rules related to temporary, auxiliary, emergency, and standby service.

Seven states—Illinois, Indiana, Minnesota, New Jersey, Oklahoma, Oregon, and Texas—have standards that include fewer elements of Michigan's Rule 203. These standards are primarily related to the provision of customer information related to service, rates, and bills. As an example, New Jersey's standards mainly deal with filing requirements for utility tariffs. The state requires utilities to file their current tariffs and publish contact information, but the rule does not include other provisions related to operating activities or other service requirements (State of New Jersey n.d.).

Illinois' standard requires utilities to file a description of their billing practices, service connection procedures, utility contact information, and service and reliability standards. Similarly, standards focus on the provision of information to customers regarding their rules for customer billing, service connection, and meter reading. They also cover utilities' published rates and contact information for appropriate utility contacts (State of Minnesota 2009).

R 460.3204: Customer Records; Retention Period; Content

Michigan Standard

Rule 204: "(1) The utility shall retain, either within the utility or as contracted through a third party with access by the utility, customer records as necessary to comply with R 460.3309. The utility shall retain the records for not less than three years.

2) Records for customers must show, if applicable, all of the following information:

a) Kilowatt-hour meter reading.
b) Metered kilowatt-hour consumption.
c) Kilowatt, kilovolt ampere, and kilovar meter reading.
d) Kilowatt, kilovolt ampere, and kilovar measured demand.
e) Kilowatt, kilovolt ampere, and kilovar billing demand.
f) Total amount of bill" (MPSC n.d.b, 3–4).

Michigan's Rule 204 requires that utilities keep customer meter-read records for at least three years. These records need to be maintained in compliance with Rule 309 to enable utilities to address meter inaccuracies and make necessary billing adjustments.

Benchmarked State Standards

Of the states included in this study, 12 have standards for retaining customer meter records. The high end of required record retention periods are capped at six years, while the low end is two years. Benchmarked states' record retention rules are described below in Exhibit 16.

EXHIBIT 16. Customer Meter Records Retention Standards

State	Time Period	Examples
New Jersey and Wisconsin	6 years	In the case of New Jersey, these records must ensure the "computation of the customer's bill for any billing period occurring within six years"
Iowa	5 years	Iowa's standard is very similar to Michigan's in that it requires records to be retained to ensure compliance with separate provisions for meter errors and billing adjustments, but the state requires records be maintained for a longer period of time
California, Illinois, Indiana, Michigan, and Washington	3 years	California's requirement for customer records to be maintained is not contained in the state's administrative rules but in Direct Access Standards for Metering and Meter Data In California, which was established by the California Public Utilities Commission (CPUC) and governs all participants in the state's direct access electricity market. Illinois' customer records rule states, "Each MSP shall retain all meter usage data collected from each meter for at least three years".
Massachusetts, New Mexico, Oklahoma, Texas, and Virginia	2 years	Texas requires utilities to "maintain monthly billing records for each account for at least two years after the date the bill is mailed. The billing records shall contain sufficient data to reconstruct a customer's billing for a given month. Copies of a customer's billing records may be obtained by that customer on request".

Source: State of New Jersey n.d.; State of Iowa 2020;CPUC 1999; PUCT n.d; State of Illinois n.d.b

R 460.3205: Security Reporting

Michigan Standard

Rule 205: "(1) To inform the commission regarding matters that may affect the security or safety of persons or property, whether public or private, an electric provider must do both of the following:

a) Provide a written or oral annual report, individually or jointly with other electric providers, to designated members of the commission staff regarding the electric provider's cybersecurity program and related risk planning. This report on the threat assessment and preparedness strategy must contain all of the following information: (i) An overview of the program describing the electric provider's approach to cybersecurity awareness and protection. (ii) A description of cybersecurity awareness training efforts for the electric provider's staff members, specialized cybersecurity training for cybersecurity personnel, and participation by the electric provider's cybersecurity staff in emergency preparedness exercises in the previous calendar year. (iii) An organizational diagram of the electric provider's cybersecurity organization, including positions and contact information for primary and secondary cybersecurity emergency contacts. (iv) A description of the electric provider's communications plan regarding unauthorized actions that result in loss of service, financial harm, or breach of sensitive business or customer data, including the electric provider's plan for notifying the commission and customers. (v) A redacted summary of any unauthorized actions that resulted in material loss of service, financial harm, or breach of sensitive business or customer data, including the parties that were notified of the unauthorized action and any remedial actions undertaken. (vi) A description of the risk assessment tools and methods used to evaluate, prioritize, and improve cybersecurity capabilities. (vii) General information about current emergency response plans regarding cybersecurity incidents, domestic preparedness strategies, threat assessments, and vulnerability assessments.

b) In addition to the information required under subdivision (a) of this subrule, an investor-owned public utility must include in its annual report to the Michigan Public Service Commission an overview of major investments in cybersecurity during the previous calendar year and plans and rationale for major investments in cybersecurity anticipated for the next calendar year.

(2) As soon as reasonably practicable and prior to any public notification, an electric provider must orally report the confirmation of a cybersecurity incident to a designated member of the commission staff and to the Michigan fusion center, unless prohibited by law or court order or instructed otherwise by official law enforcement personnel, if any of the following occurred:

a) A person intentionally interrupted the production, transmission, or distribution of electricity.

b) A person extorted money or other thing of value from the electric provider through a cybersecurity attack.

c) A person caused a denial of service in excess of 12 hours.

d) An unauthorized person accessed or acquired data that compromises the security or confidentiality of personal information maintained by the electric provider, as defined by section 3(r) of the Identity Theft Protection Act, 2004 PA 452, MCL 445.63(r), prior to public and customer notification.

e) At the electric provider's discretion, any other cybersecurity incident, attack, or threat which the electric provider deems notable, unusual, or significant.

(3) For purposes of this rule, "electric provider" means any of the following:

a) Any person or entity that is regulated by the commission for the purpose of selling electricity to retail customers in this state.

b) A member-regulated cooperative electric utility in this state.

(4) For purposes of subrule (2) of this rule, "person" means any individual, firm, corporation, educational institution, financial institution, governmental entity, or legal or other entity.

(5) For purposes of subrule (2)(c) of this rule, "denial of service" means, for an electric provider, a successful attempt to prevent a legitimate user from accessing electronic information made accessible by the electric provider or by another party on the behalf of the electric provider" (MPSC n.d.b., 4–5).

Michigan's newest technical standard for electric service was established in 2019 and provides requirements for utilities to prepare cybersecurity plans and report cybersecurity incidents. Utilities' cybersecurity plans must be presented annually to the MPSC and include a description of cybersecurity programs; utilities' training efforts; key personnel, organization chart, and contact information; a communications plan; a summary of intrusions and remedial actions taken, risk assessment tools, and emergency response plans; and an overview major cybersecurity investment. Additionally, Rule 205 includes requirements for utilities to report cybersecurity incidents, such as interruption of electric grid operations, financial extortion, denial of service attacks, data breaches, and other security incidences or attacks experienced.

Benchmarked State Standards

Of the benchmarked states, only a few had cybersecurity requirements outlined in their administrative rules. Oklahoma recently adopted a cybersecurity requirement for electric utilities and enabled utilities to recover costs associated with these plans. Chapter 165 subchapter 35 of the Oklahoma Administrative Code (OAC), added in July 2019, defines the following requirements for electric utilities.

> **"165:35-33-1. Purpose and Scope**
>
> (a) The purpose of this subchapter is to require utilities to take all reasonable measures necessary to protect their critical infrastructures from extended interruption of service from all extraordinary events, natural and man-made.
>
> (b) The commission requires electric utilities to develop, implement, and maintain Homeland Security and Critical Infrastructure Plans according to the industry standards enumerated in subsection (d) below.

(c) To the extent that a utility seeks to recover costs for security measures outside of a general rate review for the implementation of Homeland Security and/or Critical Infrastructure protections, the utility shall comply with all provisions of this Subchapter.

(d) Each electric utility serving Oklahoma jurisdictional ratepayers is required to follow the most current applicable North American Electric Reliability Corporation's (NERC's) Security Guidelines and Standards or equivalent cybersecurity framework, as may be amended from time to time, for use as guidelines for protecting the utility's Critical Infrastructure from extended service interruption.

(e) Each electric utility seeking to recover costs for security measures from Oklahoma jurisdictional ratepayers outside of a general rate review shall develop, implement, and maintain a Critical Infrastructure and Security Plan as further set forth within this Subchapter.

(f) If the utility has implemented a Security Plan or process in accordance with the applicable industry guidelines but is not seeking or receiving cost recovery for security-related costs, the utility shall submit the Certification Letter required by OAC 165:35-33-7(f) and the plan shall be subject to review pursuant to the Authorized Participation and Confidentiality provisions of OAC 165:35-33-10 and OAC 165:35-33-11. The utility is not otherwise required to comply with the provisions of this subchapter.

(g) The commission retains its jurisdictional and supervisory authority to address the reasonableness and/or prudence of any proposed security cost recovery.

(h) Nothing in this subchapter shall relieve any utility from any duty otherwise prescribed by the laws of the State of Oklahoma or this commission's rules.

(i) Nothing in this Subchapter is intended to divest the utility of its right to object to any discovery requests from intervenors seeking access to "Highly Sensitive Confidential" materials.

(j) If any provision of this subchapter is held invalid, such invalidity shall not affect other provisions or applications of this Subchapter which can be given effect without the invalid provision or application, and to this end, the provisions of this Subchapter are declared to be severable" (State of Oklahoma 2019, 79).

Similarly, Pennsylvania also defines cybersecurity planning requirements for electric utilities, which requires annual self-certification of the plan designed to ensure safe, continuous, and reliable utility service (Commonwealth of Pennsylvania 2019).

Several other state commissions have begun or are undergoing cybersecurity planning efforts, but to date, requirements have not been included in rules or standards. These states include California, Connecticut, Illinois, New York, Massachusetts, Missouri, and Louisiana. As an example of these efforts, the Connecticut Public Utilities Regulatory Authority (PURA) has hosted workgroup sessions and authored the *Connecticut Public Utilities Cybersecurity Action Plan* that describes the impetus for the state's action and outlines a path to establish processes and collaboration related to cybersecurity for the state's utilities. Through this process, PURA outlined several national standards for cybersecurity, including the

National Institute of Standards and Technology (NIST) Framework, the North American Electric Reliability Corporation Critical Infrastructure Protection standards and requirements, and the U.S. Department of Energy *Electricity Subsector Cybersecurity Capability Maturity Model* (ES-C2M2). Electric utilities in Connecticut informed state regulators that they support an oversight process for their respective cybersecurity, but informed state officials that they “are already following the ES-C2M2 for their cybersecurity programs and believe it would be more meaningful and easier to use than state reporting requirements” (State of Connecticut n.d.).

Part Three: Meter Requirements

R 460.3301: Metered Measurement of Electricity Required; Exceptions

Michigan Standard

Rule 301: "(1) All electricity that is sold by a utility shall be on the basis of meter measurement, except where the consumption can be readily computed or except as provided for in a utility's filed rates.

(2) Where practicable, the consumption of electricity within the utility or by administrative units associated with the utility shall be metered.

(3) Meters shall be in compliance with part 6 of these rules" (MPSC n.d.b., 5).

Rule 301 requires utilities to measure all electricity consumption using meters except in specific instances where consumption is otherwise provided for in a utility's filed rate structures.

Benchmarked State Standards

Eleven of the states reviewed—Illinois, Iowa, Kentucky, Minnesota, New Mexico, Ohio, Oklahoma, Oregon, Texas, Washington, and Wisconsin—have a similar standard in place that explicitly describes a utility's obligation to use a meter for measuring customer consumption. Examples of these metering requirements include:

- **Illinois**: "Meter service providers shall read all meters serving retail customers in compliance with the delivery service provider's tariff requirements" (State of Illinois n.d.b).
- **Iowa**: "All electricity consumed by the utility shall be on the basis of meter measurement except where consumption may be readily computed without metering, or where metering is impractical" (State of Iowa 2020).
- **Kentucky**: "All energy sold within the state of Kentucky shall be measured by commercially acceptable measuring devices owned and maintained by the utility, except where it is impracticable to meter loads, such as multiple streetlighting, temporary or special installations, in which case consumption may be calculated" (State of Kentucky 2019).
- **New Mexico**: "All electricity sold by a utility shall be on a basis of meter measurement except for service of installations where the load is constant and the consumption may be readily computed. Wherever practicable, consumption of electricity within the utility itself or by administrative units associated with it shall be metered" (State of New Mexico n.d.).
- **Washington**: "Electric utilities must use electric meters or other such devices to accurately record or indicate the quantity of electricity sold to customers. Such measuring devices will allow utilities to calculate a customer's consumption in units of kilowatt hours (kWh) or other units as filed in the company's tariffs" (State of Washington 2019).
- **Wisconsin**: "Where practical to do so, all electrical quantities required to be reported to the commission shall be metered" (State of Wisconsin 2019).

R 460.3303: Meter Reading Data

Michigan Standard

Rule 303: "The meter reading data must include all of the following information:

a) A suitable designation identifying the customer.

b) Identifying number and description of the meter.

c) Meter readings or, if a reading was not taken, an indication that a reading was not taken.

d) Any applicable multiplier or constant" (MPSC n.d.b., 6).

Requirements for meter reading data are defined by Michigan's Rule 303. This data must include customer identification, meter identification, any meter readings, and meter multipliers or constants.

Benchmarked State Standards

Iowa, New Mexico, North Carolina, and Oklahoma all have standards that are closely aligned with Michigan's Rule 303.

- **Iowa**: The meter records must include customer information, applicable rates, reference to the type of meter equipment installed, and any applicable multipliers or adjustments (State of Iowa 2020).
- **New Mexico**: "The meter reading sheets, cards, or records from which the customer's bills are prepared shall show: (1) customer's name, address, and rate schedule; (2) identification number or description of the meter(s); (3) meter readings; (4) if the reading has been estimated; and (5) any applicable multiplier or constant" (State of New Mexico n.d.).
- **North Carolina**: "The meter reading sheets, cards, or data shall show: (1) Customer's name, address, and rate schedule. (2) Identifying number and/or description of the meter(s). (3) Meter readings. (4) If the reading has been estimated. (5) Multiplier or constants should be shown if applicable" (NCUC 2019).
- **Oklahoma**: Meter reading records shall show a consumer's name, address, rate schedule symbol, identifying number or description of the meter, meter readings and dates thereof, and any estimated readings. Every meter must be read by the utility or by consumers, in a manner prescribed in this rule (State of Oklahoma 2019).

Based on review of the other states included in this analysis, there appears to be overlap between Rule 303 meter reading data reporting and Rule 615 pertaining to meter equipment records. While Rule 615 only covers records from meter testing, many of the states examined incorporate meter reading data and meter testing data into a single standard. One example of a meter record standard that combines elements of Rules 303 and 615 is Illinois' meter record standards, which are provided below.

“Section 460.330 Meter Records

a) Each MSP shall keep records that contain the following information about each service watt-hour meter and var-hour meter the MSP owns or has in service in this State:

1) manufacturer and date of purchase, along with any testing data provided by the manufacturer that is used by the MSP for acceptance testing of the meter;

2) manufacturer or MSP identification number;

3) nameplate data, including:

A) form designation or circuit description;

B) "watt-hour meter" or other description;

C) manufacturer's name or trademark;

D) manufacturer's type;

E) electrical current class;

F) rated voltage;

G) number of wires;

H) frequency;

I) test amperes;

J) watt-hour meter constant; and

K) watt-hour meter test constant (if applicable);

4) date and place of present or most recent installation;

5) date and type of last major repair, or of final disposition; and

6) accuracy of each meter in accordance with the testing policies set forth in this Subpart, including:

A) date of test;

B) reason for test;

C) reading and accuracy of meter as found and as left;

D) creep test results, if applicable;

E) identification of person performing test; and

F) identification of equipment used to test meter” (State of Illinois n.d.b).

Similarly, Washington’s standards for meter history records includes requirements for utilities to track the history of each installed meter, including date of purchase, meter type, unique identifying number, location of installation, periodic readings from installation and removal, and meter test records (State of Washington 2019).

Another way states approach reporting for meter reading is through standards for utility bill content. Six of the states reviewed—Minnesota, New Jersey, New York, Ohio, Oregon, and Texas—have clear standards for billing data that include aspects of meter reading data as it appears in Michigan’s Rule 303, but no specific requirements that is referred to as meter reading data. For example, New York requires that utility bills include the following information:

- Service provider identification and location of offices for bill payment
- Rate information, including charge or credit adjustments
- Meter reading information, including current and previous meter reading, reading dates, multiplier or constant, and billed demand
- Outstanding balances (State of New York n.d.).

R 460.3304: Meter Data Collection System

Michigan Standard

Rule 304: "A meter data collection system that takes data from recording meters must indicate all of the following meter information:

a) The date of the record.
b) The equipment numbers.
c) A suitable designation identifying the customer.
d) The appropriate multipliers" (MPSC n.d.b., 6).

PSC could not locate any instances of states requiring a meter data collection system as outlined in Rule 304. The underlying implication of requiring the collection of meter reading and meter testing data is that utilities have a collection system in place to house this data.

R 460.3305: Meter Multiplier

Michigan Standard

Rule 305: "If it is necessary to apply a multiplier to the meter registration, then the multiplier shall be displayed on the face of the meter" (MPSC n.d.b., 6).

Rule 305 requires that meter multipliers be displayed on the face of a meter.

Benchmarked State Standards

Similar requirements for displaying meter multipliers are included in Illinois, Indiana, Iowa, Kentucky, New Mexico, Ohio, Oklahoma, Washington, and Wisconsin standards. Besides New York, South Carolina, and Texas, all of these states have provisions explicitly requiring meter multipliers, if in use, to have their value plainly marked somewhere on the meter. Oftentimes, the exact location and marking material is detailed by each state's provision as well.

The use of meter multipliers is also referenced in New York, South Carolina, and Texas standards, but these states do not explicitly require the labeling of multipliers on meters. In New York and South Carolina, the use of a meter multiplier must be marked on customers' bills.

R 460.3308: Standards of Good Practice; Adoption by Reference

Michigan Standard

Rule 308: "In the absence of specific rules of the commission, a utility shall apply the provisions of the publications set forth in this rule as standards of accepted good practice. The following standards are available from the American National Standards Institute (ANSI).

a) ANSI standards for electricity meters ANSI C12.1-2014 and C12.20-2010.
b) ANSI/American Society for Quality (ASQ) Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming (ANSI/ASQ Z1.9-2003(R2013)).
c) ANSI IEEE Standard Requirements for Instrument Transformers (ANSI C57.13-2016).
d) ANSI IEEE Standard for High Accuracy Instrument Transformers, IEEE Std. (C57.13.6-2005)" (MPSC n.d.b., 6–7).

Michigan's Rule 308 adopts several national standards for meters and associated equipment, including ANSI and ANSI/ASQ standards for meters, instrument transformers, inspection, and sampling. ANSI is a private organization that develops standards for various industries, including electric utility service; ASQ is a member of ANSI that is accredited to also develop standards.

Benchmarked State Standards[12]

Adoption of standards by reference is common practice in state rules governing electric utilities. PSC reviewed published standards for the 25 states included in this analysis with the goal of identifying other states that had adopted the specific standards included in Michigan's *Technical Standards for Electric Service*. The following section provides an inventory of states that have adopted the five national standards referenced in Rule 308 as well as other standards that were identified through this collection effort.[13]

ANSI Standard C12.1-2014 and C12.20-2010

The following states have adopted ANSI Standard C12 either in part or in total: Connecticut, Illinois, Indiana, New Mexico, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Virginia, and Washington. Connecticut, Indiana, Massachusetts, Ohio, Virginia, and Washington also reference ANSI standard C12.1. Other states, including Illinois, New Mexico, Oklahoma, Pennsylvania, South Carolina, and Texas, reference this standard but do not list applicable subsections.

[12] The information compiled in this section related to states' adoption of standards by reference is the result of PSC's best efforts to identify applicable standards adopted in the 25 targeted states; however, references to these standards were contained in a number of different documents and various sections of state rules, as such there may be additional standards that are not included in this list.

[13] In some cases, the year listed for adopted standards differs from the specific standard adopted in Michigan.

ANSI Standard C57.13-2016 and C57.13.6-2005

Kentucky, Indiana, Iowa and New Mexico all reference ANSI Standard C57.13. Only Iowa identifies specific subsections of this standard that apply, including C57.13.1 and C57.13.3.

ANSI/ASQ Standard Z1.9-2003

Illinois, Indiana, Massachusetts, and Washington all reference ANSI/ASQ Standard Z1.9. However, Illinois specifically references the 1993 edition, while the other states do not limit their adoption to one specific edition.

Other Standards

- **Illinois:** ANSI/ASQC Z1.4-1993, and Military Standards 414 and 105 are referenced as acceptable meter sample testing procedures for testing certain types of network meters.
- **Indiana**: ANSI/IEEE C57.13–1978, American National Standard Requirements for Instrument Transformers, approved September 9, 1976 (State of Indiana 2020).
- **Iowa**: "The utility shall use the applicable provisions in the publications listed below as standards of accepted good practice unless otherwise ordered by the board. Iowa Electrical Safety Code, as defined in 199—Chapter 25, National Electrical Code, ANSI/National Fire Protection Association (NFPA) 70-2014, American National Standard Requirements for Instrument Transformers, and American National Standard Code for Electricity Metering, ANSI C12.1-2014" (State of Iowa 2020).
- **Kentucky**: "A utility shall construct and maintain its plant and facilities in accordance with good accepted engineering practices. Unless the commission specifies otherwise, the utility shall use applicable provisions in the following publications as standards of accepted good engineering practice for construction and maintenance of plant and facilities, herein incorporated by reference: (1) NESC; ANSI C-2. 1990 Edition, (2) National Electrical Code; ANSI-NFPA 70. 1990 Edition, (3) American National Standard Code for Electricity Metering; ANSI C-12.1, (4) USA Standard Requirements for Instrument Transformers; ANSI Standard C57.13, 1978 Edition, (5) the adoption and applicability of the National Electrical Code as a standard of utility construction is limited to electric utility auxiliary buildings, which are not an integral part of a generating plant, substation, or control center. "Integral part" is defined as essential to the operation or necessary to make complete" (State of Kentucky 2019).
- **Minnesota**: Utilities are encouraged to follow the recommended practices of the IEEE. and the ANSI on electricity metering and standard voltage ratings for electric power systems and equipment. Utility compliance with these recommended practices creates a rebuttable presumption that a practice is reasonable (State of Minnesota 2009).
- **New Mexico**: Unless otherwise specified by the commission, the utility shall use the applicable provisions in the latest edition of the publications listed below as standards of accepted good practice. NESC as compiled by the National Bureau of Standards and National Electrical Code, NFPA No. 70, ANSI standard C-1 (State of New Mexico n.d.).
- **New York:** "If utilities use a sampling method for meter testing, they must follow ANSI Z1.4-1993" (State of New York n.d.).
- **North Carolina**: "The current rules and regulations of the ANSI entitled 'National Electrical Safety Code' are hereby adopted by reference as the electric safety rules of this commission and shall apply to all electric utilities which operate in North Carolina under the jurisdiction of the commission" (NCUC 2019).

- **Oregon**: "Construction, operation, and maintenance of electrical supply and communication lines. Every operator shall construct, operate, and maintain electrical supply and communication lines in compliance with the standards prescribed by the 2017 Edition of the National Electrical Safety Code approved April 26, 2016, by the ANSI" (State of Oregon n.d.).
- **Washington**: "Adoption by reference. The NESC is published by the NFPA. The commission adopts the edition effective in 2017" (State of Washington 2019).
- **Wisconsin**: Standard and maintenance of a service voltage. For polyphase voltage unbalance issues, ANSI C.84.1–1989 Appendix D is the reference that will be followed (State of Wisconsin 2019).

R 460.3309: Metering Inaccuracies; Billing Adjustments

Rule 309: "(1) An adjustment of bills for service for the period of inaccuracy must be made for over registration and may be made for under registration under any of the following conditions:

a) A mechanical meter creeps.

b) A metering installation is found upon any test to have an average inaccuracy of more than 2.0 percent.

c) A demand metering installation is found upon any test to have an average inaccuracy of more than 1.0 percent in addition to the inaccuracies allowed under R 460.3609.

d) A meter registration has been found to be inaccurate due to apparent tampering by a person or persons known or unknown.

(2) The amount of the adjustment of the bills for service must be calculated on the basis that the metering equipment is 100 percent accurate with respect to the testing equipment used to make the test. The average accuracy of watt-hour meters must be calculated in accordance with R 460.3616.

(3) If the date when the inaccuracy in registration began can be determined, then that date must be the starting point for determining the amount of the adjustment and is subject to R 460.115.

(4) If the date when the inaccuracy in registration cannot be determined, then it is assumed that the inaccuracy existed for the period of time immediately preceding discovery of the inaccuracy that is equal to half of the time since the meter was installed on the present premises, half of the time since the last test, or six years, whichever is the shortest period of time, except as otherwise provided in subrule (5) of this rule and subject to subrule (12) of this rule.

(5) The inaccuracy in registration due to creep must be calculated by timing the rate of the creeping under R 460.3607 and by assuming that the creeping affected the registration of the meter for the period of time immediately preceding discovery of the inaccuracy that is equal to one-quarter of the time since the meter was installed on the present premises, one-quarter of the time since the last test, or six years, whichever is the shortest period of time, subject to subrule (12) of this rule.

(6) If the average inaccuracy cannot be determined by test because part, or all, of the metering equipment is inoperative, then the utility may use the registration of check metering installations, if any, or estimate the quantity of energy consumed based on available data. The utility shall advise the

customer of the metering equipment failure and of the basis for the estimate of the quantity billed. The same periods of inaccuracy must be used as explained in this rule.

(7) Recalculation of bills must be on the basis of the recalculated monthly consumption.

(8) Refunds must be made to the two most recent customers who received service through the meter found to be inaccurate. If a former customer of the utility, a notice of the amount of the refund must be mailed to such customer at the last known address. The utility shall, upon demand made by the customer within three months of mailing of the notice, forward the refund to the customer.

(9) If the external meter display is not operating so that the customer can determine the energy used, but the meter is recording energy correctly, then no adjustment is required. The utility shall repair or replace the meter promptly upon discovery of the failure" (MPSC n.d.b,7).

Michigan Standard

Fair and accurate billing practices are based on the level of accuracy provided by electric meters. Meters can over- or underrepresent the actual consumption of electricity and as such need to be periodically tested (more discussion of meter testing is provided in Part Six: Metering Equipment Inspections and Tests). Despite best efforts to ensure accurate meter readings and customer bills, there are still instances where billing adjustments need to be made. Michigan's Rule 309 establishes a statewide standard for electric utilities to provide billing adjustments.

Benchmarked State Standards

PSC's review of state standards for electric utilities identified 16 states with standards for billing adjustments to address meter reading inaccuracies. These states are Connecticut, Illinois, Indiana, Kentucky, Minnesota, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Washington, and Wisconsin. The primary differences between states' billing adjustment provisions have to do with conditions that qualify for bill adjustments (e.g., meter reading inaccuracy), the basis for calculating billing adjustments, the period for which billing adjustments can be made, who is eligible for a billing adjustment, and exceptions to billing adjustment provisions. The following discussion has been divided into these five components.

