

Attachment A: Details for Form 15

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I. Summary

Item EVF-23.6 came to a vote at the 2023 Annual Meeting, where it received a vote of approval in the House of State Representatives and a negative vote in the House of Delegates. The submitters have revised EVF-23.6 to address concerns raised by several commenters during the debate. In addition, the submitters have revised their submission to incorporate modifications that the Specifications and Tolerances Committee made to the item.

The revised proposal would amend Handbook 44, Section 3.40 Tentative Code in the following ways:

1. Paragraph T.2.1 would be revised for DC chargers. The 1% (acceptance) / 2% (maintenance) tolerances would apply to devices from after January 1, 2024. For devices from before that date, the tolerances would be 5% (acceptance and maintenance). In accordance with changes by the Specifications and Tolerances Committee, a device qualifies based on being placed in service before 2024.

2. For the sake of clarity and transparency for customers and inspectors, a device subject to the 5% tolerance would have to be marked as such. Previously, the proposal specified that a given charger should say it “operates at a tolerance” of 5%. The revised proposal instead requires a charger subject to the 5% tolerance to be marked as Class 5. The revised proposal incorporates the change made at the Annual Meeting, to state expressly that the indicating element can be used for the marking, so long as the customer can see the marking before starting a transaction. The proposal would establish the definition of Class 5 as a pre-2024 device that is subject to the

proposed T.2.2(a) tolerances. This approach is similar to how Handbook 44 approaches accuracy classes in various other categories of device.

3. If a manufacturer has achieved 1%-capable chargers earlier than the January 2024 timeframe, users of those chargers might prefer not to mark the chargers as 5% chargers; and then those chargers would be subject to the 1%/2% tolerance. The revised proposal simplifies the language that establishes this treatment. A DC charger that was installed and placed in service before January 1, 2024, and that is marked Class 5, would be subject to the 5% tolerance (until the expiration date in 2034). All others would be subject to the 1% / 2% tolerance.

4. The 5% tolerance for pre-2024 chargers would end on January 1, 2034. After that date, all DC chargers would be subject to the 1% (acceptance) / 2% (maintenance) tolerance.

5. The revised proposal incorporates a revision that the Specifications and Tolerances Committee made, to change paragraph S.5.2 so that it says markings shall be “permanent[]” rather than “indelible[].”

II. Text of the Proposed Amendments

S.5.2. EVSE Identification and Marking Requirements. – In addition to all the marking requirements of Section 1.10. General Code, paragraph G-S.1. Identification, each EVSE shall have the following information conspicuously, legibly, and **permanently** ~~indelibly~~ marked:

- (a) voltage rating;
- (b) maximum current deliverable;
- (c) type of current (AC or DC or, if capable of both, both shall be listed);
- (d) minimum measured quantity (MMQ); and
- (e) temperature limits, if narrower than and within –40°C to +85°C (40 F to +185°F).

S.5.2.1. Marking of Accuracy Class, DC EVSEs Placed in Service Prior to 2024. - A DC EVSE that was placed into service prior to 2024 and is subject to the tolerances of T.2.2(a) is a Class 5 EVSE, and shall be marked with Class 5. The marking shall be conspicuously and legibly displayed in a position plainly visible to a person accessing a charging port of the EVSE. The indicating element may be used for the marking, provided the marking is visible to the customer prior to the beginning of the transaction.
(Added 202X)

T.2. Test Tolerances.

T.2.1. EVSE Load ~~Accuracy~~ **Accuracy** Test Tolerances for **AC Systems**. – The tolerances for EVSE load tests **for AC systems** are:

- (a) Acceptance Tolerance: 1.0 %; and
- (b) Maintenance Tolerance: 2.0 %.

T.2.2 EVSE Accuracy Test Tolerances for DC Systems. -- The tolerances for EVSE load tests on DC systems shall be as follows:

(a) For a DC system that was placed in service prior to January 1, 2024, and that is marked Class 5, acceptance and maintenance tolerances are: 5.0 %. This paragraph

T.2.2(a) shall expire on January 1, 2034; after that date, all DC EVSEs shall be subject to the tolerances of paragraph T.2.2(b).

(b) For any DC system not subject to paragraph T.2.2(a), tolerances are:

(1) Acceptance Tolerance: 1.0 %; and

(2) Maintenance Tolerance: 2.0 %.

All DC EVSE are exempt from this requirement until January 1, 2028.

III. Explanation and Justification

A. The effect of the proposed revisions

The changes we propose would work as follows:

Currently all DC chargers are exempt from the accuracy tolerances until January 1, 2028, as NCWM adopted at the 2022 annual meeting. The proposal would not alter this existing text in paragraph T.2.

