ChargeX Prescribed Testing Program at CharIN November 2024 Testival

Outcomes and Future Recommendations

CHARGEX consortium

MAY 2025

ANL/TAPS-25/4

Argonne NATIONAL LABORATORY
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Executive Summary

In November 2024, the ChargeX Consortium developed an optional prescribed testing program for electric vehicle (EV) and electric vehicle supply equipment (EVSE) manufacturers that attended the CharIN November Testival as testers. Seeing as this was the second implementation of the ChargeX Consortium's prescribed test program (PTP) at Charging Interface Initiative (CharIN), the foundation of this event was based on the structure of the June 2024 ChargeX PTP with some variation. This program contained 13 test scenarios (TS) to be performed during the final 40-minutes of a 90-minute testing slot with details such as purpose, setup, pass criteria, etc. included within a written test plan document. A $2,000 rebate was offered to those who participated, and a ChargeX moderation force was present to collect EV and EVSE meta data, testing meta data, and testing results.

The biggest change to this PTP was an added gamification aspect, with this event being implemented under the alias "*The ChargeX Challenge*". Compared to June PTP's sequential approach of completing all TSs in the allotted time, this event had points associated with test attempt, EV pass criteria, EVSE pass criteria, and additional stretch goal pass criteria. Based on feedback received from the previous event, multiple tiers of pass criteria were created for each TS, allowing testers to achieve partial points if not all were met. Throughout the test slots that contained prescribed testing, test pairings worked together to achieve as many points as possible with the more advanced charging tests worth more points, therefore incentivizing their attempt. Points in this "competition" worked towards a series of awards made available by the ChargeX team that any opted-in test pairing or individual EV/EVSE could work towards. These awards included highest scoring pairings, individual EV across all test slots, and individual EVSE across all test slots, as well as additional awards for most ambitious, most persevering, stretch goal recognition, ISO 15118-20 recognition, and seamless retry recognition. Overall, the gamified PTP was received extremely positively by those who participated, with many very eager to hear updates on leaderboards and find out who had the highest scores throughout the event. Within this report, the names of testers who claimed awards have been kept anonymous.

In terms of participation, there were 10 EVs and 13 EVSE that opted-in to the program with 7 out of 10 of the test slots containing a 40-minute prescribed testing window. Opted-in testers matchmade with opted-out testers were given the option to participate in the prescribed testing program if desired, and two opted-in testers were expected to perform the tests when paired together. The testers participating in this program were limited to EVs and EVSEs capable of either AC or DC charging, with test systems being excluded from this program. In total, 45 unique test pairings worked to attempt 344 TS, with 275 that met some or all pass criteria and 69 attempts that met no pass criteria. Like the June 2024 PTP, it was seen that some TS had much higher attempt rates and/or success rates than others due to the difficulty range in tests. This attempt/success rate was a major increase from June 2024's PTP which yielded 163 TS attempts with 112 of those meeting all defined pass criteria. Time to perform TS was captured for future planning of TS and given testing time.

For a high-level summary of testing outcomes, TS 1 and 2 had a very high attempt/success rate for basic plug-first tests using DIN SPEC 70121, J1772 or ISO 15118-2. TS 3 had a much lower attempt/success rate for plug-first using ISO 15118-20 as it is a HLC protocol still in the early implementation stage by testers, however it did yield one successful attempt. TS 5-9 explored fault injections and stop methods, which yielded high attempt/success rates and discovered both expected and unexpected behavior from EV and EVSE systems. TS 11-13 explored Plug&Charge and certificate testing, with TS 11 having the highest attempt-to-success ratio for valid certificates Plug&Charge testing. TS 12 and TS 13 expired certificate Plug&Charge testing

had a much lower attempt and success rate due to several reasons, one of those being compatibility issues between tester's equipment and CharIN provided expired certificates, as well as testers inability to issue expired certificates themselves.

Feedback was received for the PTP before, during, and after the CharIN November 2024 Testival which was combined and summarized in this report. Areas of discussion included communication improvements, preparation time, results recording, including test systems, gamification feedback, matchmaking involvement, pass criteria, etc. CharIN survey data that pertained specifically to prescribed testing participation, incentives, and future interest was also included in this report. Feedback from the June 2024 PTP and how it was addressed in this event was also summarized within this report.

For future implementations of prescribed testing there are many directions that can be taken. This document outlines the ChargeX Consortium's journey and decision-making process in creating this program, including what worked well and what could be improved upon. The hybrid structure of ad-hoc and prescribed testing was quite effective, and testers gave positive feedback towards the moderation team present to support questions and record results. A "gamified" approach was very positively received by testers and was noted to be a great incentive for future participation. Ensuring proper and timely communication/promotion of an upcoming PTP is essential to success so testers can arrive prepared and ready to perform a prior reviewed test plan. The ChargeX Consortium team gathered a tremendous number of insights from this testing event and is interested in supporting the testing landscape to include prescribed testing moving forward.

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1. Introduction

Electric vehicle (EV) charging is a complex system where interoperability issues often arise, as different manufacturers and technologies can lead to inconsistent performance and user experience. Interoperability in EV charging refers to the ability of different EV charging networks and equipment to work seamlessly together, allowing users to charge their vehicles across various charging stations without compatibility issues. Testing events play a pivotal role in addressing these challenges by allowing companies to evaluate and refine their products in real-world scenarios.

Charging Interface Initiative (CharIN) is a prominent organization that was established in 2015, with a mission to ensure a seamless, efficient, and standardized charging experience across various EV models and charging infrastructure worldwide. By fostering collaboration among automotive and energy stakeholders, CharIN supports rigorous testing and certification processes, while advancing standards to accommodate emerging technologies. CharIN is prominently known for their in-person testing events – known as Testivals - where they facilitate real-world testing of interoperability, performance, and compliance for EV and EVSE original equipment manufacturer (OEM) pre-production equipment as well as test systems, controllers (including SECC/EVCC), and other testing devices to support the testing activities. CharIN hosts 7-9 Testivals annually, with two located each year in North America. The Testivals are hosted by CharIN members and partners at locations with sufficient space and power. Logistics support is provided by CharIN Academy GmbH and technical support is contracted from Keysight Technologies for tester matchmaking and other logistical information.

The ChargeX Consortium's Testing Task Force (TF) has a targeted goal of improving upon and scaling interoperability for EVs and charging infrastructure. In June 2024, the TF implemented the Prescribed Testing Program (PTP) at CharIN June 2024 Testival, the first of its kind in recent history where a hybrid approach to ad-hoc and prescribed testing was taken during a CharIN testing event. In this program, testers opted-in to a series of interoperability tests to be performed sequentially during a dedicated 30-minutes out of the full 90-miniute test slots with a ChargeX moderation team present to facilitate test execution and record results, with the other 60-minutes dedicated to free-time (i.e. "ad-hoc") for testers to utilize how they desired. This PTP was executed with great success and a full report on its outcomes has since been published on the ChargeX website.

The ChargeX Consortium's Testing TF facilitated a second optional PTP during the CharIN November 2024 Testival with a slightly different approach. This PTP contained a gamified approach where TS pass criteria had points assigned for EV and EVSE pairings to achieve together throughout a dedicated prescribed testing window. Many of the PTP aspects remained similar to that of the June 2024 PTP, such as the hybrid ad-hoc /prescribed approach, moderator facilitation, multiple TS, rebate incentive, etc. This approach sparked friendly competition between testers and was received positively, yielding some interesting results that this report details in greater length.

2. Event Details and Program Structure

The following contains details on the CharIN Testival and the ChargeX PTP.

2.1 CharIN November 2024 Testival

CharIn November 2024 Testival took place during November 19-21, 2024 and was hosted by WattEV in San Bernardino, CA utilizing their facilities as testing grounds and conference center. Figure 1 shows the layout and electrical connections present at WattEV and Table 1 highlights those who participated in testing, with some participants having more than one pre-production testing equipment present.

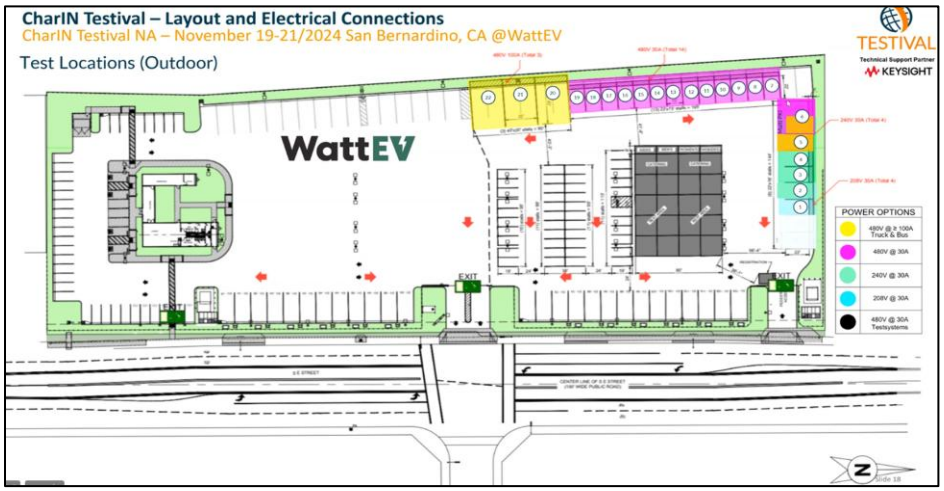


Figure 1: WattEV in San Bernardino, CA testing grounds map

Table 1: CharIN November 2024 All Testival Participants

EVs	EVSEs	Test Systems
Ford Motor Company	Autel Energy	DEKRA North America
Hexagon Purus	Bender GmbH and Co. KG	Keysight Technologies
American Honda Motor Co.	BTC Power	TESCO
International Motors	ChargePoint	Vector North America
KPIT Technologies Inc.	Chargetronix	
Lucid Motors	Dover Fueling Solutions	
Mercedez-Benz	Ekoenergetyka	
Nissan North America	Enphase Energy	
PACCAR	EVgo	
Rivian Automotive	Heliox Energy	
Volvo Cars	Lincoln Electric	
	Pionix	
	Power Innovations International	
	Rivian	
	Siemens	

EVs	EVSEs	Test Systems
	Sinexcel Electric Co. Ltd	
	WattEV	

For event scheduling, Monday was a dedicated equipment setup day for EVs and EVSEs. Matchmade testing was performed on day 1 and 2 (Tuesday and Wednesday, test slots 1-7), and day 3 (Thursday) testing slots were dedicated for dynamic testing (test slots 8-10). In addition to testing on day 2, CharIN hosted a “public day” for non-testers to attend presentations, demonstrations, and observe testing activities. The ChargeX team executed the PTP entirely on days 1 and 2, a schedule for which can be seen below in Figure 2 along with day 2 demonstrations and presentations.

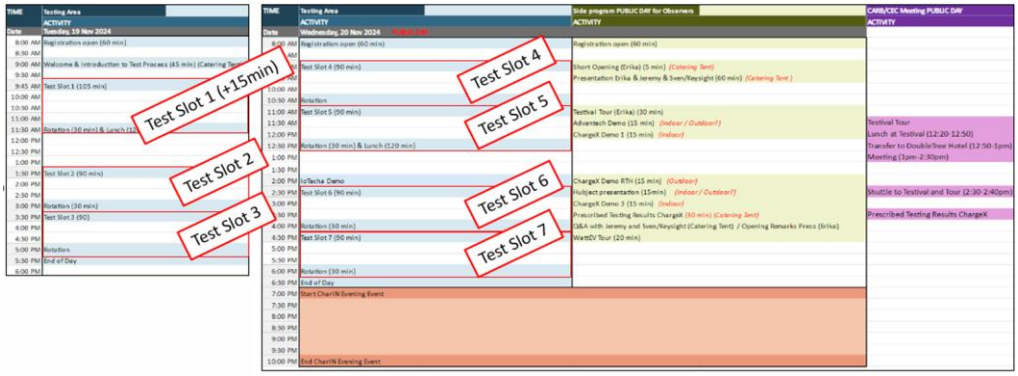


Figure 2: CharIN Testing Schedule for Tuesday and Wednesday

2.2 ChargeX PTP Structure

The foundation of this was developed from the previous PTP executed by ChargeX during the CharIN June 2024 Testival. Further details surrounding prescribed testing duration and test categories were gathered through the bi-weekly Testing TF meetings using surveys and discussions.

