2021 DOE Vehicle Technologies Office Annual Merit Review

HANDBOOK 44 (ANL)





ANL Transportable 500kW HB44
EVSE Field Compliance Test System

Theodore Bohn
Argonne National Laboratory
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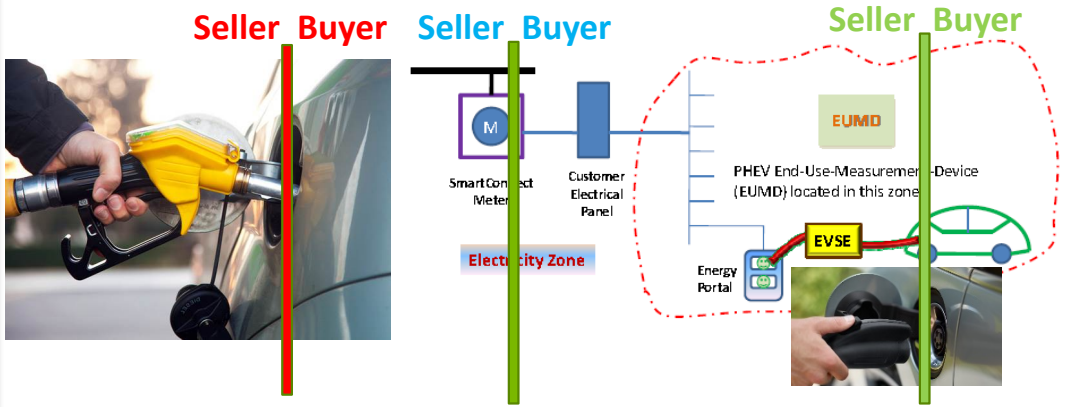
Project ID: elt268
poster session

NIST Handbook 44-3.40 Measurement Requirements for Commercial Dispensing of Electricity as a Fuel

Weights and Measures Enforcement at State Level (not federal level)

Line of demarcation for the point of sale of electricity for EV charging is at the tip of the charging cable (like liquid fueling), not at the feed circuit, as is the case for utility service

- NIST HB44-3.40 was released in 2016, adopted by most states, enforced only in California as of January 2021
- Type approval certification of 'system level' dispensed energy accuracy and billing information is required for **ALL** commercial EV charging stations before deployment
- Only three manufacturers have type approved stations as of May 2021 (Evercharge, ChargePoint, BTCPower)