When accuracy tolerances come into force, a DC charger that was placed in service after January 1, 2024, would have to satisfy the 1% (acceptance) / 2% (maintenance) tolerance, the same levels as for AC chargers. But a DC charger placed in service before January 1, 2024, would have to meet only a 5% accuracy tolerance. That 5% accuracy tolerance would expire on January 1, 2034, at which point all the legacy chargers will have to have been retrofitted or replaced.

The proposal would require a charger that is subject to the 5% tolerance to be marked as Class 5. This approach is similar to a model that is common in Handbook 44, such as in chapter 2.21, paragraphs S.4 and T.1. The marking can be presented on a digital display, the charger's indicator, so long as the marking is visible to customers before they undertake transactions.

Thus, the proposal leaves open the possibility that a given manufacturer might achieve the 1%/2% tolerance earlier, and then would specify that capability for a given model. Devices in that model would not have to be marked as Class 5; but if they are not marked that way, they would of course be subject to the 1%/2% level as for new chargers.

B. The basic justification

DC and AC chargers are fundamentally different—in technology, in customer use, and in metering capabilities. AC charging technology, the older form, delivers energy in the same form—voltages and currents oscillating at 60 Hertz (in the United States) as utilities have provided it for a century. Because a vehicle has to convert AC energy to DC for charging the battery, AC charging stations operate at no more than 19.7 kW, and most no more than 6-7 kW. These charging rates will add 24-80 miles of range in an hour of charging a typical car, and consequently AC charging involves extended sessions—the median time that a customer uses an AC station is 22 hours.¹ The voltages delivered are no more than 480 volts ac, and the current is no more than 50 amps ac (and more

¹ Idaho National Laboratory, “Plugged In: How Americans Charge Their Electric Vehicles,” p.14, <https://avt.inl.gov/sites/default/files/pdf/arra/PluggedInSummaryReport.pdf>.

typically 30 amps ac). By contrast, DC chargers deliver energy in the same form that a battery ultimately needs it. Using voltages of 400 to 950 volts dc and currents up to 500 amps dc (higher levels are coming in the future for applications like charging heavy trucks), they are able to deliver 50kW, 150 kW, 350 kW, or higher charging rates. These stations will add 200-1400 miles of range in an hour of charging, or, more meaningfully, 400 miles of range in as little as 20 minutes. A customer at a DC station will arrive, charge briefly, and then depart. Customers incorporate AC chargers into their regular routines, such as by driving to work and charging there. DC chargers are more commonly used to support long-distance trips.²

For AC charging, manufacturers have been able to utilize metering technology that has been developed over a century for electric utilities. When Handbook 44, section 3.40 was developed in 2015, that AC metering technology was well understood. There have been long-established standards for AC revenue meters—though those standards, in the utility sector, are not necessarily the same in every respect as how a weights and measures standard would work. One indication of the relatively mature state of AC metering is that NIST has long provided ordinary-course calibration services for AC watt-hour meters that operate at 60 Hertz, within ranges of 69 to 480 volts and 0.5 to 30 amps (sufficient to cover typical AC chargers).³ DC metering technology, by contrast, has been “in research and development.”⁴ When section 3.40 was adopted, the accuracy tolerances of 1.0% (acceptance) and 2.0% (maintenance) were predictive and aspirational for DC chargers. As of November 2019, when California adopted its own regulation based on section 3.40, meters and chargers meeting that standard were not yet generally commercially available.⁵ Meanwhile, NIST calibration services for DC watt-hour meters are non-standard, and are available only up to 240 volts and 5 amps⁶—far below the levels needed for testing DC chargers.

Argonne National Lab has studied the availability of DC metering technology. Our understanding is that its draft report (not yet finalized, so far as we are aware) concludes that there are now on the market (at least in principle) meters for use in DC chargers that can meet a 1% acceptance / 2% maintenance tolerance. It is reasonable to conclude that the 1% / 2% tolerance will be achievable in general. The current proposal is focused on how to handle the chargers that are installed before that point. Previously installed chargers will not in general be able to satisfy a 1% / 2% accuracy tolerance. To be clear, we do not suggest that every existing charger would be more than 2% inaccurate. Indeed, it would not genuinely be possible to make that assessment, given the lack of NIST-traceable measurement apparatus to test fast DC chargers in the field. There is presumably a distribution of potential deviations among devices in the field. Given what metering technology has

² As the California Energy Commission has explained, “it is therefore useful to treat infrastructure for interregional travel (predominantly DCFCs) differently from infrastructure for intraregional travel (predominantly Level 1 and Level 2 chargers).” <https://efiling.energy.ca.gov/GetDocument.aspx?tn=233986&DocumentContentId=66805> at page 14.