Qualifying Conditions

Michigan's standards list four qualifying conditions for adjusted billing, meter creep, meter inaccuracy above 2 percent, demand meter inaccuracy greater than 1 percent, and tampering with a meter. Meter error is the most common qualifying condition shared across state standards included in this review. The majority of states with billing adjustment rules set the meter error threshold at 2 percent. Only Kentucky has a stricter standard at 1 percent (State of Kentucky 2019). Indiana and Connecticut allow meter error of 3 and 4 percent, respectively (State of Indiana 2020; State of Connecticut n.d.a). Meter error thresholds for Ohio, Oregon, Pennsylvania, and Texas, were not determined. Several states indicate a different meter error standard for demand meters. Indiana allows up to 4 percent meter error for demand meters (State of Indiana 2020). Wisconsin and Iowa allow a 1.5 percent meter error. New Mexico adopts the same standard as Michigan at 1 percent (State of Iowa 2020; State of Wisconsin 2019).

Meter creep is another qualifying condition for a billing adjustment according to Michigan's standards. Illinois, Wisconsin, Iowa, and New Mexico's standards also include meter creep.

Michigan's fourth qualifying condition for billing adjustment is cases where a meter has been tampered with, resulting in inaccurate readings. States whose standards reference tampering include Connecticut, Illinois, New Jersey, New, Mexico, Ohio, Oklahoma, Oregon, South Carolina, Texas, Washington, and Wisconsin.

Eligible Time Frame

States have established different parameters governing the time period for which utility customers can receive billing adjustments. Establishing the time frame for billing adjustments is important because it is not always possible to know when the meter became inaccurate. Where the cause and timing for a meter's error is determinable, most states allow billing credits to be based on this date. However, more commonly, states have had to establish acceptable time frames for billing adjustments that reference a fixed time period or the last known date a meter was verified to be in working order. Michigan's time frame is calculated based on either the date a meter was installed or from the last time the meter was tested. In cases where the date on which the inaccuracy began cannot be determined, the eligible time frame is half the time since the date the meter was last tested or the meter installation date, or six years. In the case of meter creep, the meter error is determined to be either one-quarter of the time since the last meter test or installation date, or six years, whichever is less. When the date of inaccuracy can be identified, the billing adjustment will be limited to the 12-month period before the inaccuracy was discovered (MPSC n.d.c, 14). Eligible time frames in other states vary. For example:

- **Illinois:** The state standard for determining the period for billing adjustments is much more straightforward. The standard establishes in cases where a meter is running fast the presumption that, unless demonstrated otherwise, a meter inaccuracy has existed for a period of two years and that the period of inaccuracy does not exceed the time for which records of the current customer's usage exist. In cases where the meter is slow, it shall be presumed, unless demonstrated otherwise, that the inaccuracy has existed for a period of one year prior for small commercial and residential customers and two years prior to the test for all other customers (State of Illinois n.d.a).
- **Indiana:** Billing adjustment standards specifies if the date from which the meter began reading in error cannot be determined, then the eligible period is half of the period of time since the meter was last tested or one year, whichever is shorter (State of Indiana 2020).
- **Minnesota:** The period for which a billing adjustment can occur is capped at one year in cases where there has not been a meter test for more than a year. Otherwise, the billing adjustment can only apply for half the time since a meter was last inspected, but this is capped at six months (State of Minnesota 2009).
- **New Jersey:** If the date the inaccurate readings began is known, then the billing adjustment period is based on the percentage of error that has been determined and the total consumption during the time period identified. Otherwise, the applicable time period is determined based on the date of most recent meter test or date a meter was taken out of service. The state's method for determining the eligible time period is as follows:

"i. Determine the period of inaccuracy; that is the period between the test that found the meter inaccuracy and the earlier of the events at (c)2i(1) or (2) below (Note: The period of inaccuracy may be longer than the time the meter has served the existing customer):

(1) The most recent previous test of the meter; or

(2) The date upon which the meter was taken out of service at the customer's premises;

ii. Perform the following calculation:

(1) If the period of inaccuracy determined under (c)2i is shorter than the maximum permitted time between meter tests, as determined under 14:5-3.2, 14:6-4.2, or 14:9-4.1(b), divide the period of inaccuracy in half; or

(2) If the period of inaccuracy is longer than the maximum permitted time between meter tests, divide the permitted maximum time between meter tests in half; then add the difference between the maximum permitted time between meter tests and the period of inaccuracy;

iii. If the time determined under (c)2ii above is longer than the time the meter has served the existing customer, the applicable time period is the time the meter has served the existing customer;

iv. If the time determined under (c) 2ii above is shorter than the time the meter has served the existing customer, the applicable time period is the time determined under (c)2ii above" (State of New Jersey n.d.).

Bill Adjustment Calculations

Michigan requires billing adjustment to be recalculated based on the determined monthly consumption after the error has been corrected. Estimated bills can be used if consumption cannot be quantified, but they must be based on available data. All 17 states with billing adjustment standards provide a similar explanation of how those adjustments should be calculated. The common approach requires meter readings be corrected for the period during which the inaccuracy was found to have occurred and the amount over- or undercharged shall be refunded or billed to the customer. Similar to Michigan, Minnesota, North Carolina, Oklahoma, and South Carolina allow utilities to estimate the amount of electricity consumed if a specific error level cannot be determined or in the case of failed readings. Examples of state billing adjustment calculations include:

- **Indiana**: "The amount of the charge to the customer shall be estimated on the basis of either an average bill as herein below described or separate bills individually adjusted for the percent of error. An average bill shall be calculated on the basis of kWh and/or demand units registered on the meter over corresponding periods either prior or subsequent to the period for which the meter is determined to be slow or stopped" (State of Indiana 2020).
- **Minnesota**: "Whenever any meter is found upon test to have an average error of more than 2 percent slow, the utility may charge for electricity consumed but not included in the bills previously rendered. The refund or charge for both fast and slow meters shall be based on corrected meter readings" (State of Minnesota 2009).

- **Texas**: "The charge for any period in which the meter was not in compliance with the accuracy standard shall be based on an estimate of consumption under conditions similar to the conditions when the meter was not registering accurately, during a prior or subsequent period for that location or a similar location, to the extent such information is available" (PUCT n.d.).
- **Washington**: "The utility must use the rates and rate schedule in effect during the billing period(s) covered by the corrected bill. A corrected bill may take the form of a newly issued bill or may be reflected as a line item adjustment on a subsequent monthly or bimonthly bill. When a corrected bill is issued, the utility must provide the following information on the corrected bill, in a bill insert, letter, or any combination of methods that clearly explains all the information required to be sent to the customer: (a) The reason for the bill correction; (b) A breakdown of the bill correction for each month included in the corrected bill; (c) The total amount of the bill correction that is due and payable; (d) The time period covered by the bill correction; and (e) When issuing a corrected bill for underbilling, an explanation of the availability of payment arrangements in accordance with WAC 480-100-138(1) payment arrangements" (State of Washington 2019).

Eligible Recipients

While all benchmarked states with billing adjustment standards apply these provisions to current customers, only Iowa, Minnesota, New Mexico, and Wisconsin state that utilities must issue refunds to previous customers who were impacted by meter reading errors. Generally, states allow up to three months for a customer to claim their refund and require utilities to mail notification to the last known address. Iowa requires that the refund due to a previous customer must exceed ten dollars for the utility to make notification efforts. Wisconsin and Minnesota both stipulate that refunds must exceed two dollars.

Exceptions

Several states allow for exceptions to billing adjustment standards if certain conditions are met. Washington allows utilities to choose not to issue a corrected bill if the underbilled amount is less than 50 dollars. New Mexico also allows utilities to establish a minimum threshold required for the issuance of a corrected bill for unregistered usage.

Part Four: Customer Relations

R 460.3408: Temporary Service; Cost of Installing and Removing Equipment Owned by Utility

Michigan Standard

Rule 408: "If the utility renders temporary service to a customer, it shall require that the customer bear the cost of installing and removing the utility-owned equipment in excess of any salvage realized" (MPSC n.d.b, 9).

Michigan's Rule 408 dictates that customers receiving temporary service from a utility are responsible for installation and removal costs of utility-owned equipment postsalvage.

Benchmarked State Standards

Seven of the states reviewed have a similar standard in place that explicitly describes a customer's payment obligation when a utility provides temporary service. These states are Connecticut, Iowa, Minnesota, New Mexico, Oklahoma, Oregon, and South Carolina. Examples of these service requirements include:

- **Connecticut**: "When the utility renders temporary or intermittent service to a customer, it may require that the customer bear all the cost of installing and removing the service in excess of any salvage realized" (State of Connecticut n.d.b).
- **Minnesota**: "When a utility renders a temporary service to a customer, it may require that the customer bear the cost of installing and removing the service in excess of any salvage realized. The utility may require the customer to make an advance payment sufficient to cover the estimated cost of service" (State of Minnesota 2009).
- **Oklahoma**: "Customers requiring temporary service shall pay installation and removal costs, less salvage value, of facilities installed by the utility to furnish temporary service to the customers" (State of Oklahoma 2019).
- **Oregon**: "Each energy or large telecommunications utility may render temporary service to a customer and may require the customer to bear all the cost of installing and removing the service in excess of any salvage realized" (State of Oregon n.d.).

Temporary service costs are also referenced in Kentucky, which allows utilities to assess turn-on charges for temporary service customers, and Texas, which allows utilities to require deposits from customers for the assumed risks of temporary service.

R 460.3409: Protection of Utility-owned Equipment on Customer's Premises

Michigan Standard

Rule 409: "(1) The customer shall use reasonable diligence to protect utility-owned equipment on the customer's premises and to prevent tampering or interference with the equipment. The utility may shut off service in accordance with applicable rules of the commission if the metering or wiring on the customer's premises is unsafe, or has been tampered with or altered in any manner that allows unmetered or improperly metered energy to be used.

(2) If a utility shuts off service for unauthorized use of service, then both of the following provisions apply:

a) The utility may bill the customer for the unmetered energy used and any damages that have been caused to utility-owned equipment.

b) The utility is not required to restore service until the customer does all of the following: (i) Makes reasonable arrangements for payment of the charges in subdivision (a) of this subrule. (ii) Agrees to pay the approved reconnection charges. (iii) Agrees to make provisions and pay charges for relocating utility-owned equipment or making other reasonable changes that may be requested by the utility to provide better protection for its equipment. (iv) Provides the utility with reasonable assurance of the customer's compliance with the utility's approved standard rules and regulations.

(3) Failure to comply with the terms of an agreement to restore service after service has been shut off pursuant to subrule (1) of this rule is cause to shut off service in accordance with the rules of the utility and the commission.

(4) If service is shut off pursuant to subrule (3) of this rule and the utility must incur extraordinary expenses to prevent the unauthorized restoration of service, the utility may bill the customer for the expenses, in addition to all other charges that may apply under this rule, and may require that the expenses and other charges be paid before restoring service. A reasonable effort must be made to notify the customer at the time of shutoff that additional charges may apply if an attempt is made to restore service that has been shut off.

(5) The customer of record who benefits from the unauthorized use is responsible for payment to the utility for the energy consumed.

(6) The utility may bill the customer for the reasonable actual cost of the tampering investigation" (MPSC n.d.b, 9–10).

Ensuring the protection of utility equipment is essential for utilities to ensure fair and accurate compensation. Rule 409 instructs customers to ensure the protection of utility-owned equipment and grants utilities the ability to shut off service in cases of unauthorized service, unsafe wiring, or tampering. The rule also details what steps customers are required to take before service can be restored and that customers may be responsible for costs related to the prevention of unauthorized service, unauthorized consumption, and any tampering investigations.

Benchmarked State Standards

The standards of many other states focus on a narrower set of topics than Michigan's Rule 409. Where Michigan's rule details a few reasons a utility may shut off customer service, what steps the customer must take to restore their service, and what costs may be incurred relating to service shutoff, other states primarily focus on why service may be disconnected and how they may do it. Of the states examined, 20 have standards addressing service disconnections—California, Connecticut, Illinois, Indiana, Iowa, Kentucky, Massachusetts, Minnesota, Missouri, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Texas, Washington, and Wisconsin.

Michigan's rules are similar to those of other states' regarding shutoffs due to evidence of tampering or unsafe conditions. Of the states examined, 14 have provisions allowing shutoffs due to unsafe conditions, and 13 allow a utility to shut off service if there is evidence of equipment tampering.

Michigan's rule also explicitly states what steps a customer needs to take in order to restore service, which primarily includes resolving outstanding payments and achieving compliance with utility standards. Similarly, five other states—Iowa, Kentucky, New Mexico, North Carolina, and Wisconsin—have standards dictating that customers must be given the opportunity to remedy their violations, pay debts, and achieve compliance before having their service shut off.

None of the other states reviewed have standards that include all of the provisions provided in Michigan's rule. Other states clearly outline the instances in which utilities can shut off service to customers, noting when they are and are not required to provide advanced notice of shutoff to customers, but no other states explicitly describe a customer's responsibility to protect utility-owned equipment, nor do they explain that utilities can charge customers for the cost of preventing unauthorized service or conducting an investigation into tampering. The most similar rule is from Ohio, where utilities must submit plans to the Service Monitoring and Enforcement Department of the Ohio Public Utilities Commission.

Standards in other states vary based on when utilities must provide a shutoff notice, when they are not required to provide notice, what reasons are valid and invalid for discontinuing service, and how explicit standards are regarding notices and days when service can be shut off.

Valid Reasons for Shutoff

Of the states examined, 19 listed the various reasons that a utility may discontinue service to a customer; California, however, did not explicitly state the reasons for which a utility may discontinue a customer's service, but disconnections must still happen in accordance with the provider's protocols, and shutoffs can only be executed by the providers directly.

Reasons that utilities are permitted to shut off a customer's service are diverse, ranging from financial to the behavioral. Reasons seen in examined states include delinquency of payment for electric service; noncompliance with provider; local, state, or national policies; failure to pay deposits; unauthorized consumption; tampering with equipment; safety concerns; inaccessible meters; superseding orders by a government body; customer request; abandonment; a customer moving to a new location; and misrepresentation on or failure to file a service application. The number of acceptable reasons for a service shutoff varies greatly between states. For instance, in Connecticut and New York, the only listed reason service may be discontinued is due to nonpayment of services present on tariffs, while New Jersey and Oklahoma each list upward of 12 reasons that a provider may shut off a resident's service.

Invalid Reasons for Shutoff

While nearly every examined state had standards detailing reasons a customer's service could be shut off, fewer explicitly listed reasons that are invalid for discontinuing service. The states that list invalid reasons for shutoffs include Illinois, Indiana, Kentucky, Massachusetts, New York, Ohio, and . Invalid reasons for discontinuing service include any nonpayment resulting from flawed disputes and delinquency for nonutility, nontariff services, such as appliance purchases. Massachusetts, New York, and Kentucky all forbid shutoffs when a serious illness or medical condition is present in the residence, and Massachusetts has special provisions to ensure that service is not shut off to residences with elderly or infant residents present.

Indiana is unique in that customers can prevent their service from being shut off if they prove that they are unable to pay the full amount due. Customers in these scenarios can prevent shutoffs by paying a portion of their bill, entering into payment plans, agreeing to pay future bills, and successfully completing similar payment agreements with the utility in the past year.

Shutoff with Notice

Of the 19 states that identified potential reasons for discontinuing service, 15 also listed when utilities must provide notice to customers prior to shutting off service. For example, North Carolina specifies that as little as 24 hours' notice is required when discontinuing service, whereas New Mexico requires at least ten days' written notice prior to a shutoff. Iowa, Massachusetts, Ohio, and Pennsylvania provide detail as to what constitutes a notice and what information that notice must contain regarding electric service shutoffs. Five of the 19 states with notice requirements—Iowa, Kentucky, New Mexico, North Carolina, and Wisconsin—also explicitly state that customers must have a specific amount of time before their service is shut off to fix the issues leading to the shutoff. Three states—Connecticut, Illinois, and Oregon—do not specify whether utilities must give notice before shutting off a customer's service, while Ohio expects utilities to issue a default notice to be given before shutting customers' service off, but only explicitly lists scenarios under which notice procedures can be foregone.

Shutoff Without Notice

In some instances, notice before discontinuing service is not required. Eleven states list scenarios when utilities are not required to provide notice, the most common of which is when service presents a safety risk to consumers and/or producers of electricity. Other reasons that utilities may not have to provide customers with notice include evidence of tampering with equipment, unauthorized consumption, and superseding orders by government bodies. Six states do not outline when utilities can forego notice requirements before shutting off service—Illinois, Massachusetts, New Jersey, New York, Oklahoma, Wisconsin. Oklahoma and Minnesota do not specifically outline when utilities can forego notifying customers, but rather provide a process for utilities to receive waivers for notice requirements.

Dates and Times for Shutoff

Massachusetts, New Jersey, New York, and Pennsylvania provide details as to the dates and times utilities are allowed to shut off a customer's service. For these states, shutoffs are restricted to standard business hours, Monday through Friday, and not on certain holidays or days surrounding certain holidays like Christmas and New Year's Eve.

R 460.3410: Extension of Facilities Plan

Michigan Standard

Rule 410: "Each utility shall develop a plan, approved by the commission, for the extensions of facilities where the investment is in excess of that included in the regular rates for service and for which the customer is required to pay all or part of the cost" (MPSC n.d.b, 10).

Michigan's Rule 410 states that utilities must create plans for facility extensions where required investment would exceed regular service rates and when customers would be required to pay all or some of the costs. These commission must approve these plans.

Benchmarked State Standards

Six of the states reviewed—Minnesota, Missouri, New Mexico, North Carolina, Pennsylvania, and Washington—have a similar standard that requires utilities to develop plans for facility extensions when investment from regular rates does not cover costs and when customers will be responsible for at least some of the cost. Examples of these service requirements include:

- **Minnesota**: Utilities file their service extension plans in cases when additional costs will be incurred that were not considered in the utility's existing service rates (State of Minnesota 2009).
- **Pennsylvania**: The state requires utilities to file their plan with the commission. The rules governing these plans are more detailed than other states with requirements for utilities to specify the maximum extension distance for single-phase line extensions and the conditions under which it will make the line extensions beyond this distance. Utilities' plans must also include how they will "construct, operate, and maintain single-phase and polyphase line extensions required to serve customers who will guarantee revenues in an amount sufficient to comply with the requirements set forth in the rule, and a statement of the terms upon which the guarantee shall be reduced to the minimum charges as provided in the rate schedules applicable to each class of service supplied" (Commonwealth of Pennsylvania 2019).

Other states, such as Oklahoma and Wisconsin, provide robust frameworks for facility extension cost allocations, but do not require extension plans to be filed with the public utility regulating authority. Connecticut, Illinois, Kentucky, New Jersey, and New York require that extension costs be included in tariffs and updated periodically but do not require extension plans. Indiana, Iowa, Ohio, and Texas are very specific regarding facility extensions in that they specifically dictate not only how extensions will be financed, but also how quickly utilities must complete requested extensions and when utilities must notify customers about extension requests.

R 460.3411: Extension of Electric Service in Areas Served by Two or More Utilities

Michigan Standard

Rule 411: "(1) As used in this rule:

a) "Customer" means the buildings and facilities served rather than the individual, association, partnership, or corporation served.

b) "Distances" means measurements which are determined by direct measurement from the closest point of a utility's existing distribution facilities to the customer's meter location and which are not determined by the circuit feet involved in any extension.

c) "Distribution facilities" means single-phase, V-phase, and three-phase facilities and does not include service drops.

(2) Existing customers shall not transfer from one utility to another.

(3) Prospective customers for single-phase service that are located within 300 feet of the distribution facilities of two or more utilities shall have the service of their choice.

(4) Prospective customers for single-phase service that are located more than 300 feet, but within 2,640 feet, from the distribution facilities of one or more utilities shall be served by the closest utility.

(5) Prospective customers for single-phase service that are located more than 2,640 feet from the distribution facilities of any utility shall have the service of their choice, subject to the provisions of subrule (10) of this rule.

(6) Prospective customers for three-phase service that are located within 300 feet of the three-phase distribution facilities of two or more utilities shall have the service of their choice.

(7) Prospective customers for three-phase service that are located more than 300 feet, but within 2,640 feet, from the three-phase distribution facilities of one or more utilities shall be served by the closest utility.

(8) Prospective customers for three-phase service that are located more than 2,640 feet from the three-phase distribution facilities of any utility shall have the service of their choice, subject to the provisions of subrule (10) of this rule.

(9) Regardless of any other provisions in these rules, a prospective industrial customer, as defined under the industrial classification manual, division D, manufacturing, for three-phase service that will have a connected load of more than 500 kilowatts shall have its choice of service from any nearby utility that is willing to construct the necessary facilities. The facilities that are constructed to serve an industrial customer that would otherwise have been served by another utility shall not qualify as a measuring point in determining which utility will serve new customers in the future.

(10) The extension of distribution facilities, except as provided in subrules (3), (4), (6), and (7) of this rule, where an extension will be located within one mile of another utility's distribution facilities, shall not be made by a utility without first giving the commission and any affected utility ten days' notice of its intention by submitting a map showing the location of the proposed new distribution facilities, the

location of the prospective customers, and the location of the facilities of any other utility in the area. If no objections to the proposed extension of distribution facilities are received by the commission within the ten-day notice period, the utility may proceed to construct the facilities. If objections are received, the determination of which utility will extend service may be made the subject of a public hearing and a determination by the commission, upon proper application by any affected party.

(11) The first utility serving a customer pursuant to these rules is entitled to serve the entire electric load on the premises of that customer even if another utility is closer to a portion of the customer's load.

(12) A utility may waive its rights to serve a customer or group of customers if another utility is willing and able to provide the required service and if the commission is notified and has no objections.

(13) Nothing contained in these rules shall be construed to circumvent the requirements of Act No. 69 of the Public Acts of 1929, as amended, being S460.501 et seq. of the Michigan Compiled Laws, or to authorize a utility to extend its service into a municipality then being served by another utility without complying with the provisions of Act No. 69 of the Public Acts of 1929, as amended.

(14) Regardless of other provisions of this rule, except subrule (9), a utility shall not extend service to a new customer in a manner that will duplicate the existing electric distribution facilities of another utility, except where both utilities are within 300 feet of the prospective customer. Three-phase service does not duplicate single-phase service when extended to serve a three-phase customer.

(15) The first utility to serve a customer in a new subdivision under the other provisions of this rule has the right to serve the entire subdivision. In extending service to reach the subdivision, the utility shall not duplicate the existing facilities of another utility" (MPSC n.d.b, 10–11).

The extension of utility service can be complicated, particularly when a utility's extension would enter the service area of another utility. Rule 411 outlines how utility service is coordinated based on customer need (e.g., single-phase or three-phase service, customer class, etc.) and distance from utility facilities. This rule also details that the providing utility is entitled to service the entire electric load of a customer (and an entire subdivision if they are the first provider), that the utilities must still abide by Act 69 of the Public Acts of 1929 of the MCL. This act defines the certificate of convenience and necessity that is the basis for state regulators' review to ensure costs incurred by utilities are necessary. Rule 411 also defines when utilities can waive their service rights if desired. The rule also explicitly forbids the duplication of existing utility facilities.

Benchmarked State Standards

None of the other states reviewed have extension coordination standards as comprehensive as Michigan's Rule 411. While many states have standards regarding the financing and definition of service extensions, fewer have standards that reference the coordination of service extensions in relation to other utilities' service areas, how much of a customer's (or subdivision's) load the utility must service, or how service extensions apply to municipalities. The states with standards most closely matching Michigan's are Minnesota and Louisiana. In addition to considering a similar set of factors when determining if a customer can receive a service extension, both of these states also explicitly forbid, or discourage, duplication of service. Three states—Illinois, New Jersey, and South Carolina—require utilities to file to receive approval from the commission to extend service, but the factors that the commission will consider are not explicitly listed in their standards.

Minnesota

Minnesota standards, like Michigan, consider customer load, proximity, and customer preference in determining whether a utility extension is warranted. However, Minnesota relies much more heavily on commission review of potential service extensions. The commission reviews potential cases of service extensions and, in addition to factors like customer load, proximity, and preference, considers supply availability and potential system improvements when deciding whether to approve an extension. The factors that are similar between Minnesota and Michigan—load, proximity, and preference—are less standardized in Minnesota than they are in Michigan. While prospective customer load needs to exceed 2,000 kW, no exact distance away from or within utility service areas is mentioned in Minnesota's standards, nor is customer preference the deciding factor for service as in some cases in Michigan. Minnesota's standards also describe the service responsibilities of municipalities as they expand their boundaries, as well as how utilities serving municipalities are to coordinate service territories if they are not the sole provider for customers in the municipality.

Louisiana

Louisiana's standards are dictated in a general order from the Louisiana Public Service Commission. Like Michigan, Louisiana explicitly forbids a utility from extending service to a customer already receiving service, or within 300 feet of an existing line. Unlike Michigan, Louisiana's standards state that municipalities can extend service to unserved customers up to one mile outside of their service area, provided the customer's peak load is more than 50 megawatts. Louisiana's order also has provisions that exempt municipalities from some of these standards if they have a municipality-wide agreement with a single service provider. Additionally, like Michigan's Rule 411, Louisiana's general order dictates that electric public utilities should discourage paralleling and duplication of service lines or extensions. Louisiana's order also explicitly states that regular construction operations, like facility replacement, do not invalidate a utility's right to serve.

Service Obligations

While Michigan is the only state with standards explicitly discussing the coordination of service extensions, six of the states examined—Connecticut, Kentucky, New Jersey, New York, Ohio, and Pennsylvania—have standards in place explicitly stating a utility's obligation to extend service to all eligible applicants in their service territory. How close potential customers in various states must be to existing distribution lines and minimum potential customer load are outlined in Michigan's Rule 410.

Part Five: Engineering

R 460.3501: Electric Plant; Construction, Installation, Maintenance, and Operation Pursuant to Good Engineering Practice Required

Michigan Standard

Rule 501: "The electric plant of the utility shall be constructed, installed, maintained, and operated pursuant to accepted good engineering practice in the electric industry to ensure, as far as reasonably possible, continuity of service, uniformity in the quality of service furnished, and the safety of persons and property" (MPSC n.d.b, 12).

Rule 501 establishes that engineering best practices should be used in the construction, installation, maintenance, and operation of utilities' electric plants.

Benchmarked State Standards

Of the 25 states that PSC reviewed, only four—Iowa, Kentucky, New Mexico, and South Carolina—had a standard similar to Michigan's. Similar to Michigan's Rule 501, these four states establish a broad requirement for how utilities design, build, and operate power plants. A common theme of these standards is the goal of maintaining quality service and safety. More specifically, these rules include language relating to good engineering practice. These rules are as follows:

- **Iowa:** "The electric plant of the utility shall be constructed, installed, maintained, and operated in accordance with accepted good engineering practice in the electric industry to assure, as far as reasonably possible, continuity of service, uniformity in the quality of service furnished, and the safety of persons and property" (State of Iowa 2020).
- **Kentucky:** "A utility shall construct and maintain its plant and facilities in accordance with good accepted engineering practices" (State of Kentucky 2019).
- **New Mexico:** "The electric plant of the utility shall be constructed, installed, maintained, and operated in accordance with accepted good engineering practice in the electric industry to assure, as far as reasonably possible, continuity of service, uniformity in the quality of service furnished, and the safety of persons and property" (State of New Mexico n.d.).
- **South Carolina:** "The electric plant of an electrical utility shall be constructed, installed, maintained and operated in accordance with good engineering practice to ensure, as far as reasonably possible, continuity of service, uniformity in the quality of service, and the safety of persons and property" (State of South Carolina 2019).

Additionally, while New Jersey's standard does not explicitly state that utilities should use the language of good engineering practice, it does set construction, installation, and maintenance standards for electric plant.

Other State Standard Variations

PSC also found that five states had rules that set standards for a type of plant (generation facilities, overhead and underground lines, and transformers), a type of utility service activity (construction, installation, maintenance, operation) and/or both.

