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EV Charging Station Accuracy Testing

Upper Canada District Metering Technologies Conference

September 18th, 2025, 14h30 – 15h00

Patrick Lawton, TESCO &
Mesurina Ltée/ Mesurina Ltd.

TOPICS OVERVIEW

- DC Energy Traceability and ISO 17025 Accreditation
- EV Charging Station Accuracy Testing

TESCO MISSION STATEMENT

To become the primary outside metering resource for all electric utility customers

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DC Energy Traceability and ISO 17025 Accreditation

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TESCO EVSE History

- TESCO: Metering since 1904; energy measurement is what we do
- ~10 years ago we saw that EV chargers, since they would be selling energy, would need to be calibrated and tested similar to revenue grade utility meters
- 2015: TESCO's first patents for AC/DC calibration of EVSE

TESCO EVSE History: AC vs DC

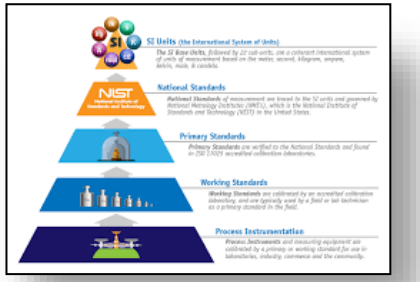
- Developed AC calibration capability first
  - Familiarity with AC measurement in shop and field test units for utility space was helpful here
- DC was not so easy….
  - First electric meter standards developed in 1910… a few years *after* DC meters were obsolete
  - There was never a recognized standard in NA for DC metering
  - TESCO worked to develop the methodology and process for DC metrology
  - Created equipment, took data, reviewed data, adjusted equipment, more data…
    - ***Fast-forward several years.. TESCO's lab received expansion of scope for ISO 17025:2017 accreditation to include DC Energy Measurement***

EVSE TRACING

Level 1, 2, 3 EVSE Charger

TESCO Catalog #T4350

TESCO DCT



TESCO ISO 17025:2017 Accreditation

EVSE TRACING

AC CALIBRATION

DC CALIBRATION

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ATTAINING DC ENERGY MEASUREMENT ACCREDITATION

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DC Energy Traceability

- TESCO Expansion of Scope of ISO17025 Accreditation for DC measurement (2022)
  - Standards: ANSI/IS0 9001: 2015, ISO/IEC 17025: 2017
    - Past and other standards
  - Testing
  - Known Process
  - Traceability
  - Uncertainty
  - Audit and Accreditation

STANDARDS

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- ISO9001: 2015 – Quality Management Systems
- “ISO 9001 Certified” means an organization has met the requirements in ISO 9001, which defines an ISO 9001 Quality Management System (QMS). ISO 9001 evaluates whether your Quality Management System is appropriate and effective, while forcing you to identify and implement improvements.
- QMS, QM
- Process based approach
- Continuous Improvement

STANDARDS

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- MIL-STD 45662(A)
  - US Military Standard
  - First Issued as a Mil-C in early 1960's
  - Requirements for establishing and running a Calibration "System"
  - Rescinded 1995, replaced by ANSI/NCSL Z540-1
- ANSI/NCSL z540-1
  - A U.S. National Standard
  - First Issued 1994
  - Requirements for operating a Calibration Laboratory
  - Compliance of suppliers to customers requirements
  - Withdrawn 2007, replaced by IS0/IEC 17025 and ANSI/NCSL Z540.3

STANDARDS

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- ISO/IEC 17025
  - An Inter-national Standard
  - First Issued 1999 (1990 as a guide)
  - Requirements for the competence of a Testing or Calibration Laboratory
  - Includes quality system requirements of IS09001
  - Current version is 2017
  - Contained three main pillars in establishing competence-
    - **Metrological Traceability, specifically to the SI unit**
    - **Measurement Uncertainty, the “accuracy of a calibration”**
    - **Assuring the validity of results, all accredited labs must do proficiency testing, usually in the form of inter-laboratory testing to validate their processes**
- ANSI/NCSL z540.3
  - A U.S. national standard
  - First Issued 2006
  - Requirements for establishing the technical requirements of a Calibration Lab
  - Withdrawn as an active standard October 2020 and superseded by IS0/IEC 17025:2017

STANDARDS – TERMS

- TAR-TEST ACCURACY RATIO
  - MIL-STD-45562A, beginning of z540.1
  - Required uncertainties to be “sufficiently small”
    - 4:1
    - If 4:1 not achieved, it must then be stated
- TUR – TEST UNCERTAINTY RATIO
  - Latter part of z540.1, z540.3
  - Thought of added error from calibration process
  - 4:1