Table 2 below summarizes the key changes between the ChargeX June 2024 PTP and the ChargeX November 2024 PTP. Some major changes of note were that the prescribed testing time was increased from 30-minutes to 40-minutes, number of testing scenarios increased from 8 to 13, most of the tests scenarios chosen were changed, and a gamified “competition”-style approach was implemented.

Table 2: PTP Event Details June vs November

PTP Event Details	ChargeX June 2024 PTP	ChargeX November 2024 PTP
Total test slot duration	90-minutes	90-minutes
Ad-hoc testing duration	60-minutes	50-minutes
Prescribed testing duration	30-minutes	40-minutes
Sequential or Gamified testing	Sequential	Gamified
Moderators	1 moderator per pairing	1 moderator per pairing

PTP Event Details	ChargeX June 2024 PTP	ChargeX November 2024 PTP
PKI Providers available	Hubject certificate pool	Hubject certificate pool
# of Test Scenarios	8	13
Test Categories	HLC protocol selection, Authentication types/methods, Timeouts, Fault injections/MRECs, Plug&Charge/Certificates	HLC protocol selection, Authentication types/methods, Timeouts, Stop methods, Fault injections/MRECs, Plug&Charge/Certificates
Participation rebate	$2,000 per asset	$2,000 per asset

A testing schedule for the ChargeX PTP was developed based on the CharIN event test slot schedule which can be seen below in Figure 3. It should be noted that tester feedback led CharIN to grant test slot 1 an additional 15-minutes than test slots 2-7 to help mitigate early testing issues. In each test slot during the dedicated prescribed testing time, testers would work to complete as many of the 13 TS described in Figure 4 as possible, incentivized to prioritize more advanced tests to achieve higher points.

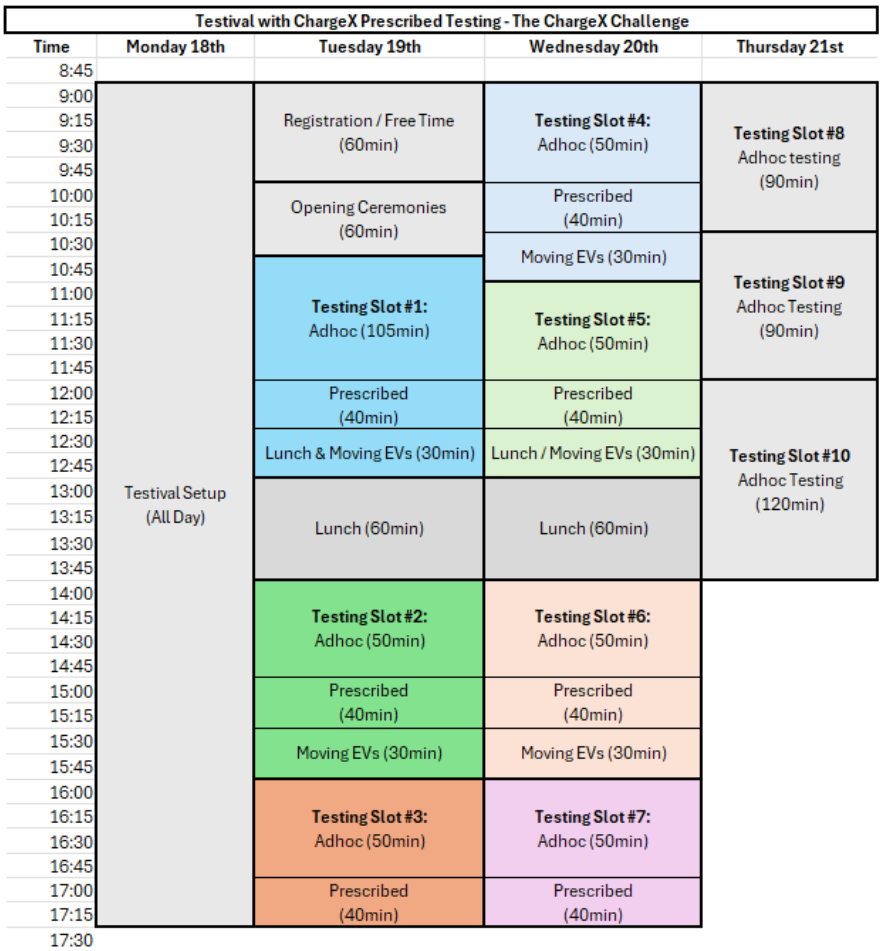


Figure 3: ChargeX PTP Schedule

November 2024 Test scenarios
TS1: Plug-first using DIN 70121 or J1772
TS2: Plug-first using ISO 15118-2
TS3: Plug-first using ISO 15118-20
TS4: Plug-first timeout
TS5: Disconnect PILOT @ EVSE, start charge
TS6: Holding connector lock, plug-in & start charge
TS7: Press latch to attempt stop during PT
TS8: Press EVSE emergency stop during PT
TS9: Press EV UI "Stop" during PT
TS10: Press EVSE UI "Stop" during PT
TS11: PnC Valid EV & EVSE Certificates
TS12: PnC Expired EV Contract Certificate - session terminates
TS13: PnC Expired EV Contract Certificate - fallback methods utilized

Figure 4: ChargeX PTP Test Scenarios

Gamified testing was a major addition to this PTP, where points were achieved by test pairings through TS execution that worked towards a series of awards and recognitions at the PTP's end. This gamified PTP, titled '*The ChargeX Challenge*", contained points that could be achieved through test attempts, EVSE pass criteria, EV pass criteria, and additional stretch goal pass criteria. Regardless of the outcome, testers could achieve points for attempting any test, with the more advanced tests yielding higher points. EVSE and EV pass criteria had multiple tiers, whereby successfully completing a more comprehensive pass criteria, the test pairing could attain higher points. The stretch-goal pass criteria were those that necessitated substantial pre-competition work for testers to ensure the required equipment functionalities were operational, reflecting their significantly higher point value (i.e. MREC was produced, timeout time met, 3rd-party PKI provider used for Plug&Charge). A full list of all TS and pass criteria can be seen below in Figure 5.

Test Scenario #	Category, Test Type, Test Name, #Points for attempting	EV Pass Criteria	Additional "Stretch Goal (SG)" Pass Criteria	Min points	Max points	TOTAL w/ SG & Max points
TS1	Authentication Types, Intentional Charging, **TS1: Plug-first using DIN 70121 or J1772** (2pt)	• EV started charge using DIN 70121 or J1772 (2pt)	--	2	6	6
TS2	Authentication Types, Intentional Charging, **TS2: Plug-first using ISO 15118-2** (2pt)	• EV started charge using ISO 15118-2 (3pt)	--	2	8	8
TS3	Authentication Types, Intentional Charging, **TS3: Plug-first using ISO 15118-20** (2pt)	• EV started charge using ISO 15118-20 (5pt)	--	2	12	12
TS4	Authentication Types & Methods, Timeouts, **TS4: Plug-first timeout** (3pt)	• EV timeout (not 120s +/-10s) occurred with visual timeout notification (3pt) • EV timeout (not 120s +/-10s) occurred without visual timeout notification (1pt)	• 120 second (+/-10s) timeout time occurred (5pt) • EVSE "AuthorizationTimeout" MREC thrown (4pt)	3	9	18
TS5	Session Initialization (SI) Intentional Faults & Error Codes, **TS5: Disconnect PILOT @ EVSE, start charge** (3pt)	• EV visual "Pilot" error, session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "PilotFault" MREC thrown (5pt)	3	9	14
TS6	Session Initialization (SI) Intentional Faults & Error Codes, **TS6: Holding connector lock, plug-in & start charge** (3pt)	• EV visual "Connector Lock" session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "ConnectorLockFailure" MREC thrown (5pt)	3	9	14
TS7	Power Transfer (PT), Stop Methods (Error Stop), **TS7: Press latch to attempt stop during PT,** (3pt)	• EV does not allow latch to be pressed during PT (3pt) • EV visual "Prox Loss" or similar error, session ends (2pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "ProximityFault" MREC thrown if session ends OR EVSE "ConnectorLockFailure" MREC thrown if session ends (5pt)	3	9	14
TS8	Power Transfer (PT), Stop Methods (Error Stop), **TS8: Press EVSE emergency stop during PT,**	• EV visual "Emergency Stop" or similar error, session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "EmergencyStop" MREC thrown (5pt)	3	9	14
TS9	Power Transfer (PT), Stop Methods (Intentional Stop), **TS9: Press EV UI "Stop" during PT,** (3pt)	• EV visual "EV Shutdown" or similar error, session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	--	3	9	9
TS10	Power Transfer (PT), Stop Methods (Intentional Stop), **TS10: Press EVSE UI "Stop" during PT,** (3pt)	• EV visual "EVSE Shutdown" or similar reason, session ends (3pt) • EV visual generic reason, session ends (2pt) • EV no visual reason, session ends (1pt)	--	3	9	9
TS11	Single PKI, Certificate Validity Tests, **TS11: PnC Valid EV & EVSE Certificates,** (4pt)	• EV uses valid EV certs, session begins (3pt)	• CharIN provided certificate pool utilized for valid EVSE leaf certs (2pt) • CharIN provided certificate pool utilized for valid EV certs (2pt)	4	10	14
TS12	Single PKI, Certificate Validity Tests, **TS12: PnC Expired EV Contract Certificate - session terminates,** (4pt)	• EV attempts using expired EV certs, session terminates (3pt)	• CharIN provided certificate pool utilized for valid EVSE leaf certs (2pt) • CharIN provided certificate pool utilized for expired EV certs (4pt)	4	10	16
TS13	Single PKI & Seamless Retry, Certificate Validity Tests, **TS13: PnC Expired EV Contract Certificate - fallback methods utilized,** (5pt)	• EV attempts using expired EV certs, payment is declined, EVSE falls back to EIM, prompts user for authentication, EV allows session to begin (5pt)	• CharIN provided certificate pool utilized for valid EVSE leaf certs (2pt) • CharIN provided certificate pool utilized for expired EV certs (4pt)	5	15	21

Figure 5: ChargeX PTP Test Scenarios and Points

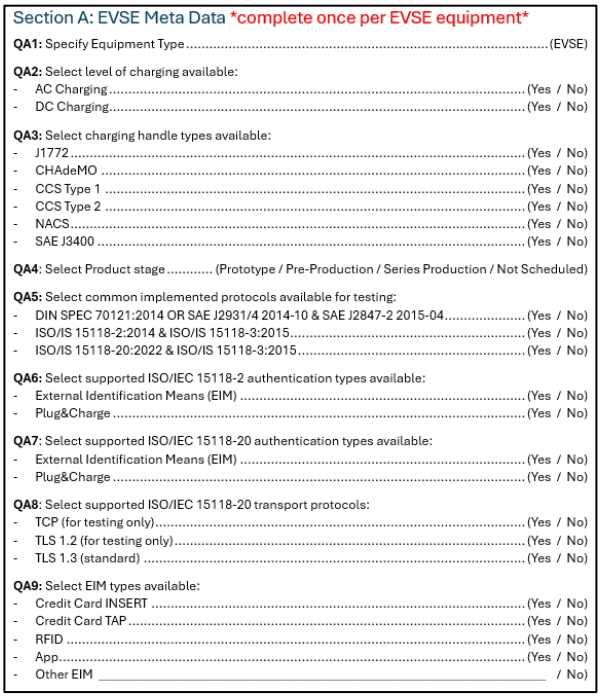
Achieving points in these TS worked towards a pre-defined set of awards made available for anyone who opted-in to the ChargeX PTP. These awards were distributed at the conclusion of the PTP on day 3 (Thursday) during an awards ceremony hosted by the ChargeX moderation team. These awards included a series of trophies, medals, and certificates that were awarded based on the final scores of the ChargeX Challenge. Descriptions for these awards and recognitions can be seen in Table 3.