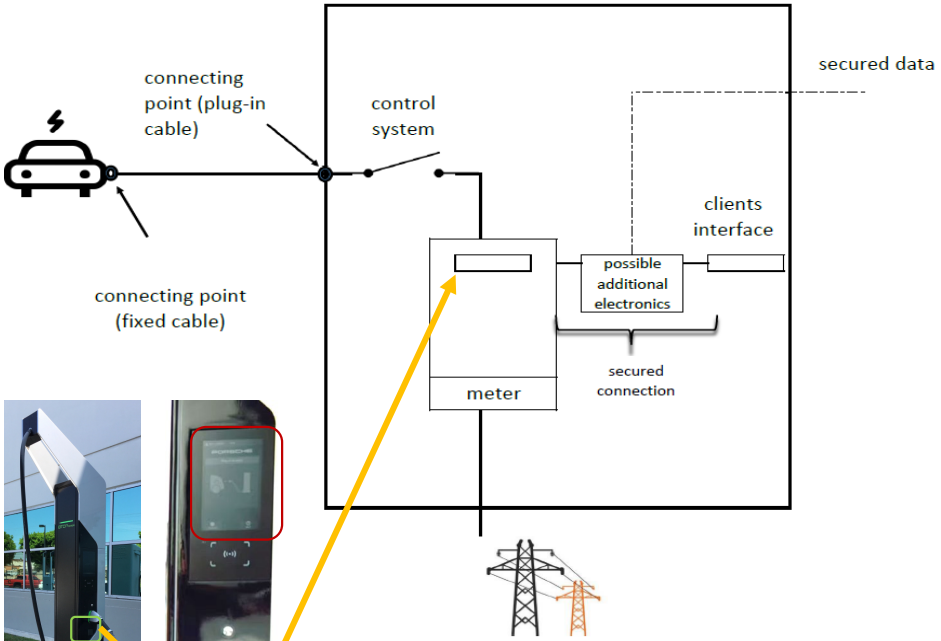


Comparison of the line of demarcation at the point-of-sale for liquid fuels, utility distribution of electricity and commercial dispensing of electricity as a fuel (at the edge of the vehicle).

Differences Between US and Other Regions on Transaction Record Pathway and Certification

Three Regional Levels of EV Charging Accuracy and Transaction Certification

- In North America NIST HB44-3.40 is enforced, based on type approval of the dispenser as a system. Meter is an embedded device.
- Europe-Germany enforces PTB (NIST equivalent) tracable accuracy requirements via VDE-AR-E-2418-3-100 evaluation process for meter type approval, independent of the EVSE (meter is an accessory to the EVSE)
- OIML R46 EV charging annex, is an international metering treaty that bridges the difference between PTB/VDE and HB44 by allowing both methods- direct meter or measurement functions as embedded.

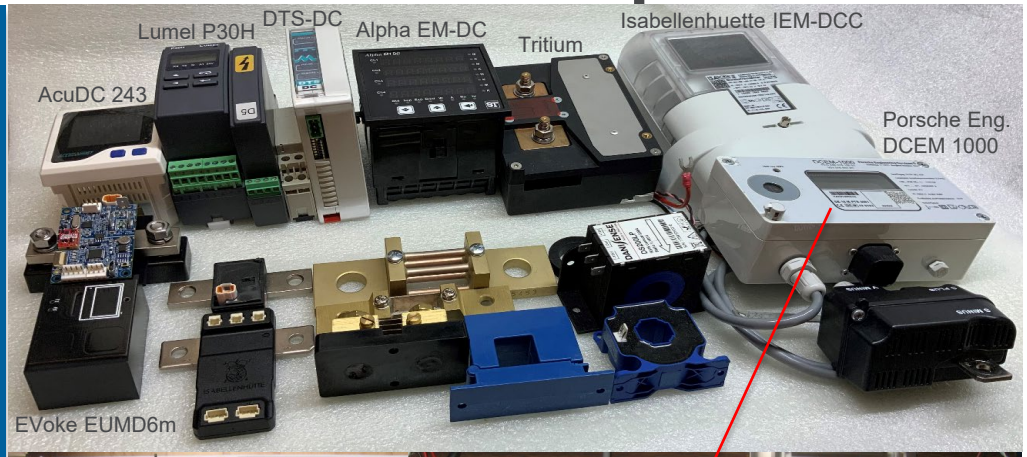


OIML R46 power flow diagram, highlighting window on side of EVSE direct to meter display, independent of EVSE transactions display (upper window)

Concerns About Lack of Adequate EVSE-Ready DC Meter Solutions that Meet HB44-3.40 Requirements

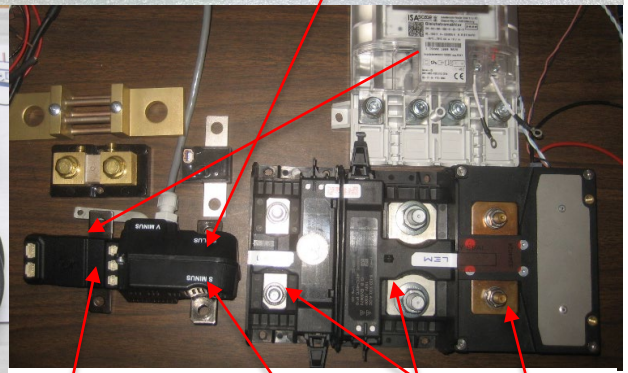
Industry request letter for independent third party benchmark study of rated DC meters along with cable loss errors.