³ https://shop.nist.gov/ccrz__ProductDetails?sku=56200C&cclcl=en_US.

⁴ Cal. Dep’t of Food & Agriculture, Final Statement of Reasons on Electric Vehicle Fueling Systems, p.23 (Nov. 1, 2019).

⁵ *Id.*

⁶ https://shop.nist.gov/ccrz__ProductDetails?sku=56110S&cclcl=en_US.

been commercially available, a 2% maintenance accuracy would lead to inspection problems for a high proportion of devices.

The proposal would establish a tolerance of 5% for devices installed before January 1, 2024. The justification for this particular choice of tolerance and timeline is as follows:

1. In 2019, California adopted a regulation that put a modified version of section 3.40 into force for new devices. DC chargers installed before January 2023 are subject to no weights and measures standards at all until 2033. DC chargers installed after January 2023 (and before January 2033) are subject to a maintenance tolerance of 5.0% (and acceptance tolerance of 2.5%). Consequently, in California, which represents roughly 30% of the currently-existing base of DC chargers, the maintenance tolerance will be 5.0% for the coming decade. A maintenance tolerance of 5.0% for legacy chargers in section 3.40 will be stricter overall than the California regulation (because it will apply to all legacy chargers, whereas the California standard applies only to post-2023 chargers), but will align with the numerical tolerance used in California. Although a 5.0% tolerance is among the larger tolerances used in Handbook 44, it is not unprecedented. And the fact that new chargers in California will be subject to that standard will mean EV charging customers have substantial experience with that chargers at that tolerance, and the 5.0% tolerance we propose would be the same transactional experience as customers in California (the largest EV charging market in the country) receive. It bears mention, too, that as Measurement Canada prepares to implement standards for AC chargers, the tolerance (acceptance and maintenance) will be 3.0%, not the 1% acceptance in Handbook 44. The cost of a typical charging session is \$15 to \$20. A 5.0% maintenance standard would mean a variation, beyond that, of an additional plus *or minus* 40 cents. As with any tolerance, that variation could at any given charger be for or against either side to the transaction.
2. The industry submitters have studied carefully their existing chargers, measurement devices and existing models now available. They believe the 5% maintenance tolerance is achievable at a manageable cost in the future, because it will generally not require extensive reconfiguring of cabinets and the installation of four-wire cables.
3. The cost of bringing legacy chargers into line with the 1%/2% standard would be extreme. Although equipment is not available to test DC fast chargers in the field, some operators have found in tests of existing devices that they can be brought to a 5% tolerance, but cannot meet the 1%/2% standard without replacing the meters or implementing an entirely new measurement system, which means a physical reconfiguration at each station and/or replacing the cables for delivering the energy to vehicles. Section 3.40 standards are based on the energy delivered at the connector to the car; in other words, a charger must account for losses in the cables. The most straightforward way to account for losses is to measure the voltage at the vehicle connector; that means the cable must have two additional high-voltage leads, to carry that voltage back to the meter.⁷ In California's Initial Statement of Reasons (ISOR) for adopting specifications and tolerances requirement for commercial EVSE, California estimated that it costs approximately \$20,000 to retrofit an existing DC charger.⁸

⁷ Charging cables are themselves complex objects, with liquid coolant and high-voltage insulation. Cables for fast DC chargers that include additional high-voltage sensing leads were not available in 2015.

⁸ https://www.cdfa.ca.gov/dms/pdfs/regulations/EVSE_ISOR.pdf.

We understand that cost to represent the cost (parts and labor) to replace the charging cable, and possibly to replace the meter if that task is simple. This cost may be a significant underestimate for some models of charger, because replacing the meter may not always be possible without physical reconfiguration of the space within the charger. Which charger models would require that sort of reconfiguration, and what proportion of the installed base they represent, is impossible to know without a detailed model-by-model study and detailed model-by-model installation data across manufacturers. The upper end of cost would be simply the cost of replacing a charger, which many operators would find preferable to physical reconfiguration of charger internals anyway. The International Council on Clean Transportation (“ICCT”) reported in 2019 that fast DC chargers cost between \$75,000 and \$140,000 per charger, for the charger itself.⁹ Installation costs range from \$18,000 per charger (for six 150 kW chargers at a site) to \$65,000 per charger (for one 350 kW charger at a site).¹⁰ The total cost (installation and equipment) for a 4-charger site would be roughly \$720,000. That said, some amount of the installation cost represents upgrades to electrical supply lines and basic site construction, costs that would not be incurred anew to replace equipment. So for a rough estimate, it is appropriate to use the lowest cost estimate from the ICCT, which is \$17,692 (the cost per charger for a large site of 50 kW chargers). With that figure, replacing a 4-charger site of 350 kW chargers would cost roughly \$630,000, or \$157,000 per charger.