Standards for a Particular Plant

Illinois sets specific standards for the design, construction, and maintenance of electric supply (and communication) lines and equipment but no other utility plant. Oregon and Indiana's rules similarly focus on lines.

As for California, its rule solely focuses on standards for electric generation facilities. California, broadly, states that it will establish and enforce standards for the maintenance and operation of electric generating facilities owned by electrical corporation. It also explains that it will enforce protocols for coordinating planned outages.

Standard for a Particular Utility Service Activity

North Carolina's standards establish the responsibility of each utility to maintain their plants, distribution systems, and facilities for the purpose of providing safe and adequate service.

R 460.3502: Standards of Good Practice; Adoption by Reference

Michigan Standard

> **Rule 502:** "In the absence of specific rules of the commission, a utility shall apply the standards of accepted good practice that are adopted by reference in R 460.811 et seq." (MPSC n.d.b, 12).

Rule 502 requires utilities to employ standards of good practice in cases where the MPSC has not established specific rules and refers to national standards adopted in Michigan's rule 813. This rule contains the adoption by reference parts one, two, three, and nine of the NESC 2017 edition (ANSI Standard C2-2017). Additional standards have been adopted by reference in Michigan's *Technical Standards for Electric Service* Rule 308 (discussed earlier in this report).

Benchmarked State Standards

Results of a nationwide survey of state adoption of the 2017 NESC indicate that 29 states have adopted the most recent version of the NESC. Of these 29 states, 17 automatically adopt the most recent version, which is released every five years. Several states have adopted older versions (IEEE n.d.).

EXHIBIT 17. NESC Adoption

NESC Version	Number of States	States
1997	1	**Kansas**
2002	2	Hawaii, **Illinois**
2007	2	Arizona, **Indiana**
2012	11	Colorado, Delaware, Idaho, New Hampshire, **New Jersey, Oklahoma, Ohio, Texas, Virginia, Washington, Wisconsin**
2017	29	Alabama*, Alaska, Arkansas*, **Connecticut*,** Florida^, **Iowa, Kentucky*,** Maine*, Maryland*, **Michigan, Minnesota*,** Mississippi*, **Missouri,** Montana*, Nebraska, Nevada^, **New Mexico*, New York*, North Carolina*,** North Dakota, **Oregon, Pennsylvania,** Rhode Island*, **South Carolina*,** Tennessee, Utah, Vermont, West Virginia*, Wyoming*
None adopted	6	**California,** District of Columbia, **Georgia, Louisiana, Massachusetts,** South Dakota

States included in PSC's Standards Benchmarking Study
* Automatically adopts newest version of NESC
^ Adopts the newest version of NESC following review
Source: IEEE 2019

R 460.3503: Utility Plant Capacity

Michigan Standard

Rule 503: "The electric capacity regularly available from all sources shall be large enough to meet all normal demands for service and to provide a reasonable reserve for emergencies" (MPSC n.d.b, 12).

Benchmarked State Standards

Four of the 25 states that PSC reviewed—California, Iowa, New Mexico, and Oklahoma—had similar capacity standards as those established by Michigan's Rule 503. Each emphasizes having enough capacity from a variety of sources to meet normal demands and for energy emergencies.

- **California**: Its standard requires that state regulators ensure adequate facilities are available to maintain the reliability of the electric supply, maintain open competition, and avoid an overconcentration of market power. "In order to determine whether the facility needs to remain available and operational, the commission shall utilize standards that are no less stringent than the Western Electricity Coordinating Council and North American Electric Reliability Council standards for planning reserve criteria" (State of California n.d.).
- **Iowa**: "Adequacy of supply and reliability of service. The generating capacity of the utility's plant, supplemented by the electric power regularly available from other sources, must be sufficiently large to meet all normal demands for service and provide a reasonable reserve for emergencies. In appraising adequacy of supply the board will segregate electric utilities into two classes viz., those having high capacity transmission interconnections with other electrical utilities and those which lack

such interconnection and are therefore completely dependent upon the firm generating capacity of the utility's own generating facilities"(State of Iowa 2020).

- **New Mexico**: "The generating capacity of the utility's plant supplemented by the electric power regularly available from other sources must be sufficiently large so as to meet all normal demands for service and provide a reasonable reserve for emergencies" (State of New Mexico n.d.).
- **Oklahoma**: "The generating capacity of a utility's plant, supplemented by the electric power regularly available from other sources or firm contracts for electric power by a utility which operates no generating plants, must be sufficiently large to meet all normal demands for service and provide a reasonable reserve for emergencies" (State of Oklahoma 2019).

Iowa's Supply Evaluation

Iowa's capacity requirement goes further by including methodology on how the Iowa Utilities Board (IUB) will determine the adequacy of each utility's capacity. To make determinations on the adequacy of capacity supply, utilities are divided into two classes: utilities with high-capacity transmission interconnections with other electrical utilities and those which lack these connections. The IUB uses the following two methods of evaluation:

- **"In the case of utilities having interconnecting ties with other utilities,** the board will appraise the adequacy of supply, taking appropriate notice of the utility's recent record of any widespread service interruptions and any capacity shortages along with the consideration of the supply regularly available from other sources, the normal demands, and the required reserve for emergencies.
- **In the case of noninterconnected utilities,** the board will give attention to the maximum total coincident customer demand which could be satisfied without the use of a single element of generating plant equipment, the disability of which would produce the greatest reduction in total net generating capacity and also give attention to the normal demands for service and to the reasonable reserve for emergencies" (State of Iowa 2020).

Other State Capacity-related Rules

Pennsylvania and Texas's rules require utilities to submit an annual resource planning report that provides a description of existing generating capability, being recovered by the electric distribution company in a competitive transition charge, and planned generating capability changes. Texas also requires utilities to file generating capacity reports annually with the following information:

- Generating unit capacity
- Total capacity of generating facilities that are connected with a transmission or distribution system
- Total capacity of generating facilities used to generate electricity for consumption by the person owning or controlling the facility
- Total capacity of generating facilities that will be connected with a transmission or distribution system and operating within 12 months
- Total affiliate installed generation capacity
- Total amount of capacity available for sale to others
- Total amount of capacity under contract to others
- Total amount of capacity dedicated to its own use

Massachusetts and New York's rules declare its unique state system operators are responsible for managing utilities' electric reliability and capacity requirements.

R 460.3504: Electric Plant Inspection Program

Michigan Standard

> **Rule 504:** "Each utility shall adopt a program of inspection of its electric plant to ensure safe and reliable operation. The frequency of the various inspections shall be based on the utility's experience and accepted good practice. Each utility shall keep sufficient records to verify compliance with its inspection program" (MPSC n.d.b, 12).

Rule 504 requires utilities to institute an inspection program for their electric plant while also maintaining adequate records of the program for compliance purposes. For the purposes of these standards, "electric plant" is defined as " all real estate, fixtures, or property that is owned, controlled, operated, or managed in connection with, or to facilitate the production, transmission, and delivery of, electric energy" (MPSC n.d.b). Inspections should be completed based on the utility's previous experience and best practices.

Benchmarked State Standards

Nine of the 25 reviewed states—Kentucky, Missouri, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, South Carolina, and Wisconsin—had standards similar to Michigan's Rule 504 in their content or intent. Each of these state's rules provides a degree of guidance as it relates to the utilities' inspection programs and the frequency of inspections. Four state's had rules that were nearly identical to Michigan's Rule 504.

- **North Carolina:** Each utility shall maintain its plant, distribution system, and facilities at all times in proper condition for use in rendering safe and adequate service. Each utility shall, upon request of the Commission or the Public Staff, file with it a statement regarding the condition and adequacy of its plant, equipment, facilities, and service in such form as may be required by the Commission (NCUC 2019).

Kentucky, Missouri, New Jersey, and Ohio provide additional guidance to utilities on how their electric plant inspection programs should be conducted.

- **Kentucky**: Establishes inspection frequencies for specific aspects of electric plants requiring that inspections shall be made at least every six months or as often as necessary. These inspection requirements apply to the following elements of electric plants:
    - Unmanned production facilities, including peaking units not on standby status, and all monitoring devices, for evidence of abnormality
    - Transmission switching stations if the primary voltage is 69 kilovolt (kV) or greater, for damage to or deterioration of components including structures, fences, gauges, and monitoring devices
    - Underground network transformers and network protectors in vaults located in buildings or under sidewalks, for leaks, condition of case, connections, temperature, and overloading

    - Electric lines operating at 69 kV or greater, including insulators, conductors, and supporting facilities, for damage, deterioration, and vegetation management consistent with the utility's vegetation management practices (State of Kentucky 2019)
- **Missouri:** Assigns maximum intervals for plant inspections (State of Missouri 2019).
- **New Jersey**: Directly identifies for utilities what they should be looking for when inspecting their electric plant. This standard requires inspection and maintenance programs be established based on industry codes, national industry practices, manufacturer's recommendations, and sound engineering judgment. These plans must also be focused on mitigating interruptions that have the greatest impact on reliability (e.g., equipment failures, vegetation, and animals) (State of New Jersey n.d.).
- **Ohio:** Each electric utility and transmission owner shall, at a minimum, inspect its electric transmission and distribution facilities to maintain quality, safe, and reliable service on the following scheduled basis:
    - Distribution: All distribution circuits and equipment shall be inspected at least once every five years.
    - Transmission: All transmission circuits and equipment shall be inspected at least once every year.
    - Substations: All transmission and distribution substations and equipment shall be inspected 12 times annually, with no inspection interval exceeding 40 calendar days between inspections (State of Ohio n.d.).

Iowa's inspection standard does not apply to all elements of utilities' electric plants. It focuses primarily on their electric supply lines, substations, and poles outlining requirements what should be included in their inspection plans and establishing inspection timing. Some of those elements include:

- A listing of all counties where a utility has electric supply lines.
- District or regional offices responsible for implementing a portion of the plan, their addresses, and a description of the territory for which they are responsible.
- A schedule for the periodic inspection of the various units of the utility's electric plant. This period shall be based on accepted practices in the industry but shall not exceed ten years for any given line or piece of equipment. Lines operated at 34.5 kV or above shall be inspected at least annually for damage and to determine the condition of the overhead line insulators.
- A complete listing of all categories of items to be checked during an inspection (State of Iowa 2020).

In addition to inspection plan elements, the rule also directs utilities to maintain sufficient records to be able to demonstrate compliance. It is also important to note that this rule discusses vegetation management as part of this inspection plan.

R 460.3505: Utility Line Clearance Program

Michigan Standard

> **Rule 505:** "Each utility shall adopt a program of maintaining adequate line clearance through the use of industry-recognized guidelines. A line clearance program shall recognize the national electric safety code standards that are adopted by reference in R 460.811 et seq. The program shall include tree trimming" (MPSC n.d.b, 12).

Rule 505 directs utilities to adopt a line clearance program that adequately maintains line clearance and safety while following industry-recognized standards.

Benchmarked State Standards

Of the 25 states that PSC reviewed, 13 have a standard requiring utilities to have a line clearance or vegetation management program—California, Connecticut, Illinois, Iowa, Missouri, New Jersey, Ohio, Oklahoma, Oregon, Pennsylvania, Texas, Washington, and Wisconsin. While all these state standards address line clearance, PSC found variations in the levels of detail and guidance given to the utilities. Missouri, New Jersey, Oregon, and Texas have the most prescriptive standards out of the 12 identified states. For example, Texas's rule requires utilities to include the following elements in their vegetation management plan:

- Tree pruning methodology, trimming clearances, and scheduling approach
- Methods used to mitigate threats posed by vegetation to applicable distribution assets
- Tree risk management program
- Participation in continuing education by the utility's internal vegetation management personnel
- Estimate of the miles of circuits along which vegetation is to be trimmed or method for planning trimming work for the coming year
- Plan to remediate vegetation-caused issues on the worst vegetation-caused performing feeder list for the preceding calendar year's System Average Interruption Duration Index and System Average Interruption Frequency Index
- Customer education, notification, and outreach practices related to vegetation management (PUCT n.d.)

Oklahoma's vegetation management plan standard does not provide the same level of detail and guidance as Texas, but it does offer similar material.

- Vegetation management means all activities associated with the trimming, removal, or control of plant material in the proximity of energized electric utility conductors and equipment. As part of its reliability program, each utility shall prepare an annual vegetation management plan and submit this plan to the commission for review prior to implementation. This plan shall be an integrated part of the utility's reliability program and shall include:
  - Definitions of activities
  - Calendar of activities
  - Implementation plan

    - Criteria to assess results of the vegetation management plan
    - The name and contact information of a company representative who is knowledgeable about the plan, its implementation, and potential results
- Each utility shall, at a minimum, perform vegetation management on a four-year cycle, unless needed otherwise or unless otherwise ordered by the commission. The utility may request an exemption from this requirement by submitting an alternative(s) to the four-year cycle to the commission in its annual vegetation management plan for review and hearing.
- Each utility shall track and record all vegetation management costs for easy identification upon commission review (State of Oklahoma 2019).

National Standards

In terms of states that reference national standards for vegetation management or line-clearing programs, as is the case in Michigan, PSC found there were only six states using the NESC—Missouri, Oregon, Pennsylvania, Texas, Washington, and Wisconsin.

Part Six: Metering Equipment Inspections and Tests

R 460.3601: Customer-requested Meter Tests

Michigan Standard

Rule 601: "(1) Upon request by a customer to a utility, a utility shall make a test of the meter serving the customer. Any charge to the customer shall conform with the utility's filed and approved rates and rules. Provided, however, that the utility need not make more than one test in any 12-month period.

(2) The customer, or his or her representative, may be present when his or her meter is tested.

(3) A report of the results of the test shall be made to the customer within a reasonable time after the completion of the test, and a record of the report, together with a complete record of each test, shall be kept on file at the office of the utility" (MPSC n.d.b, 13).

The accuracy of a customer's meter is central to ensuring customers are being charged fairly for their electric consumption. Michigan allows all customers to request one test per 12-month period. The customer can be present during the meter test and will receive a report detailing test results.

Benchmarked State Standards

Of the benchmarked states, 22 have a standard that outlines customers' ability to request a meter test as well as utility practices for conducting these tests. There are three main meter testing elements included in all state standards—the time frame for reporting test results, the frequency of customer-requested testing, and the ability to witness a meter test. All of the states that have customer-request metering provisions enable the customer or a representative to witness the test. Between these states there is variation in the time frame that a completed report must be provided to a customer as well as in the frequency with which meter tests can be requested without incurring additional costs.

Connecticut, Kentucky, Missouri, New Jersey, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina, Texas, Wisconsin do not specify how long a utility has to provide a report of the meter test results to customers, though some standards require completion in a reasonable time frame. Six states—Indiana, Iowa, Minnesota, Ohio, Oklahoma, and Virginia—require test records be provided within ten days of the test's completion. Only Washington and Illinois have longer specified time frames for the provision of reports—20 and 30 days, respectively.

The most common standard for the frequency of customer-requested meter tests is one test during a 12-month period; however, several states have standards that dictate 18-, 24-, and 36-month periods between customer-requested meter tests. Ohio has the longest period between free meter tests at 36 months, Wisconsin and Virginia's standards allow one test per a 24-month period, and both New Mexico and Iowa allow one test within an 18-month period (State of Ohio n.d.; State of Wisconsin 2019; Commonwealth of Virginia n.d.; State of New Mexico n.d.; State of Iowa 2020).

Fewer states have requirements that prescribe the amount of time from when a test is requested until the test is completed. Ohio and New York both require tests to be completed within 30 days of a request.

New York requires utilities to respond to customer requests within one business day, schedule tests within five business days, and complete tests within 30 days.

R 460.3602: Meter and Associated Device Inspections and Tests; Certification of Accuracy

Michigan Standard

Rule 602: "Every meter shall be inspected and tested, and associated device(s) shall be inspected, in the meter shop of the utility, or a meter testing facility certified by the utility, before being placed in service. The accuracy of each meter shall be certified to be within the tolerances permitted by these rules, except that the utility may rely on the certification of accuracy by the manufacturer on all new meters" (MPSC n.d.b, 13).

Michigan's Rule 602 requires all meters to be tested and certified before being placed in service.

Benchmarked State Standards

Standards for meter testing prior to a meter's installation are common in Connecticut, Indiana, Illinois, Iowa, Missouri, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Texas, and Washington. These standards only exhibited slight variations from state to state. The largest degree of variation was whether states included other elements of meter testing in the same standard as the requirement to inspect meters prior to installation. Two examples of these standards are:

- **Ohio:** "The electric utility's meters shall be installed and removed by the electric utility's personnel or authorized agent. Before initial service to a service location is energized, the electric utility shall verify that the installation of the meter base and associated equipment has either been inspected and approved by the local inspection authority or, in any area where there is no local inspection authority, has been inspected by a licensed electrician" (State of Ohio n.d.).
- **New Jersey:** "A utility shall ensure that its meter testing equipment is tested and either sealed or certified in accordance with this section at each of the following events or time intervals:
  - Each time the equipment is moved, except if the equipment is portable meter testing equipment
  - Each time the security seal on the equipment is broken
  - Each time the equipment is cleaned, handled or maintained in any way that could affect its accuracy" (State of New Jersey n.d.)

Three additional states referenced meter testing standards but did not explicitly require meter testing prior to installation.

- **California:** Allows utilities to establish standards for meter testing but allows oversight of these standards by the state public utility commission.
- **South Carolina**: Requires all meters to be kept within the degree of accuracy defined by the state utility commission but does not specifically reference testing before installation.

- **Virginia:** Provides standards for submeter testing, but there are no standards for electric meters overall.

R 460.3603: Meters with Transformers; Postinstallation Inspection; Exception

Michigan Standard

Rule 603: "Meters with associated instrument transformers and phase-shifting transformers shall be inspected to determine the proper operation and wiring connections. Inspections shall be made within 60 days after installation by a qualified person who, when possible, should be someone other than the original installer. All self-contained, socket-type meters are excluded from post-installation inspections, except that the original installation shall be inspected when the meter is installed" (MPSC n.d.b, 13).

Michigan's Rule 603 requires inspection of meters with instrument and phase-shifting transformers after installation.

Benchmarked State Standards

Only ten of the states included in this analysis—California, Connecticut, Illinois, Indiana, Iowa, New Mexico, Pennsylvania, Oklahoma, Washington, and Wisconsin—have a standard covering the inspection of meters with associated transformers; however, fewer states prescribe the time period in which postinstallation tests must be completed. In the case of Wisconsin, Pennsylvania, and Indiana, meters and associated equipment must be tested when placed into service. Illinois provides up to 90 days for inspection postinstallation, and Iowa and New Mexico incorporate standards by reference to ANSI/IEEE Standard C57.13.1-2006 and C57.13.3-2005, which specify requirements for instrument transformers.

Two of the standards reviewed exhibit similarities with Michigan, but overall Michigan's standard is more prescriptive than other standards examined, as it details the time frame for postinstallation testing. Examples of similarly robust standards include:

- **Oklahoma**: "Meters installed with instrument transformers shall be tested on a 100 percent basis and adjusted to conform to the accuracy requirement outlined in this chapter prior to installation. In addition, a complete inspection shall be made of the wiring after installation to assure proper connections for metering"(State of Oklahoma 2019).
- **Washington**: "Meters used in conjunction with instrument transformers must be adjusted so that the overall accuracy of the meter installation (including both meter and instrument transformers) will meet the requirements specified in . . . accuracy requirements for electric meters. Instrument transformers may be tested with the meter with which they are associated, or separately. Except as provided in these rules, if transformers are tested separately, meters must also be tested to assure that the overall installation meets the prescribed accuracy requirements" (State of Washington 2019).

Another common approach related to meter testing and inspection is that taken by North Carolina and South Carolina, which both require periodic testing and inspection of meters and associated equipment. However, their standards do not explicitly identify transformers as part of this equipment. These standards have broader requirements for all meters to be tested according to national standards or other procedures established by state regulators.

R 460.3604: Meters and Associated Devices; Removal Tests

Michigan Standard

Rule 604. All meters and associated devices shall be tested after they are removed from service unless they are retired because of obsolescence.

Benchmarked State Standards

Only six out of the 25 states included in this analysis have a standard requiring testing of meters removed from service. Common practice is for meters to be tested before they are placed into service and periodically thereafter (see Rule 603). States that require testing upon removal include Indiana, New Mexico, Oregon, Pennsylvania, Texas, and Wisconsin, and their standards are provided below:

- **Indiana**: "Service watt-hour meters; inspection and repair; installation tests and adjustments. (b) All meters removed from service shall be carefully inspected for any possible causes of faulty operation that may have developed in use, cleaned and repaired, as necessary, before being tested and adjusted to the accuracy conditions prescribed in section" (State of Indiana 2020).
- **New Mexico**: "All instrument transformers shall be tested in accordance with the applicable procedures of American standard requirements, terminology and test code for instrument transformers, ANSI standard C-57.13: (1) when first received except in cases where a certificate of test is furnished by the manufacturer; (2) when removed from service if there is subsequently found to be visual evidence of damage; (3) upon complaint; (4) while still in service if there is visual evidence of damage; and (5) whenever an approved check, such as the variable burden method in the case of current transformers, made whenever the meter was tested indicated that a quantitative test is required" (State of New Mexico n.d.).
- **Oregon**: "New meters, repaired meters, and meters that have been removed from service shall be correct to within 2 percent fast or slow before being installed or reinstalled" (State of Oregon n.d.).
- **Pennsylvania**: "A service watt-hour meter which is removed from service shall be tested for ''as found" registration accuracy" (Commonwealth of Pennsylvania 2019).
- **Texas**: "No permanently installed meter shall be placed in service unless its accuracy has been established. If any permanently installed meter is removed from actual service and replaced by another meter for any purpose, it shall be properly tested and adjusted before being placed back in service unless such meter is monitored by a test program approved by the commission" (PUCT n.d.).
- **Wisconsin**: Requires the following meter types be tested when removed from service:
  - "PSC 113.0911: Testing of self-contained, single-phase meters and three-wire network meters at fixed periodic intervals
  - PSC 113.0912: Testing of self-contained polyphase meters
  - PSC 113.0913: Testing of meters used with instrument transformers on single-phase service

- PSC 113.0914: Testing of polyphase electromechanical and completely solid-state electronic meters used with instrument transformers at fixed periodic intervals
- PSC 113.0916: Testing of instrument transformers." (State of Wisconsin 2019)

R 460.3605: Metering Electrical Quantities

Michigan Standard

Rule 605: "(1) All electrical quantities that are to be metered, as provided in R460.3301, must be metered by commercially acceptable instruments, which are owned and maintained by the utility.

(2) Every reasonable effort must be made to measure at one point all the electrical quantities necessary for billing a customer under a given rate.

(3) Metering facilities located at any point where energy may flow in either direction and where the quantities measured are used for billing purposes shall consist of meters equipped with ratchets or other devices to prevent reverse registration and shall be so connected as to separately meter the energy flow in each direction, unless used to implement a utility tariff approved by the commission for service provided under a net metering program.

(4) A utility shall not employ reactive metering for determining the average power factor for billing purposes, where energy may flow in either direction or where the customer may generate an appreciable amount of his or her energy requirements at any time, unless suitable directional relays and ratchets are installed to obtain correct registration under all conditions of operation.

(5) All electric service of the same type rendered by a utility under the same rate schedule must be metered with instruments having like characteristics, except that the commission may be requested to approve the use of instruments of different types if their use does not result in unreasonable discrimination. Either all of the reactive meters, which may run backwards, or none of the reactive meters used for measuring reactive power under one schedule must be ratcheted. This rule is only applicable to equipment owned by the utility" (MPSC n.d.b, 13–14).

Rule 605 builds on Rule 301, discussed earlier in this report, and establishes additional requirements for how utilities meter electricity consumption. This rule specifies provisions related to situations where there may be bidirectional energy flows (e.g., where customer-owned generation is connected to the grid). In these cases, utilities must provide separate meters to measure energy flow in each direction. Utilities are prohibited from using reactive metering in these situations, unless meters have the required components to ensure accurate readings.

Benchmarked State Standards

Of the 25 benchmarked states, none have a rule containing the same level of detail as Michigan's Rule 605. However, PSC identified two different approaches to establishing standards for metering bidirectional energy flows. One approach, used in ten states, is to meter electrical quantities through administrative rules, and nine have provisions through legislation or commission orders. Of the remaining six, four have limited administrative rules addressing this topic, and two do not have any identifiable standards.

The ten states with provisions in their administrative rules are California, Connecticut, Georgia, Indiana, Iowa, New Jersey, New Mexico, Ohio, Virginia, and . Largely, these states' standards are primarily categorized within rules pertaining to net metering, and there However, there are variations in how meter standards are addressed. California, Georgia, Iowa, New Jersey, Ohio, Virginia, and Wisconsin provide for net-metering to be administered through a single meter that measures energy flows in either direction, as illustrated in the following examples:

- **California**: "Net-energy metering shall be accomplished using a single meter capable of registering the flow of electricity in two directions" (State of California n.d.).
- **New Jersey**: "A customer-generator facility used for net metering shall be equipped with metering equipment that can measure the flow of electricity in both directions at the same rate. This is typically accomplished with a single bidirectional meter" (State of New Jersey n.d.).
- **Wisconsin**: "A single watt-hour meter may be used for net-energy billing, where reverse meter registration is intended to occur during reverse power flow through the meter, and where the service is rendered under an authorized net-energy billing tariff" (State of Wisconsin 2019).

Other states, including Indiana, allow utilities to either use a single meter that measures net-energy consumption or two separate meters. If two meters are used, one meter will measure the energy that flows to the customer, while second will capture the energy sent back to the electric grid. To determine the net-energy consumption for billing purposes, the second meter reading will be subtracted from the first meter (State of Indiana 2020, 37).

Similarly, New Mexico and Connecticut's standards only require utilities to install necessary metering to measure the net energy delivered and do not specify the type or number of meters used (State of New Mexico n.d.; State of Connecticut n.d.a).

Twelve states do not specifically address metering of bidirectional energy flow through rules. Several only provide general discussion of the required metering equipment and do not address the number of meters or other requirements. These states are Missouri, Oklahoma, Oregon, and Texas. Illinois, Kansas, Kentucky, Massachusetts, Minnesota, and Washington do not address metering requirements related to bidirectional energy flows through rules; instead, they include provisions in state statutes. Finally, New York, North Carolina, and Pennsylvania are the only states where meter standards for bidirectional energy flows are determined through other regulatory proceedings.

R 460.3606 Nondirect Reading Meters and Meters Operating from Instrument Transformers; Marking of Multiplier on Instruments; Marking of Charts and Magnetic Tapes; Marking of Register Ratio on Meter Registers; Watt-hour Constants

Michigan Standard

Rule 606. "(1) Meters that are not direct reading and meters operating from instrument transformers must have the multiplier plainly marked on the dial of the instrument or otherwise suitably marked. All charts and magnetic tapes taken from recording meters must be marked with the date of the record, the meter number, customer, and chart multiplier, except as in R 460.3304.

(2) The register ratio must be marked on all meter registers.

(3) The watthour constant for the meter itself must be shown on all watthour meters" (MPSC n.d.b, 14).

In some cases, electric meters cannot be read directly, requiring the use of multipliers, register ratios, and watt-hour constants instead. Rule 606 specifies that these components be clearly marked on watt-hour meters.

Benchmarked State Standards

Nearly half of the benchmarked states require utilities to disclose information necessary for calculating readings on the meter itself. These states are Connecticut, Illinois, Indiana, Iowa, Kentucky, New Mexico, New York, Ohio, Oklahoma, Oregon, Washington, and Wisconsin. All of these states reference meter multipliers and constants as they pertain to watt-hour meters; however, only Illinois, Kentucky, New York, Ohio, and Wisconsin have provisions for register ratios. The exclusion of these ratios from the remaining states is likely a result of fewer states having standards for instrument transformers and other associated meter equipment.