STANDARDS – TERMS

- Mu – Measurement Uncertainty
  - ISO/IEC 17025
  - Shifted the focus from a test ratio to understanding a calibration process and the contributors to the uncertainty or inaccuracies of the calibration
  - Mu must be reported for each calibration test point
  - The concept was that by knowing the Mu the lab established more confidence in their measurements
  - Left the customer the responsibility to understand uncertainties and what it meant for their tests

ISO/IEC 17025: 2017

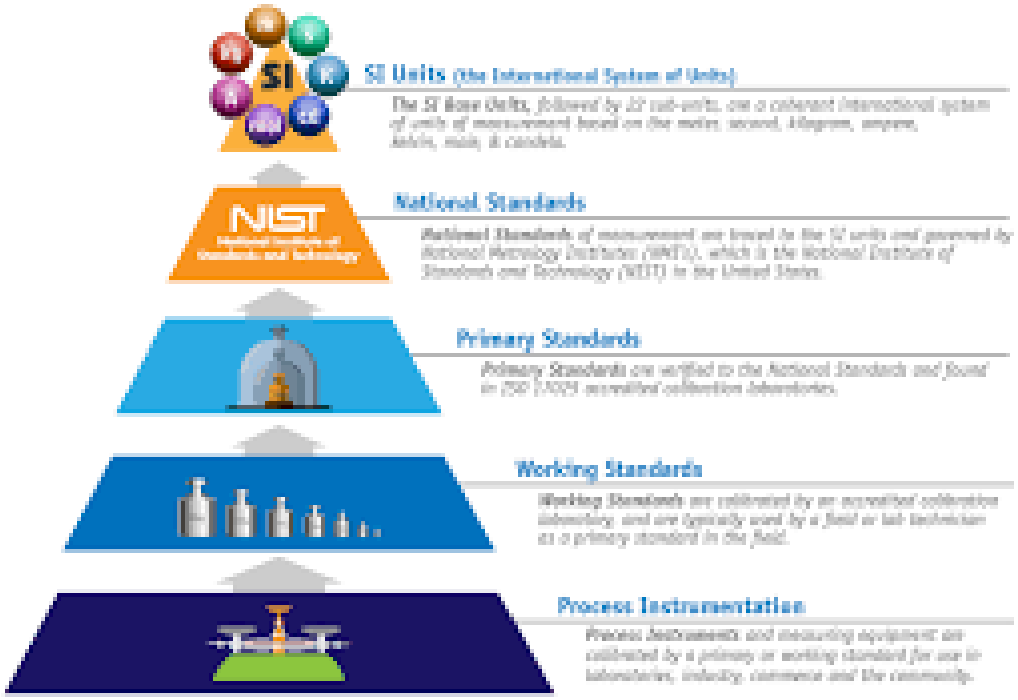
- General requirements for the competence of testing and calibration laboratories
- Measurement Uncertainty
- ISO9001
- SI Traceability
- Inter-national
- Proficiency Testing
- Accreditation – Different than certification

ISO/IEC 17025: 2017

- Certification - Certification is used for verifying that personnel have adequate credentials to practice certain disciplines, as well as for verifying that products meet certain requirements.
- Accreditation - Accreditation is used to verify that laboratories have an appropriate quality management system and can properly perform certain test methods (e.g., ANSI, ASTM, and ISO test methods) and calibration parameters according to their scopes of accreditation.

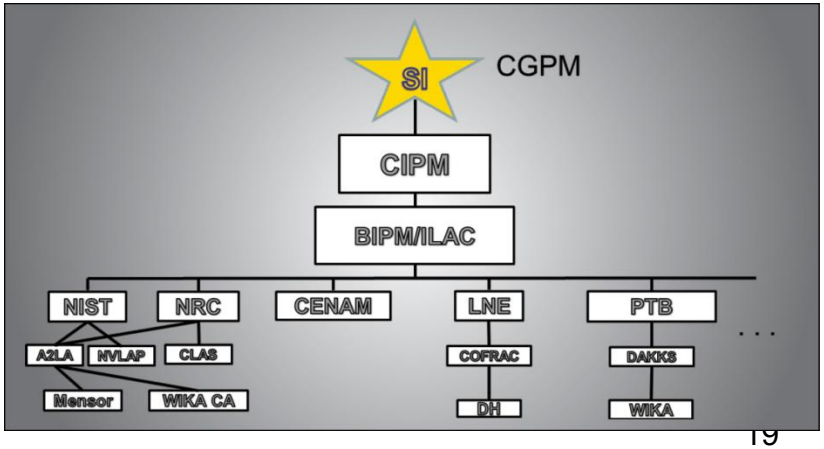
TRACEABILITY

- NRC/NIST Traceable?
- SI – BIPM
- Metre convention – Paris May 20 1875
- NMIs – NRC, NRC PTB
- Units Traceable?
  - NO
  - Measurements
- Unbroken Chain