4. Based on data on the existing charge base from the National Renewable Energy Laboratory’s Alternative Fuels Data Center (“AFDC”), we can assume there will be about 36,000 “pre-2024” DC chargers.¹¹ These are only a fraction of the overall chargers that will be installed nationwide over the coming decade, but bringing them into compliance with a 1%/2% tolerance will be highly costly. Taking out the 30% that are in California (which already has regulations with a 5.0% maintenance tolerance, for all post-2023 DC chargers), retrofitting all of those at the \$20,000 cost would total \$720 million. If meter replacement is not possible and those chargers must all be replaced, the total would be \$5.6 billion. The actual cost of bringing the pre-2024 chargers to compliance with a 2.0% maintenance tolerance would be somewhere between these numbers.¹²

5. The January 2024 date moves faster than the California regulation. Under the California regulation, the 1% / 2% tolerance would not come into force until 2033. It appears that meters capable of that tolerance are now available on the market. The submitters propose January 2024 as

⁹ Michael Nicholas, “Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas,” ICCT Working Paper 2019-14, p.2 tab. 2 (Aug. 2019), https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf.

¹⁰ *Id.* at 4 tab. 4.

¹¹ According to the AFDC’s station locator database, there are 6,580 DC stations with 22,767 chargers. The AFDC also reports that the number of DC ports grew 29% year-on-year to the second quarter of 2021. https://afdc.energy.gov/files/u/publication/electric_vehicle_charging_infrastructure_trends_second_quarter_2021.pdf. With growth at this rate, about 6,600 additional DCFC stations will be installed in 2022 and 2023, leading to a total of about 36,000 DC chargers that would be “pre-2024” chargers under the proposal.

¹² A charger that is not qualified for a given tolerance level may well be within the bounds of the tolerance, because there is some distribution in metering performance. Even if devices are replaced only after inspection, a significant fraction would need replacement, thus incurring this scale of cost. Moreover, it might be most sensible for an operator to ensure all its devices are qualified, rather than waiting to see what the results of inspection might be for a given charger.

the date for distinguishing “legacy” from “new” chargers, because the existence of these meters on the market is not all that is needed. Manufacturers have to access the meters, design products incorporating them; revise production lines; test the new products to ensure they are safe and reliable; and obtain third-party certifications (such as from Underwriters Laboratory) of the revised products. After those steps, a manufacturer can begin delivering a revised product to operators. Installation of a charger is not simply a matter of placing it on a counter; charging sites involve construction work, leading to the secure attachment of a charger to a specially built concrete pad. In other words, from the first delivery of a new model of charger to the first installations of those chargers also takes time. The January 2024 date is appropriate for expecting new chargers to incorporate meters that were available a few years before that date.

6. The proposal focuses on installation before January 2024, rather than using the concept of retroactive/non-retroactive that is more common in Handbook 44, because non-retroactive is ordinarily based on when a device is placed in service. Many states do not yet regulate EV chargers and consequently have no placed-in-service process. In these states, “placed in service” would not be a well-defined concept, and regulators might not have good ways to determine when a device was placed in service. Installation is a reasonably well-defined process, and it should be possible to identify when a given charger was installed. California’s regulation has differing status for pre-2023 and post-2023 chargers, and it bases that line on installation.

7. The proposal also specifies 5.0% as the acceptance tolerance, not just the maintenance tolerance. As a practical matter in field inspections, the acceptance tolerance for pre-2024 chargers will not be important. Section 3.40 (as amended at the 2022 NCWM meeting) exempts DC chargers from the accuracy tolerance until 2028. When they become subject to accuracy tolerances, no pre-2024 charger will be at the point of acceptance. The proposal specifies an acceptance tolerance for clarity in type evaluations, which ordinarily evaluate device models against the applicable acceptance tolerance.