- **Illinois**: If a billing multiplier is used to calculate customer usage, the utility must mark the billing multiplier on the front of the meter (or near the multiplier where it is plainly visible) and identify it as a billing multiplier at the time of installation or test, using a permanent marking method. Any entity providing instrument transformers must mark the multiplier based on instrument transformer ratios on all new installations and shall mark the multiplier on all existing installations when periodic meter testing is performed on the meter at that installation. The billing multiplier shall include the transformer and meter multipliers (State of Illinois n.d.a).
- **Ohio**: Meters that are not direct-reading meters, such as those with a multiplier not equal to one, shall have the multiplier plainly marked on or near the meter. All charts taken from recording meters shall be marked with the date of the record, the meter number, the customer name, and the chart multiplier. The register ratio shall be marked on all meter registers, and the watt-hour constant for the meter shall be placed on all watt-hour meters (State of Ohio n.d.).
- **Washington**: Electric utilities must use electric meters or other similar devices to accurately record or indicate the quantity of electricity sold to customers. Such devices allow utilities to calculate a customer's consumption in kWh or other units, as filed in the company's tariffs. Electric utilities that

decide to either measure a customer's consumption with a device that employs a multiplier or calculate consumption from recording devices must provide customers, upon request, information that allows customer to compute the quantity consumed. Indirect-reading meters, and those that operate from instrument transformers, must have the multiplier plainly marked on the instrument's dial or suitably marked otherwise. The watt-hour constant for the meter itself must be placed on all watt-hour meters (as specified in ANSI Standard C12.1) (State of Washington 2019).

- **Wisconsin**: Indirect-reading meters shall have the multiplier plainly marked on the dial of the instrument or otherwise suitably marked. All charts taken from recording meters shall be marked with the date of the record, the meter number, the customer, and the chart multiplier. The register ratio shall be marked on all meter registers. The watt-hour constant for the meter shall be placed on each watt-hour meter (State of Wisconsin 2019).

R 460.3607: Watt-hour Meter Requirements

Michigan Standard

Rule 607: "(1) Watt-hour meters that are used for measuring electrical quantities supplied shall conform to ANSI specifications and meet all of the following requirements:

a) Be of proper design for the circuit on which the meters are used; be in good mechanical and electrical condition; and have adequate insulation, correct internal connections, and correct register.

b) Not creep at no load with all load wires disconnected at a rate of one complete revolution of the moving element in ten minutes when potential is impressed.

c) Be accurate to within plus or minus 1.0 percent, referred to the portable standard watt-hour meter as a base, at two unity power factor loads: light load (l.l.) and heavy load (h.l.).

Meter Must Be Accurate within ± 1.0% to Portable Standard

Meter Class	Light-load Test Amperes	Heavy-load Test Amperes	Inductive-load 50% Lagging Power Factor test Amperes
Self-contained	10% Rated Test Amperes of Meter	75–- 100% Rated Test Amperes of Meter	75–- 100% Rated Test Amperes of Meter
Transformer Rated	5–-10% Rated Test Amperes of Meter	75–- 100% Rated Test Amperes of Meter	75–- 100%Rated Test Amperes of Meter

d) Be accurate to within plus or minus 2.0 percent, referred to the portable standard watt-hour meter as a base, at inductive load (i.l.).

(2) Polyphase meters shall have their elements in balance within 2.0 percent at rated test amperes at unity power factor and at approximately 50 percent lagging power factor.

(3) Meters that are used with instrument transformers shall be adjusted so that the overall accuracy of the metering installation meets the requirements of this rule.

(4) Meters and associated devices shall be adjusted as close as practical to zero error and within the accuracy limits specified in subrule (1)(c) of this rule" (MPSC n.d.b,14.).

Rule 607 specifies watt-hour meter requirements are based on ANSI Standard C12. The Michigan standard lays out four primary requirements for meters:

- Watt-hour meters are properly designed, maintained, and accurate
- Polyphase meters maintain balance
- Meters used with instrument transformers are accurate
- Meters are adjusted to limit range

Benchmarked State Standards

States take various approaches to watt-hour meter standards. Several have adopted ANSI Standard C12 relating to meters, including California, Iowa, New Mexico, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, and Virginia. Another approach is to allow state utility commissions to establish standards, like Oregon, which does not reference ANSI and instead allows the Oregon Public Utility Commission to establish metering requirements. California and New York share many similarities with Michigan, but their watt-hour meter requirements are not included in statewide rules and standards. Instead, they are established through other regulatory proceedings.

Eleven states have standards in place that are similar to Michigan's: Connecticut, Illinois, Indiana, Missouri, New Mexico, North Carolina, Oklahoma, Pennsylvania, South Carolina, Washington, and Wisconsin. Discussion on watt-hour metering standards are provided in the next section.

Watt-hour Meter Design, Maintenance, and Installation

Michigan's standard includes a general requirement for meters to be properly designed for use on the circuit, be in good condition, and have adequate insulation, correct internal connections, and correct register. Only five states include a similar statement in their standards, two of which are discussed below.

- **Washington**: All meters must be properly designed for the circuit on which they are used, be in good mechanical and/or electronic condition, and have adequate insulation, correct internal connections, and correct register (State of Washington 2019).
- **Wisconsin**: Watt-hour meters used for measuring electrical quantities supplied to customers must be properly designed for the circuit on which they are used, be properly connected and installed, be in good mechanical condition, and have adequate insulation, correct internal connections, and correct register (State of Wisconsin 2019).

Watt-hour Meter Creep

Meter creep is the most consistent element of states' watt-hour meter standards. Of the benchmarked states, 13 have similar standards to Michigan, including provisions regarding meter creep. Two are discussed below.

- **Indiana**: No watt-hour meter that registers at no load (the moving element making more than one complete revolution when at no load), when the applied voltage is less than 110 percent of standard service voltage, shall be placed or allowed to remain in service (State of Indiana 2020).
- **New Mexico**: Meters shall not creep, meaning no continuous rotation of the moving element of a meter at a speed in excess of one revolution in ten minutes when the meter-load wires have been removed and voltage is applied to the potential elements of the meter (State of New Mexico n.d.).

Watt-hour Meter Accuracy

Though most states establish meter accuracy requirements at different load levels, these standards are similar overall. There are nine varying accuracy standards used by 13 states, as shown in Exhibit 18.

EXHIBIT 18 Watt-hour Meter Accuracy Standards, Light and Heavy Load

State	Tolerance at Light Load	Tolerance at Heavy Load
New York	0.8%	1%
South Carolina	1%	0.5%
Kentucky, Illinois, Michigan, and Missouri	1%	1%
New Mexico	1%	1.5%
Wisconsin	1%	2%
Indiana	1%	3%
Oklahoma and Pennsylvania	2%	2%
Washington	2%	3%
North Carolina	4%	2%
Average Tolerance (N = 13)	1.45%	1.62%

Source: State of New York n.d.; State of South Carolina 2019; State of Kentucky 2019; State of Illinois n.d.b; MPSC n,d.; State of Missouri 2019; State of New Mexico n.d.; State of Wisconsin 2019; State of Indiana 2020; State of Oklahoma 2019; Commonwealth of Pennsylvania n.d.; State of Washington 2019; NCUC 2019

Only Indiana, Washington, and Wisconsin have provisions that explicitly reference meter accuracy when measured at inductive load.

Polyphase Meters and Meters with Instrument Transformers

Fewer states have established standards for polyphase meters and meters with instrument transformers. Only four—Connecticut, New York, Washington, and Wisconsin—have polyphase meter standards. These states had the same accuracy rules as Michigan, which requires meter "elements in balance within 2.0 percent at rated test amperes at unity power factor and at approximately 50 percent lagging power factor" (MPSC n.d.b, 15).

Connecticut, Washington, and Wisconsin have their own standards for meters with instrument transformers, while Indiana and New Mexico include references to ANSI Standard C-57.13 for these transformers. Washington and Connecticut require meters tested with instrument transformers to meet overall accuracy requirements. Wisconsin, however, establishes an additional requirement that specifies accuracy standards in cases where a transformer is supplying more than one meter (State of Wisconsin 2019).

R 460.3608: Demand Meters, Registers, and Attachments; Requirements

Michigan Standard

Rule 608. "A meter that records, or is capable of recording electric demand, is subject to the requirements of this rule. A demand meter, demand register, or demand attachment that is used to measure a customer's service shall meet all of the following requirements:

a) Be in good mechanical and electrical condition.
b) Have proper constants, indicating scale, contact device, recording tape or chart, and resetting device.
c) Not register at no load.
d) Curve-drawing meters that record quantity-time curves and integrated-demand meters must be accurate to within plus or minus 2.0 percent of full scale throughout their working range. Timing elements measuring specific demand intervals must be accurate to within plus or minus 2.0 percent, and the timing element which serves to provide a record of the time of day when the demand occurs must be accurate to within plus or minus four minutes in 24 hours" (MPSC n.d.b, 15–16).

Michigan's Rule 608 provides standards for meters that record electric demand.

Benchmarked State Standards

Fewer states have adopted standards for demand meters than watt-hour meters. PSC identified ten states with established standards for demand meters, nine of which—Connecticut, Illinois, Indiana, Kentucky, New Mexico, Oklahoma, Pennsylvania, Washington, and Wisconsin—publish these statewide. New York has also adopted demand-meter requirements through separate proceedings overseen by state regulators (State of New York n.d.). One state, Iowa, references their adoption of ANSI Standard C12.1-201 for metering and meter testing (State of Iowa 2020). For states with their own demand-meter standards, there are several common elements:

- Every one of the states identified above—with the exception of Oklahoma—requires demand meters to be accurate within 2 percent. Oklahoma allows demand meters to have a registered error of 4 percent (State of Oklahoma 2019).
- Four states—Kentucky, New Mexico, Pennsylvania, and Wisconsin—require a demand meter to register zero under no load conditions (State of Kentucky 2019; State of New Mexico n.d.; Commonwealth of Pennsylvania n.d.; State of Wisconsin 2019).
- Only Kentucky and Wisconsin require that demand meters have proper constants, indicating scale, constant devices, and resetting device (State of Kentucky 2019; State of Wisconsin 2019).

Kentucky and Wisconsin's demand-meter standards are nearly identical to Michigan's.

Kentucky

- "A demand meter, demand register, or demand attachment used to measure customer's service shall:
  - Be in good mechanical and electrical condition
  - Have proper constants, indicating scale, contact device, and resetting device
  - Not register at no load
  - Be accurate to the following degrees:
    - Graphic meters that record quantity-time curves and integrated-demand meters shall be accurate to within plus or minus 2 percent of full scale throughout their working range. Timing elements measuring specific demand intervals shall be accurate to within plus or minus 2 percent, and the timing element that provides a record of the time when demand occurs shall be accurate to within plus or minus four minutes in 24 hours" (State of Kentucky 2019).

Wisconsin

- "A demand meter, demand register, or demand attachment used to measure customer's service shall:
  - Be in good mechanical and electrical condition
  - Have proper constants, indicating scale, contact device, and resetting device
  - Not register at no load
  - Be accurate to the following degrees:
    - Curve-drawing meters and integrated-demand meters shall be accurate to within plus or minus 2 percent of full scale throughout their working range. Timing elements measuring specific demand intervals shall be accurate to within plus or minus 2 percent; the timing elements that provide a record of the time when the demand occurs shall be accurate to within plus or minus four minutes in 24 hours" (State of Wisconsin 2019).

R 460.3609: Instrument Transformers Used in Conjunction with Metering Equipment; Requirements; Phase-shifting Transformers; Secondary Voltage

Michigan Standard

Rule 609: "(1) Instrument transformers used in conjunction with metering equipment to measure a customer's service shall meet both of the following requirements:

a) Be in proper mechanical condition and have satisfactory electrical insulation for the service on which used.

b) Have characteristics such that the combined inaccuracies of all transformers supplying one or more meters in a given installation will not exceed the percentages listed in the following chart:

	100% Power Factor		**50% Power Factor**	
Current	10%	100%	10%	100%
Error	1%	0.75%	3%	2%

(2) Meters that are used in conjunction with instrument transformers shall be adjusted so that the overall accuracies will come within the limits specified in this part.

(3) Instrument transformers shall be tested with the meter with which they are associated by making an overall test or may be checked separately. If the transformers are tested separately, the meters shall also be checked to see that the overall accuracy of the installation is within the prescribed accuracy requirements. (See R 460.3613 (6).)

(4) The results of tests of instrument transformers shall be kept on record and shall be available for use.

(5) Phase-shifting transformers shall have secondary voltages under balanced line voltage conditions within plus or minus 1.0 percent of the voltage impressed on the primary side of the transformer" (MPSC n.d.b, 16).

Rule 609 builds on Rules 603 and 607 regarding equipment inspection and watt-hour meter use, and describes additional requirements for the operation, testing, and accuracy of instrument and phase-shifting transformers.

Benchmarked State Standards

Standards for instrument and phase-shifting transformers are uncommon. Of the 25 benchmarked states, only five—Connecticut, Kentucky, Oklahoma, Washington, and Wisconsin—have a comparable standard to Rule 609. Additionally, Indiana, Iowa, and New Mexico have adopted portions of ANSI/IEEE Standard C57.13 for instrument transformers in lieu of state standards.

Of the five states with established state standards for transformers, only Kentucky, Washington, and Wisconsin provide the same level of detail as Michigan. However, Wisconsin and Kentucky have minor differences in their accuracy requirements. Exhibit 19 presents allowable errors for instrument transformers in these states.

EXHIBIT 19 Allowable Errors for Instrument Transformers

	Michigan				Kentucky				Wisconsin			
	100% Power Factor		50% Power Factor		100% Power Factor		50% Power Factor		100% Power Factor		50% Power Factor	
Load	10%	100%	10%	100%	10%	100%	10%	100%	10%	100%	10%	100%
Error	1.0%	0.75%	3.0%	2.0%	1.5%	0.75%	3.0%	2.0%	0.6%	0.3%		1.0%

Sources: MPSC n.d.b, 16; State of Kentucky 2019; State of Wisconsin 2019

R 460.3610: Portable Indicating Voltmeters; Accuracy

Michigan Standard

Rule 610: "All portable indicating voltmeters that are used for determining the quality of service voltage to customers shall be checked against a suitable secondary reference standard at least once every six months for analog devices, and once every 12 months for digital devices. The accuracy of these voltmeters shall be rated so that the error of the indication is not more than plus or minus 1 percent of full scale. If the portable indicating voltmeter is found to be in error by more than the rated accuracy at commonly used scale deflections, it shall be adjusted" (MPSC n.d.b, 17).

Benchmarked State Standards

PSC identified 15 states with equipment standards for routine testing. These standards varied across certain elements, including the frequency of equipment tests and the testing standards used for different equipment. The most common approach for ensuring voltmeter accuracy is to require this equipment be tested against an approved standard as often as necessary. Four states specified the frequency of this testing:

- **New Jersey**: Once a week (State of New Jersey n.d.)
- **Oklahoma**: Every three months (State of Oklahoma 2019)
- **New Mexico and Wisconsin**: At least every six months (State of New Mexico n.d.; State of Wisconsin 2019)

Some states specified the acceptable level of error for voltmeters, ranging from 0.5 percent (Illinois) to 1 percent (Indiana, Iowa, Michigan, and Washington) to 3 percent (New Mexico) (State of Illinois n.d.b; State of Indiana 2020; State of Iowa 2020; MPSC n.d.b; State of Washington 2019; State of New Mexico n.d.).

R 460.3611: Meter Testing Equipment; Availability; Provision and Use of Primary Standards

Michigan Standard

Rule 611: "(1) A utility shall maintain sufficient laboratories, meter testing shops, secondary standards, instruments, and facilities to determine the accuracy of all types of meters and measuring devices used by the utility. The utility may, if necessary, have all or part of the required tests made, or its portable testing equipment checked, by another utility or agency which is approved by the commission and which has adequate and sufficient testing equipment to comply with these rules.

(2) At a minimum, a utility shall keep all of the following testing equipment available:

a) One or more portable standard watthour meters that has a capacity and voltage range which is adequate to test all watthour meters used by the utility.

b) Portable indicating instruments that are necessary to determine the accuracy of all instruments used by the utility.

c) One or more secondary standards to check each of the various types of portable standard watthour meters used for testing watthour meters. Each secondary standard shall consist of an approved portable standard watthour meter which is kept permanently at 1 point and which is not used for fieldwork. Standards shall be well compensated for both classes of temperature errors, shall be practically free from errors due to ordinary voltage variations, and shall be free from erratic registration due to any cause.

d) Suitable standards, which are not used for fieldwork, to check portable instruments used in testing.

(3) A utility shall provide and use primary standards that have accuracies which are traceable to the United States National Institute of Standards and Technology (NIST)" (MPSC n.d.b, 17).

Utilities rely on a wide array of specialized equipment to ensure the safe, reliable operation of the electric grid. As this equipment is fundamental to measuring, monitoring, and testing operations, it is essential that the equipment works properly and provides reliable results. To do this, utilities must maintain appropriate facilities and equipment. Rule 611 establishes these facility and equipment requirements.

Benchmarked State Standards

PSC identified two common approaches to establishing meter testing standards for facilities and equipment. One approach—used in Illinois, Indiana, Missouri, North Carolina, Oregon, South Carolina, Texas, Virginia, and Washington—is to provide a high-level description of utilities' responsibilities for testing, enabling them to implement their own procedures. Though these standards do not provide explicit requirements regarding the type of equipment or how much of this equipment is needed, they do outline a broad goal to ensure adequate, accurate testing procedures. Illinois, Indiana, North Carolina, and Virginia offer effective examples of this approach:

- **Illinois**: "Each meter service provider shall provide a meter shop adequately equipped with the reference standards, instruments, equipment, and personnel necessary to conduct MSP-required tests. Each MSP must also provide working portable standards to conduct the required tests. All apparatus and equipment shall be available at all times during the MSP's established business hours for the inspection of or use by authorized commission representatives. If meters used for billing and maintaining customer usage data are tested at a facility located outside of the state, the MSP shall take precautions to ensure that the meters are not damaged in transit to or from that testing facility" (State of Illinois n.d.b).
- **North Carolina**: "Each utility providing metered electric service shall provide and have available such meter laboratories, standard meters, instruments, and facilities as may be necessary to make the tests required by these rules, together with such portable indicating electrical testing instruments, watt-hour meters, and facilities of suitable type and range for testing service watt-hour meters, voltmeters, and other electrical equipment, used in its operations, as may be deemed necessary and satisfactory to the commission. All portable indicating electrical testing instruments, such as voltmeters, ammeters, and watt-hour meters, when in regular use for testing purposes, shall be

checked against suitable reference standards periodically, and with such frequency as to ensure their accuracy whenever used in testing service meters of the utility" (NCUC 2019).

- **Virginia**: "Each owner shall engage a qualified expert or factory representative to perform the required equipment tests; tests performed with instruments, portable standards, reference manuals, and other equipment and facilities must comply with ANSI C12.1 or ANSI B109 standards for submetering equipment and with manufacturer's recommended practices for energy allocation equipment. These practices shall be available at all reasonable times for the commission's inspection" (Commonwealth of Virginia n.d.).

The second, more prescriptive, approach is to provide specific requirements for testing equipment that include the type of equipment, the minimum number of this equipment the utility must provide, and how it should be handled and stored. Connecticut, Kentucky, New Jersey, New Mexico, New York, Oklahoma, Pennsylvania, and Wisconsin use this approach. Kentucky and Wisconsin are discussed in the next section.

Kentucky

- "Each utility shall maintain sufficient laboratories, meter testing shops, standards, instruments, and facilities to determine the accuracy of all meters and measuring devices used by the utility, except as provided in 807 KAR 5:006, Section 17. The following testing equipment shall be available as minimum requirements for each utility or agency making tests or checks for a utility pursuant to 807 KAR 5:006, Section 17(2):
    - One or more working watt-hour standards and associated devices of capacity and voltage range adequate to test all watt-hour meters used by the utility.
    - One or more watt-hour standards, which shall be the utility's master standard for testing its working watt-hour standards. These standards shall be of an approved type, be well compensated for both classes of temperature errors, free from errors due to ordinary voltage variations, and free from erratic registration. These standards shall be of capacity and voltage range adequate to test all working watt-hour standards at all loads and voltages at which they are used. These standards shall be kept permanently at one place and not used for routine testing.
    - Working indicating instruments, such as ammeters, voltmeters and wattmeters, of such various types required to determine the quality of service to customers.
    - A voltmeter and ammeter, which shall be the master indicating instruments and be used for testing of working indicating and recording instruments. These instruments shall be of an approved type and of accuracy class and range sufficient to determine accuracy of working instruments to within 0.5 percent of all ranges and scale deflections at which working instruments are used. They shall be kept permanently at one place and not used for routine testing" (State of Kentucky 2019).

Wisconsin

- "Each utility shall maintain sufficient laboratories, meter testing shops, secondary standards, instruments, and facilities to determine the accuracy of all types of meters and measuring devices used. A utility may, however, with the commission's approval, have all or part of the required tests made or its portable testing equipment checked by the original equipment manufacturers, another utility, or testing agency with adequate, sufficient testing equipment to comply with these rules. Each utility shall have the following minimum testing equipment available:

- One or more portable standard watt-hour meters of capacity and voltage range adequate to test all watt-hour meters used by the utility.
- Various portable indicating instruments to determine the accuracy of all instruments the utility uses.
- One or more secondary standards to check the various types of portable standard watt-hour meters used for testing watt-hour meters. Each secondary standard must include either an approved portable standard watt-hour meter kept permanently at one point and not used for fieldwork, or not less than three approved watt-hour meters connected with current coils in series and voltage coils in parallel and kept running by connecting a ten-watt load. These meters must be well compensated for both classes of temperature errors, practically free from errors due to ordinary voltage variations, and free from erratic registration due to any cause.
- Suitable standards that are not used for fieldwork to check portable instruments used in testing" (State of Wisconsin 2019).

R 460.3612: Test Standards; Accuracy

Michigan Standard

Rule 612. (1) The accuracies of all primary reference standards shall be certified as traceable to the National Institute of Standards and Technology (NIST), either directly or through other recognized standards laboratories. These standards shall have their accuracy certified at the time of purchase. Standard cells shall be intercompared regularly and at least 1 standard cell shall be checked by a standardizing laboratory at intervals of not more than 2 years. Reference standards of resistance, potentiometers, and volt boxes shall be checked at intervals of not more than 3 years.

(2) Secondary watthour meter standards shall not be in error by more than plus or minus 0.3 percent at loads and voltages at which they are to be used, and shall not be used to check or calibrate working standards, unless the secondary standard has been checked and adjusted, if necessary, within the preceding 6 months. Each secondary standard watthour meter shall have calibration data available and shall have a history card.

(3) Secondary standards indicating instruments shall not be in error by more than plus or minus 0.5 percent of indication at commonly used scale deflection and shall not be used to check or calibrate portable indicating instruments, unless the secondary standard has been checked and adjusted, if necessary, within the preceding 12 months. A calibration record shall be maintained for each standard.

(4) Regularly used working portable standard watthour meters shall be compared with a secondary standard at least once every 6 months. Infrequently used working standards shall be compared with a secondary standard before they are used.

(5) Working portable standard watthour meters shall be adjusted so that their percent registration is within 99.7 percent and 100.3 percent at 100 percent power factor and within 99.5 percent and 100.5 percent at 50 percent lagging power factor at all voltages and loads at which the standard may be used. A history and calibration record shall be kept for each working standard.

(6) The meter accuracies required in this rule for all primary, secondary, and working standards shall be referred to 100 percent. Service measuring equipment shall be adjusted to within the accuracies required assuming the portable test equipment to be 100 percent accurate with the calibration correction taken into consideration.

Using certified standards is a pivotal component of ensuring that testing and measurements are accurate over time and across jurisdictions.[14] As such, there are practices to ensure reliable standards for calibrating utilities' equipment. Rule 612 provides the framework for ensuring that Michigan utilities are using standards that have been tested, certified, and assessed periodically to maintain consistency.

Benchmarked State Standards

Of the 25 benchmarked states, only Michigan and Wisconsin include separate testing requirements for reference standards, a secondary watt-hour meter standard, secondary standards indicating instruments, and working portable standard watt-hour meters. Ten other states have requirements relating to one or more standards: Connecticut, Illinois, Indiana, Kentucky, New Jersey, New Mexico, Oklahoma, Pennsylvania, South Carolina, and Texas. Discussion of state requirements for each meter type is provided in the next section.

Reference Standards Certification for Primary Standards

The eight states, in addition to Michigan, that have testing requirements for reference standards are described in Exhibit 20. Five of these states require reference standards to be tested at least once per year, three states require this testing every two years, and one state requires tests to be performed at an unspecified frequency. Only Illinois and Kentucky specify the error levels that would require reference standards be adjusted.

EXHIBIT 20. Reference Standard Certification for Primary Standards

State	Review Time Frame	Error Level
Pennsylvania	Tested periodically	N/A
Illinois	<12 months	0.5%
Oklahoma	<12 months	N/A
Connecticut	<12 months	N/A
Texas	<12 months	N/A
Kentucky	<12 months	0.3% at 100% load factor 0.5% at 50% load factor
Indiana	<2 years	N/A
Wisconsin	<2 years	N/A

[14] "Standards," as used in Rule 612, refers to the tools that utilities use to measure their equipment.

State	Review Time Frame	Error Level
Michigan	<2 years <3 years—resistance, potentiometers, and volt box standards	N/A

Sources: Commonwealth of Pennsylvania n.d.; State of Illinois n.d.b; State of Oklahoma 2019; State of Connecticut n.d; PUCT n.d.; State of Kentucky 2019; State of Indiana 2020; State of Wisconsin 2019; MPSC n.d.b

Secondary Watt-hour Meter Standards

Testing frequency requirements for the three states with secondary meter standards range from four months (Texas) to six months (Michigan) to 12 months (Wisconsin). Michigan and Wisconsin both specify that standards that register an error level of 0.3 percent would trigger the need for calibration (Exhibit 21).

EXHIBIT 21 Secondary Watt-hour Meter Standards

State	Review Time Frame	Error Level
Michigan	<6 months	0.3%
Texas^	<4 months	
Wisconsin	<12 months	0.3%

^ Shop instrument test equipment
Sources: MPSC n.d.b, 17; PUCT n.d.; State of Wisconsin 2019

Secondary Standards Indicating Instruments

All three states with test requirements for indicating instrument secondary standards have the same provisions, requiring testing on an annual basis and a maximum 0.5 percent error level for standards (Exhibit 22).

EXHIBIT 22. Secondary Standards Indicating Instruments

State	Review Time Frame	Error Level
Michigan	<12 months	0.5%
New Mexico	<12 months	0.5%
Wisconsin	<12 months	0.5%

Sources: MPSC n.d.b, 17; State of New Mexico n.d..; State of Wisconsin 2019

Working Portable Standard Watt-hour Meters

State standards for working portable standard watt-hour meters exhibit the most variability of the four test standards, with required testing time frames ranging from every week to at least once per year (Exhibit 23). However, the established error levels for these meters have less variability. Of the benchmarked states, five specify these error levels. The common practice is to adjust meters that exceed

0.5 percent error. In the case of Kentucky, Michigan, and Wisconsin, error levels are delineated on the basis of the meter's power factor.