Table 3: ChargeX PTP Awards

Awards	Description
Highest Scoring EV	• Individual EV with highest combined score across all 7 test slots • 1st, 2nd, 3rd place awards • Score normalization for non-PTP test slots
Highest Scoring EVSE	• Individual EVSE with highest combined score across all 7 test slots • 1st, 2nd, 3rd place awards • Score normalization for non-PTP test slots
Highest Scoring Pairing	• EVSE and EV pairing with highest score across all test pairings • 1st, 2nd, 3rd place awards

Awards	Description
Most Ambitious Pairing	• EVSE and EV pairing who attempted the highest number of advanced tests
Most Persevering Pairing	• EVSE and EV pairing who attempted the same advanced test scenario most times until success
Stretch Goal Recognition	• Recognition for any pairing who completes a stretch goal
ISO 15118-20 Recognition	• Recognition for any pairing who completes TS3 (ISO 15118-20)
Seamless Retry Recognition	• Recognition for any pairing who completes TS13 (Plug&Charge fallback - Seamless retry)

EV and EVSE anonymized meta data was collected from each tester by moderators. This meta data covered equipment type, available charging levels, inlet type, product stage, communication protocols implemented, authentication methods supported, etc. These EV and EVSE meta data question sets can be seen below in Figure 6 and Figure 7.



Section A: EVSE Meta Data *complete once per EVSE equipment*

QA1: Specify Equipment Type ..... (EVSE)

QA2: Select level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QA3: Select charging handle types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QA4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)

QA5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 & SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 & ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 & ISO/IS 15118-3:2015 ..... (Yes / No)

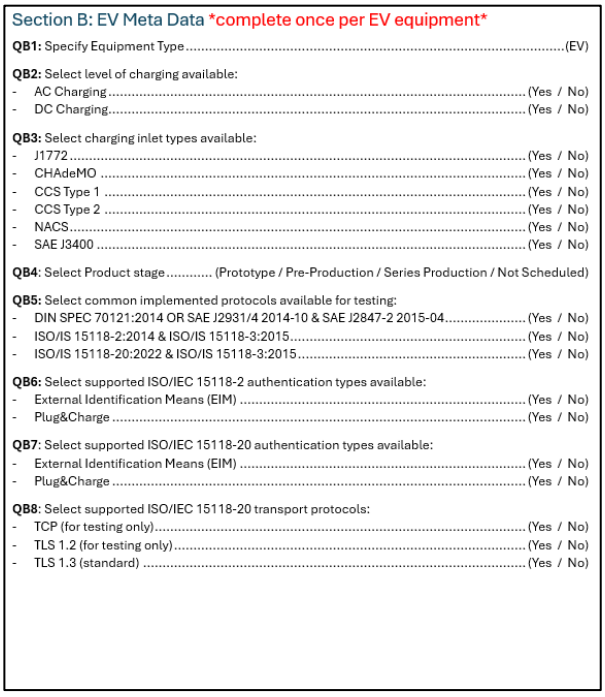
QA6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

QA9: Select EIM types available:
- Credit Card INSERT ..... (Yes / No)
- Credit Card TAP ..... (Yes / No)
- RFID ..... (Yes / No)
- App ..... (Yes / No)
- Other EIM _____ / No)

Figure 6: EVSE Meta data



Section B: EV Meta Data *complete once per EV equipment*

QB1: Specify Equipment Type ..... (EV)

QB2: Select level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QB3: Select charging inlet types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QB4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)

QB5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 & SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 & ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 & ISO/IS 15118-3:2015 ..... (Yes / No)

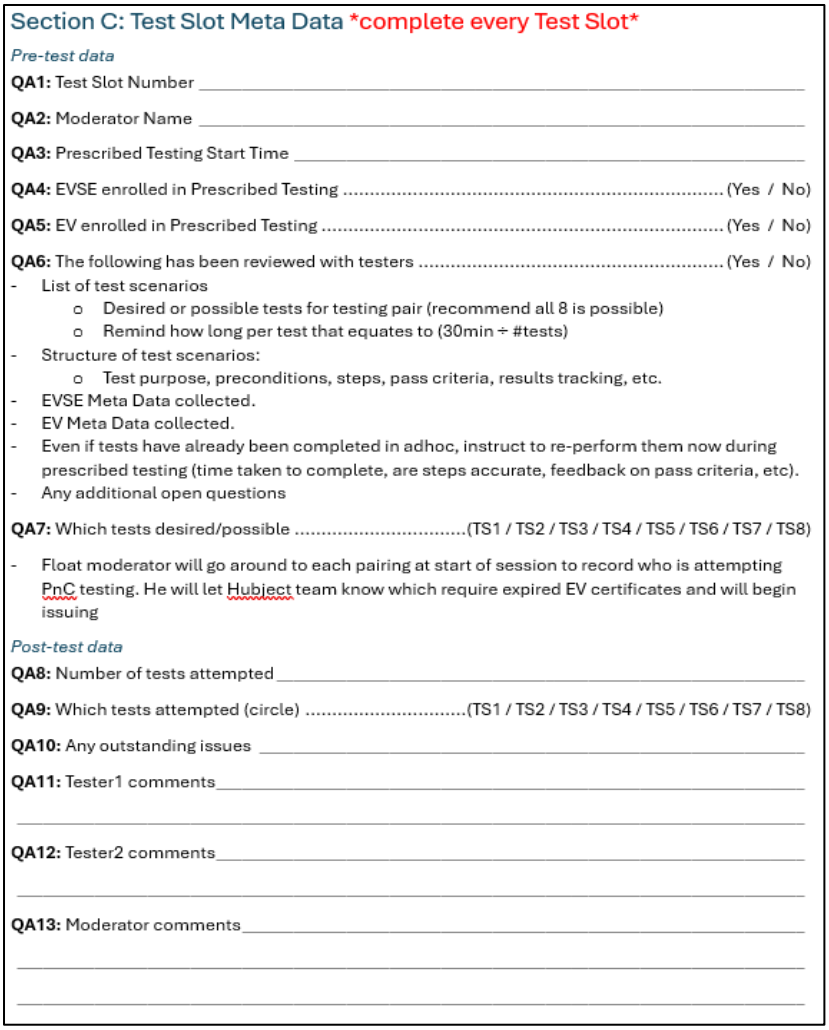
QB6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QB7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QB8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

Figure 7: EV Meta data

Test slot meta data was completed at the start of each prescribed testing period for each test pairing to identify test slot number, start time, opt-ins/opt-outs and desired/possible TS. Additionally, test slot meta data was completed during each test at the end of each prescribed testing period to capture the number of tests attempted, scenarios attempted, end time, outstanding issues, testers comments, and moderator comments. These test slot meta data question sets can be seen below in Figure 8.



Section C: Test Slot Meta Data *complete every Test Slot*

Pre-test data

QA1: Test Slot Number _____

QA2: Moderator Name _____

QA3: Prescribed Testing Start Time _____

QA4: EVSE enrolled in Prescribed Testing ..... (Yes / No)

QA5: EV enrolled in Prescribed Testing ..... (Yes / No)

QA6: The following has been reviewed with testers ..... (Yes / No)

- List of test scenarios
  - Desired or possible tests for testing pair (recommend all 8 is possible)
  - Remind how long per test that equates to (30min ÷ #tests)
- Structure of test scenarios:
  - Test purpose, preconditions, steps, pass criteria, results tracking, etc.
- EVSE Meta Data collected.
- EV Meta Data collected.
- Even if tests have already been completed in adhoc, instruct to re-perform them now during prescribed testing (time taken to complete, are steps accurate, feedback on pass criteria, etc).
- Any additional open questions

QA7: Which tests desired/possible .....(TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

- Float moderator will go around to each pairing at start of session to record who is attempting PnC testing. He will let Hubject team know which require expired EV certificates and will begin issuing

Post-test data

QA8: Number of tests attempted _____

QA9: Which tests attempted (circle) .....(TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

QA10: Any outstanding issues _____

QA11: Tester1 comments_____

_____

QA12: Tester2 comments_____

_____

QA13: Moderator comments_____

_____

_____

Figure 8: Test Slot Meta data

Each TS followed a tabular structure that was mapped directly from the "*EV-EVSE Interoperability Test Plan (EEITP)"* document developed within the ChargeX Testing TF. A TS example from this test plan can be seen in Figure 9, covering all details in terms of test identifier, name, type, category, purpose, conditions, steps, pass criteria, observable metrics, error codes, and recorded results. This format was repeated up to thirteen times in each test slot, one for each TS included in this November 2024 PTP.

Test Identifier:	TS6		
Test Name:	Holding Connector Lock, Plug-in & attempt charge start		
Test Type:	Intentional Faults & Error Codes		
Test Category:	Session Initialization (SI)		
Purpose:	To ensure connector lock was not detected & prevents charge start. To ensure appropriate error codes & UI instructions are provided upon error.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
Steps:	1	Set EVSE authentication option to '**Authentication Type'.**	
	2	While holding down connector lock, plug-in EV.	
	3	While continuing to hold connector lock, Within 30 seconds provide '**Authentication Type'.**	
	4	Observe session initialization stages, recording EVSE UI and EV UI behavior/faults.	
	5	If session does not fault, terminate charge session 30-60 seconds into power transfer.	
	6	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Visual "Connector Lock" or "Proximity" error on EVSE UI, session ends.		Met (3pt)
	EVSE #2: Visual generic error on EVSE UI, session ends.		Met (2pt)
	EVSE #3: No visual error on EVSE UI, session ends.		Met (1pt)
	EV #1: Visual "Connector Lock" or "Proximity" error on EV UI, session ends.		Met (3pt)
	EV #2: Visual generic error on EV UI, session ends.		Met (2pt)
	EV #3: No visual error on EV UI, session ends.		Met (1pt)
	Stretch Goal A: EVSE "ConnectorLockFailure" or "ProximityFault" MREC thrown.		Met (5pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"ConnectorLockFailure" or "ProximityFault"		
Possible MRECs/Errors:	"Invalid Sequence", Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

Figure 9: ChargeX PTP Test Scenario 7 Tabular Details

A moderator schedule was created and used to keep track of which tester pairings would be assigned to each moderator throughout the event, as well as some initial tracking of results and comments throughout to be adaptable to changes that could arise. This moderator tracking sheet can be seen in Figure 10 where moderators, EVs, EVSEs, and test device names have been kept anonymous. This schedule was compiled based on the CharIN November 2024 Testival matchmaking schedule developed by Keysight Technologies for CharIN, where indicators for those who opted-in to the ChargeX PTP were present. This moderator schedule included pairings where both testers had opted-in, as well as those where only one tester had opted-in. Pairings where neither tester had opted-in to the PTP, and those paired with test devices were not considered in the making of this schedule. Those highlighted green indicated opted-in, yellow indicated opted-out, and red indicated not included in prescribed testing (i.e. test devices).