TRACEABILITY

- CIPM - The CIPM Mutual Recognition Arrangement (CIPM MRA) is the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates they issue.
- ILAC – International Laboratory Accreditation counsel
- ISO - International Organization for Standardization
- IAF - International Accreditation Forum
  - PJLA, A2LA



Calibration and Testing

- Calibrate DCT
- Rigorous Testing
- Repeatability
- Reproducibility
- Best Measurement, best measurement practices
- Ensure traceability with calibrated Measuring and Testing Equipment
  - What does it mean to calibrate?
  - What are the Specifications for calibration?
  - What determines calibration lifecyle?

KNOWN PROCESS

- Document process
- ISO9001
- Repeatable process
- Work Instruction, SOP
- QMS
- Training
- Continuous Improvement

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EV Charging Station Tracing

EV Charging Station Tracing

- What are we doing?
- Why are we doing it?
- How are we doing it?

WHAT ARE WE DOING? EVSE TESTING CA

- Testing Electric Vehicle Supply Equipment (EVSE) as per Scope identified in S-E-EVSE-01, issued under the authority of Section 12 of the Electricity and Gas Regulations
- Level 1+2 to start; Temporary dispensation for Level 3+ electric vehicle supply equipment (canada.ca)
  - Level 3 placed in service prior to July, 2024

Source: S-E-EVSE-01—Specifications for approval of type of electric vehicle supply equipment (canada.ca)

What are we doing? EVSE Testing CA

- **B) Level 3+ EVSE put into service between July 1, 2024, and December 31, 2029**

  No later than December 31, 2029, eligible owners, or an authorized individual designated by the owner as acting on their behalf, wishing to take advantage of the dispensation shall:

  1. Meet all the requirements for Level 3+ EVSE in service prior to July 1, 2024, listed above in section (A);
  2. Supply electricity to the purchaser within an acceptable limit of error of ±3%;
  3. Provide evidence that the EVSE is dispensing electricity within the acceptable limit of error, either by submitting:
     1. test results for their meters, using a method and testing standard acceptable to Measurement Canada; or
     2. a letter, report or other similar document from the meter manufacturer, attesting to the accuracy of the EVSE, as established through the manufacturer's recognized evaluation program; and
  4. Ensure that every eligible EVSE identified in (A)(1)(b) is equipped with:
     1. a metering system capable of measuring the delivered energy; and
     2. a means to display the software and firmware version.

Source: Temporary dispensation for Level 3+ electric vehicle supply equipment (canada.ca)

What are we doing? EVSE Testing CA

- Testing of EVSE is done using the same transactional process as is used in the normal operation of the EVSE and consists of at least the following steps:

1. Initiating a charging session using the standard handshake exchange between the EVSE and a vehicle. A vehicle may be replaced by a simulated vehicle, as long as it conforms to the standard protocols for handshake exchange.
2. Charging at a specified power level for a specified quantity of energy (must be greater than the MMQ).
3. Terminating the delivery of energy as would occur when terminating normal charging of an electric vehicle.
4. Comparing the energy delivered as measured by the EVSE with that measured by the test equipment.
5. Comparing the energy received (if applicable) as measured by the EVSE with that measured by the test equipment.

- Note: For DC EVSE the energy delivered should be sufficient so that the amount of energy delivered during ramp up and ramp down are less than 10 percent of the energy delivered at the test power.
- Note 2: The tests can be performed either with real load or with phantom load.

Source: S-E-EVSE-01—Specifications for approval of type of electric vehicle supply equipment (canada.ca)

WHAT ARE WE DOING?

Table 2: Maximum permissible errors		
Current range	Power factor	Maximum permissible error
$I_{st} \leq I < I_{min}$	>0.9	±15%
$I_{min} \leq I < I_{tr}$	>0.9	±1.5%
$I_{tr} \leq I \leq I_{max}$	>0.9	±1.0%

S-E-EVSE-01—Specifications for approval of type of electric vehicle supply equipment (canada.ca) Section 7.6 Table 2

How are we doing it?