EXHIBIT 23. Working Portable Standard Watt-hour Meters

State	Review Time Frame	Error Level
Connecticut	At frequent intervals	
New Jersey	Every week	
Kentucky	<4 weeks	0.3% at 100% load factor 0.5% at 50% load factor
New Mexico	Every month	0.5%
Pennsylvania	Every month—inductive-type meters <3 months—solid-state meters	
Oklahoma	<3 months <6 months—solid-state meters	
Texas^	<120 days	
Michigan	<6 months—frequently used Prior to use—infrequently used	0.3% at 100% power factor 0.5% at 50% power factor
Illinois	<6 months—solid-state meters Every month—other meters	0.5%
Wisconsin	<12 months	0.3% at 100% power factor 0.5% at 50% power factor

^ Portable instrument test equipment
Sources: State of Connecticut n.d; State of New Jersey n.d.; State of Kentucky 2019; State of New Mexico n.d.; Commonwealth of Pennsylvania n.d.; State of Oklahoma 2019; PUCT n.d.; MPSC n.d.b; State of Illinois n.d.b; State of Wisconsin 2019

Other State Standards

Eight states provide more general guidance on acceptable review time frames and error levels for meter testing instruments—California, Iowa, Missouri, New York North Carolina, South Carolina, Virginia, and Washington. Within these states' rules, there are varying levels of guidance. For example, South Carolina's rule does not specify a standard for metering-testing equipment, but it does direct utilities to test this equipment against suitable standards.

- **South Carolina:** "Each electrical utility furnishing metered electric service is required to provide a meter laboratory, standard meters, instruments, and facilities to make the tests required by these rules or other orders of the commission together with such portable indicating electrical testing instruments, watt-hour testing meters, and facilities of a suitable type and range for testing service watt-hour meters, voltmeters, and other electrical equipment, used in its operation, as may be deemed necessary and satisfactory to the commission. All portable indicating electrical testing instruments, such as voltmeters, ammeters, and wattmeters, when in regular use for testing purposes, shall be checked against suitable reference standards whenever used in testing service meters of the electrical utility" (State of South Carolina 2019).

Similar to South Carolina, Missouri also focuses on ensuring their utilities have meter testing equipment standards:

- **Missouri:** "Each utility furnishing metered electric service shall maintain suitable working standards of a rugged type for the testing of electric service meters. These standards must be calibrated frequently to ensure accuracy. All secondary and working standards of utilities not required to maintain secondary standards must be submitted at frequent intervals to the National Bureau of Standards or to a recognized testing laboratory for calibration where the utility does not maintain a testing laboratory having primary standards" (State of Missouri 2019).

Washington also leaves testing up to individual utilities, directing them to keep records of this information:

- **Washington:** "Electrical utilities must provide a written statement to the commission regarding their practices, including a description of test standards and meter testing equipment, if maintained by the electrical utility. It must also describe the methods employed to ascertain and maintain the accuracy of the standards and equipment, including the frequency of such tests, if the electrical utility chooses to maintain its own standards and equipment, rather than use the services of a certified testing laboratory. If an electrical utility chooses to maintain its own standards and instruments, it must retain records indicated the date when each standard and instrument was tested, calibrated, or adjusted. Standards cannot be used in the field as working instruments" (State of Washington 2019).

R 460.3613: Meter and Metering Equipment Testing Requirements

Michigan Standard

Rule 613: "(1) The testing of any unit of metering equipment must consist of a comparison of its accuracy with a standard of known accuracy. Units that are not properly connected or that do not meet the accuracy or other requirements of these meter and metering equipment rules at the time of testing shall be reconnected or rebuilt to meet such requirements and must be adjusted to within the required accuracy and as close to zero error as practicable or else their use shall be discontinued.

(2) Self-contained, electromechanical, solid-state, single-phase, and all network meters must be in compliance with all of the following requirements:

a) Be checked for accuracy as provided for in R 460.3602.

b) Notwithstanding the provisions of subdivision (a) of this subrule, upon application to the commission and upon receipt of an order granting approval, the testing of self-contained, electromechanical, solid-state, single-phase, and all network meters in service must be governed by a quality control plan as follows: (i) Meters must be divided into homogenous groups by manufacturers' types, and certain manufacturers' types must be further subdivided into separate groups by manufacturers' serial numbers. (ii) The meters in each homogeneous group must then be further subdivided into lots of not less than 301, and not more than 35,000, meters each, except that meters of the most recent design may be combined into lots regardless of manufacturers' type, except that where the number of meters of a single type is

8,001 or more, that number of meters must be segregated by types for the formation of lots. (iii) From each assembled lot, a sample of the size specified in table A-2, ANSI/ASQC Z1.9, must be drawn annually. The sample must be drawn at random. (iv) The meters in each sample must be tested for accuracy pursuant to paragraphs (v) to (xi) of this subdivision. (v) The test criteria for acceptance or rejection of each lot must be based on the test at heavy load only and must be that designated for double specification limits and an acceptable quality level that is not higher than 2.50 (normal inspection),) as shown in table B-3, ANSI/ASQC Z1.9. (vi) The necessary calculations must be made pursuant to Example B-3 of ANSI/ASQC Z1.9. The upper- and lower-specification limits, U and L, must be 102 percent and 98 percent, respectively. (vii) A lot must be rejected if the total estimated percent defective (p) exceeds the appropriate maximum allowable percent defective (M) as determined from table B-3 as specified in paragraph (v) of this subdivision. (viii) All meters in a rejected lot must be tested within a maximum period of 60 months and be adjusted pursuant to the provisions of R 460.3607 or be replaced with meters that are in compliance with the requirements of R 460.3607. (ix) During each calendar year, new meter samples must be drawn as specified in this subdivision from all meters in service, with the exception that lots that have been rejected must be excluded from the sampling procedure until all meters included in the rejected lots have been tested. (x) The utility may elect to adopt a mixed variables-attributes sampling plan as outlined in Section A9 of ANSI/ASQC Z1.9, in which case, a lot that is not in compliance with the acceptability criteria of the variables sampling plan shall be resampled the following year using an attributes sampling plan. If the acceptability criteria of the attributes sampling plan are met, then the lot shall be considered acceptable and shall be returned to the variables sampling plan the following year. If the acceptability criteria of the attributes sampling plan are not met, then the utility shall reject that lot and all meters in the lot must be tested and adjusted or replaced within a maximum period of 48 months after the second rejection. (xi) The plan specified in paragraph (x) of this subdivision does not alter the rules under which customers may request special tests of meters.

c) Be checked for accuracy in all of the following situations: (i) When a meter is suspected of being inaccurate or damaged. (ii) When the accuracy of a meter is questioned by a customer. (See R 460.3601.)

d) Be inspected for mechanical and electrical faults when the accuracy of the device is checked.

e) Have the register and the internal connections checked before the meter is first placed in service and when the meter is repaired.

f) Have the connections to the customer's circuits checked when the meter is tested on the premises or when removed for testing.

g) A meter need not be tested or checked for any reason if the device was tested, checked, and adjusted within the previous 12 months except when a complaint is received.

(3) All single-phase instrument rated electro-mechanical meters must be in compliance with all of the following requirements:

a) Be checked for accuracy at unity power factor at the point where a meter is installed, at a central testing point, or in a mobile testing laboratory as follows: (i) Not later than 9 months after 144 months of service for a surge-resistant meter and not later than 9 months after 96 months of service for a non-surge-resistant meter. (ii) When a meter is suspected of being inaccurate or damaged. (iii) When the accuracy of a meter is questioned by a customer. (See R 460.3601.) (iv) Before use when a meter has been inactive for more than 1 year after having been in service.
b) Be inspected for mechanical and electrical faults when the accuracy of the device is checked.
c) Have the register and the internal connections checked before the meter is first placed in service and when the meter is repaired.
d) Have the connections to the customer's circuits checked when the meter is tested on the premises or when removed for testing.
e) Be checked for accuracy at 50 percent power factor when purchased and after rebuilding.
f) A meter need not be tested or checked for any reason if the device was tested, checked, and adjusted within the previous 12 months except when a complaint is received.

(4) All self-contained electromechanical and solid-state three-phase meters and associated equipment must be in compliance with all of the following requirements. However, a utility may elect to include self-contained solid-state three-phase meters in service in its quality control plan as provided for in R 460.3613(2)(b). Therefore, a utility may be exempt from the periodic meter test requirements as provided in subdivision (a)(ii) of this subrule.

a) Be tested for accuracy at unity and 50 percent power factor as follows: (i) Before being placed in service. (ii) Not later than nine months after 120 months of service. (iii) When a meter is suspected of being inaccurate or damaged. (iv) When the accuracy of a meter is questioned by a customer. (See R 460.3601.) (v) When a meter is removed and put back in service.
b) Be inspected for mechanical and electrical faults when the accuracy is checked.
c) Have the register and internal connections checked before the meter is first installed, when repaired and when the register is changed.
d) Have the connections to the customer's circuits and multipliers checked when the equipment is tested for accuracy on the customer's premises.

(5) All transformer-rated electromechanical and solid-state three-phase meters and associated equipment must be in compliance with all of the following requirements. However, a utility may elect to include transformer-rated solid-state three-phase meters in service in its quality control plan as provided for in R 460.3613(2)(b). Therefore, a utility may be exempt from the periodic meter test requirements as provided in subdivision (a)(iii) of this subrule.

a) Be checked for accuracy at unity and 50 percent power factor as follows: (i) Before being placed in service. (ii) On the customer's premises within 60 days after installation, unless the transformers are in compliance with the specifications outlined in ANSI C-57.13, and unless the meter adjustment limits do not exceed plus or minus 1.5 percent at 50 percent power factor. (iii) Not later than nine months after 72 months of service. (iv) When a meter is suspected of being inaccurate or damaged. (v) When the accuracy is questioned by a customer. (See R 460.3601.) (vi) When a meter is removed and put back in service.

b) Be inspected for mechanical and electrical faults when the accuracy is checked.

c) Have the register and internal connections checked before the meter is first placed in service and when the meter is repaired.

d) Have the connections to the customer's circuits and multipliers checked when the equipment is tested for accuracy on the premises or when removed for testing and when instrument transformers are changed.

e) Be checked for accuracy at 50% power factor when purchased and after rebuilding.

(6) A utility shall test instrument transformers in all of the following situations:

a) When first received, unless a transformer is accompanied by a certified test report by the manufacturer.

b) When removed and put back in service.

c) Upon complaint.

d) When there is evidence of damage.

e) When an approved check, such as the variable burden method in the case of current transformers that is made when the meter is tested indicates that a quantitative test is required" (MPSC n.d.b, 18–21).

(7) Demand meters must be in compliance with both of the following requirements:

a) Be tested for accuracy in all of the following situations: (i) Before a meter is placed in service. (ii) When an associated meter is tested and the demand meter is a block interval nonrecording type or a thermal type. (iii) After 2 years of service if the meter is of the recording type, but testing is not required if the meter is of the pulse-operated type and the demand reading is checked with the kilowatt-hour reading each billing cycle. (iv) When a meter is suspected of being inaccurate or damaged. (v) When the accuracy is questioned by a customer. (See R 460.3601.)

b) Be inspected for mechanical and electrical faults when a meter is tested in the field or in the meter shop.

Michigan's Rule 613 includes four primary components:

- Comparison of metering equipment to testing standards and meter adjustment[15]
- Specific requirements for different types of metering equipment
- Requirements for accuracy testing and sampling procedures
- Testing frequency for different types of metering equipment

[15] Testing standards refers to the tools that utilities use to measure their equipment for accuracy.

The rule is organized by the type of meter equipment, with each having unique requirements related to accuracy, adjustment, sampling, and testing frequency.

Benchmarked State Standards

There are a wide range of standards regarding meter testing and testing requirements across benchmarked states. Of these states, 19 have standards that share elements of Michigan's Rule 613, partially due to the number of meter types and testing requirements covered in this rule. These states are California, Connecticut, Illinois, Indiana, Iowa, Kentucky, Missouri, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Virginia, Washington, and Wisconsin.

Rule 613 is one of the most comprehensive standards for meter testing of the states examined. The 19 states with meter testing standards can be organized into two groups. Eleven states—California, Illinois, Indiana, Kentucky, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Pennsylvania, and Wisconsin—have detailed standards that specify requirements related to equipment and testing parameters. The remaining eight have more limited rules for testing metering equipment, but they tend to grant authority to state regulators or rely on national standards to oversee meter testing.

- **Connecticut:** The state requires utilities to test all watt-hour meters within 60 days of installation and then periodically in conformity with the most recent ANSI Standard. Companies are required to submit testing records to state regulators (State of Connecticut n.d.a).
- **Iowa:** The state standard for metering equipment accuracy testing specifies that all meters and associated metering devices shall, when tested, be adjusted as closely as practicable to the condition of zero error (State of Iowa 2020).
- **Texas:** Meter test periods for all types of meters shall conform to the latest edition of ANSI Standard C12, unless specified otherwise by the commission (PUCT n.d.).

Comparison to Test Standards and Accuracy Adjustment

Michigan's Rule 613 requires all metering equipment to be tested against accurate standards. PSC identified similar requirements in 19 states; however, there is minor variability in their approaches. Some states—Kentucky and Wisconsin—take an overt approach, like Michigan, including provisions that require all meters be tested against standards.

- **Kentucky:** Testing of metering equipment must compare results with a standard of known accuracy. All equipment must be in good order and be adjusted to as close to zero error as possible (State of Kentucky 2019).
- **Wisconsin:** Meters must be tested against a standard of known accuracy to determine its accuracy (State of Wisconsin 2019).

Other states, such as California, Illinois, Indiana, New Jersey, New York, North Carolina, and Washington, reference the role of test standards in their rules, but they are not as explicit as Michigan's rule.

- **California:** Specifies that test standards used for testing meter accuracy are appropriately calibrated and accurate (CPUC 1999).

- **Illinois:** Requires utilities to use necessary reference standards, equipment, and personnel to perform meter tests (State of Illinois n.d.b).
- **North Carolina:** Requires utilities have standard meters, instruments, and facilities to conduct the required tests (NCUC 2019).

While many states, including Michigan, dictate acceptable error levels for metering equipment in separate rules, Michigan's Rule 613 requires equipment that displays incorrect values to be adjusted "as close to zero error as practicable or else their use shall be discontinued" (MPSC n.d.b, 18) Many other states share some or all of this language, with five states—Iowa, Kentucky, New Jersey, New York, and Washington—specifying that equipment should be adjusted to have as close to zero error as practicable, and 13 states—Connecticut, Illinois, Iowa, Kentucky, Massachusetts, Missouri, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Texas, and Washington—stating that if metering equipment is found to be outside the range of acceptable error, adjustments must be made to the reduce error to acceptable levels before using the device.

Unlike Michigan, which does not stipulate acceptable error limits alongside Rule 613 provisions for meter testing requirements, eight states do specify these limits in the same rule: Connecticut, Illinois, Missouri, New Jersey, New York, Oregon, Pennsylvania, and Texas. This is one example of a marked organizational difference between Michigan's rules and many of the other states examined in this study.

Metering Equipment

Michigan's Rule 613 provides detailed requirements for when and how meters, transformers, and associated devices are tested. The following types of equipment are included:

- Self-contained, electromechanical, solid-state, single-phase, and all network meters
- Single-phase, instrument-rated, and electromechanical meters
- Self-contained, electromechanical, and solid-state three-phase meters and associated equipment
- Transformer-rated, electromechanical, and solid-state three-phase meters and associated equipment
- Instrument transformers (MPSC n.d.b, 18)

It is difficult to directly compare the equipment included in Michigan's rule to other state rules due to the various names for metering equipment. However, PSC found that Michigan's grouping of meters in the five classes listed previously is unique. In fact, there was no common approach for the categorization of meters, despite more than half of the states examined included references to ANSI Standard C.12 for electric meters.

Some states, such as Connecticut, Missouri, South Carolina, and Texas, simply require all meters to be tested. For Iowa, Oregon, Virginia, and Washington, utilities must file their meter testing plans with state regulators; however, there is no statewide rule or standard or specific metering equipment specified. There are other states that list as many as 15 or as few as six types of metering equipment subject to testing requirements. California, Illinois, Kentucky, New York, and Oklahoma's rules are also notable for the inclusion of testing requirements for demand registers, electronic registers, pulse records, and other technologies not mentioned by other states. Exhibit 24 shows the number of meter testing equipment requirements in different states.

EXHIBIT 24. Different Metering Equipment Types Included in State Standards

Different Types of Meters Referenced	State(s)
15	Kentucky
11	California
10	Pennsylvania and Wisconsin
9	Illinois and New York
8	New Jersey and North Carolina
7	Oklahoma
6	Indiana and New Mexico
All types*	Connecticut, Missouri, South Carolina, and Texas
Meter testing determined by utilities' plans submitted to state regulators	Iowa, Oregon, Virginia, and Washington

* Utilities must test all types of meters; standards do not delineate different types
Sources: State of Kentucky 2019; CPUC 1999; Commonwealth of Pennsylvania 2019; State of Wisconsin 2019; State of Illinois n.d.b; New York State 2003; State of New Jersey n.d.; NCUC 2019; State of Oklahoma 2019; State of Indiana 2020; State of New Mexico n.d.; State of Connecticut n.d.a; State of Missouri 2019; State of South Carolina 2019; State of Iowa 2020; State of Oregon n.d.; Commonwealth of Virginia n.d.; State of Washington 2019; PUCT n.d.

Requirements for Accuracy Testing and Sampling

As specific meter testing requirements are provided elsewhere in Michigan's rules, this section will not explore accuracy testing.

Recognizing the logistical challenges of testing metering equipment, especially for large utilities, Michigan provides guidance for sampling procedures that utilities can use in lieu testing every device. Michigan's rules detail acceptable sampling methods, as defined in ANSI/ASQ Standard Z1.9. PSC identified 14 states with similar provisions that enable the use of sampling in meter testing. Only California, Illinois, Indiana, and New York use the same national standard as Michigan. Iowa, New Mexico, Pennsylvania, and South Carolina reference ANSI Standard C.12 related to the use of sampling in meter tests. Wisconsin is the only other state that uses a national standard for sampling procedures—Military Standard 414 (State of Wisconsin 2019). Connecticut, Kentucky, North Carolina, Oklahoma, and Oregon have provisions for sampling meters that do not reference a specific national standard.

- **Connecticut:** Provides that companies maintaining a high degree of meter accuracy can employ a sampling method that will allow selective testing of meters (State of Connecticut n.d.a)
- **Kentucky:** Enables utilities to adopt a scientific sample meter testing plan subject to approval by state regulators (State of Kentucky 2019)
- **North Carolina:** Allows utilities to use statistical sampling program in lieu of the periodic testing program (NCUC 2019)
- **Oregon:** Enables utilities to seek approval for a random sampling technique for testing new meters (State of Oregon n.d.)

North Carolina also details various probabilities and other statistical values that the tested equipment should achieve. However, Michigan is unique in this category because of its level of detail provided to utilities regarding acceptable sampling processes.

Testing Frequency

The testing schedules for metering equipment vary widely across benchmarked states, especially given the range of equipment types (Exhibit 25). Some states, such as Oregon and Texas, have unspecified testing schedules, leaving regular testing to be determined through national standards or by state regulators. Other states, like Kentucky, have specific testing schedules for different categories of equipment. New York is unique in that it provides a high level of flexibility in testing requirements for different types of metering equipment. California is the only state that does not provide testing frequency requirements by the type of equipment; instead, it uses customer characteristics to define testing schedules. Finally, some states, like Pennsylvania and Wisconsin, have many technologies and various equipment schedules in their rules.

EXHIBIT 25. Meter Testing Frequency Standards

State	Equipment Type	Testing Frequency
Michigan	**Watt-hour Meters**	
	Single-phase instrument-rated electromechanical meter (surge resistant)	12.75 years
	Single-phase instrument-rated electromechanical (nonsurge resistant)	8.75 years
	Self-contained electromechanical and solid-state three-phase meters and associated equipment	10.75 years
	Transformer-rated electromechanical and solid-state three-phase meters and associated equipment	6.75 years
Illinois	**AC Watt-hour Meters and Associated Var-hour Meters**	
	Self-contained single-phase and three-wire network (nondemand)	8 years
	Self-contained single-phase and three-wire network (demand, pulse-operated electronic demand registers)	4 years
	Self-contained single-phase and three-wire network (demand, surge-proof magnets or solid state)	8 years
	Watt-hour Meters	
	Self-contained 480 V single-phase and polyphase meters; transformer-rated single-phase meters (nondemand, with surge-proof magnets)	8 years
	Self-contained 480 V single-phase and polyphase meters; transformer-rated single-phase meters (nondemand, without surge-proof magnets)	4 years
	Self-contained 480 V single-phase and polyphase meters; transformer-rated single-phase meters (demand, mechanical with pulse-operated electronic demand registers)	4 years
	Self-contained 480 V single-phase and polyphase meters; transformer-rated single-phase meters (demand, with surge-proof magnets or solid state)	8 years
	Transformer-rated polyphase	8 years
	Direct-current (DC) watt-hour meters	12 years

State	Equipment Type	Testing Frequency
	Watt-hour meters	16 years
	Electromechanical Watt-hour Meters with Surge-proof Magnets and the Following:	
	Mechanical kWh registers	16 years
	Mechanical demand registers	8 years
	Electronic demand registers	16 years
	Mechanical cam pulse initiators	2 years
	Mechanical gear shutter pulse initiators	8 years
	Electronic pulse initiators	12 years
	Electronic registers	16 years
	Thermal demand registers	8 years
	Electronic meters	16 years
New Jersey	**DC Watt-hour Meters**	
	Up to 6 kW	3.5 years
	6 kW to 100 kW	1.5 years
	Over 100 kW	1 year
Wisconsin	**Watt-hour Meters**	
	Self-contained single-phase meters and three-wire network meters (nonmagnetic-bearing meters)	4.5–5.5 years
	Self-contained single-phase meters and three-wire network meters (magnetic-bearing, surge-proof meters)	19.5–20.5 years
	Self-contained polyphase meters (surge proof)	11.5–12.5 years
	Self-contained polyphase meters (nonsurge proof)	7.5–8.5 years
	Meters used with instrument transformers on single-phase service (surge proof)	11.5–12.5 years
	Meters used with instrument transformers on single-phase service (nonsurge proof)	7.5–8.5 years
	Lagged demand meters	8 years
	Polyphase electromechanical and solid-state electronic meters used with instrument transformers (nonmagnetic-bearing electromechanical meters)	1.75–2.25 years
	Polyphase electromechanical and solid-state electronic meters used with instrument transformers (magnetic-bearing surge-proof meters)	3.75–4.25 years
	Solid-state electronic meters with electronic registers capable of downloading voltage and current monitoring readings from the instrument transformers to digital meter-reading devices	5.75–6.25 years
North Carolina	**Watt-hour Meters**	
	Two- and three-wire commutating type and mercury type (≤50 A-rated capacity)	1.5 years
	Two- and three-wire commutating type and mercury type (>50 A-rated capacity)	1 year

State	Equipment Type	Testing Frequency
	Two- and three-wire single-phase induction type	8 years
	Self-contained polyphase	6 years
	Connected polyphase	4 years
Pennsylvania	**Watt-hour Meters**	
	Two- and three-wire single-phase induction type (rated test current > 50 amps)	8 years
	Two- and three-wire single-phase induction-type (≤ 50 amps, manufactured pre-1940, not class I and II temperature-compensated, nonsurge-proof magnets/shields)	3 years
	Two- and three-wire single-phase induction type (≤ 50 amps, class I and II temperature-compensated, surge-proof magnets/shields)	15 years
	Two and three-wire single-phase induction-type (≤ 50 amps, manufactured post-1959, class I and II temperature-compensated, surge-proof magnets/discharge gaps/shielded magnetic-bearing system)	20 years
	Self-contained polyphase (without surge-proof magnets)	8 years
	Self-contained polyphase (with surge-proof magnets)	16 years
	Connected single phase (without surge-proof magnets)	8 years
	Connected single phase (with surge-proof magnets)	16 years
	Connected polyphase (without surge-proof magnets)	8 years
	Connected polyphase (with surge-proof magnets)	16 years
Kentucky	**Watt-hour Meters**	
	Self-contained, single phase	8 years
	Self-contained three-wire network	
	Self-contained polyphase	6 years
	Meters with instrument transformers	
	Single phase	6 years
	Polyphase	4 years
	Instrument transformers	Same as associated watt-hour meter
	DC Watt-hour Meters	
	Up to and including 6 kW	4 years
	6 kW–100 kW	2 years
	More than 100 kW	1 year
Oklahoma	**Watt-hour Meters**	
	Polyphase	At least once every 16 years
	Single phase	
	Self-contained, single phase	

State	Equipment Type	Testing Frequency
	Self-contained, single-phase, and three-wire network	
	Var-hour meters	Same as associated watt-hour meter
	Other Meters	
	Meters without surge-proof magnets and without demand registers or pulse initiators	8 years
	Demand Meters	
	Block-interval demand registers equipped with watt-hour meters and surge-proof magnets	12 years.
	Block-interval demand registers equipped with watt-hour meters and without surge-proof magnets	8 years
	Block-interval graphic watt-hour demand meters	2 years
	Lagged demand meters	2 years
	Pulse recorders and pulse-operated demand meters in combination with pulse initiator–equipped watt-hour meters	2 years
New York	Watt-hour meters	8 years
New Mexico	**Alternating Current (AC) Watt-hour Meters**	
	Meters used with instrument transformers: polyphase meters	8 years
	Self-contained polyphase meters	6 years
	Self-contained, single-phase meters	8 years
	Self-contained, single-phase meters and three-wire meters	Subject to ANSI C.12
	Var-hour meter	Same as associated watt-hour meter
	Demand Meters	
	Block-interval nonrecording demand meters and registers	Same as associated watt-hour meter
	Block-interval graphic watt-hour demand meters	2 years
	Block-interval pulse-operated recording demand meters	2 years
	Lagged-demand meters	Same as associated watt-hour meter
	Instrument transformer	Subject to ANSI C.57.13
California	**All Meters**	
	Customer's annual usage of >2 million kWh	1 year
	Customer's annual usage between 720,000 kWh and 2 million kWh	2 year

State	Equipment Type	Testing Frequency
	Nonresidential customer's annual usage <720,000 kWh	Annual statistical sample plan
	Residential meters	Either a formal sampling plan performed annually, or tests done upon request and removal, where applicable
	DC meters	
Missouri	**Watt-hour Meter Manufactured Before 1927**	
	Induction-type meters having rated current capacity <50 amperes	5 years
	Induction-type meters having rated current capacity >50 amperes	2 years
	Watt-hour Meter Manufactured from 1927 to 1936	
	Induction-type meters having rated current capacity <50 amperes	8 years
	Induction-type meters having rated current capacity >50 amperes	2.5 years
	Commutator-type meters with rated current capacities >50 amperes and voltage ratings <250 volts	2 years
	All other meters	1 year
	Induction-type meters manufactured during and since 1937	20 years
Oregon	Subject to approval by state regulators	
Washington	Subject to approval by state regulators	
South Carolina	Subject to ANSI Standard C.12	
Texas	Subject to ANSI Standard C.12	
Connecticut	Subject to ANSI Standard C.12	
Iowa	Frequency of inspection and methods of testing shall be based on the utility's experience, manufacturer's recommendations, and accepted good practice (ANSI Standard C.12)	

Sources: MPSC n.d.b; State of Illinois n.d.b; State of New Jersey n.d.; State of Wisconsin 2019; NCUC 2019; Commonwealth of Pennsylvania n.d.; State of Kentucky 2019; State of Oklahoma 2019; State of New York n.d.; State of New Mexico n.d.; State of California; n.d.; State of Missouri 2019; State of Oregon n.d.; State of Washington 2019; State of South Carolina 2019; PUCT n.d.; State of Connecticut n.d.a; State of Iowa 2020

R 460.3614: Standards Check by the Commission

Michigan Standard

> **Rule 614:** "(1) Upon request of the commission, a utility shall submit one of its portable standard watt-hour meters and one portable indicating voltmeter, ammeter, and wattmeter to a commission-approved standards laboratory for checking of their accuracy.
>
> (2) A utility shall normally check its own working portable standard watt-hour meters or instruments against primary or secondary standards and shall calibrate these working standards or instruments before they are submitted with a record of such calibration attached to each of the working standards or instruments"(MPSC n.d.b, 21–22).