	TS1							TS2						
Moderators	TYPE	EV	EVSE	Location#	Tested?	EV Meta	EVSE Meta	TYPE	EV	EVSE	Location#	Tested?	EV Meta	EVSE Meta
MOD1														
MOD2	DC	EV1	EVSE1	7	Yes (3 done)	Yes	N/a	DC	EV14	EVSE15	24	Yes (5 done)	Yes	N/a
MOD3	DC	EV2	EVSE2	8	Yes (3 done)	Yes	N/a	DC	EV7	EVSE14	21	Yes (5 done)	N/a	N/a
MOD4	DC	EV3	EVSE3	9	Yes (4 done)	Yes	Yes	DC	EV12	EVSE3	9	No	--	--
MOD5	DC	EV4	EVSE4	10	No	N/a	Yes	DC	EV2	EVSE4	10	Yes (6 done)	--	--
MOD6	DC	EV5	EVSE5	17	No	No	No	DC	EV10	EVSE5	17	No	Yes	Yes
MOD7	DC	EV6	EVSE6	18	Yes (4 done)	Yes	Yes	DC	EV6	EVSE16	16	No	--	N/a
MOD8	DC	EV7	EVSE7	23	No	N/a	Yes	DC	EV8	EVSE7	23	No	N/a	--
MOD9	DC	EV8	EVSE8	25	No	N/a	Yes	DC	EV9	EVSE17	25	Yes (2 done)	--	Yes
MOD10	AC	EV9	EVSE9	2	Yes (3A 0done)	Yes	No	AC	EV13	EVSE9	2	No	Yes	Yes
MOD11	AC	EV10	EVSE10	4	Yes (1A TS5, 0 d	Yes	Yes	AC	EV3	EVSE10	4	Yes (4 done)	--	--
MOD12	AC	EV11	EVSE11	15	No	N/a	No	AC	EV1	EVSE11	15	No	--	--
MOD13	DC	EV12	EVSE12	20	No	Yes	N/a							
MOD14														
MOD15														
Not Testing 1	DC	EV13	TD1	5				DC	EV5	TD1				
Not Testing 2	DC	TD2	EVSE13	19				DC	TD3	EVSE13				
Not Testing 3	DC	TD3	EVSE14	21				DC	EV15	TD6				
Not Testing 4	AC	EV14	TD4	1										
Not Testing 5	AC	EV15	TD5	11										
Not Testing 6														

Figure 10: ChargeX PTP Moderator Schedule

3. Results and Feedback

The following sections contain the results of the competition side of the PTP, results from the individual TS, the comments, feedback received, and recommendations for future implementations of PTP.

3.1 Competition Results

During the execution of "*The ChargeX Challenge"*, the ChargeX moderation team tracked the points achieved by test pairings throughout the event to keep an updated leaderboard available after every test slot. This updated leaderboard was a running score for top three highest scoring pairings and their relative points. This was something highly requested by testers throughout the event as they wanted to see where they fell on the scoreboard and how many points were needed to achieve a "podium finish" for each category. The running for the highest scores were quite close, with 1st place achieving an impressive 147 points out of a possible 151. The top 10 final pairing scores can be seen in Table 4.

Table 4: Top 10 Highest Pairing Points Achieved

Place	Points	Place	Points
1st Place	146	6th Place	100
2nd Place	131	7th Place	95
3rd Place	117	8th Place	89
4th Place	114	9th Place	88
5th Place	101	10th Place	85

The awards for highest scoring individual EVs and EVSEs were calculated by summing the points achieved by each tester during the test slots they participated in prescribed testing. Considering there were testers that had more/less test slots where prescribed testing took place due to the matchmaking schedule (i.e. being paired with a test system, opted-out tester, or other), a normalization strategy needed to be implemented to even the playing field. There are many different approaches to normalization that could have been implemented, however the approach that the ChargeX moderation took was to average all the test pairings' points achieved for each individual test slot and assign that average as points for the opted-in testers who did not perform prescribed testing. An example of how this was executed from the ChargeX moderation team's competition tracking sheet can be seen below in Figure 11, with EV and EVSE identifiers omitted. The "total points" in black represent those who participated in prescribed testing, and the red represent those who were given normalized scores for test slot 1. The final scores of individual EVs and EVSEs can be seen in Table 5.

Test Slot #1																						
Test Scenario	EVSEs											EVs										
TS1		4		4	4			4	4	2		4	4	4	4	4	2				4
TS2		0		5	0			2	0	0		0	0	0	0	2	0				5
TS3		0		0	0			0	0	0		0	0	0	0	0	0				0
TS4		11		8	6			15	0	0		0	6	4	9	9	0				9
TS5		4		4	5			0	4	4		5	5	0	4	0	5				5
TS6		3		4	5			4	4	5		5	3	4	3	5	5				4
TS7		4		6	6			3	6	5		6	4	4	5	3	5				6
TS8		5		0	6			11	0	5		0	4	5	5	5	5				0
TS9		5		3	6			0	4	5		4	6	6	6	0	6				6
TS10		6		0	5			3	6	6		7	4	5	5	3	5				0
TS11		0		0	0			0	0	0		0	0	0	0	0	0				0
TS12		0		0	0			0	0	0		0	0	0	0	0	0				0
TS13		0		0	0			0	0	0		0	0	0	0	0	0				0
TOTAL PTS	36	42	0	34	43	36	36	42	28	32	36	31	36	32	41	31	33	36	36	36	39

Figure 11: Test Slot 1 Points Tracking with Normalization Added

Table 5: Highest Scoring Individual EV and EVSE Across all 7 Test Slots

EV	Total Points	EVSE	Total Points
EV1	296	EVSE1	255
EV2	254	EVSE2	254
EV3	241	EVSE3	242
EV4	202	EVSE4	235
EV5	194	EVSE5	234
EV6	183	EVSE6	222
Ev7	182	EVSE7	213
EV8	177	EVSE8	202
EV9	150	EVSE9	198
EV10	127	EVSE10	193
		EVSE11	190
		EVSE12	175
		EVSE13	122

The most ambitious award was given to an EV and EVSE pairing that attempted the most advanced test cases in a single test slot, however the recipient of this award ended up being the same pairing that achieved the top scoring EV and EVSE pairing. The most persevering award was given to the test pairing that sacrificed a substantial amount of potential test pairing points to continuously attempt TS 3 “Plug-first using ISO 15118-20”, one of the more advanced TS. These attempts required a lot of on-the-fly equipment debugging, but it resulted in the event’s only successful ISO 15118-20 charge session earning them the Most Persevering Award.

The 3 recognition awards were available for any tester to achieve throughout the event, those 3 being met any stretch goal pass criteria, achieved a successful ISO 15118-20 charge session, and achieved a successful Plug&Charge fallback – seamless retry charge session. In total, 16 testers achieved a stretch goal recognition, 2 testers achieved ISO 15118-20 recognition, and no testers met seamless retry recognition.

3.2 Equipment Meta data

Collecting EV and EVSE meta data is essential for providing context, ensuring traceability in equipment history, and ensuring accurate comparisons between different units. Further, collecting meta data is an effective method of benchmarking capabilities of equipment attending testing events over time. Figures 12-19 give us insight into the type of equipment present at testing events which also provides context for testing results and may explain why certain tests were/weren’t attempted. The “*ChargeX Prescribed Testing Program at CharIN June 2024 Testival Outcomes and Future Recommendations”* report contains the same meta data questionnaire data that can be used for benchmarking/comparison, available on the ChargeX website.

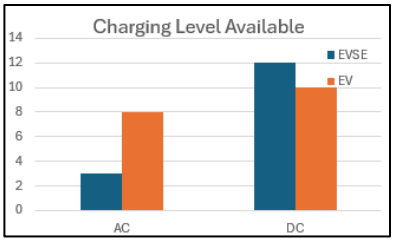


Figure 12: Charging Level Available

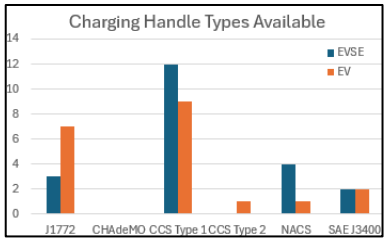


Figure 13: Charging Handle Types Available

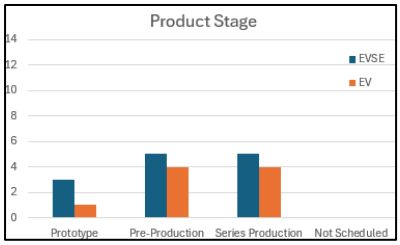


Figure 14: Product Stage

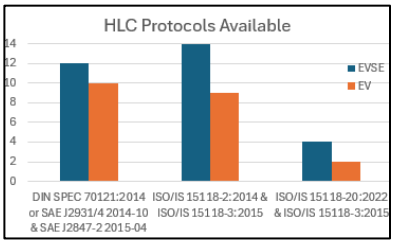


Figure 15: HLC Protocols Available

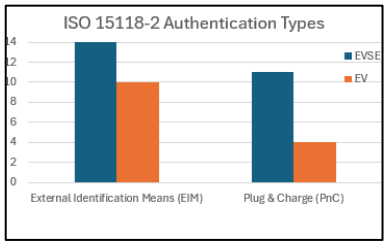


Figure 16: ISO 15118-2 Authentication Types

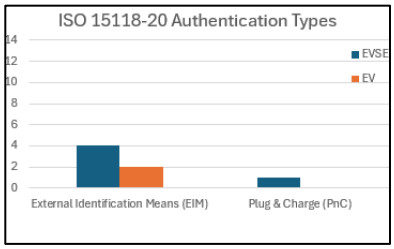


Figure 17: ISO 15118-20 Authentication Types

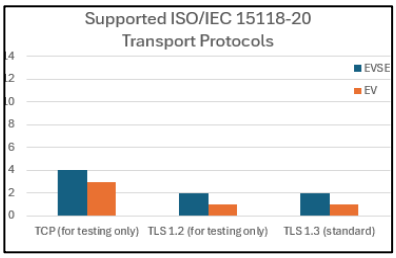


Figure 18: ISO/IEC 15118-20 Transport Protocols

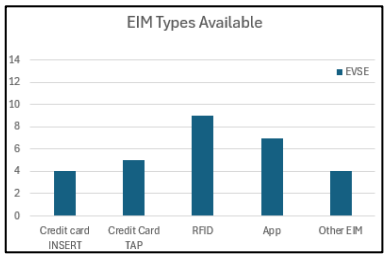


Figure 19: EIM Types Available

3.3 Testing Meta data

Collecting both pre-test and post-test meta data was crucial for ensuring accurate analysis and comparison, as it provided a comprehensive understanding of the testers' initial expectations and any changes or issues that occurred during testing. One example of this was tracking desired tests before and the actual tests attempted at the end of the testing period, which is captured in Figure 20 and Figure 21. As with the EV and EVSE meta data, the same testing meta data was collected and reported on in the "*ChargeX Prescribed Testing Program at CharIN June 2024 Testival Outcomes and Future Recommendations"* report for comparison, which can be found on the ChargeX website. Compared to June 2024's PTP, the November 2024 PTP had a significant rise in test attempt percentage from 30% to 58%.