Test Methods

- Simulation
  - Use of a “programmable load” emulator, (Phantom Load style test)
- Man-in-the-middle (MITM)
  - Use of an electric vehicle as “Customer Load”

SIMULATION

MAN-IN-THE-MIDDLE

TESCO EVSE SUITE - T4350

T4350 Portable EVSE Tester

Rugged, Portable, and Built for the Field
The TESCO T4350 EVSE Test System is an industry-leading electric vehicle charging test solution, designed for high-accuracy EVSE performance measurement. This 4th generation EVSE analyzer delivers lab-grade precision (±0.05%) across voltage, current, and power, ensuring reliable testing for CCS1 and Tesla charging stations.

Universal Compatibility with CCS1 & Tesla Standards

CCS1 AC: AC charging up to 80A at 240VAC (SAE J1772, North America)
CCS1 DC: DC charging up to 650A peak, 350A sustained at 1000VDC
Tesla AC: AC charging up to 80A at 240VAC
Tesla DC: DC charging up to 650A peak, 350A sustained at 1000VDC (SAE 3400, North America)

This makes the T4350 portable EVSE tester a complete solution for field engineers, utilities, and testing laboratories.

TESCO EVSE Suite - Load Boxes

Load Boxes & Interface Solutions

150 kW Programmable Load Box (PL4150)

- A charger-agnostic load box apable of testing various EV charger types up to 150 kW — from CCS1, CCS2, NACS, CHAdeMO, to GBT.
- Features Auto-Interface, Auto Cool-off, environmental sensors (temperature, humidity, fan speed), safety sensors, and a NEMA 3R waterproof rating.

Programmable AC Load Box (PL4000)

- A rugged, portable, lab-grade load box for single-phase AC testing of EV chargers up to 14kW.
- Offers Auto-Interface, Auto Cool-off, built in-temperature, humidity, fan speed sensors, and both AC and DC breakers.

Man-in-the-Middle (MitM) Cable

- A specialized cable featuring a Staubli interface on one end and an EVSE-specific interface on the other, enabling real-time precision testing when paired with TESCO's T4350.
- Built-in MCU for communication, protective Staubli terminal cap, and high-capacity electrical specs (up to 1000 V DC, 350 A sustained, 650 kW peak).

T4350 vs T4000

- T4350 – what's in a name?
  - "T": Tester
  - "4": 4th generation
  - "350": rated for 350A continuous load

- What's changed?
  - The T4350 is capable of higher power testing and supports the full spectrum of charger types across AC/DC

	T4000		T4350
Continuous Load	200A		350A
Max Load	400A		650A

PL4150 vs. PL4000

- PL4150 – what's in a name?
  - "PL": Programmable load
  - "4": 4th generation
  - 150: 150 kW Capable

- PL4150 is an AC/DC, 150kW capable dissipative load-box
- What's Changed?
  - The PL4000 was only capable of ~14kW and thus was only relevant for AC Load dissipation in a regulatory capacity; the PL4150 can handle up 150 kW @ 100% FL

		Test Currents (Amps) at Various Charging Levels at 400VDC									
	Max Current (A)	75	125	187.5	250	375	500	625	750	875	1000
Test Percentage	Max Power (kW)	30	50	75	100	150	200	250	300	350	400
Low Point											
10%		7.5	12.5	18.75	25	37.5	50	62.5	75	87.5	100
20%		15	25	37.5	50	75	100	125	150	175	200
Middle Point											
40%		30	50	75	100	150	200	250	300	350	400
60%		45	75	112.5	150	225	300	375	450	525	600
High Point											
70%		52.5	87.5	131.3	175	262.5	350	437.5	525	612.5	700
100%		75	125	187.5	250	375	500	625	750	875	1000