- ANL researchers completed the benchmark study with input and assistance from DC meter manufacturers; top 10 models tested.
- Selection criteria based on present CCS-Tesla voltage and current levels (350A-500A, 1000v) with HB44-3.40 tolerance of +/- 1% error at the end of the charging cable (w/cable loss)
- Voltage and current transducer errors are combined with meter errors and voltage-drop errors of output cable. Photos on this slide show styles of sensors; conventional shunt, isolated shunt, Hall and fluxgate types.





LEM DCBM ~1000 Euro



IVT sensor, Porsche, LEM, Tritium

Overview of DC Meter Approaches/Groupings

Benchmark of DC meters grouped by similar attributes:

Meter prices range from below $100 (retail) to over $1700 in qty 1. Grouped by packaging types:

(1) purpose built (EVSE manufacturer derived product)
(2) 'EVSE ready' design meters (PTB/VDE spec)
(3) panel mount meters
(4) DIN rail mounted meters

	Manufacturer	Model	Comments/Attributes
1	Porsche	DCEM 1000	Current/voltage sensor module separated from display (VDE cert.)
	Tritium	{integral part}	Fan cooled, purpose built/integral, unique data/display to meet VDE cert.
	EVoke/BTC Power	EUMD6m	Smallest footprint via meter directly mounted on COTS current sensor
2	LEM	DCBM	Meter solution designed specifically for German market EVSEs (VDE cert.)
	Isabellenhuette	IEM-DCC	Meter based on IVT series isolated current/voltage sensor; (VDE cert.)
3	AccuEnergy	AcuDC 243	72mm square panel mount meter, external current sensor, general purpose
	Rish	Alpha EM-DC	92mm square panel mnt, 4 channel inputs, ext. sensor, general purpose
4	Lumel	P30H	Automation oriented packaging, prescale module needed for 1000v input
	MeasurLogic	DTS-DC	Automation oriented packaging, prescale module needed for 1000v input
	Satec	PM235-PRO DC	Automation oriented packaging, prescale module needed for 1000v input

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Lab Testing of Meters, Charging Cables, Mounting Location of Meter Inside EVSE (Dispenser Kiosk)

DC meter voltage sensors typically located in high current dispenser at output terminals; some w/sense leads

- 5 of the 10 meters have cable voltage drop software function (programmed resistance) Others can use charging cables with remote (4-wire) voltage sensing avoiding cable errors.
- Non-cooled cables from 65A to 350A tested along with cooled cables from 350A-500A up to CharIN MCS current levels at 3000A.
- Voltage drop for 300A non-cooled cable is 118W out of 120kW or .1% error. Liquid cooled cables have smaller conductors resulting in 660W(300A) out of 120kW (.55%)
- Longer cables have more resistance, voltage drop and corresponding measurement error.



350A-3000A liquid cooled

65A-350A non-cooled





Dispenser DC power path, meter connections

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SUMMARY

HB44-3.40 Type Approval/Requirements

Commercial dispensing of electricity as a fuel is covered by State level weights&measures enforcement; +/-1% tolerance type approval certificate required before EVSE can be put into service.

Approach

Top 10 DC meters capable of 1000v/350A-500A with +/-1% tolerance at end of charging cable were purchased and independently tested with ANL traceable accuracy equipment.
Typical present market CCS, CHAdeMO and future MCS (up to 3000A) cooled cables were tested.

Results/Conclusions

Independent testing verified that all of the tested meters achieved claimed accuracy of <+/-1% tolerance at room temperature from 10% to 100% rated current. Cable loss tests show voltage error was ~.55% error or less, with non-cooled cables (<350A) ~0.1% typical voltage drop at full current.

Future work

Dissemination of benchmark report via distribution to industry stakeholder; tentative webinar planned.