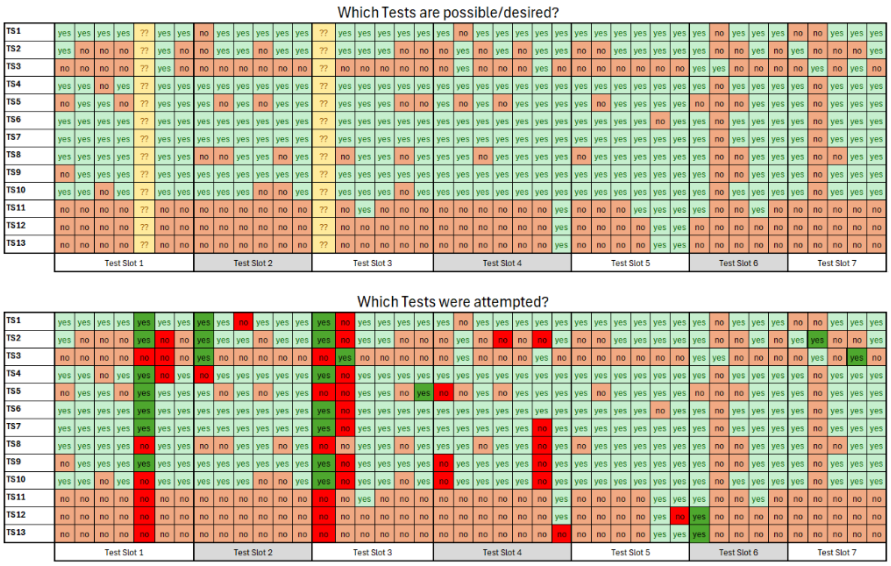


Figure 20: Tests Possible and Tests Attempted Tracking

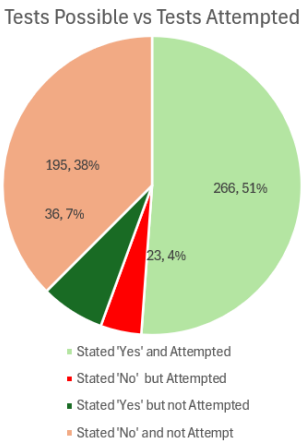


Figure 21: Tests Possible vs Attempted % Breakdown

The matchmaking process contains more useful information, elaborating on how the decision to allow opted-in testers to perform prescribed testing with opted-out testers impacted results. Figure 22**Error! Reference source not found.** highlights that of the 45 test pairings, only 4% were opt-ins paired with those who opted-out of the program, a significant percentage drop from June 2024 PTPs rate of 42%. However, even though the opt-in/opt-out percentage decreased, there were more pairings overall, increasing from 43 to 45. The total breakdown from those at the event who were and were not opted-in to the PTP can be seen in Figure 23.

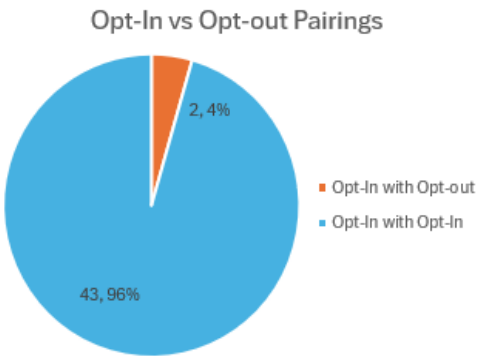


Figure 22: Opt-In and Opt-Out Test Pairings

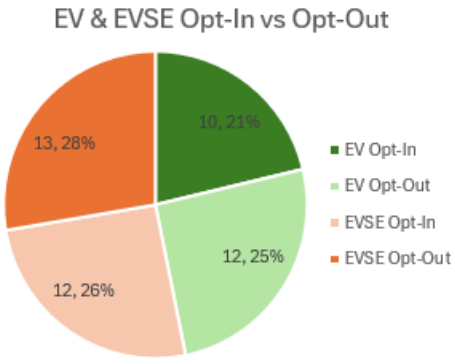


Figure 23: EV and EVSE Opt-In vs Opt-Out

3.4 Test Scenario Results

In total, 45 unique test pairings worked to attempt 344 TS, with 275 that met some or all pass criteria and 69 attempts that met no pass criteria. This attempt/success rate was a major increase from June 2024's PTP which yielded 163 TS attempts with 112 of those meeting all defined pass criteria. As with June 2024 ChargeX PTP, it was seen that some TS had much

higher attempt rates and/or success rates than others due to the difficulty range in tests. The results from these TS yielded valuable insights for test attempt behavior, testing difficulty progression, individual TS successes, and issues that arose throughout testing.

It should be noted that any results within this report do not reflect successes or shortcomings within the current EV charging ecosystem outside of this CharIN testing event, as all equipment tested is assumed to be reported on as **pre-production equipment**. With that said, the results from these interoperability tests provide valuable information back to testers and allow them to use such findings for future software and hardware revisions. These results also provide crucial feedback for future PTP planning, giving insight as to where testers commonly see great success, how TS design could be improved upon, etc.

One area of interest is how testing behavior changed over time throughout this test event. Figure 24 plots each individual TS's attempt rate during each test slot. It should be noted that this plot reflects any EV or EVSE opted-in to the PTP that attempted TS 1-13. One noteworthy outcome was that TS 3, TS 11, TS 12, and TS 13 (some of the most advanced TSs) had zero attempts during the first test slot and gradually increased throughout the event. This behavior exemplifies that there is a noticeable "warm-up" period during testing events, where bugs/issues can often arise during the initial test slots and more basic TS are prioritized. Figure 25 shows the same data as Figure 24, but with the x-axis changed to individual TS rather than test slots.

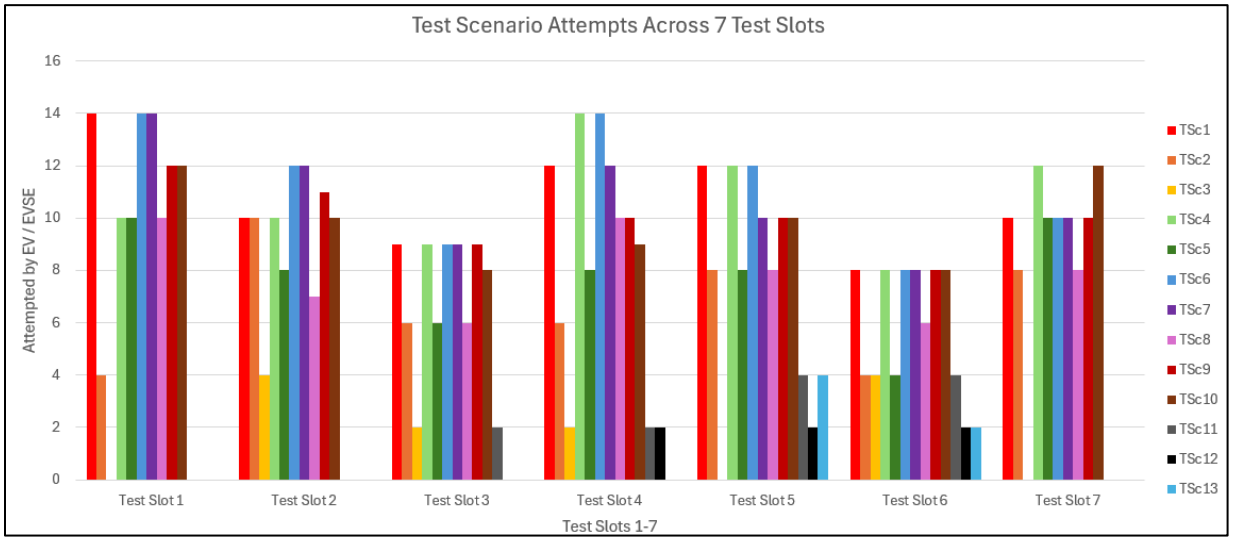


Figure 24: Test Scenario Attempts for each Test Slot

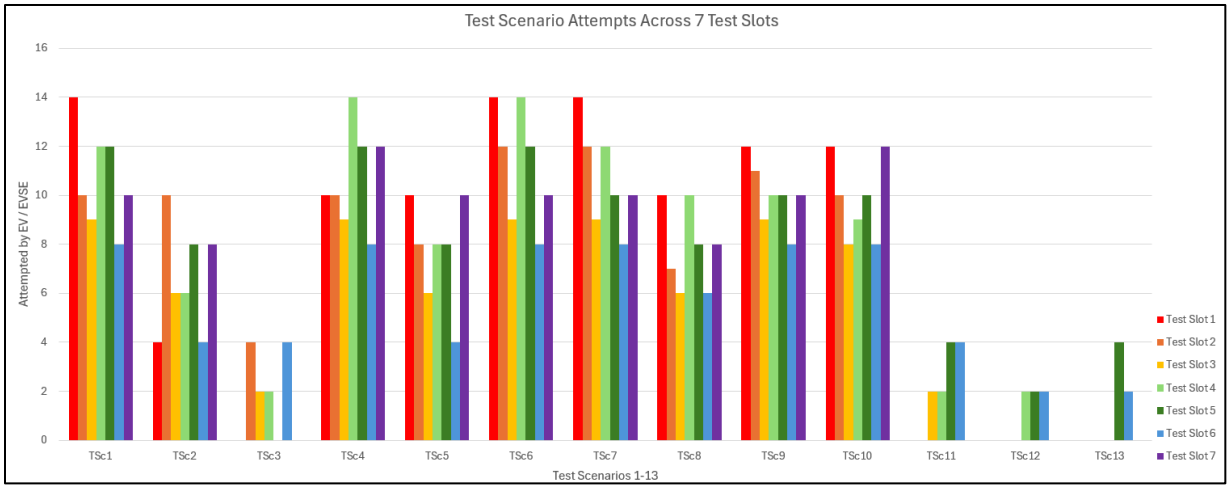


Figure 25: Test Scenario Attempts for each Test Slot Alternative Plot

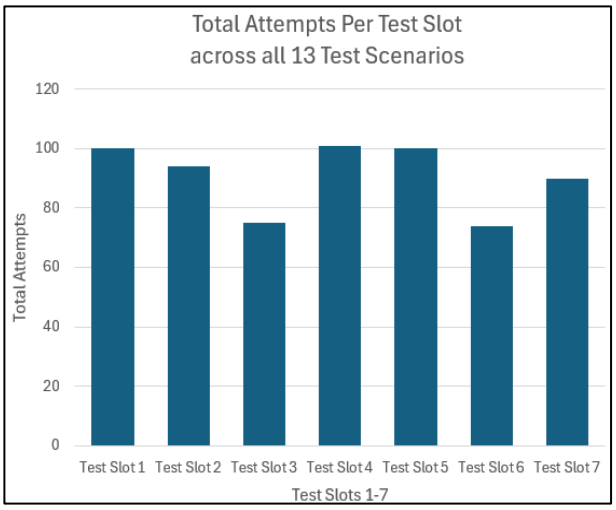


Figure 26: Total Test Scenarios attempted per Test Slot (Bar)

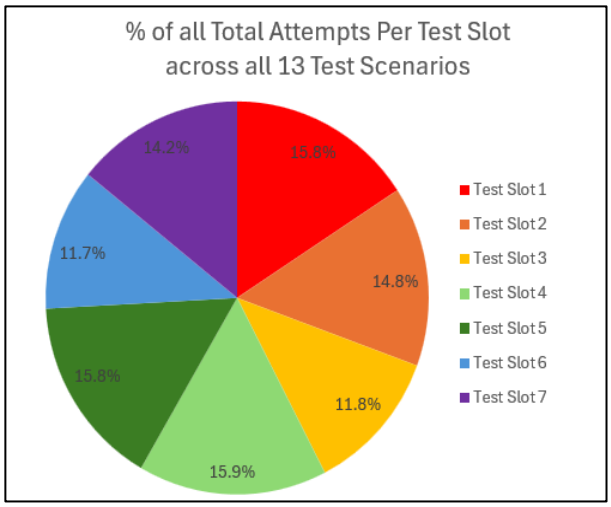


Figure 27: Total Test Scenarios attempted per Test Slot (Pie)

The following sections outline results from individual TS 1-13, highlighting total pairing attempt/success rate along with generalized comments for high-level findings.