< 30A Testable with a 150kW load. requires 300 kW load

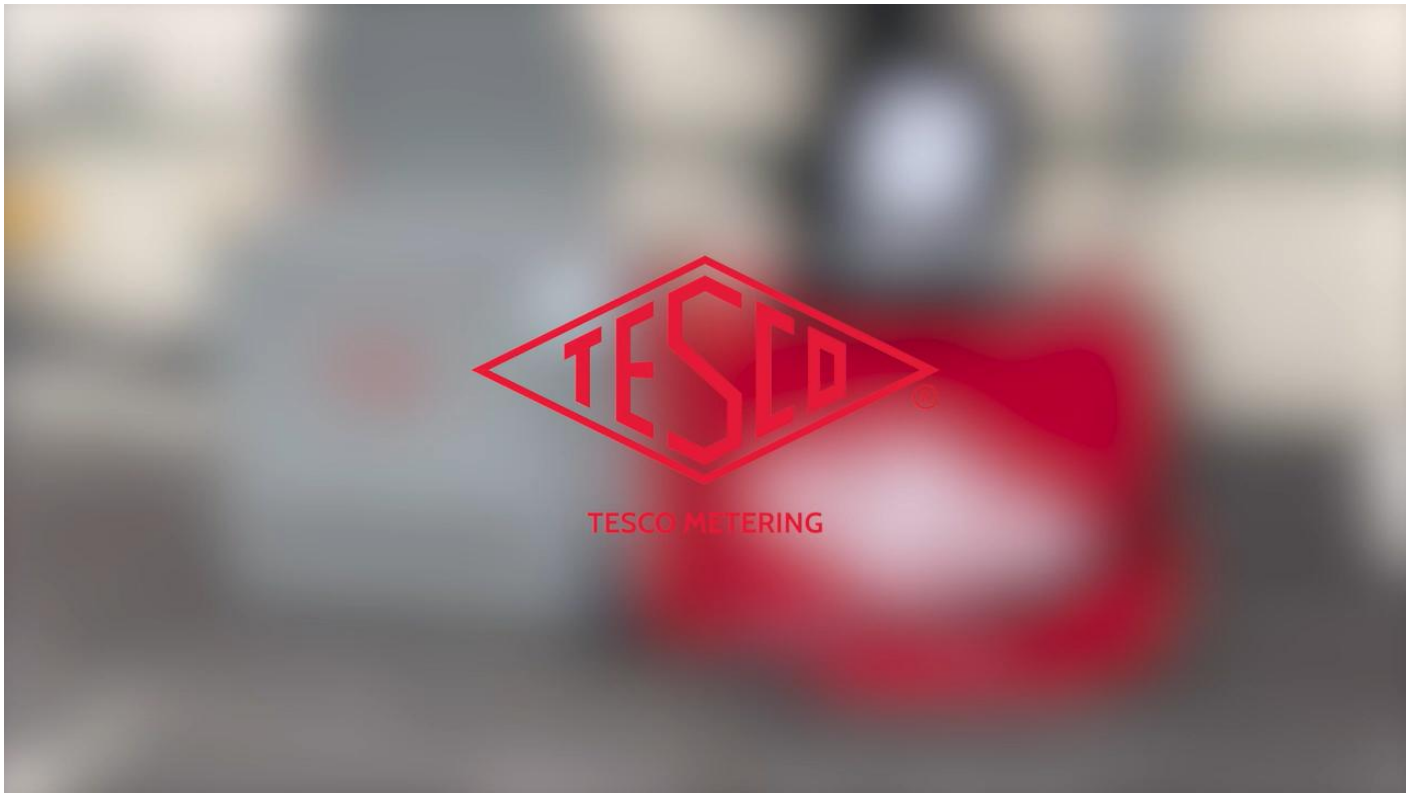
T4350 and PL4150 Hands-On Demonstration

Live Demonstrations

& Demos of EVSE

Accuracy

EVSE Testing In Action



TESCO EVSE TESTING

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EV Charging Station Test Report

DEVICE MANAGER

EVSE TESTER DEVICE INFO:

System Name: **T4000**
Software Version: **1.3.4r**

Serial Number: **00046**
Calibration Date: **Nov-22-2022 7:23 AM**

EVSE Charger Info:

Establishment Name: **l'Esplanade**
Customer: **Hydro Quebec**

Address:
8181 Av de l'Esplanade, Montreal
ON, HGP 2R5

EVSE INFO:

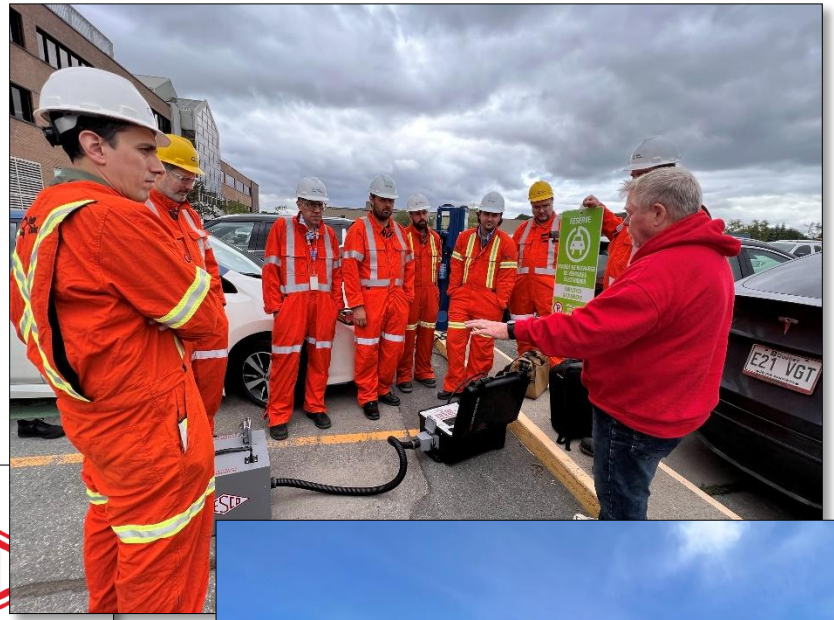
Manufacturer: **Circuit Electrique**
Serial Number: **CEA-10028**

Model: **smartTwo**
GFCI rating: **0.02**

PORTS INFO:

Port #1:
Name: **Port1**

Connector Type: **CCS1 AC**



DEVICE MANAGER

EvseSimulation TEST

AC-FAST : CCS1 AC
PORT: Port1

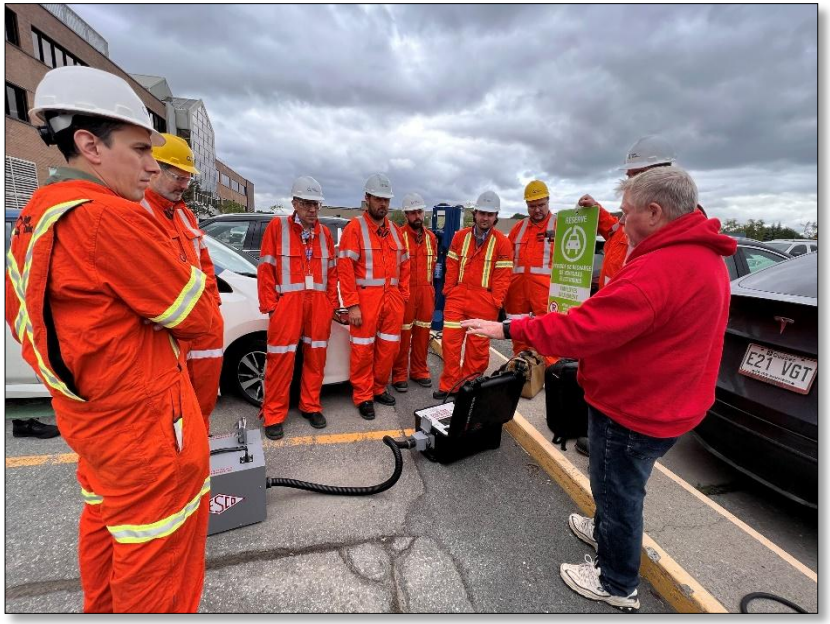
Conducted by: **HYDRO QC**
Conducted on: **Jun-07-2023 12:03 PM**

TEST INDEX	TEST NAME	DURATION	RESULT	ENERGY DELIVERED	ENERGY READING	% ERROR	COMPUTED SALES AMT	EVSE SALES AMT	TOLERANCE TYPE	TOLERANCE
1-1	FL	00:00:52	PASS	0.1003	0.1000	-0.30	0.100	0.000	Maintenance	2.00%
1-2	FL	00:00:52	PASS	0.1003	0.1000	-0.30	0.100	0.000	Maintenance	2.00%

Test Types: **NL** = No Load, **SL** = Startup Load, **LL** = Light Load, **FL** = Full Load, **GFCI** = Ground Fault Test, **DIODE** = CP Diode Test
% Error = ((X-S)/S) * 100

Review of Key Points

- DC Energy Measurement is possible with certified, SI traceable equipment from TESCO's 17025:2017 accredited lab
- Canada has released guidance for type approval, field testing, and temporary dispensation for Level 1, 2, and 3+ EVSE
- Level 1, 2, 3+ EVSE can be tested using available, traceable equipment on the market today; TESCO offers several options of test equipment that are currently being used across the US and in Canada today



Questions and Discussion

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This presentation can also be found under Meter Conferences and Schools on the TESCO website: tescometering.com

ISO 9001:2015 Certified Quality Company

ISO 17025:2017 Accredited Laboratory