8. The exemption until 2028 adopted at the 2022 meeting does not eliminate the need for this proposal. When DC chargers are subject to accuracy tolerance requirements, pre-2024 chargers will still need to meet the applicable tolerance or be retrofitted or replaced. The 2028 time frame is unreasonably soon to do that, given the cost estimates above. California estimated that chargers have an effective 10-year lifespan.¹³ This estimate is highly uncertain, in part because it was based in part on older AC chargers. Newer DC chargers, using more advanced technology for significantly more expensive equipment, are likely to have usable lifetimes greater than 10 years. The proposal recognizes that, nonetheless, there is a tradeoff between the cost of retrofitting or replacing devices, and the value of tighter tolerances. Some number of chargers will fail and need replacement earlier than 10 years, thus reducing the number that eventually need to be retrofitted or replaced to comply with tighter accuracy tolerances. Overall, the proposal uses the same 10-year period that several states have already adopted.¹⁴ Notably, the effect is significantly more stringent than in the California regulation. Under California’s rule, a charger installed before 2023 is subject to no standards for 10 years, and then becomes subject to standards in 2033; a replacement of the charger in 2032 would be subject to the 5.0% maintenance tolerance. A charger installed in 2023 (and that hypothetical 2032 installation) would be subject to the 5.0% tolerance indefinitely, with no end

¹³ Cal. Dep’t of Food & Agriculture, Final Statement of Reasons, p.6.

¹⁴ 4 Cal. Code of Regulations § 4002.11; Rev. Code Wash. § 19.94.190(6).

point. Our proposal, by contrast, would make a pre-2024 charger subject to the 5.0% tolerance once the 2028 compliance dates kicks in but only until 2034, at which point the charger would have to be retrofitted, replaced, or otherwise brought to the 1%/2% tolerance.

C. Potential objections

In response to the industry's original proposal, some people commented that AC and DC chargers should be treated the same. As explained above, they are not the same, not only because of technology differences but also because customers use them and view them differently. California and NTEP have distinguished AC and DC chargers since at least 2021, and NCWM has already recognized important differences between them, in Handbook 44.

Some have also commented that there should not be parallel accuracy classes for a given application. But this approach is not unprecedented. In 1986, NCWM required new scales to be marked with an accuracy class. Pre-1986 scales could remain unmarked, and those unmarked scales were subject to various accuracy tolerances (depending on application) that ranged up to 5.0%, compared to the largest tolerance for any marked scale at 2.0%. For grain moisture meters, Handbook 44 has completely separate sections for pre-1998 and post-1998 devices, with some different tolerance specifications for older and newer devices. For both scales and grain moisture meters, there was no sunset date; the older devices have been allowed to continue in use for as long as they operated. We do not suggest that the circumstances with EV chargers are the same. Each of those past examples was based on justifications particular to that situation. Nonetheless, these examples show that it has been done to maintain parallel tolerances for a given application. In addition, there are already parallel, differing tolerances for EV chargers. If the proposal is not adopted, pre-2023 chargers in California will have no tolerance at all until 2033; post-2023 chargers will have a 5.0% maintenance tolerance for the indefinite future; and chargers elsewhere in the country, including in states neighboring California, will have the existing Handbook 44 tolerances. The proposal shifts the line between differing tolerances, but the situation of differing tolerances for the same application is already in place without the proposal.

There have been claims that some manufacturers may be able to achieve 1% devices (DC chargers) before January 2024, and one or more may already have done so. Even so, the proposal is still warranted. Operators of EV chargers should not be forced to replace their existing chargers simply because they could not get access to chargers made by a given manufacturer. It is generally agreed that when section 3.40 was adopted, the equipment to satisfy it did not exist for DC chargers. Reaching that point has required research and development by meter manufacturers and charger manufacturers. The goal of regulation should be to handle the technology transition in a reasonable, fair manner, without prejudice to operators that have made diligent efforts in procurement and operation of their chargers.

At the 2023 Annual Meeting, a floor amendment was proposed to eliminate the marking requirement. As the submitters understand the concern, the proposer did not want devices to state to consumers that the devices have an accuracy of plus or minus 5 percent. The revised proposal is meant to address that concern by simplifying the marking so that it simply states the charger is of Class 5.

The U.S. National Work Group subgroup on EV charging has reviewed and voted on similar proposals three times, beginning in June 2022. In June 2022, the subgroup voted affirmatively to

approve and recommend a similar proposal. In December 2022, the subgroup voted to reaffirm its approval of that June 2022 proposal. That proposal was not identical to EVF-23.6, and the submitters have previously (in a letter on October 15, 2022) communicated the text of that June 2022 proposal to the Specifications and Tolerances Committee. In March 2023, the subgroup voted to approve and recommend then-existing EVF-23.6, including the changes made by the Specifications and Tolerances Committee up to that point. The revised proposal differs from that version of EVF-23.6 in the ways discussed above.