3.4.1 Test Scenario 1

TS 1, “Plug-first using DIN 70121 or J1772”, had a high attempt and success rate with 34 of the 42 attempts meeting all pass criteria. Though there were many successful test attempts, there were many comments captured on errors that occurred due to a variety of reasons. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 1 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	42	• HLC Communication Issues • No session start – just hangs • Too low power • FreeVendMode error • Failure at pre-charge • Connector lock fault
Attempts with top pass criteria met	34	
Attempts that met some pass criteria	0	
Attempts that met no pass criteria	8	
Average test duration	1.5-min	

3.4.2 Test Scenario 2

TS 2, “Plug-first using ISO 15118-2”, had a high attempt and success rate with 17 of the 29 attempts meeting all pass criteria. Though there were many successful test attempts, there were many comments captured on errors that occurred due to a variety of reasons, such as issues with HLC communication, protocol selection, authentication, and adapters. Feedback was also received that the specific release version of ISO 15118-2 was not specified in this TS description (i.e. ISO 15118-2:2013 or ISO 15118-2:2025) could be a possible cause of compatibility issues. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 2 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	29	• HLC chose DIN over ISO 15118-2 • No session start • FreeVendMode error • Error @ connection – cable • Adapter fault
Attempts with top pass criteria met	17	
Attempts that met some pass criteria	0	
Attempts that met no pass criteria	12	
Average test duration	1.5-min	

3.4.3 Test Scenario 3

TS 3, “Plug-first using ISO 15118-20”, had a lower attempt and success rate than others with only 1 of the 7 attempts meeting all pass criteria. This outcome could be expected as ISO 15118-20 implementations are still under development by OEMs at this time. Most comments received as to why this test was not attempted was that the equipment brought to Testival was not equipped with ISO 15118-20 at this time. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 3 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	7	• ISO 15118-20 HLC communication issues • ISO 15118-20 not available
Attempts with top pass criteria met	1	
Attempts that met some pass criteria	0	
Attempts that met no pass criteria	6	
Average test duration	2-min	

3.4.4 Test Scenario 4

TS 4, “Plug-first timeout”, had a high attempt and success rate with 10 of the 38 attempts meeting all pass criteria, and 25 meeting some pass criteria. Some areas where testers did not meet all pass criteria came from not reporting a timeout fault on either the EVSE or EV side, and/or not meeting the test-specified timeout time of 120s. Feedback was received that timeouts with longer/shorter durations were by design and are likely to remain the same moving forward. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 4 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	38	• 120s timeout time met • Timeout never occurs • Timeouts longer than 120s (up to 10min) • Authorization Fault • Other generic faults
Attempts with top pass criteria met	10	
Attempts that met some pass criteria	25	
Attempts that met no pass criteria	3	
Average test duration	5-min	

3.4.5 Test Scenario 5

TS 5, “Disconnect PILOT @ EVSE, start charge”, had a high attempt and success rate with 1 of the 28 attempts meeting all pass criteria, and 21 meeting some pass criteria. Some areas where testers did not meet all pass criteria came from not reporting a pilot fault on either the EVSE or EV side, and/or not recognizing a pilot fault at all. One reason why some testers did not attempt this scenario was because there was no streamlined method of removing the pilot signal on either the EVSE or EV side. Some testers performed this test by slightly altering the procedure and removing the pilot signal on the EV side rather than the EVSE. Feedback was received that from an EV driver perspective it may not be very user friendly to communicate a technical fault such as “pilot failure”. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 5 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	28	• Session ended with error reported • Session ended but no error reported • Color-indicated error • EV/EVSE didn’t recognize pilot fault • Authentication error
Attempts with top pass criteria met	1	
Attempts that met some pass criteria	21	
Attempts that met no pass criteria	6	
Average test duration	4-min	

3.4.6 Test Scenario 6

TS 6, “Holding connector lock, plug-in and start charge”, had a high attempt and success rate with 1 of the 40 attempts meeting all pass criteria, and 34 meeting some pass criteria. Some areas where testers did not meet all pass criteria came from not reporting a connector lock fault on either the EVSE or EV side, and/or not recognizing a lack of connector lock at all and allowing charge to begin. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 6 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	40	• Session never started • EVSE maintained “Starting Charge” • Faulted after 30-seconds • “EV connecting” message • EVSE timeout • EVSE didn’t detect plug-in
Attempts with top pass criteria met	1	
Attempts that met some pass criteria	34	
Attempts that met no pass criteria	5	
Average test duration	2-min	

3.4.7 Test Scenario 7

TS 7, “Press latch to attempt stop during power transfer”, had a high attempt and success rate with 14 of the 45 attempts meeting all pass criteria, and 20 meeting some pass criteria. Some areas where testers did not meet all pass criteria came from not reporting latch press errors if allowed on either EVSE or EV side. It should be noted that both outcomes of “latch press ends session with fault” and “latch cannot be pressed” were worth equal points in terms of top pass criteria as either are justifiable outcomes. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 7 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	45	• Does not allow for Latch press • Shuts down upon latch press with error • Not latch press with adapters • Other generic failures
Attempts with top pass criteria met	14	
Attempts that met some pass criteria	20	
Attempts that met no pass criteria	11	
Average test duration	3-min	

3.4.8 Test Scenario 8

TS 8, “Press EVSE emergency stop during power transfer”, had a high attempt and success rate with 4 of the 29 attempts meeting all pass criteria, and 21 meeting some pass criteria. Some areas where testers did not meet all pass criteria came from not reporting E-stop or “power loss” errors on either EVSE or EV side. One reason why some testers did not attempt this scenario was because their test equipment did not have an E-stop installed. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 8 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	29	• E-Stop ended session with/without fault • No E-Stop on equipment • No EV side error reported • Other generic issues
Attempts with top pass criteria met	4	
Attempts that met some pass criteria	21	
Attempts that met no pass criteria	4	
Average test duration	2-min	

3.4.9 Test Scenario 9

TS 9, “Press EV UI stop during power transfer”, had a high attempt and success rate with 8 of the 37 attempts meeting all pass criteria, and 26 meeting some pass criteria. Some areas where

testers did not meet all pass criteria came from not reporting “EV shutdown” stop reason on either EVSE or EV side, and/or not having the ability to end charge from the EV side. One interesting behavior witnessed was that some EVSEs attempted to restart a charge session after EV UI stop was commanded. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 9 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	37	• EV UI stop ended session with/without fault • EVSE prompts unplug after stop • EV must be ON to press UI stop • No PT shown on EV UI • Session auto retries after EV UI stop
Attempts with top pass criteria met	8	
Attempts that met some pass criteria	26	
Attempts that met no pass criteria	3	
Average test duration	2-min	

3.4.10 Test Scenario 10

TS 10, “Press EVSE UI stop during power transfer”, had a high attempt and success rate with 5 of the 35 attempts meeting all pass criteria, and 27 meeting some pass criteria. Some areas where testers did not meet all pass criteria came from not reporting “EVSE shutdown” stop reason on either EVSE or EV side. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 10 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	35	• EVSE UI stop ended charge without fault • Session stop indicated on display • No indication on EV charge ended • Other generic issues
Attempts with top pass criteria met	5	
Attempts that met some pass criteria	27	
Attempts that met no pass criteria	3	
Average test duration	2-min	

3.4.11 Test Scenario 11

TS 11, “Plug&Charge valid EV and EVSE certificates”, had a lower attempt rate, but a relatively high success rate with 5 of the 6 attempts meeting all pass criteria. Most test pairings utilized private certificates brought with them to Testival, but some others were able to utilize valid CharIN provided certificates for a successful Plug&Charge session. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 11 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	6	• Successful using private certificates • Successful using CharIN provided certificates • Unsuccessful using CharIN provided certificates
Attempts with top pass criteria met	5	
Attempts that met some pass criteria	0	
Attempts that met no pass criteria	1	
Average test duration	1-min	

3.4.12 Test Scenario 12

TS 12, “Plug&Charge expired EV certificate – session ends”, had a low attempt and success rate with 0 of the 3 attempts meeting any pass criteria. Most test pairings attempted to utilize CharIN provided expired certificate, however, there were compatibility issues between testers equipment and the PKI provider platform. Most testers either did not bring with them or were unable to issue privately owned expired certificates for this Testival. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 12 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	3	• Issues using CharIN provided expired certificates • Could not issue private expired certificates
Attempts with top pass criteria met	0	
Attempts that met some pass criteria	0	
Attempts that met no pass criteria	3	
Average test duration	2-min	

3.4.13 Test Scenario 13

TS 13, “Plug&Charge expired EV certificate – fallback methods utilized”, had a low attempt and success rate with only 1 of the 5 attempts meeting any pass criteria. As with TS 12, most test pairings attempted to utilize CharIN provided expired certificate, however, there were compatibility issues between testers equipment and the PKI provider platform. Most testers either did not bring with them or were unable to issue privately owned expired certificates for this Testival. The one successful test attempt was able to achieve seamless retry fallback with the use of CharIN provided certificates. The full details of this TS can be found in the appendix and a summary of the testing outcomes can be seen below.

TS 13 Details		Generalized Reported Issues/Comments
Total Pairing Attempts	5	• Issues using CharIN provided expired certificates • Could not issue private expired certificates • EV reported “fail replug” after 5 seconds
Attempts with top pass criteria met	1	
Attempts that met some pass criteria	0	
Attempts that met no pass criteria	4	
Average test duration	2-min	

3.5 Feedback and Future Recommendations

Table 6 includes comments that were received from the June 2024 ChargeX PTP, how those comments were addressed for the November 2024 ChargeX PTP, and any new feedback that we received for this program’s implementation.

Table 6: June 2024 PTP to Nov. 2024 PTP Feedback Summary

Topic	June 2024 Feedback	Nov 2024 Resolution and Feedback
Communication Improvements	• Lack of communication or promotion of ChargeX PTP leading up to June Testival. • Many testers were unaware of what ChargeX PTP was going into the event.	• Many were much more familiar with what ChargeX PTP was at this event due to June PTP exposure and the testing process, making things run much smoother. • Deep-dive sessions prior to Testival helped on board testers. • However, there were still some testers new to CharIN Testival who needed onboarding for the PTP and ChargeX.
Preparation Time	• Provide TSs earlier so testers can prepare equipment to execute such tests. • Provide training sessions to onboard testers on TSs.	• Tests were developed in the ChargeX Testing TF along with industry. • TSs were sent out earlier than for June and deep dive sessions were held explaining the details of the PTP, which showed an increase in test attempts and successes overall.
Rephrasing Meta data Questionnaire	• Rather than ask “what is equipment capable of” ask “what tests can this equipment execute”.	• The questionnaire was kept the same for this event for benchmarking purposes. • Utilized test-slot meta data to answer which tests are possible/desirable.
Digital Recording of Results	• Physical copies of test plan were very desirable by testers. • Digital recording would help export results data quicker.	• The same approach was taken using paper copies, the argument still stands for both sides being feasible with their own pros/cons.
Including Test Equipment in PTP	• Test systems were not included in June 2024 PTP, they expressed interest in taking part.	• Test systems were not included in Nov. 2024 PTP. • Open for future discussion, as these tests are designed for interoperability testing and not conformance testing.
Day 3 Dynamic Testing	• ChargeX PTP could potentially utilize day 3 dynamic test slots for prescribed testing	• Nov. PTP did not utilize day 3 dynamic testing • Day 3 was used for awards ceremony for the gamified “*ChargeX Challenge”*
List of Scenarios to Choose From	• It might be beneficial to provide a larger series of tests for testers to choose from. • Downside is less TS result comparison.	• This was implemented for Nov. 2024 PTP and worked well alongside the gamified approach having points incentivize more advanced tests. • A larger list allowed for more test unique types to be included.