Rule 612 establishes requirements for utilities to periodically test equipment standards. This rule applies an additional layer of verification to standards testing, enabling the MPSC to request standards be checked by an approved laboratory, which provides an independent verification of standards.

Benchmarked State Standards

State regulators' ability to request utilities to submit standards for testing has been adopted in ten of the benchmarked states. The procedure and timing for these checks vary somewhat, but, overall, states have provided flexibility for regulators to periodically assess standards equipment in use.

While Connecticut, Illinois, Indiana, Kentucky, New Mexico, Oklahoma, Pennsylvania, South Carolina, Texas, and Wisconsin all enable regulators to play a role in checking equipment, they all maintain different approaches. For example, New Mexico requires testing facilities be "open for inspection by authorized representatives of the commission at all reasonable times, and the facilities and equipment as well as the methods of measurement and testing employed shall be subject to the approval of the commission" (State of New Mexico n.d.). Unlike Michigan, New Mexico's standard does not say that utilities have to submit a set amount of standards; however, it does define state regulators' broad authority to inspect facilities and oversee testing procedures.

Other states, like Illinois, maintain a more straightforward approach, allowing authorized representatives to "check or establish the accuracy of all testing equipment owned by each MSP that is used for testing metering equipment used or intended for use in this state, as well as the methods of operating such equipment." (State of Illinois n.d.a) This representative must conduct an annual "audit of each MSP's testing equipment and methods at least every three years" (State of Illinois n.d.a).

State regulators' authority to order standards checks is not as clear in Oregon and New York. These states have provisions that outline the role that regulators play in establishing testing procedures, but do not specify the role regulators can play in ongoing monitoring.

R 460.3615: Metering Equipment Records

Michigan Standard

Rule 615: "(1) A utility shall maintain a complete record of the most recent test of all metering equipment. The record must show all of the following information:

a) Identification and location of unit.
b) Equipment with which the device is associated.
c) The date of test.
d) Reason for the test.
e) Readings before and after the test.
f) A statement as to whether or not the meter creeps and, in case of creeping, the rate.
g) A statement of meter accuracies before and after adjustment sufficiently complete to permit checking of the calculations employed.
h) Indications showing that all required checks have been made.
i) A statement of repairs made, if any.
j) Identification of the testing standard and the person making the test.

(2) The utility shall also keep a record of each unit of metering equipment which shows all of the following information:

a) When the unit was purchased.
b) The unit's cost.
c) The company's identification.
d) Associated equipment.
e) Essential nameplate data.
f) The date of the last test. The record must also show either the present service location with the date of installation or, if removed from service, the service location from which the unit was removed with the date of removal" (MPSC n.d.b, 22).

Record keeping for metering equipment and testing is an important part of preserving accuracy and consistency for service delivery. Rule 615 establishes the required information that must be reported for all meters.

Benchmarked State Standards

There are two primary types of metering information collected by utilities—meter testing records and meter equipment records. Testing records identify a meter and provide information related to its accuracy, past performance, and any previous adjustments to correct errors. Meter equipment records include information about the meter itself, such as date purchased, associated equipment, and ownership. Michigan's standard requires reporting on ten variables related to meter testing and six for meter equipment. While these requirements vary, PSC found 16 states with similar standards: Connecticut, Illinois, Indiana, Iowa, Kentucky, Missouri, New Jersey, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Washington, and Wisconsin. Even within these states, the requirements range in the level of detail required.

- **Kentucky**: Requires detailed reporting of meter test and equipment records. Kentucky's rule is similar to Michigan's in content and structure, providing lists of required information for meter testing and adjustment, as well as records for meter equipment (State of Kentucky 2019).

Oklahoma: Requires meter equipment and testing records, but is less specific than Kentucky and Michigan. This is because the rule does not request specific information related to the reason for meter tests, any repairs made after the test, or the testing standard used. Additionally, Oklahoma provides limited specific requirements for meter records (State of Oklahoma 2019).North Carolina and Oregon both require utilities to maintain meter test records, but do not have specific provisions covering meter equipment data (NCUC 2019; State of Oregon n.d.).

R 460.3616: Average Meter Error; Determination

Michigan Standard

Rule 616: "If a metering installation is found upon any test to be in error by more than 2 percent at any test load, the average error shall be determined in one of the following ways:

a) If the metering installation is used to measure a load which has practically constant characteristics, such as a streetlighting load, the meter shall be tested under similar conditions of load and the accuracy of the meter 'as found' shall be considered as the average accuracy.

b) If a single-phase metering installation is used on a varying load, the average error shall be the weighted algebraic average of the error at light load and the error at heavy load, the latter being given a weighting of four times the former.

c) If a polyphase metering installation is used on a varying load, the average error shall be the weighted algebraic average of its error at light load given a weighting of one, its error at heavy load and 100 percent power factor given a weighting of four, and at heavy load and 50 percent lagging power factor given a weighting of two.

d) If a load, other than the light, heavy, and low power factor load specified for routine testing, is more representative of the customary use of the metering equipment, its error at that load shall also be determined. In this case, the average error shall be computed by giving the error at such load and power factor a weighting of three and each of the errors at the other loads (light, heavy, and 50 percent lagging power factor) a weighting of one. Each error shall be assigned its proper sign" (MPSC n.d.b, 22–23).

Michigan has several standards in place for calculating average meter errors based on the type of meter and different load characteristics. These standards apply to one of four categories:

- The meter serves consumption that is practically constant (e.g., streetlighting)
- Single-phase meters that serve varying load
- Polyphase meters that serve varying load
- Cases where a normal use pattern can be established

Benchmarked State Standards

Michigan is one of 12 states included in this analysis that has established calculations for determining average meter error through state standards. However, the majority of examined states only include one method for calculating average meter error for watt-hour meters. PSC observed four approaches to calculating this type of average meter.

Meters Serving Varying Load

Iowa, Michigan, New Mexico, Oklahoma, and Wisconsin all employ the same method for determining average meter error. Utilities must first determine meter error at low load and heavy load. Then, the heavy-load error is weighted at four times the light-load error. Finally, the algebraic average of these errors is calculated to establish the average meter error.

Five states—Connecticut, Illinois, New York, Pennsylvania, and South Carolina—use a similar approach to determine the average meter error, but instead of calculating the light-load average and weighted heavy-load errors, the combined errors are divided by five to establish the average meter error. Examples of these standards include the following:

- **Connecticut:** The average error of the meter shall be computed by taking one-fifth of the algebraic sum of the error at light load and four times the error at heavy load (State of Connecticut n.d.a).
- **New York:** The final average percentage registration of a watt-hour meter shall be determined by multiplying the average of the test results at heavy load by four, adding the average of the test results at light load, and dividing the total by five (Sate of New York 2003).
- **Pennsylvania:** Average error is determined as follows: If the meter is used to measure a substantially constant load, the meter shall be tested at that load. The error of the meter at the constant load shall be accepted as the average meter error. If the meter is used to measure a variable load, the average error shall be obtained by taking one-fifth of the algebraic sum of both of the following: One part of the error at light load and four parts of the error at heavy load (Commonwealth of Pennsylvania 2019).

Two other approaches for calculating average meter errors were found. These approaches vary slightly from the two previously described.

- **Kentucky:** Does not require the heavy-load meter error to be weighted, and average meter error is determined by dividing the combined light and heavy-load errors by two (State of Kentucky 2019).
- **North Carolina**: Introduces another variable that resembles Section D of Rule 616 and is not included in any of the other standards reviewed. All of the other average meter error determinations are only based on error readings at low- and high-load conditions. North Carolina requires meter errors at the normal load level also be included. The normal load error level is weighted by three before being added to the low- and high-load errors. The total error amount is then divided by five (NCUC 2019).

Pennsylvania and Wisconsin include standards for calculating average meter error when consumption for the meter is practically constant. In these cases, the meter error measurement shall be accepted as the average meter error (Commonwealth of Pennsylvania 2019; State of Wisconsin 2019).

Only Wisconsin's standards include provisions related to determining average errors for polyphase meters:

> "Whenever a metering installation is found upon any test to be in error by more than 2 percent at any test load, the average error shall be determined in one of the following ways:
>
> (1) If the metering installation is used to measure a load, which has practically constant characteristics, such as a streetlighting load, the meter shall be tested under similar conditions of load and the accuracy of the meter 'as found' shall be considered as the average accuracy.
> (2) If a single-phase metering installation is used on a varying load, the average error shall be the weighted algebraic average of the error at light load and the error at heavy load, the latter being given a weighting of four times the former.
>
> (3) If a polyphase metering installation is used on a varying load, the average error shall be the weighted algebraic average of its error at light load given a weighting of one, its error at heavy load and 100 percent power factor given a weighting of four and at heavy load, and 50 percent lagging power factor given a weighting of two.
> (4) If a load, other than the light-, heavy-, and low-power factor load specified for routine testing, is more representative of the customary use of the metering equipment, its error at that load should also be determined. In this case, the average error is to be computed by giving the error at such load and power factor a weighting of three and each of the errors at the other loads (light-, heavy-, and 50-percent lagging power factor) a weighting of one. Each error shall be assigned its proper sign" (State of Wisconsin 2019).

R 460.3617: Reports to Be Filed with the Commission

Michigan Standard

Rule 617: "(1) A utility shall file, with the commission, within 30 days after the first day of January of each year, an officer-certified statement that the utility has complied with all of the requirements set forth in these rules relating to meter standardizing equipment.

(2) For all meters that are not included in the provisions of R 460.3613(2)(b), the utility shall file, with the commission, on or before the first day of April of each year, its annual tabulation of all of its prior-to-adjustment meter test results covering the 12-month period ending December 31. The utility shall summarize, by meter type, all individual meters and overall light and heavy load prior-to-adjustment test results at the power factors required by these rules. The summary shall be divided into heavy-load 100 percent power factor, light-load 100 percent power factor, and heavy-load 50 percent power factor test results and shall also be divided according to the length of meter test period and types of single-phase and polyphase meters. The summary shall show the number of meters or overall tests found within each of the following accuracy classifications:

a) No recording.

b) Creeping.
c) Equal to or less than 94.0 percent.
d) 94.1 to 96.0 percent.
e) 96.1 to 97.0 percent.
f) 97.1 to 98.0 percent.
g) 98.1 to 99.0 percent.
h) 99.1 to 100.0 percent.
i) 100.1 to 101.0 percent.
j) 101.1 to 102.0 percent.
k) 102.1 to 103.0 percent.
l) 103.1 to 104.0 percent.
m) 104.1 to 106.0 percent.
n) Over 106.0 percent.

When a utility is subject to multiple state jurisdictions, these accuracy classifications may be modified with the approval of the commission.

(3) For all meters that are included in the provisions of R 460.3613(2)(b), the utility shall file, with the commission, on or before the first day of April, all of the following information:

a) A summary of all samples of meter lots that pass the acceptability criteria as set forth in ANSI/ASQC Z1.9-1980, including complete data on all of the following: (i) The type of meter. (ii) The number of meters in a lot. (iii) The size of the sample. (iv) The average months in service since the last test. (v) The computed p (total estimated percent defective in lot). (vi) The corresponding M (maximum allowable percent defective) as determined from table B-3 in ANSI/ASQC Z1.9-1980.

b) The necessary calculations made pursuant to Example B-3 of ANSI/ASQC Z1.9-1980 shall be retained for each sample or resample drawn. In addition to the actual computation, the data shall include all of the following: (i) The type of meter. (ii) The number of meters in the lot. (iii)The meter numbers of sample meters. (iv) The actual prior-to-adjustment test data of each meter tested. (v) The number of months since the last test for each meter in the sample. A sample of the calculations and data for a lot that passes the acceptability criteria shall be included in the report to the commission.

c) A copy of the complete data, as outlined in this subrule, shall be included for each meter lot that is not in compliance with the acceptability criteria of the sampling plan employed as set forth in ANSI/ASQC Z1.9-1980.

d) A report summarizing the testing of all meters in rejected lots that are to be returned to service. The heavy load preadjustment tests only shall be recorded, and the accuracy classifications as established in subrule (2) of this rule shall be used. Each rejected lot shall be reported separately and shall be separated into groups by the number of months since the last test as follows: (i) 0 to 48 months. (ii) 49 to 72 months. (iii) 73 to 96 months. (iv) More than 96 months" (MPSC n.d.b, 23–24).

Rule 617 directs Michigan utilities to file an annual report with the MPSC by April 1. The report must include meter test results covering the prior calendar year. The rule also prescribes how the summary of meter types and testing results should be divided, what format the data should be reported in, and a summary of the testing results from meters in rejected lots that are to be returned to service.

Benchmarked State Standards

Of the 25 states PSC reviewed, only 16 included reporting requirements for meter testing (discussed in the previous section). Despite the number of states where testing is required, only two have requirements for annual reporting of meter testing records: Illinois and New Jersey.

- **Illinois:** Each utility shall compile a report of all meter accuracy test results at least once a year that includes the number of meters tested and the number of meters that tested outside of accuracy limits for each of the following categories: sample testing, periodic testing, and at customer request. Each utility must keep copies of their report for at least eight years (State of Illinois n.d.b).
- **New Jersey:** State standards require utilities to supply records of all meter tests to state regulators but do not specify a timeline (State of New Jersey n.d.).

The other 14 states require that meter testing records be gathered and maintained, but do not expressly require states to file this information. Several states detail how this information should be maintained and made available to state regulators.

- **Connecticut:** Meter test records shall be preserved for at least two years, or until a new test record has been obtained, and state regulators can request these records (State of Connecticut n.d.a).
- **Indiana:** Its rule provides guidance to utilities on what should be included in a meter testing record; however, it also leaves the possibility for the Indiana Utility Regulatory Commission to request annual reports at any point in the future. When required by the commission, utilities must provide annual result tabulations of all meter tests, and arrange them by average accuracy (State of Indiana 2020).
- **New Mexico:** If state regulators request meter testing data, the utility has ten business days to provide all of this data for the past year (State of New Mexico n.d.).

R 460.3618: Generating and Interchange Station Meter Tests; Schedule; Accuracy Limits

Michigan Standard

Rule 618: "(1) Generating and interchange station and watt-hour meters shall be tested in conjunction with their associated equipment as follows:

a) At least once every 24 months for generating station meters.
b) At least once every 12 months for interchange meters.

(2) The accuracy limits for any particular device shall not be greater than the accuracy limits required elsewhere in these rules" (MPSC n.d.b, 24–25).

Michigan also has standards for generating and interchanged meters that establish testing frequencies and accuracy requirements.

Benchmarked State Standards

Only five states have a standard related to generating or interchange station meters. Wisconsin and Kentucky's standards refer to meters for generation that are installed to serve a single customer. Indiana, New Mexico, and Texas' standards have more in common with Michigan's and reference metering equipment located at all of a utility's generating equipment.

Part Seven: Standards of Quality Service

R 460.3701: AC Systems; Standard Frequency

Michigan Standard

Rule 701: "The standard frequency for AC systems shall be 60 hertz (Hz). The frequency shall be maintained within limits that will permit the satisfactory operation of customers' clocks, which are connected to the system" (MPSC n.d.b, 25).

Maintaining the grid's operation requires careful frequency regulation. Michigan's Rule 701 establishes a requirement for utilities to maintain their AC systems within limits and establishes a standard frequency of 60 Hz.

Benchmarked State Standards

Of 25 states reviewed, 15 have standards for the operating frequency of their electric systems. Ten states use the same 60-Hz standard as Michigan: Connecticut, Indiana, Iowa, Kentucky, New Mexico, Ohio Oklahoma, South Carolina, Texas, and Washington. Only Iowa and New Mexico specifically reference the role this standard frequency plays in ensuring operation of clocks connected to the system. Examples of state standards are provided below:

- **Indiana**: Each public utility supplying AC shall adopt a standard nominal frequency of 60 Hz. Momentary variations of frequency of more than 5 percent, which are clearly due to no lack of proper equipment or reasonable care on the part of the public utility, shall not be considered in violation of this rule (State of Indiana 2020).
- **Iowa**: The standard frequency for AC distribution systems shall be 60 cycles per second. The frequency shall be maintained within limits that will permit the satisfactory operation of customer's clocks connected to the system (State of Iowa 2020).
- **Ohio**: Each electric utility supplying AC shall adopt a standard frequency of 60 Hz; this standard frequency shall be stated in the electric utility's tariff (State of Ohio n.d.).
- **Washington**: Any electric utility supplying AC must design and maintain its distribution system for a standard operating frequency of 60 cycles per second under normal operating conditions (State of Washington 2019).

Illinois, New Jersey, North Carolina, Pennsylvania, and Wisconsin have standards for frequency operations as well, but these standards are not set at 60 Hz. Instead, these states allow utilities to operate their systems in accordance with other suitable standards reviewed by state regulators. Only Wisconsin's standard references a specific national standard—ANSI C.84.1-1989—which establishes nominal voltages and operating tolerances for electric power systems.

R 460.3702: Standard Nominal Service Voltage; Limits; Exceptions

Michigan Standard

Rule 702: "(1) Each utility shall adopt and submit standard nominal service voltages.

(2) With respect to secondary voltages, the following provisions shall apply:

a) For all retail service, the variations of voltage shall be not more than 5 percent above or below the standard nominal voltage as submitted pursuant to subrule (1) of this rule, except as noted in subrule (4) of this rule.

b) Where three-phase service is provided, the utility shall exercise reasonable care to ensure that the phase voltages are balanced within practical tolerances.

(3) With respect to primary voltages, the following provisions shall apply:

a) For service rendered principally for industrial or power purposes, the voltage variation shall not be more than 5 percent above or below the standard nominal voltages as submitted pursuant to subrule (1) of this rule, except as noted in subrule (4) of this rule.

b) The limitations in subdivision (a) of this subrule do not apply to special contracts in which the customer specifically agrees to accept service with unregulated voltage.

(4) Voltages outside the limits specified in this rule shall not be considered a violation if the variations are infrequent fluctuations or occur from adverse weather conditions, service interruptions, causes beyond the control of the utility, or voltage reductions that are required to reduce system load at times of supply deficiency or loss of supply" (MPSC n.d.b, 25).

Rule 702 establishes standard primary and secondary service voltages as well as limits for voltage variations. Additionally, the standard provides for exceptions to voltage limits in cases of adverse weather, service interruptions, and other factors.

Benchmarked State Standards

The establishment of standard service voltages through statewide rules is a common practice. Of the benchmarked states, 19 have such standards. Generally, these states take a similar approach, establishing a range of acceptable voltage variations for residential service and a wider range of voltage variation for large customers (primary voltages or industrial consumers).

- Ten states—Connecticut, Indiana, Kentucky, Minnesota, New Jersey, North Carolina, Oklahoma, Oregon, Pennsylvania, and Wisconsin—use a standard voltage variation range of plus or minus 5 percent in relation to residential service (State of Connecticut n.d.a; State of Indiana 2020; State of Minnesota 2009; State of New Jersey n.d.; Commonwealth of Pennsylvania n.d.; State of Wisconsin 2019; NCUC 2019; State of Oklahoma 2019; State of Oregon 2019).
- Iowa and South Carolina allow larger voltage variations for standard service at 7.5 percent and 10 percent, respectively (State of Iowa 2020; State of South Carolina 2019).
- Nine states—Connecticut, Illinois, Kentucky, Missouri, North Carolina, Oklahoma, Pennsylvania, Texas, and Wisconsin—have an established voltage variation range for nonstandard voltages, allowing

up to a 10 percent positive or negative variation (State of Connecticut n.d.a; State of Illinois n.d.b; State of Kentucky 2019; State of Missouri 2019; NCUC 2019; State of Oklahoma 2019; PUCT n.d.; Commonwealth of Pennsylvania n.d.; State of Wisconsin 2019).

In addition to establishing acceptable voltage ranges, state standards also indicate an acceptable time period for variations. Iowa, New Jersey, and New Mexico require that variations do not exceed five minutes, while Illinois requires variations last less than two minutes (State of Iowa 2020; State of New Jersey n.d.; State of New Mexico n.d.; State of Illinois n.d.b).The states with the strictest standards for voltage variation are Connecticut and Missouri, which require variations be less than one minute (State of Connecticut n.d.a; State of Missouri 2019).

Six states—Connecticut, Minnesota, New Mexico, Oklahoma, Texas, Wisconsin—have service voltage rules that specifically reference ANSI Standard C84.1. Oklahoma's rules include a table for standard voltages and the tolerable ranges of variation to conform to the current version of ANSI Standard C84.1 b (Exhibit 26).

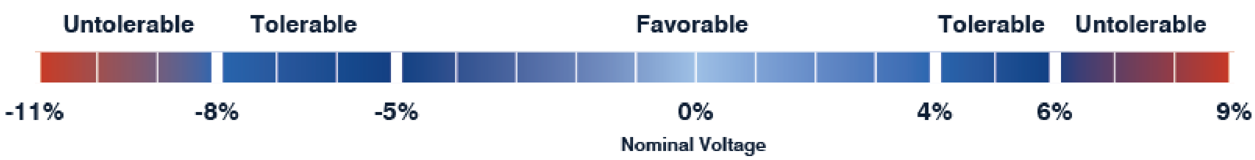
EXHIBIT 26. Oklahoma Voltage Limits

	Preferred Voltage Range		Tolerable Voltage Range	
Normal Voltage	**Minimum**	**Maximum**	**Minimum**	**Maximum**
120	114	126	110	127
208Y/120	197Y/114	218Y/126	191Y/110	220Y/127
240/120	228/114	252/126	220/110	254/127
208	197	218	191	220
416Y/240	395Y/228	436Y/252	381Y/220	440Y/254
480/240	456/228	504/252	40/220	508/254
460Y/265	437Y/252	483Y/279	422Y/244	487Y/281
480Y/277	456Y/263	504/Y291	440Y/254	508Y/293
440	418	462	403	466
480	456	504	440	508
832Y/480	790Y/456	873Y/504	762Y/440	880Y/508
600	570	630	550	655

Source: State of Oklahoma 2019

Similarly, Missouri describes voltage ranges in terms of preferred, tolerable, and untolerable, as shown in Exhibit 27.

EXHIBIT 27. Missouri's Acceptable Voltage Range



Source: State of Missouri 2019

R 460.3703: Voltage Measurements and Records

Michigan Standard

Rule 703: "(1) A utility shall make voltage measurements at the utility's service terminals.

(2) Each utility shall make a sufficient number of voltage measurements, using recording voltmeters, to determine if voltages are in compliance with the requirements stated in R 460.3702. For installations in which the meter measures voltage variations, measurements using recording voltmeters are not necessary unless records of the measurements through the meter are not available.

(3) All records obtained under subrule (2) of this rule must be retained by the utility for not less than two years and must be available for inspection by the commission's representatives. The records shall indicate all of the following information:

a) The location where the voltage was measured.
b) The time and date of the measurement.
c) For installations without meters that measure voltage variations, the results of the comparison with an indicating voltmeter at the time a recording meter is set" (MPSC n.d.b, 25–26).

To ensure compliance with the voltage variation standards described in Rule 702, Rule 703 requires utilities to make periodic voltage measurements and retain records of these readings, including where the measurement was taken and a comparison of an indicating voltmeter reading to a recording meter set.

Benchmarked State Standards

While 19 benchmarked states have service voltage standards in place, only 13 of these have standards requiring voltage measurement and record keeping: Illinois, Indiana, Iowa, Kentucky, Missouri, New Mexico, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Texas, and Wisconsin. The six remaining states—Connecticut, Minnesota, New Jersey, New York, Oklahoma, and Washington—do not specify voltage reading/measurement or record-keeping procedures.

State standards for voltage measurement and records are closely aligned with Michigan's. Examples include:

- **Illinois**: "Each entity shall make voltage surveys of its system to inform itself of the character of the service being furnished from the system. Such surveys may be made by recording instruments, analytical methods, or a combination of these. All charts or readings taken, or analyses made in voltage surveys, shall be retained for at least five years and kept in a systematic manner. The entity shall record the date, hour, and place of the test, distance from and the size of the transformers, the instruments used, and the name of the person making the test" (State of Illinois n.d.b).
- **Indiana**: "Each public utility shall have available suitable voltage measuring equipment to conduct voltage surveys in sufficient number and diversity to satisfy the commission of the utility's compliance with the voltage requirements" (State of Indiana 2020).
- **New Mexico**: "Each utility shall make a reasonable number of voltage measurements using recording voltmeters or minimum/maximum voltmeters to determine if voltages are in compliance with the requirements as stated in Subsection B of 17.9.560.15. Voltage measurements shall be made at the customer's point of metering and at other pertinent locations on the utility system. All voltmeter records obtained under (1) and (2) above shall be retained by the utility in accordance with 17.3.310 New Mexico Administrative Code and shall be available for inspection by the commission's representatives. Notations on each record shall indicate the following:
    - The location where the voltage was taken
    - The time and date of the test
    - The results of the comparison with an indicating voltmeter" (State of New Mexico n.d.)
- **Oregon**: "Each electric company shall make a sufficient number of voltage surveys to indicate the service furnished is in compliance with the standard as indicated under section one of this rule. Each electric company shall keep a complete record of each test of voltage and service conditions, as made under these rules, and this record shall be accessible to the commission or its authorized representatives. Each record of tests of voltage or service conditions so kept shall contain complete information concerning the test, including such items as the commission may from time to time require" (State of Oregon n.d.).

R 460.3704: Voltage Measurements; Required Equipment; Periodic Checks; Certificate or Calibration Card for Standards

Michigan Standard

Rule 704: "(1) Each utility shall have access to at least one indicating voltmeter that has a stated accuracy within 0.25 percent of full scale. The instrument shall be maintained within its stated accuracy.

(2) Each utility shall have not less than two indicating voltmeters that have a stated accuracy within 1.0 percent of full scale.

(3) Each utility shall have not less than two portable recording voltmeters, or their electronic equivalent, with a stated accuracy within 1.5 percent of full scale.

(4) Standards shall be checked in accordance with R 460.3612.

(5) Working instruments shall be checked in accordance with R 460.3610.

(6) Each standard shall be accompanied at all times by a certificate or calibration card, duly signed and dated, on which the corrections required to compensate for errors found at the customary test points at the time of the last test are recorded" (MPSC n.d.b, 26).

Ensuring voltage can be effectively measured and managed within prescribed standards requires accurate measuring devices. Rule 704 outlines utility requirements to maintain accurate voltmeters to measure voltage in accordance with accuracy standards (Rule 612).

Benchmarked State Standards

Michigan's standard for voltmeters shares several key elements with 16 states in this analysis. These states—Connecticut, Illinois, Indiana, Iowa, Kentucky, Missouri, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, Texas, Washington, and Wisconsin—vary across several elements, including the frequency of required testing, the number of voltmeters required to maintain, and the timing for test, but their standards reflect a common approach to accurately measuring voltages.

Review of states' voltage measurement equipment reveals similarities in the composition of standards. For example, Washington's standard for portable indicating instruments requires utilities to check voltmeters be kept in reasonable working order and checked against suitable reference standards. If found to be in error by more than 1 percent, then the utility is required to calibrate the meter and document the adjustments on a calibration card. Utilities must also keep a record of these adjustments (State of Washington 2019).

Wisconsin's standards are also similar to Michigan's, requiring utilities to submit their standard voltmeter for examination at least every two years to ensure accuracy. Each utility in Wisconsin is required to have accurate portable digital indicating recording voltmeters that can measure service voltage supplied to customers; the measuring equipment must be maintained within 0.8 percent accuracy. Wisconsin also requires utilities to have at least one digital recording voltmeter to measure voltage at the point of service (State of Wisconsin 2019).[16]

R 460.3705: Interruptions of Service; Records; Planned Interruption; Notice to Commission

Michigan Standard

Rule 705: "(1) Each utility shall make a reasonable effort to avoid interruptions of service. When interruptions occur, service shall be restored within the shortest time practical, consistent with safety.

(2) Each utility shall keep records of sustained interruptions of service to its customers and shall make an analysis of the records for the purpose of determining steps to be taken to prevent recurrence of the interruptions. The records shall include the following information concerning the interruptions:

[16] Utilities with more than 1,000 customers.

a) Cause.
b) Date and time.
c) Duration.

(3) Planned interruptions shall be made at a time that will not cause unreasonable inconvenience to customers and shall be preceded, if feasible, by adequate notice to persons who will be affected.

(4) Each utility shall promptly notify the commission of any major interruption of service to its customers" (MPSC n.d.b, 26–27).

Rule 705 requires utilities to make efforts to avoid service interruptions and restore service in a timely manner. In the event of a sustained outage, Rule 705 lays out record-keeping procedures for utilities. When utilities have to schedule planned service interruptions, they must provide adequate notice and attempt to avoid inconveniencing their customers.

Several elements of Rule 705 pertaining to service interruptions and interruption reporting are similar to Rules 721 and 722 from the MPSC's *Service Quality and Reliability Standards for Electric Distribution Systems*. As such, this section of the report will focus on planned interruptions and standards for notice as required by Rule 705. For further discussion of Rule 705 sections one and two, please refer to the "Service Quality and Reliability" section of this report.

Benchmarked State Standards

Fifteen states have standards governing utilities' efforts to avoid service interruptions and planned disruption management. These states are Connecticut, Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, New Jersey, New Mexico, Oklahoma, Oregon, Pennsylvania, South Carolina, Washington, and Wisconsin. Separate discussion of utility standards for reestablishing service and planned interruptions are provided below.

Reestablishing Service

Utility standards for reestablishing service in event of an outage share a common element, requiring utilities to make reasonable efforts to restore service with the shortest delay possible. Examples include:

- **Oregon**: Each energy utility shall make reasonable efforts to prevent service interruptions. When interruptions occur, the energy utility shall try to reestablish service with the shortest possible delay, consistent with the safety of its customers and the general public. Each energy utility shall keep a record of any service interruption affecting its whole system, or a major section of it, including a statement of the time, duration, and cause of interruption (State of Oregon n.d.).
- **Pennsylvania**: An electric distribution company shall furnish and maintain adequate, efficient, safe, and reasonable service and facilities, and shall make repairs, changes, alterations, substitutions, extensions, and improvements in or to the service and facilities necessary for the accommodation, convenience, and safety of its patrons, employees, and the public. The service shall be reasonably continuous and without unreasonable interruptions or delay. An electric distribution company shall strive to prevent interruptions. When interruptions do occur, the company must restore service within the shortest reasonable time (Commonwealth of Pennsylvania 2019).

- **South Carolina**: Each electrical utility shall make all reasonable efforts to avoid service interruptions, but when interruptions occur, service shall be reestablished within the shortest time practicable, consistent with safety of its employees, customers, and of the general public. Planned interruptions shall be made at a time that will not cause unreasonable inconvenience to customers and shall be preceded by a reasonable attempt to give adequate notice to those who will be affected (State of South Carolina 2019).

Planned Interruptions

Standards governing utility practice in advance of planned service interruptions vary across a number of factors, such as how much advance notice must be given and the type of communication required. While most states have a requirement for planned outages to minimize inconvenience or hardship for customers, overall, state standards were found to be more robust than those provided in Michigan's Rule 705. Examples include:

- **Indiana**: "Whenever service is intentionally interrupted, the utility shall, except in emergencies, make reasonable attempts to minimize the inconvenience to affected customers. The utility shall make reasonable attempts to notify affected customers in advance of a planned interruption (no more than one hour) for scheduled maintenance or facilities upgrades, consistent with safety and security considerations. This rule does not apply to customer interruptions pursuant to an interruptible tariff or agreement approved by the commission" (State of Indiana 2020).
- **Minnesota**: "Utilities shall give customers the most effective notice possible if a planned service interruption is expected to last longer than 20 minutes. For any planned interruption expected to exceed four hours, the utility shall provide, if feasible, a mailed notice one week in advance and a notice by telephone or door-to-door household visits 12 to 72 hours beforehand. Planned interruptions must be scheduled at times to minimize inconvenience to customers. When planned interruptions exceeding four hours are canceled, utilities shall notify, if feasible, the customers who received notice of the interruption" (State of Minnesota 2009).
- **Oregon**: "Each energy utility shall make reasonable efforts to notify every customer affected in advance of any scheduled work that will interrupt service, but such notice shall not be required in case of interruption due to emergency, repairs, or maintenance work performed by a telecommunications utility resulting in an interruption that is less than five minutes. All scheduled interruptions shall be made at a time causing minimum inconvenience to customers. In determining reasonable notice, the energy utility shall consider the length of the interruption, the type and number of customers affected, the potential impact on customers, and other circumstances. Notice may be given in writing, either via mail or a door hanger, or by contact with the customer or an adult at the residence by personal visit or by telephone" (State of Oregon n.d.).
- **Washington**: "When it is necessary for an electric utility to make repairs to or change its facilities, the utility may, without incurring any liability, suspend service for such periods as may be reasonably necessary and in such a manner as to minimize inconvenience to customers. When practicable, such interruption will be during the working hours maintained by the utility. The utility must individually notify police and fire departments affected by a suspension. All customers affected by a scheduled interruption associated with facilities other than meters will be notified through newspapers, radio announcements, or other means at least one day in advance" (State of Washington 2019).

- **Wisconsin**: "Unless conditions of an actual or potential emergency nature require otherwise, each utility shall strive to give reasonable advance notice to affected customers of each planned service interruption expected to last more than 30 minutes. No such notification is necessary when applying load control or on-peak control systems. Whenever feasible, interruptions expected to last more than one hour and affect more than 100 customers, or interruptions to critical loads, shall be scheduled for periods that cause a minimum of customer inconvenience" (State of Wisconsin 2019).

Part Eight: Safety

R 460.3801: Protective Measures

Michigan Standard

Rule 801: "Each utility shall exercise reasonable care to reduce the hazards to which its employees, its customers, and the general public may be subjected" (MPSC n.d.b, 27).

Rule 801 outlines efforts utilities can take to ensure safety for employees and the general public.

Benchmarked State Standards

Eight of the 25 benchmarked states maintain protective measures for its employees and the public. These states are California, Iowa, Kentucky, New Mexico, Oklahoma, Pennsylvania, South Carolina, and Wisconsin. Though these states have safety standards, only three have provisions that cover broad protective measures. Pennsylvania's standard requires utilities to warn and protect the public, using caution to minimize potential hazards to those affected (Commonwealth of Pennsylvania 2019). Similarly, Iowa and New Mexico's standards include requirements for utilities to exercise reasonable care in protecting the public.

The other five states have requirements tied to other inspection and maintenance practices for utilities. For example, New Jersey's standard requires electric distribution companies to "have inspection and maintenance programs for its distribution facilities, as appropriate, to furnish safe, proper, and adequate service" (State of New Jersey n.d.). California outlines a similar requirement, requiring utilities to "construct, maintain, and operate its line, plant, system, equipment, apparatus, tracks, and premises in a manner so as to promote and safeguard the health and safety of its employees, passengers, customers, and the public" (State of California n.d.).

The majority of states do not have standards that govern protective measures for utilities.

R 460.3802: Safety Program

Michigan Standard

Rule 802: "Each utility shall comply with the provisions of the occupational safety and health act, 29 U.S.C. S651 et seq., and Act No.154 of the Public Acts of 1974, as amended, being S408.1001 et seq. of the Michigan Compiled Laws, and known as the Michigan occupational safety and health act, and shall operate under applicable federal and state health and safety laws and regulations" (MPSC n.d.b, 27).

Rule 802 defines electric utilities' compliance with the Occupational Safety and Health Act (OSHA) and Michigan's Occupational Safety and Health Administration.

Benchmarked State Standards

Only four of the states examined have standards for safety programs that were similar to Michigan's. Of these, only Minnesota directly requires utilities to comply with OSHA standards when constructing, installing, refurbishing, or maintaining facilities (State of Minnesota 2009). New Mexico, Pennsylvania, and South Carolina also had provisions for safety programs; however, these programs outlined safety requirements without referencing OSHA or other state safety standards.

- **Pennsylvania:** The state requires utilities to comply with the minimum safety standards established by the National Electric Safety Code (Commonwealth of Pennsylvania 2019).
- **New Mexico**: The state requires utilities to have a minimum safety program that provides employees with suitable tools and equipment needed to do their job safely, as well as the appropriate training to help protect employees performing hazardous work (State of New Mexico n.d.).
- **South Carolina**: Similar to New Mexico, South Carolina requires utilities to have a minimum safety program to protect workers and the public (State of South Carolina 2019).

R 460.3803: Energizing Services

Michigan Standard

> **Rule 803:** "When energizing services, each utility shall comply with the provisions of all applicable codes and statutory requirements, unless otherwise specified by the commission. The utility may refuse to energize a service if an unsafe condition is observed" (MPSC n.d.b, 27).

Rule 803 establishes requirements for utilities to observe safety standards, including applicable codes and statutory requirements, when turning on service.

Benchmarked State Standards

Illinois, Iowa, New Jersey, New Mexico, North Carolina, Ohio, Oregon, South Carolina, Texas, and Washington have standards that cover utilities' ability to refuse to connect service. While several standards only cover service connection, the majority also cover service disconnection. New Jersey, New Mexico, and Washington separate its policies for service connection and disconnection. For example, Washington's standard states:

> "The utility may refuse to provide new or additional service if: (a) providing service does not comply with government regulations or the electric industry accepted standards concerning the provision of service [or] (b) in the utility's reasonable judgment, the applicant's or customer's installation of wiring or electrical equipment is considered hazardous or of such a nature that safe and satisfactory service cannot be provided" (State of Washington 2019).

Kentucky, North Carolina, and Texas combine standards for service connection and disconnection. Their standards are provided below:

- **Kentucky**: A utility may refuse or terminate service to a customer if the customer has violated the utility's rules, as provided in the utility tariff, or rules established by state regulators. Additionally, if dangerous conditions are present that could result in harm or damage to people or property a utility may refuse service (State of Kentucky 2019).
- **North Carolina**: Utilities can refuse to serve a customer until the customer has complied with appropriate regulations for service and safety (NCUC 2019).
- **Texas**: A retail electric provider may refuse to provide electric service to an applicant or customer for various reasons, including inadequate facilities, hazardous installation or equipment, or noncompliance with applicable state and municipal regulations (PUCT n.d.).

Indiana, Oklahoma, and Wisconsin maintain policies that govern service disconnection. These standards resemble state standards for refusing service connections, but they do not have specific provisions related to safety and compliance with codes and statutes. Wisconsin's standard allows for utility disconnections with no notice, in the event of potential hazards, such as unsafe devices or methods (State of Wisconsin 2019).

R 460.3804: Accidents; Notice to Commission

Michigan Standard

Rule 804: "Each utility shall promptly notify the commission of fatalities and serious injuries that are substantially related to the facilities or operations of the facilities" (MPSC n.d.b, 27).

Benchmarked State Standards

Of the benchmarked states, 20 require utilities to provide notice of accidents to state regulators. These states are California, Connecticut, Illinois[17], Indiana, Iowa, Kentucky, Massachusetts[18], Minnesota, Missouri, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Virginia, Washington, and Wisconsin. The extent of information required for reporting as well as the reporting timeline vary by state.

New Mexico and Oklahoma specify that information related to accidents will only be made available upon request of state regulators. New Mexico's standard does not require specific record-keeping procedures or specify the type of information to report. Instead, utilities must keep summaries of utility-caused accidents and make them available to the commission (State of New Mexico n.d.). Similarly, Oklahoma only requires that utilities maintain "adequate records of accidents" (State of Oklahoma 2019, 62).

Connecticut and Missouri's standards include a requirement that utilities provide notification within one business day of an incident and that formal accident reports are submitted within five business days (State of Connecticut n.d.a; State of Missouri 2019). Oregon also requires immediate notification, but allows utilities to take 20 days before submitting a written report (State of Oregon n.d.).

[17] Accident reporting requirements contained in state statute 220 Illinois Complied Statutes 5/8-507.

[18] Accident reporting requirements provided in the Department of Public Utilities 12-120-D.

North Carolina and Virginia have somewhat limited standards for accident reporting. These states only require utilities to collect information and do not detail reporting to state regulators.

- **North Carolina**: Each utility shall exercise reasonable care to reduce potential hazards to its employees, customers, and the general public. The utility shall reasonably assist the commission in investigating the cause of accidents and determining suitable means to prevent them. Each utility shall maintain a summary of all reportable accidents arising from its operations (NCUC 2019).
- **Virginia**: Utilities must record and maintain records, papers, reports, and statements related to accidents that result in property damages or personal injuries (Commonwealth of Virginia n.d.).

Several states include a requirement for utilities to provide the same reporting that is submitted to OSHA. Examples include:

- **Minnesota**: Each utility shall file a report on its safety performance during the last calendar year. This report shall include at least the following information:
  - Summaries of all reports filed with OSHA and the Occupational Safety and Health Division of the Minnesota Department of Labor and Industry during the calendar year
  - A description of all incidents in the past calendar year that resulted in an injury requiring medical attention or property damage, resulting in compensation as a result of downed wires or other electrical system failures, and all remedial action taken as a result of any injuries or property damage (State of Minnesota 2009)
- **Wisconsin**: Each public utility subject to the accident reporting requirements of OSHA shall provide a safety performance report annually to the commission at the same time it is submitted to OSHA. The report shall include the OSHA incidence rate and lost-time rate. The report shall also include the last three years' average for these rates (State of Wisconsin 2019).

No accident reporting standards were found for Georgia, Kansas, Louisiana, Ohio, and Texas.

Appendix A: State Selection Methodology

To determine what states to include in this report, Public Sector Consultants examined a number of different parameters and developed a list of recommended states. The selection methodology evolved over a number of conversations with the client and Michigan Public Service Commission staff. Discussion of the methodology and state selections are provided below.

Selection Methodology

The goal of the benchmarking analysis was to provide impactful, timely information to stakeholders engaged in discussions regarding Michigan's standards for electric utilities. To accomplish this, PSC sought to identify states that share common characteristics with Michigan and compare them. To this end, PSC compiled data for the following 47 variables, including states' reliability performance, electric industry characteristics, demographics, land use, weather, and infrastructure investments:

Reliability Indices[19]

- 2018 weighted average SAIDI with major event days (MEDs)
- 2018 weighted average SAIFI with MED
- 2018 weighted average CAIDI with MED
- 2018 weighted average SAIDI without MED
- 2018 weighted average SAIFI without MED
- 2018 weighted average CAIDI without MED
- Five-year average SAIDI with MED
- Five-year average SAIFI with MED
- Five-year average CAIDI with MED
- Five-year average SAIDI without MED
- Five-year average SAIFI without MED
- Five-year average CAIDI without MED

Electric Industry Characteristics

- Number of customers, total electric industry
- Total summer nameplate capacity (megawatts)
- Total retail sales (megawatt hours)
- Percentage of customers
- Percentage of retail sales
- Total distribution plant, 2017
- Percentage change in distribution plant, 2010–2018
- Distribution plant average annual growth rate, 2000–2018
- Underground distribution infrastructure as a percentage of total distribution plant
- Average annual distribution operating and maintenance expenses, 2014–2018
- Average annual distribution operating expenses, 2014–2018
- Average annual distribution maintenance expenses, 2014–2018

State Characteristics

- Percentage of state economic output from manufacturing
- Percentage of population living in urban areas
- Total population, 2019
- Percentage change, 1900–1950
- Percentage change, 1950–2000
- Percentage change, 1900–2018
- Percentage change, 2000–2018
- Percentage change, 2010–2018
- Population density, 2010

[19] States' reliability performance was gathered from the U.S. Energy Information Administration and aggregated at the state level. This data set includes utilities reporting on reliability indices developed by the Institute of Electrical and Electronics Engineers.

Tree Cover

- Tree cover per capita (m^2 per resident)
- Percentage of tree cover in urban/ community land
- Percentage of tree cover statewide
- State tree cover (hectares)
- State tree cover (square meters)
- State tree cover per utility customer (m^2 per customer)

Storms and Weather

- Electric emergency incident and disturbances, 2015–2019
- Billion-dollar disaster costs, 1980–2019 (Consumer Price Index–adjusted dollars)
- Number of storm events, top ten types, 2015–2019
- Average annual storm events, top ten types, 2015–2020
- Heating degree days
- Cooling degree days

Distribution Grid Infrastructure

- Percentage of advanced metering infrastructure deployment
- Percentage of utility customers for whom outages are automatically reported

Correlation Significance

Once data were compiled and cleaned, PSC began identifying states with similarities to Michigan across a number of variables. PSC determined that state selection should be prioritized based on the variables that exhibit the strongest correlation with the 12 reliability performance measures. PSC used the Pearson correlation coefficient, which measures the strength of association between two variables and provides R-values that can range from -1 to +1. A positive correlation means that if one variable increases, so does the other (or vice versa); a negative R-value means that if one variable increases, the other decreases (or vice versa). It is important to note that the Pearson coefficient does not test causation; therefore, results should not be interpreted as a causal relationship. However, the test did help determine which of the 35 variables better indicated state reliability performance and were more useful for selecting states for analysis. Of the 35 variables, nine demonstrated a statistically significant correlation to reliability performance on one or more indices (Exhibit A1).

EXHIBIT A1. Variables Correlated with Reliability Performance

	Percentage of Retail Sales (Commercial and Industrial)	Percentage of Underground Distribution Infrastructure	Percentage of Population Living in Urban Areas	Tree Cover per Capita	Percentage of Tree Cover in Urban/ Community Land	Percentage of Tree Cover Statewide	Total State Tree Cover	Tree Cover per Utility Customer	Electric Emergency Incidents and Disturbances	Percentage of Customers for Which Outages are Automatically Reported	Percentage Population Change, 2010–2018
SAIDI with MED	**-0.384****	**-0.501****	**-0.294***	**0.497****	**0.553****	**0.664****	0.176	0.119	0.179	0.048	-0.225
SAIFI with MED	-0.189	**-0.618****	**-0.568****	**0.499****	**0.447****	**0.543****	0.106	0.228	0.052	-0.172	**-0.329***
CAIDI with MED	**-0.373****	-0.220	-0.003	**0.454****	**0.568****	**0.621****	-0.045	-0.059	0.119	0.219	-0.231
SAIDI without MED	0.030	**-0.516****	**-0.434****	0.175	0.160	**0.296***	**0.360***	**00.343***	**0.383****	-0.196	-0.252
SAIFI without MED	-0.050	**-0.594****	**-0.561****	**0.333***	**0.289***	**0.372****	**0.168**	**.307***	0.076	**-0.285***	**-0.282***
CAIDI without MED	0.148	0.044	**-0.351***	0.070	0.049	0.163	0.206	**0.293***	0.119	-0.057	-0.204

** Correlation is significant at the 0.01 level (two-tailed)
* Correlation is significant at the 0.05 level (two-tailed)

The variable with the greatest degree of correlation to reliability performance was the percentage of tree cover in a state. The next two variables were the percentage of tree cover in urban areas and communities and the amount of tree cover per capita. In all three cases, the correlation coefficient indicates that states with increased tree cover experience increased frequency and duration of electric outages.

The other two variables with the strongest correlation to electric reliability are the percentage of a state's population living in urban areas and the extent of underground electric lines as a percentage of total distribution plants. In both cases, the correlation coefficient is negative, indicating that the more rural a state's population is, the greater the incidence and duration of electric outages; the higher the proportion of a state's underground distribution assets, the better overall performance reliability.

States' retail sales composition also exhibit a correlation with the duration of electric outages. States with a higher proportion of electric sales to the commercial and industrial sector exhibit shorter outages when measured with SAIDI and CAIDI with MEDs.

PSC also found that population change from 2010 to 2018 were correlated with the frequency of electric outages. In this case, states with high population growth since 2010 have a lower frequency of electric outages when measured with SAIFI with and without MEDs.

Selection Methodology

PSC recommended using variables with the highest degree of correlation to reliability performance as the basis for selecting states to include in the benchmarking analysis. PSC calculated the mean, median, and standard deviation for each of the variables examined, and sorted states based on their performance, selecting those most similar to Michigan.[20] PSC opted to include the ten states from the MPSC's Multi-state Electric Service Rules Comparison in the analysis. For the selection of the remaining 15 states, PSC established a three-tier review process based on the significance of variables' correlation to reliability performance. The selection process for additional states is as follows.

Tier One: Statewide Tree Cover and Population in Urban Areas

First, states were sorted based on the three variables with the most significant correlation—percentage of statewide tree cover, percentage of population living in urban areas, and underground distribution infrastructure as a percentage of total distribution plants.[21] Over 59.5 percent of Michigan's land area has tree cover, compared to the national average of 44 percent, placing Michigan in the third quartile. PSC identified 15 states with tree cover between 50 and 70 percent.[22]

In terms of population living in an urban area, Michigan ranked in the third quartile, with 74.6 percent of its population living in urban areas—which is slightly higher than the national average of 74.1 percent. For the third metric, only 14.8 percent of Michigan's distribution plant is from underground infrastructure, compared to the national average of 21.7 percent, placing the state in the first quartile.

[20] Standard deviation is represented as **σ**.

[21] There were six tree cover variables that had statistically significant correlation to reliability performance. For the purpose of selecting states, PSC decided to use only the variable with the most significant correlation—percentage of tree cover statewide.

[22] PSC opted to use a narrower range for selecting states based on tree cover.

EXHIBIT A2. Michigan Performance on Tier-one Metrics

State	Statewide Tree Cover		Percentage of Population Living in Urban Areas		Underground Distribution Infrastructure as Percentage of Total Distribution Plant
Michigan	59.5%		74.6%	14.8%	1st quartile
Descriptive Statistics					
Minimum	2.6%	**Minimum**	38.7%	**Minimum**	4.1%
Maximum	88.9%	**Maximum**	100.0%	**Maximum**	43.0%
Mean	44.0%	**Mean**	74.1%	**Mean**	21.7%
σ	23.7%	**σ**	14.7%	**σ**	9.6%
1 σ above	67.9%	**1 σ above**	88.8%	**1 σ above**	31.3%
1 σ below	20.3%	**1 σ below**	59.4%	**1 σ below**	12.1%

Source: PSC calculations

PSC examined states' performance on these three metrics to identify similar states to Michigan. Similarity was determined when Michigan and the other states fell within one standard deviation of the mean. PSC identified five states that had similar characteristics for all three of the metrics evaluated in tier one: Georgia, North Carolina, Pennsylvania, South Carolina, and Virginia.

Sixteen other states exhibited similarities for two of three metrics: Connecticut, Delaware, Florida, Idaho, Iowa, Kansas, Kentucky, Louisiana, Missouri, New Mexico, North Dakota, Oklahoma, Oregon, Tennessee, Texas, and Wyoming. To narrow these, PSC compared states' scoring for the next two variables that demonstrated significant correlation with reliability performance—percentage of sales to commercial and industrial customers and population change rate from 2010 to 2018.

Tier Two: Commercial and Industrial Sales and Population Change Rate

In terms of the proportion of energy sales to commercial and industrial customers, Michigan is just above the national of 66.3 percent at 66.5 percent. Of the 16 states with similarities identified in tier-one tree cover rates, seven did not demonstrate similar levels of commercial and industrial energy consumption.

The next layer of the selection process applied to these 16 states is the rate of population change experienced since 2010. Michigan has had very low population growth, coming in at 1.14 percent, compared to the national average of 5.6 percent. Of the remaining states, only Connecticut had lower growth rates than Michigan.

Six states—Iowa, Kansas, Kentucky, Louisiana, New Mexico, and Oklahoma—were similar to Michigan in terms of commercial and industrial sales, as well as population change rates, and were selected as tier-two states. Of the remaining ten, six were similar to Michigan on at least one of the tier-two characteristics and remained in consideration for the third round. The remaining four were removed from consideration.

Tier Three: Electric Emergency Incidents and Automatic Outage Reporting

The final component for state selection relied on the remaining two variables that exhibited a significant correlation to reliability performance—electric emergency incidents and automatic outage reporting. Michigan experienced 37 electric emergency incidents from 2015 to 2019, which is well above the national average of 23. Missouri, Oregon, and Texas were also above the national average. Connecticut was the next closest, with 21 incidents during the period examined. Idaho and Wyoming both had fewer than half as many emergency incidents compared to the national average. Connecticut, Mississippi, Oregon, and Texas also had a high percentage of automatic outage reporting and, thus, was included in this study.

Recommended States

The selection process above resulted in the recommendation to include 15 additional states. The final list of recommended states is provided in Exhibit A3. Additionally, selected characteristics for these states are shown in Exhibit A4.

EXHIBIT A3. States in Benchmarking Analysis

MPSC's *Multi-state Electric Service Rules Comparison*	Tier 1	Tier 2	Tier 3
1. California*	11. Georgia	16. Iowa	22. Connecticut
2. Illinois*	12. North Carolina	17. Kansas	23. Missouri
3. Indiana*	13. Pennsylvania	18. Kentucky	24. Oregon
4. Massachusetts*	14. South Carolina	19. Louisiana	25. Texas
5. Minnesota*	15. Virginia	20. New Mexico	
6. New Jersey*		21. Oklahoma	
7. New York*			
8. Ohio*			
9. Washington*			
10. Wisconsin*			

* Included in MPSC original list of ten states.