Topic	June 2024 Feedback	Nov 2024 Resolution and Feedback
Gamify Prescribed Testing	• ChargeX should consider gamifying PTP with points and awards.	• Nov. 2024 PTP had a gamified approach that was received very well, testers embraced friendly competition and strove to attain as many points as possible. • The feedback received was that gamified testing would be a motivator to opt-in for future prescribed testing.
ChargeX Involvement in CharIN Matchmaking	• Keysight/CharIN creates the testing matchmaker schedule, ChargeX should consider being involved with this.	• ChargeX was not involved in this for Nov. 2024 Testival.
Change “Pass /Fail” Scheme	• Pass/Fail scheme may indicate that equipment is “failing” by not meeting written TS requirements.	• Pass/Fail scheme was removed for Nov. 2024 PTP, and was replaced with multiple tiers of possible pass criteria that a test pairing could meet. • Feedback received that points being assigned for attempts was a good addition so that testers are not left with nothing if a test does not meet written pass criteria.
Increasing Prescribed Testing Time	• Consider increasing testing time so that all TS can be completed in the allotted time. • Additional time requested for the first TS to allow for set up glitches.	• Testing time was increased from 30-minutes to 40-minutes which was positively received. • Further feedback was that perhaps the goal isn’t to complete every TS in the allotted time, but rather to prioritize more advanced tests if possible.

Figure 28 shows CharIN survey results from the November 2024 Testival that contained questions pertaining to the ChargeX PTP. Overall, feedback shows that the November 2024 PTP was very positively received and there is interest in participating in future PTPs.

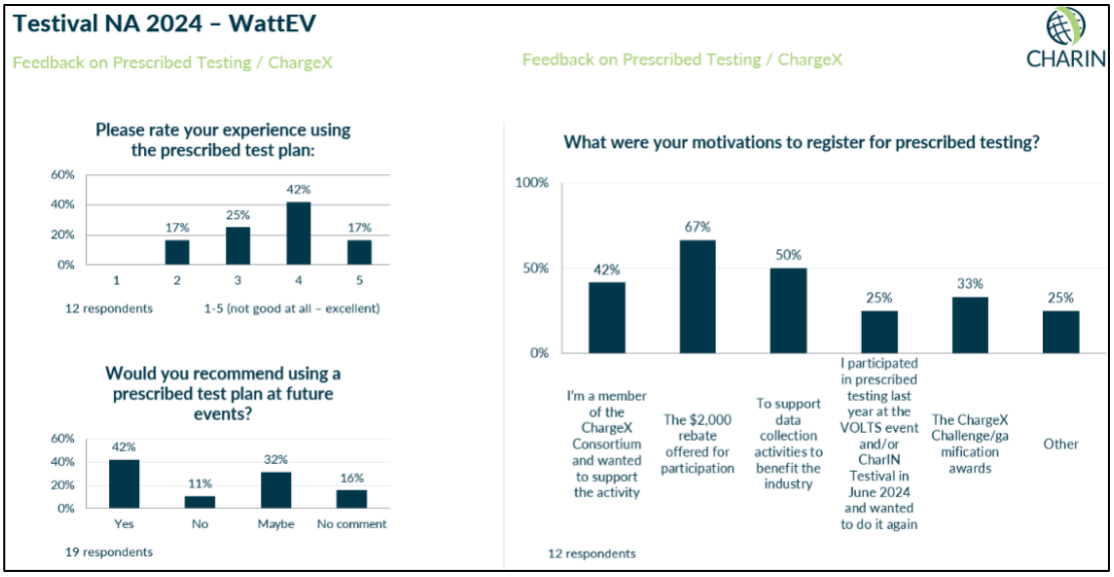


Figure 28: CharIN Feedback Survey Results

If future implementations of PTPs are of interest to CharIN and/or other test event hosts, it would be recommended to gather as much industry input and feedback throughout the program's development to ensure their experience is as seamless as possible. Utilizing a moderation team was very effective for ChargeX's PTP, however this may not always be feasible due to limited staffing, technical background of moderators, number of testers opted-in to the program, etc. A two-group structure may help a smaller moderation team execute a PTP, however, this requires more coordination and timing considerations. Performing prescribed testing without a moderation force is possible but requires much communication with testers when it comes to relaying expectations for structure, test setup, cut-off criteria, results recording, etc. The gamification of prescribed testing was a great motivator for testers and was very well received, however, it did require a considerable amount of additional planning with allocating points, maintaining leaderboards, executing an awards ceremony, etc.

Overall, prescribed testing is a very effective means of alignment and encouragement of testing, and a hybrid approach of ad-hoc and prescribed would be the most recommended approach. It is recommended that those developing their own program use this report and other test event reports as a valuable resource when it comes to understanding industry's interest and feedback towards prescribed testing.

Appendix – ChargeX PTP Document

The ChargeX Challenge

Prescribed Test Program

Prepared By: Sam Thurston – Argonne National Laboratory
Role: ChargeX Consortium, Testing Task Force Lead
Intended Use: During the CharIN November 2024 Testival in San Bernardino, CA
Date: 10/14/2024

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Contributors

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Acknowledgments

The National Charging Experience Consortium (ChargeX Consortium) is a collaborative effort between Argonne National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, electric vehicle charging industry experts, consumer advocates, and other stakeholders.

Version History

Date	Changes	Author
09.01.2024	Altered June 2024 test program document to create November test program document. Updated location, prescribed duration, gamification rules, etc.	Sam Thurston
09.15.2024	Updated cover page logo, changed name to ChargeX Challenge, minor edits throughout	Sally Glass
09.30.2024	Added in more detail on gamification, point system, etc.	Sam Thurston
10.14.2024	After TSs were reviewed and finalized by EAB and ChargeX's Testing TF, tabular versions were created and added in to this document. Further detail on awards and outcomes added, as well as full TS description in appendix.	Sam Thurston

Scope of Document

This document details the conditions for the optional prescribed testing program (PTP) to be implemented during the upcoming **CharIN November 2024** Testival at **WattEV in San Bernardino, CA.**

General Description

An optional PTP developed and facilitated by the ChargeX Consortium will be offered during the CharIN November 2024 Testival with a financial **rebate incentive of $2000** for testers who participate. Prescribed tests for this Testival will be chosen based on industry feedback through ChargeX Testing Task Force (TF) meetings. For each 90-minute test slot, a portion of that will be dedicated to prescribed testing for those who have opted-in to the program, and the remaining time will be ad-hoc. Further details on PTP rules and structure, test cases, moderator details, data sharing sensitivities, etc. may be shared with testers closer to the event.
For more information, please contact ChargeX Testing TF lead Sam Thurston (sthurston@anl.gov).

Testing Conditions

The following outlines all details surrounding testing purposes, setup, structure, rebates, etc.

Goals

- To demonstrate the **effectiveness of the *EV-EVSE Interoperability Test Plan (EEITP)*** ChargeX deliverable through a subset of tests to be included in a PTP.
- To **reflect industry-desirable test cases** based on industry feedback throughout Testing TF meetings.
- To encourage the testing of **advanced charging features** such as authentication types, authentication methods, ISO 15118-2 and ISO 15118-20 implementations, Plug&Charge capabilities, fallback mechanisms, seamless retry, MREC implementations, etc.
- To provide a **well-structured** prescribed testing approach with technical details decisions based on industry input and previous prescribed testing experiences.
- To collect **anonymous comparable results** through the outcomes of prescribed testing, and to benchmark the technological advancements and common issues of pre-production equipment /software from those participating in this program.

Test Participants

- This event targets manufacturers and CPOs of EVs and EVSEs capable of **AC level 2** or **DC fast charging** attending the CharIN Testival who have opted to participate in the PTP.
- Every participating company shall provide staff who can set up, configure, and **execute test scenarios (TS)** according to the test program and categorize potentially found interoperability issues according to the test reporting template.

Test Process

- Tests will be conducted in test pairings based on a test schedule that is derived through a technical **matchmaking** system. This matchmaking is based on registration information and PTP signup that will be provided by each participating company before the event. Matchmaking will be performed by CharIN prior to the event.

- During each test slot the registered participants will be testing in parallel to one another. Test pairings will change in Round Robin procedure between test slots according to the provided test schedule.
- A **ChargeX moderator** will be assigned to each test pairing during the PTP to relieve the testers from additional duties such as recording results, relaying test case steps and setup details, providing clarification, etc.
- The time breakdown between ad-hoc and prescribed testing is as follows:
    - **50-minutes ad-hoc, 40-minutes prescribed, 30-minutes to move EVs**
- If the number of EV and EVSE pairings exceeds 15, a **two-group structure** will be followed. All pairings will be designated as either “Group 1” or “Group 2” for each specific timeslot. This is done to minimize the necessary ChargeX moderator work force staff. The time breakdown between ad-hoc testing and prescribed testing for the two groups is as follows, and can also be seen in Figure 1:
    - Group 1: 10-minutes ad-hoc, then 40-minutes prescribed, then 40-minutes ad-hoc
    - Group 2: 10-minutes ad-hoc, then 40-minutes ad-hoc, then 40-minutes prescribed
- Testers should aim to complete as many included TS during the prescribed testing period as possible if they have the technical capabilities to do so.

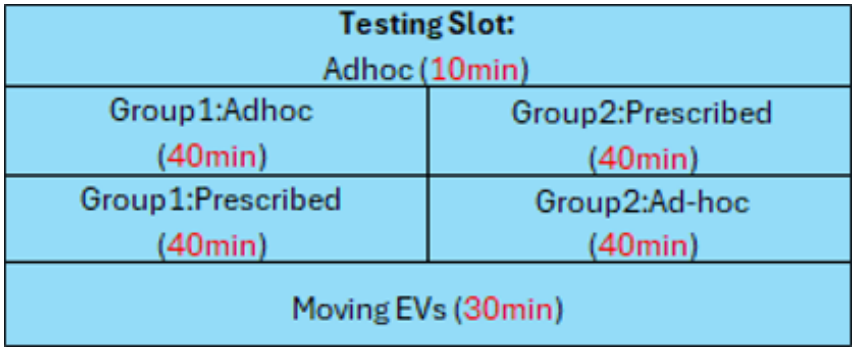

Figure 29: Typical Testing Slot and Two-Group Structure

Gamification Guidelines

This event contains a gamification approach to TS completion, meaning that points will be designated for attempting and meeting specifically defined pass criteria for each TS. Further details can be found below on this gamification approach to prescribed testing:

- Testers will receive points as a pairing, not as individual testers. EV and EVSE pairings must work together to meet test pass criteria successfully, with a moderator present tracking results.
- Points are separated into the following 4 categories:
    - Attempt points: Points awarded for attempting a TS.
    - EVSE pass criteria points: Points awarded for EVSE meeting pass criteria; multiple pass criteria are listed increasing in points with increased complexity.
    - EV pass criteria points: Points awarded for EV meeting pass criteria; multiple pass criteria are listed increasing in points with increased complexity.

- Stretch goal pass criteria points: Points awarded for additional “stretch-goal” pass criteria, may be specific to either EV or EVSE. These pass criteria go above and beyond EV and EVSE pass criteria and are worth high points.

- Multiple attempts for a single test can be made, however only the best performing attempt overall score (Attempt+EVSE+EV+SG) will be used for that scenario. It is recommended that the number of attempts per scenario does not exceed 3, if more than 3 it should be noted by moderators.

Test Report Submission

Each test couple is required to work with their assigned moderator to submit a test report until the end of each prescribed testing period according to the method provided by ChargeX.

Test Scenarios

The TSs are designed to be completed in any order, with tabular details surrounding the test case description. Test pairings will decide together **which tests they would like to attempt** from the provided list of scenarios. Further details around testing setup and conditions may be provided if necessary closer to the event date. This PTP includes the following 13 TS seen in Table 7 along with correlating points. “Min” is the number of points for attempting that scenario, “Max” is the best possible points for achieving EV and EVSE pass criteria, “Max+SG” is for additional Stretch Goal points additionally available to be added on top of “Max”. More details on the pass criteria, setup, etc. is defined for each TS in Section D.