EXHIBIT A4. Selected Characteristics of Recommended States

State		Underground Distribution Infrastructure as Percentage of Total Distribution Plant	Percentage of Retail Sales (Commercial and Industrial)	Percentage of Population Living in Urban Areas	Percentage of Tree Cover Statewide	Electric Emergency Incidents	Percentage of Outages Reported Automatically	Population Change, 2010–2018
1.	California*	31.8%	64.8%	95.0%	36.1%	132	85.3%	6.18%
2.	Connecticut	23.7%	54.1%	88.0%	72.6%	21	97.4%	-0.04%
3.	Georgia^	21.4%	57.2%	75.1%	66.4%	22	92.2%	8.59%
4.	Iowa	20.1%	71.0%	64.0%	10.4%	4	84.1%	3.6%
5.	Illinois*	30.4%	66.5%	88.5%	15.6%	12	99.7%	-0.70%
6.	Indiana*	18.7%	66.8%	72.4%	25.7%	6	93.6%	3.21%
7.	Kansas	21.4%	66.3%	74.2%	8%	12	96.6%	2.05%
8.	Kentucky	14.3%	63.8%	58.4%	58%	20	93.1%	2.97%
9.	Louisiana	10.8%	65.9%	73.2%	51.5%	33	99.4%	2.79%
10.	Massachusetts*	31.8%	61.3%	92.0%	70.8%	29	92.2%	5.41%
11.	Michigan*	14.8%	66.5%	74.6%	59.5%	37	94.1%	1.14%
12.	Minnesota*	32.7%	66.7%	73.3%	34.8%	14	78.9%	5.79%
13.	Missouri^	22.1%	54.3%	70.4%	40.3%	24	88.9%	2.30%
14.	New Jersey*	17.8%	60.7%	94.7%	57%	12	99.8%	1.33%
15.	New Mexico	22.9%	71.6%	77.4%	19.1%	7	97.6%	1.8%
16.	New York*	36.1%	63.2%	87.9%	65%	38	97.7%	0.85%
17.	North Carolina^	19.7%	55.4%	66.1%	62.6%	35	88.4%	8.89%
18.	Ohio*	17.9%	64.4%	77.9%	39.9%	22	85.7%	1.33%
19.	Oklahoma^	22.2%	62.7%	66.2%	25.9%	22	92.8%	5.11%
20.	Oregon^	21.0%	61.6%	81.0%	40.8%	30	96.8%	9.39%

State		Underground Distribution Infrastructure as Percentage of Total Distribution Plant	Percentage of Retail Sales (Commercial and Industrial)	Percentage of Population Living in Urban Areas	Percentage of Tree Cover Statewide	Electric Emergency Incidents	Percentage of Outages Reported Automatically	Population Change, 2010–2018
21.	Pennsylvania^	16.9%	62.0%	78.7%	65.8%	24	72.3%	0.82%
22.	South Carolina^	18.9%	61.1%	66.3%	64.6%	29	81.2%	9.92%
23.	Texas^	12.7%	62.9%	84.7%	23.4%	96	90.4%	14.14%
24.	Virginia^	25.0%	59.2%	75.5%	66.7%	28	96.2%	6.46%
25.	Washington*	35.7%	60.7%	84.0%	47.2%	61	67.3%	12.06%
26.	Wisconsin*	27.1%	68.4%	70.2%	47.7%	9	44.3%	2.23%
	Mean	21.7%	63.3%	74.1%	44%	23.18	83.3%	5.6%
	Maximum	43.0%	83.7%	100.0%	88.9%	132	100.0%	16.7%
	Minimum	4.1%	47.4%	38.7%	2.6%	2	0.0%	-2.5%

* MPSC-included states
^ Tier-one states

Appendix B: Technical Standards for Electric Service

Part One: General Provisions

- R 460.3101: Applicability; Purpose; Modification; Adoption of Rules and Regulations by Utility
- R 460.3102 Definitions
- R 460.3103 Rescission

Part Two: Records and Reports

- R 460.3201: Records; Location; Examination
- R 460.3202: Records; Preservation
- R 460.3203: Documents and Information; Required Submission
- R 460.3204: Customer Records; Retention Period; Content
- R 460.3205: Security Reporting

Part Three: Meter Requirements

- R 460.3301: Metered Measurement of Electricity Required; Exceptions
- R 460.3303: Meter Reading Data
- R 460.3304: Meter Data Collection System
- R 460.3305: Meter Multiplier
- R 460.3308: Standards of Good Practice; Adoption by Reference
- R 460.3309: Metering Inaccuracies; Billing Adjustments

Part Four: Customer Relations

- R 460.3408: Temporary Service; Cost of Installing and Removing Equipment Owned by Utility
- R 460.3409: Protection of Utility-owned Equipment on Customer's Premises
- R 460.3410: Extension of Facilities Plan
- R 460.3411: Extension of Electric Service in Areas Served by Two or More Utilities

Part Five: Engineering

- R 460.3501: Electric Plant; Construction, Installation, Maintenance, and Operation Pursuant to Good Engineering Practice Required
- R 460.3502: Standards of Good Practice; Adoption by Reference
- R 460.3503: Utility Plant Capacity
- R 460.3504: Electric Plant Inspection Program
- R 460.3505: Utility Line Clearance Program

Part Six: Metering Equipment Inspections and Tests

- R 460.3601: Customer-requested Meter Tests
- R 460.3602: Meter and Associated Device Inspections and Tests; Certification of Accuracy
- R 460.3603: Meters with Transformers; Post-installation Inspection; Exception
- R 460.3604: Meters and Associated Devices; Removal Tests
- R 460.3605: Metering Electrical Quantities

- R 460.3606: Nondirect Reading Meters and Meters Operating from Instrument Transformers; Marking of Multiplier on Instruments; Marking of Charts and Magnetic Tapes; Marking of Register Ratio on Meter Registers; Watt-hour Constants
- R 460.3607: Watt-hour Meter Requirements
- R 460.3608: Demand Meters, Registers, and Attachments; Requirements
- R 460.3609: Instrument Transformers Used in Conjunction with Metering Equipment; Requirements; Phase-shifting Transformers; Secondary Voltage
- R 460.3610: Portable Indicating Voltmeters; Accuracy
- R 460.3611: Meter Testing Equipment; Availability; Provision and Use of Primary Standards
- R 460.3612: Test Standards; Accuracy
- R 460.3613: Meter and Metering Equipment Testing Requirements
- R 460.3614: Standards Check by the Commission
- R 460.3615: Metering Equipment Records
- R 460.3616: Average Meter Error; Determination
- R 460.3617: Reports to Be Filed with the Commission
- R 460.3618: Generating and Interchange Station Meter Tests; Schedule; Accuracy Limits

Part Seven: Standards of Quality Service

- R 460.3701: AC Systems; Standard Frequency
- R 460.3702: Standard Nominal Service Voltage; Limits; Exceptions
- R 460.3703: Voltage Measurements and Records
- R 460.3704: Voltage Measurements; Required Equipment; Periodic Checks; Certificate or Calibration Card for Standards
- R 460.3705: Interruptions of service; records; planned interruption; notice to commission

Part Eight: Safety

- R 460.3801: Protective Measures
- R 460.3802: Safety Program
- R 460.3803: Energizing Services
- R 460.3804: Accidents; Notice to Commission

Appendix C: State Practices for Rules/Standards

Group One

PSC identified nine states, in addition to Michigan, that rely on detailed administrative rules to outline their service quality, reliability, and technical standards for electric utilities. These rules define specific requirements for performance metrics, meter and equipment monitoring, construction and maintenance procedures, commission duties, and more. Rules in these states are regularly updated as the electric industry and state policy goals develop. These rules also tend to have similar organizational structures, are centralized, and cover a similar set of topics compared to Michigan's rules. These states, and their relevant rules packages are:

- **Illinois:** Illinois Administrative Code, Title 83 Public Utilities
- **Indiana:** Indiana Administrative Code, Title 170 Indiana Utility Regulatory Commission
- **Iowa:** Iowa Administrative Code, Title 199 Utilities Division
- **Kentucky:** Kentucky Administrative Regulations, Title 807 Energy and Environment Cabinet—Public Service Commission
- **New Jersey:** New Jersey Administrative Code, Title 14 Public Utilities
- **New Mexico:** New Mexico Administrative Code, Title 17 Public Utilities and Utility Services
- **Pennsylvania:** Pennsylvania Administrative Code, Title 52 Public Utilities
- **Texas:** Texas Administrative Code, Title 16 Economic Regulation, Part 2 Public Utility Commission of Texas, Chapter 25 Substantive Rules Applicable to Electric Service Providers
- **Wisconsin:** Wisconsin Administrative Code, Chapter 113 Public Service Commission

Group Two

The following states, while relying primarily on administrative rules for establishing requirements for electric utilities, do not have the same level of detail that defines the states included in group one. Instead, the administrative rules for these states provide broad outlines for utility behavior. Several of these states substitute specificity in administrative rules for statutory or regulatory proceedings to address service quality, reliability, or technical functions for electric utilities. Group two states include varied approaches to establishing rules and/or standards for electric utilities, but are unified in that they all have dedicated components of their administrative rules pertaining to electric utilities.

- **California:** California Code of Regulations, Title 20 Public Utilities and Energy
- **Connecticut:** Regulations of Connecticut State Agencies, Title 16 Public Service Companies
- **Kansas:** Kansas Administrative Regulations, Agency 82 Kansas Corporation Commission
- **Massachusetts:** Code of Massachusetts Regulations, Title 220 Department of Public Utilities
- **Minnesota:** Minnesota Administrative Rules, Chapter 7826 Electric Utility Standards
- **Missouri:** Missouri Code of State Regulations, Title 20 Department of Commerce and Insurance, Division 4240 Public Service Commission
- **New York**: New York Codes, Rules, and Regulations, Title 16 Department of Public Service
- **North Carolina:** North Carolina Utility Commission Rules, Chapter 8 Electric Light and Power
- **Ohio:** Ohio Administrative Code, Chapter 4901 Public Utilities Commission

- **Oklahoma:** Oklahoma Administrative Code, Title 165 Corporation Commission, Chapter 35 Electric Utility Rules
- **Oregon:** Oregon Administrative Code, Division 24, Chapter 860 Public Utility Commission
- **South Carolina:** South Carolina Code of Regulations, Chapter 103 Public Service Commission
- **Virginia:** Virginia Administrative Code, Agency 5 State Corporation Commission, Title 20 Public Utilities and Telecommunications
- **Washington:** Washington Administrative Code, Chapter 480-100 Electric Companies

Despite the unifying characteristics of group two states, there is variation in states' approaches. Several examples of these different approaches are outlined below.

California

California's service quality, reliability, and technical standards are very decentralized. Standards and guidelines have been enumerated in general orders and dockets from the California Public Utilities Commission (CPUC), as well as various sections of the California Constitution. General Order 166, signed D.98-07-097 by the CPUC, primarily deals with unplanned outage standards and response, while docket D.00-05-022 focuses of restoration time standards. Only the five largest electric utilities in the state must provide annual reports detailing industry standard outage performance.

California has enacted some legislation regarding public utility service quality, reliability, and technical standards, but no administrative codes govern the industry regarding these standards. Relevant legislation is located in the Public Utilities Code, Division 1. However, these provisions tend to focus on the powers the CPUC has and general responsibilities of the utilities rather than specific utility requirements. In California, much of the power to review reliability and issue penalties lies in the commission, but even then, the CPUC has issued very few orders establishing industry-wide standards or guidelines for electric utility performance.

Connecticut

Connecticut outlines a portion of standards for electric utilities in the Regulations of Connecticut State Agencies, Title 16. However, these standards largely have to do with service quality and reliability, and do not address technical standards in detail. Instead the state delegates a significant amount of authority to the Public Utilities Regulatory Authority which regulates electric distribution companies and establishes many of the operating requirements that other states dictate in administrative rules.

Kansas

Kansas has some the most limited rules governing service quality, reliability, and technical standards in group two, even considering rules that empower the Kansas Corporation Commission as the regulatory authority for electric utilities. Public Sector Consultants reached out to individuals at the Kansas Corporation Commission for assistance in locating relevant standards, and employees were able to direct researchers to a select few dockets (18-KCPE-095-MER and 19-KCPE-178-CPL) that related to these types of standards. These documents established some metrics to be reported and penalties, but overall they provide little information. Similar to California, only the largest electric utilities are required to report their service quality performance.

Massachusetts

Massachusetts relies heavily on its Department of Public Utilities (DPU) proceedings, as well as a few statutes and regulatory codes, to establish its service quality, reliability, and technical standards. Docket number DPU 14-72-D outlines requirements for electric company emergency response plans. Most service quality and reliability standards have been developed in docket number DPU 12-120-D. On December 18, 2015, the DPU released “Order Adopting Revised Service Quality Guidelines” detailing the metrics that electric (and gas) companies must submit to the commission. Most service quality and reliability guidelines in Massachusetts are not quantitative standards that utilities must achieve, but rather metrics that must be submitted to the commission for annual review. PSC reached out to individuals at the Massachusetts DPU to locate the exact docket documents that contained finalized service quality guidelines.

Massachusetts has also established some technical standards via statute and code of regulations. Relevant legislation is located in Massachusetts’ General Laws, Part 1, Title 22, Chapter 164, while other standards are enumerated in the Code of Massachusetts Regulations, Title 220. These pieces of legislation and codes deal with a few technical standards and some DPU operations but do not establish quantitative standards or specific utility instructions.

Missouri

Missouri’s standards for service quality, reliability, and technical performance are primarily located in administrative rules in the Missouri Code of State Regulations, Division 4240. These rules are distributed amongst several chapters of the state’s code. The standards which do focus on service quality, reliability, and technical standards, tend to be detailed and organized. While Missouri’s technical standards are specific and consistent, the state’s service quality and reliability standards rely almost exclusively on commission review of reports. Although the bulk of standards in Missouri are located the state’s administrative code, a few exist in the Missouri Revisor of Statutes, Title XXV, Chapter 393, although these rules are not as comprehensive as those of other states and very few sections directly deal with service quality, reliability, and technical standards.

New York

Some of New York’s rules relevant to reliability and technical standards are located in New York’s Codes, Rules, and Regulations, Title 16. However, New York delegates many of the responsibilities regarding service quality, reliability, and technical standards for electric utilities to the State of New York Public Service Commission. One document, “Order Adopting Change to Standards on Reliability of Electric Service,” in dockets 02-E-1240 and 02-E-0701, has been largely responsible for establishing service quality, reliability, and technical standards in New York. While New York’s rules and legislation can be extremely detailed (e.g., the state’s meter testing practice), their rules are very different from the structure of rules in Michigan and similar states.

Virginia

Virginia has very few regulations regarding service quality, reliability, and technical standards, with the only standards that exist being located primarily in statute and a few administrative codes. The Virginia Administrative Code has very few regulations regarding service quality, reliability, and technical standards. These solely exist in Title 20, Agency 5, and like the statutory standards, these are brief and focus on a few select technical guidelines. Other state standards are located in the Code of Virginia, under the Virginia Electric Utility Regulation Act. This act covers a broad range of electric-related topics, but only a few sections relate to service quality, reliability, and technical standards. What standards do exist focus on energy emergencies, generating facilities, and the Virginia State Corporation Commission's ability to set reliability and quality standards.

Group Three

The third group of states have very few, if any, clearly established service quality, reliability, and technical standards. Public Sector Consultants began research into these states by examining relevant administrative rules packages and expanded the research to gather other types of proceedings. However, this research yielded very limited information relevant to this study. Only two states fit into group three.

- **Georgia:** Official Code of Georgia, Title 46 Public Utilities and Public Transportation
- **Louisiana:** Louisiana Administrative Code

Georgia

Georgia does not have well-defined service quality, reliability, and technical standards, despite appearing to have some relevant provisions in its administrative code. PSC contacted the Georgia Public Service Commission (GPSC) twice to obtain further direction regarding oversight of statewide service quality, reliability, and technical standards, but did not receive a response. Within the Official Code of Georgia, Title 46, specific chapters are dedicated to electric utilities and the service they provide, but none correlate to the topics of research for this study. Instead, these chapters generally focus on the auditing of utilities, utility service territory, municipal and membership utilities, high -voltage safety, and integrated resource planning guidelines.

Louisiana

PSC was unable to identify specific elements of Louisiana's Administrative Code that pertain to electric utilities. The sole resource identified pertaining to service quality, reliability, and technical standards for electric utilities in Louisiana was a 1998 General Order from the Louisiana Public Service Commission. This General Order, as part of docket U-22389, very briefly describes electric utilities' general responsibility to provide reliable service, the goal of reliability standards, performance levels, and reporting requirements. The commission was responsible for gradually phasing-in these standards over a set number of years, with penalties outlined for failure to meet minimum performance levels.

Appendix D: Summary of the Rulemaking Process

The rulemaking process for state government is generally prescribed in states' Administrative Procedure Acts (APA). All states examined in this study have a rulemaking process similar to Michigan's, involving established procedures for rulemaking outlined in statute. These processes aim to provide transparency and public input into rulemaking and generally involve the following elements:

- Statutory authority
- Request to initiate rulemaking
- Evaluating regulatory burden
- Allowing public input
- Review of proposed rule
- Legislative or other review
- Filing of updated rules
- Implementation timeline
- Periodic review

Statutory Authority

The authority to create, modify, or repeal rules is granted through either the state's constitution or through enabling legislation, though the latter approach is much more common. Depending on the state, rulemaking is authorized through specific statute or the public service commission is granted broad rulemaking authority. None of the states that PSC reviewed had rulemaking for utilities authorized through their state constitutions. States where the public service commission had broad rulemaking authority are noted in the State Summaries section of this appendix.

Request to Initiate Rulemaking

The agency or department responsible for a rule is required to provide formal notice at the beginning of the process to update, repeal, or institute a rule.[23] The amount of information that needs to be prepared by the agency varies by state, but general requirements include identification of the affected rule set, summary of the proper authority to make rules, identification of any comparable federal standard, the rationale for developing or revising the rule, and the expected impact of the rule change. In some states, stakeholder engagement is required before a formal rulemaking request can be submitted. Generally, the request for rulemaking is submitted to an administrative- type agency that reviews the request to ensure it complies with state laws (e.g., Michigan's Office of Regulatory Reinvention or Washington's Office of Code Reviser). In many states, the formal submittal of the request for rulemaking triggers an established window of time for the agency to finalize the rule, often one year.

Evaluating Regulatory Burden

The agency undertaking the rulemaking effort is required under states' APAs to evaluate the regulatory burden the proposed rule changes will have on certain impacted entities. Almost all the states require the

[23] Note: The term regulation and rule are used interchangeably depending on the state but for purposes of this research mean the same thing.

agency to evaluate the impact to small businesses. In some states, the legislature or state budget office is also involved in evaluating a rule's impact (e.g., California's Economic and Fiscal Impact Statement or Ohio's business impact assessment). The resulting impact statements usually include a cost-benefit analysis, the economic or fiscal impact of the proposed rule, and how the agency has minimized the impact to small businesses or local governments.

Allowing Public Input

Unless promulgating an emergency rule, or adopting a federally required standard, all states require the regulatory agency to allow for the public and impacted entities to provide public comment. Many times, the public notice is published in the state's official register, on agencies' website and list servs, and in a statewide newspaper. The public comment period may include the opportunity to provide written comments, a formal public hearing, and oral remarks. Once the public input session has closed, the agency may revise the rule based on comments received. In some of the states, a formal public input session is only required if requested by a certain amount of the public or businesses. State agencies are required to provide formal responses to the comments they received, including why any comments were addressed or not.

Review of Proposed Rule

Once the agency has completed the revision of the rule and adequately addressed stakeholder and public comments, in many states the rule must be reviewed to ensure it still complies with statutory and APA requirements. This process can take the form of review by a state's legislative service bureau or formal review by a commission or board with authority to review, comment, and/or modify the rule.

Legislative or Other Review

Many states have a legislative oversight body that can review the proposed rule before it is finalized. In a handful of states, this final check lies with the secretary of state or Governor's Office. During this review the legislature or other elected official checks to ensure:

1. The rules do not exceed the scope of the statutory authority.
2. The rules do not conflict with existing rules or those of another rulemaking agency.
3. The rules do not conflict with the intent of the legislature in enacting the statute under which the rule is proposed.
4. The agency has submitted a complete and accurate summary and fiscal analysis of the proposed rule, amendment, or rescission.
5. The agency has demonstrated through the regulatory impact analysis and response to comments that the regulatory intent of the proposed rule justifies its adverse impact on businesses in this state, if any.
6. Public comments have been sufficiently addressed.

Depending on the state, the legislature has varying levels of authority on how it can respond to the rule, from requesting changes to formally objecting and preventing implementation of the rule. In states where the authority to review rules is not vested with the legislature, the Office of the Attorney General and/or the Governor's Office will review and approve the rule.

Filing of Updated Rule

Once the final changes are made to the rule and the rule has been vetted by the appropriate oversight bodies, the final rule is filed with the secretary of state. The rule is also published in the state's register or manual and many times is also located on state agencies' website.

Implementation Timeline

The proposed rules generally have an implementation time frame built in, usually 90 days after formal approval. Some states stipulate the rule will go into effect at the start of a fiscal year or have immediate effect after filing with the secretary of state.

Periodic Review

Once rules have been finalized, several states require that rules be reviewed to ensure that they remain consistent with the law and are still necessary. Time periods for review vary by state.

Uniform Law Commission Model APA Legislation

The National Conference of Commissioners on Uniform State Laws, often referred to as the Uniform Law Commission (ULC), is an independent, nonpartisan organization that develops model legislation for adoption by the states. Many states have adopted the model APA legislation, developed by the ULC in the 1970s and last updated in 2010. The APA model legislation mirrors the process outlined above. States that have adopted the ULC's model APA legislation have been denoted in the state summaries provided below.

State Summaries

While the states' APAs all outline a similar process, many states have adopted additional requirements for their rulemaking processes. The following state summaries highlight the significant differences between Michigan's rulemaking process and the other states examined.

- **California:** Before rulemaking can begin in California the regulatory agency is required to take the following steps:
  - Express terms: Clearly outline the relevant statutory authority
  - Notice of proposed action: Time frames and findings
    - Once the notice of proposed action is published in the California Regulatory Notice Register, the APA rulemaking process is officially started and the agency has one year within which to complete the rulemaking process.
  - Initial statement of reasons: Rationale for the rule
  - Economic and fiscal impact statement: The economic and fiscal impacts of the proposed rule
  - Signature: Signed by the highest-ranking official in the agency
- **Connecticut:** Connecticut has adopted the ULC's State Administrative Procedure Act.
- **Georgia:** Georgia's rulemaking process has no significant variation from Michigan's.
- **Illinois:** Illinois has created a separate process for implementing rules stemming from federal regulations, collective bargaining agreements, and court measures that specify exactly how they must

be enforced. These rules, called peremptory rules, just need to be filed within 30 days after the action they implement and can take effect immediately. They do not require public comment.

Under the Illinois APA an agency, JCAR, the governor, an affected local government, 25 interested individuals, or an association representing at least 100 interested persons may request that the Department of Commerce and Economic Opportunity perform an analysis of the proposed rulemaking to determine its impact on small government or businesses.

The Illinois JCAR has extensive powers in reviewing a rule, allowing members to object to a rule and require the agency to respond to their concerns within 90 days, and filing a prohibition that prohibits the agency from adopting the rule unless certain changes are made.

- **Indiana:** Before the Indiana Utility Regulatory Commission (IURC) may add or make changes to its rules, it works with stakeholders to develop a draft proposed rule and then initiates the formal rulemaking process. The process ensures the opportunity for public comment and allows the issues to be fully vetted before the official rulemaking process. The IURC's Office of General Counsel oversees this process and serves as the point of contact for interested parties. The formal rulemaking process after the publication of the notice of intent can be accomplished in about ten months, depending on whether necessary approvals can be obtained. Rules expire (sunset) after seven years unless they are readopted. The process for readopting rules is abbreviated.
- **Iowa:** Iowa has adopted the Uniform Law Commission's State Administrative Procedures Act.

  The legislature's Administrative Rules Reviews Committee (ARRC) has the discretion to object to a rule. The ARRC may also delay the effective date of a proposed rule pending additional review by the General Assembly. Additionally, the Iowa General Assembly has the ability to rescind any administrative rule by joint action of both the Senate and the House of Representatives chambers.
- **Kansas:** Kansas has adopted the Uniform Law Commission's State Administrative Procedures Act.
- **Kentucky:** Kentucky's regulatory review process is similar to Michigan's except the legislature has the opportunity to review and comment on the rule in both the Administrative Regulation Review Committee and the standing committee with jurisdiction over the subject matter.
- **Louisiana:** The legislature, by concurrent resolution, may suspend, amend, or repeal any rule.
- **Massachusetts:** Rules and regulations shall be reviewed at least once every 12 years after their publication as the final rules or regulations to ensure that those rules and regulations minimize economic impact on small businesses in a manner consistent with the stated objectives of applicable statutes. In reviewing a rule or regulation to minimize economic impact of the rule or regulation on small businesses, the agency shall file a small-business impact statement.
- **Minnesota:** The Minnesota rulemaking process does not differ significantly from Michigan's; however, the governor, rather than JCAR, has the final review of a proposed rule.
- **Missouri:** If an agency is part of the executive branch, they must prefile with the Governor's Office to get a letter of approval prior to filing. All rules are reviewed every five years.
- **New Jersey:** New Jersey's rulemaking process has no significant variation from Michigan's.
- **New York:** New York's rulemaking process has no significant variation from Michigan's.
  Public service commission matters that require compliance with the APA include:
  - Amendments to the commission rules
  - Tariff filings for electric, gas, steam and water
  - Interconnection agreements

    - Waivers of commission rules
    - Financings
    - Most commission-initiated proceedings
    - Orders directing utilities to take substantive actions
    - Rate cases
    - Modifications of commission orders, if such orders adopted rules
    - Petitions for rehearing
- **North Carolina:** North Carolina's rulemaking process has no significant variations from Michigan's.
- **Ohio:** Rules adopted by the Public Utilities Commission of Ohio (PUCO) must then be approved by the Joint Committee on Agency Rule Review (JCARR). After JCARR's approval, the rules are codified in the Ohio Administrative Code. PUCO rules are issued for comment in a case before the PUCO. After all comments and replies have been considered, the commission will issue an order approving the proposed rules and directing that the rules be filed with JCARR for their review.

  State law requires the PUCO to review each of its rules every five years and all rules sunset after seven years.
- **Oklahoma:** The legislature and governor must approve any proposed rules. Rules submitted to the legislature by April 1 have no appointed date by which they must be acted on by the legislature through an omnibus joint resolution. If the rules are submitted to the legislature after April 1, the legislature has until the end of the next legislative session to act. The governor must sign the joint resolution or issue a veto.
- **Oregon:** Every agency must review all of its new rules within five years of adoption. The review must include an analysis of whether the rule had its intended effect, whether the fiscal impact was under- or overestimated, whether the rule remains consistent with the law, and whether the rule is still needed.

  The Oregon Public Utility Commission has final jurisdiction over the adoption, amendments, and repeal of it proposed rulemaking. The commission must fully consider all comments before making a final decision on a proposed rule.
- **Pennsylvania:** The Independent Regulatory Review Commission reviews proposed and final regulations from Pennsylvania state agencies for consistency with the criteria contained in the Regulatory Review Act. The criteria include the statutory authority for the agency to promulgate the regulation, consistency with the statute that the regulation implements, reports of the economic and fiscal impact of the regulation, and reports of the reasonableness of the regulation.
- **South Carolina:** The standing committee with jurisdiction over the proposed rule subject matter can introduce a joint resolution to approve or disapprove of a proposed regulation. If the joint resolution to approve the regulation is not acted on within 120 days, the regulation becomes effective upon publication in the state register. Upon introduction of a joint resolution to disapprove of the proposed regulation, the 120 days for automatic approval is tolled. An agency may revise or withdraw the rule if a joint resolution to disapprove is approved. All regulations must be reviewed by the regulatory agency every five years. In reviewing the regulations, the agency must decide if the regulation needs to be repealed, modified, or left as is.
- **Texas:** The Public Utility Commission of Texas may initiate rulemaking at any time either through a petition to the commission or through a commission-initiated rulemaking. Within six months after the date of publication of the proposed rule, the commission shall issue an order adopting the rule,

adopting as amended, or withdrawing the rule. The rule is automatically withdrawn if not acted on within six months.

- **Virginia:** The rulemaking process in Virginia does not differ in any significant way from Michigan's, except that the governor has final review of a proposed rule rather than JCAR.
- **Washington:** The rulemaking process in Washington does not differ significantly from Michigan's.
- **Wisconsin**: The Legislative Council staff serves as the Administrative Rules Clearinghouse. The clearinghouse reviews all proposed rules to check for statutory authority, form, style, and clarity, and prepares reports on the impact of the rule, including providing comments back to the state agency on the proposed rule through a clearinghouse report. As part of reviewing a rule, the **agency must specifically determine whether, over a two-year period, a total of $10 million or more in implementation and compliance costs are reasonably expected to be incurred or passed along to businesses, local governmental units, and individuals as a result of the proposed rule. Upon such a determination, the agency must stop work and may not continue promulgating the proposed rule unless one of two things occur: (1) enactment of a bill specifically authorizing the promulgation of the rule or (2) adoption of germane modifications to the proposed rule that reduce the economic impact below the $10 million threshold.**

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