Table 7: Test Scenario List and Points

Test Name	Min	Max	Max+SG
TS1: Plug-first using DIN 70121 or J1772	2	6	6
TS2: Plug-first using ISO 15118-2	2	8	8
TS3: Plug-first using ISO 15118-20	2	12	12
TS4: Plug-first Timeout	3	9	18
TS5: Disconnect PILOT art EVSE, attempt charge start	3	9	14
TS6: Holding connector lock, plug-in and attempt charge start	3	9	14
TS7: Press Latch to attempt stop charge during PT	3	9	14
TS8: Press EVSE Emergency Stop to attempt to stop charge during PT	3	9	14
TS9: Press EV UI “STOP” during PT	3	9	9
TS10: Press EVSE UI “Stop” during PT	3	9	9
TS11: PnC Valid EV and EVSE Certificates	4	10	14
TS12: PnC Expired EV Contract Certificates – Session Terminates	4	10	16
TS13: PnC Expired EV Contract Certificates – Fallback Methods Utilized	5	15	21

Awards and Outcomes

The ChargeX Consortium will work with CharIN to coordinate some sort of awards ceremony to recognize the achievements and efforts of those who participated in the ChargeX Challenge. This awards ceremony is designed to be in good spirits with rewards that may include ribbons, certificates, trophies, swag/merch, etc. Not all awards will be given solely on meeting pass criteria, some may be based on individual efforts, pairing efforts, number of attempts, striving for more challenging tests, etc. Any type of written reporting for the ChargeX Challenge produced by the ChargeX Consortium will remain anonymous.

Test Setup, Procedures and Results Tracking

*Section A: EVSE Meta Data **complete once per EVSE equipment***

QA1: Specify Equipment Type ..... (EVSE)
QA2: Select level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QA3: Select charging handle types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QA4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)
QA5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 and SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 and ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 and ISO/IS 15118-3:2015 ..... (Yes / No)

QA6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

QA9: Select EIM types available:
- Credit Card INSERT ..... (Yes / No)
- Credit Card TAP ..... (Yes / No)
- RFID ..... (Yes / No)
- App ..... (Yes / No)
- Other EIM _____ / No)

*Section B: EV Meta Data *complete once per EV equipment**

QB1: Specify Equipment Type ..... (EV)
QB2: Select level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QB3: Select charging inlet types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QB4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)
QB5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 and SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 and ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 and ISO/IS 15118-3:2015 ..... (Yes / No)

QB6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QB7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QB8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

*Section C: Test Slot Meta Data *complete every Test Slot**

Pre-test data

QA1: Test Slot Number_____
QA2: Moderator Name _____
QA3: Prescribed Testing Start Time_____
QA4: EVSE enrolled in Prescribed Testing .....(Yes / No)
QA5: EV enrolled in Prescribed Testing.....(Yes / No)
QA6: The following has been reviewed with testers .....(Yes / No)

- List of test scenarios
    - Desired or possible tests for testing pair (recommend all 8 is possible)
    - Remind how long per test that equates to (30min ÷ #tests)
- Structure of test scenarios:
    - Test purpose, preconditions, steps, pass criteria, results tracking, etc.
- EVSE Meta Data collected.
- EV Meta Data collected.
- Even if tests have already been completed in adhoc, instruct to re-perform them now during prescribed testing (time taken to complete, are steps accurate, feedback on pass criteria, etc).
- Any additional open questions

QA7: Which tests desired/possible..... (TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

- Float moderator will go around to each pairing at start of session to record who is attempting PnC testing. He will let Hubject team know which require expired EV certificates and will begin issuing

Post-test data

QA8: Number of tests attempted _____
QA9: Which tests attempted (circle) ..... (TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)
QA10: Any outstanding issues _____
QA11: Tester1 comments_____
_____
QA12: Tester2 comments_____
_____
QA13: Moderator comments _____
_____
_____

Section D: Test Scenarios

TS1: Plug-first using DIN 70121 or J1772

Test Identifier:	TS1		
Test Name:	Plug-first using DIN 70121 or J1772		
Test Type:	Intentional Charging		
Test Category:	Authentication Types, Methods & Timeouts		
Purpose:	To ensure "Plug-first" option is available.		
	To ensure different authentication types are available and accepted.		
	To ensure specified HLC protocol is accepted.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT	
		· Credit Card TAP	
		· RFID	
		· App	
		· Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC Protocol:	J1772, DIN 70121	
	Involved Systems:	EV, EVSE	
Steps:	1	Set EVSE HLC highest priority to **'HLC Protocol'**	
	2	Set EVSE authentication option to '**Authentication Type'.**	
	3	Plug-in EV.	
	4	Within 30seconds, provide '**Authentication Type'.**	
	5	Observe session initialization into power transfer.	
	6	Terminate charge session 30-60 seconds into power transfer.	
	7	Unplug EV.	
Pass Criteria:	ATTEMPT: Test scenario was attempted.		Met (2pt)
	#1 EVSE: Charge started utilizing specified **'HLC Protocol'**		Met (2pt)
	#1 EV: Charge started utilizing specified **'HLC Protocol'**		Met (2pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response		
Intended MRECs/Errors:	None		
Possible MRECs/Errors:	"Invalid Sequence"		
Recorded Test Results:	· Pass Criteria Met		
	· Point of failure (if applicable)		

TS2: Plug-first using ISO 15118-2

Test Identifier:	TS2		
Test Name:	Plug-first using ISO 15118-2		
Test Type:	Intentional Charging		
Test Category:	Authentication Types, Methods & Timeouts		
Purpose:	To ensure "Plug-first" option is available. To ensure different authentication types are available and accepted. To ensure specified HLC protocol is accepted.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC Protocol:	ISO 15118-2	
	Involved Systems:	EV, EVSE	
Steps:	1	Set EVSE HLC highest priority to **'HLC Protocol'**	
	2	Set EVSE authentication option to '**Authentication Type'.**	
	3	Plug-in EV.	
	4	Within 30seconds, provide '**Authentication Type'.**	
	5	Observe session initialization into power transfer.	
	6	Terminate charge session 30-60 seconds into power transfer.	
	7	Unplug EV.	
Pass Criteria:	ATTEMPT: Test scenario was attempted.		Met (2pt)
	#1 EVSE: Charge started utilizing specified **'HLC Protocol'**		Met (3pt)
	#1 EV: Charge started utilizing specified **'HLC Protocol'**		Met (3pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response		
Intended MRECs/Errors:	None		
Possible MRECs/Errors:	"Invalid Sequence"		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS3: Plug-first using ISO 15118-20

Test Identifier:	TS3		
Test Name:	Plug-first using ISO 15118-20		
Test Type:	Intentional Charging		
Test Category:	Authentication Types, Methods & Timeouts		
Purpose:	To ensure "Plug-first" option is available. To ensure different authentication types are available and accepted. To ensure specified HLC protocol is accepted.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC Protocol:	ISO 15118-20	
	Involved Systems:	EV, EVSE	
Steps:	1	Set EVSE HLC highest priority to **'HLC Protocol'**	
	2	Set EVSE authentication option to '**Authentication Type'.**	
	3	Plug-in EV.	
	4	Within 30seconds, provide '**Authentication Type'.**	
	5	Observe session initialization into power transfer.	
	6	Terminate charge session 30-60 seconds into power transfer.	
	7	Unplug EV.	
Pass Criteria:	ATTEMPT: Test scenario was attempted.		Met (2pt)
	#1 EVSE: Charge started utilizing specified **'HLC Protocol'**		Met (5pt)
	#1 EV: Charge started utilizing specified **'HLC Protocol'**		Met (5pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response		
Intended MRECs/Errors:	None		
Possible MRECs/Errors:	"Invalid Sequence"		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS4: Plug-first Timeout

Test Identifier:	TS4		
Test Name:	Plug-first Timeout		
Test Type:	Timeouts		
Test Category:	Authentication Types, Methods & Timeouts		
Purpose:	To ensure "Plug-first" timeout occurs. To ensure appropriate EVSE UI & EV UI notification occurs due to timeout.		
Pre-Test Conditions:	Authentication Type (choose):	~~Credit Card INSERT~~ ~~Credit Card TAP~~ ~~RFID~~ ~~App~~ ~~Other EIM~~	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE	
Steps:	1	Set EVSE authentication option to '**Authentication Type'.**	
	2	Plug-in EV.	
	3	Do not provide '**Authentication Type',** wait 2.5minutes or until timeout.	
	4	Upon timeout, log timeout time, log EV and EVSE instructions for user after timeout.	
	5	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (#1 is best, then #2, #3, etc), multiple pass criteria can be met for stretch goal criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Timeout (not 120s ±10s) occurred with visual timeout notification.		Met (3pt)
	EVSE #2: Timeout (not 120s ±10s) occurred without visual timeout notification.		Met (1pt)
	EV #1: Timeout (not 120s ±10s) occurred with visual timeout notification.		Met (3pt)
	EV #2: Timeout (not 120s ±10s) occurred without visual timeout notification.		Met (1pt)
	Stretch Goal A: 120second (±10seconds) timeout time occurred.		Met (5pt)
	Stretch Goal B: EVSE "AuthorizationTimeout" MREC thrown.		Met (4pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, Timeout times, EVSE Error Codes		
Intended MRECs/Errors:	"AuthorizationTimeout"		
Possible MRECs/Errors:	"Payment Failure", "AuthorizationTimeout", "Invalid Sequence"		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS5: Disconnect PILOT at EVSE, Attempt charge start

Test Identifier:	TS5		
Test Name:	Disconnect PILOT at EVSE, Attempt charge start		
Test Type:	Intentional Faults & Error Codes		
Test Category:	Session Initialization (SI)		
Purpose:	To ensure missing Pilot signal is detected & prevents charge start.		
	To ensure appropriate error codes & UI instructions are provided upon error.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
Steps:	1	Disconnect PILOT signal connection for dispenser cable from EVSE MCU.	
	2	Set EVSE authentication option to '**Authentication Type'.**	
	3	Plug-in EV.	
	4	Within 30 seconds, provide '**Authentication Type'.**	
	5	Observe session initialization stages, recording EVSE UI and EV UI behavior/faults.	
	6	If session does not fault, terminate charge session 30-60 seconds into power transfer.	
	7	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Visual "Pilot" error on EVSE UI, session ends.		Met (3pt)
	EVSE #2: Visual generic error on EVSE UI, session ends.		Met (2pt)
	EVSE #3: No visual error on EVSE UI, session ends.		Met (1pt)
	EV #1: Visual "Pilot" error on EV UI, session ends.		Met (3pt)
	EV #2: Visual generic error on EV UI, session ends.		Met (2pt)
	EV #3: No visual error on EV UI, session ends.		Met (1pt)
	Stretch Goal A: EVSE "PilotFault" MREC thrown.		Met (5pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"PilotFault"		
Possible MRECs/Errors:	"Invalid Sequence", "ProximityFault", Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS6: Holding connector lock, plug-in and start charge

Test Identifier:	TS6		
Test Name:	Holding Connector Lock, Plug-in & attempt charge start		
Test Type:	Intentional Faults & Error Codes		
Test Category:	Session Initialization (SI)		
Purpose:	To ensure connector lock was not detected & prevents charge start. To ensure appropriate error codes & UI instructions are provided upon error.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
Steps:	1	Set EVSE authentication option to '**Authentication Type'.**	
	2	While holding down connector lock, plug-in EV.	
	3	While continuing to hold connector lock, Within 30 seconds provide '**Authentication Type'.**	
	4	Observe session initialization stages, recording EVSE UI and EV UI behavior/faults.	
	5	If session does not fault, terminate charge session 30-60 seconds into power transfer.	
	6	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Visual "Connector Lock" or "Proximity" error on EVSE UI, session ends.		Met (3pt)
	EVSE #2: Visual generic error on EVSE UI, session ends.		Met (2pt)
	EVSE #3: No visual error on EVSE UI, session ends.		Met (1pt)
	EV #1: Visual "Connector Lock" or "Proximity" error on EV UI, session ends.		Met (3pt)
	EV #2: Visual generic error on EV UI, session ends.		Met (2pt)
	EV #3: No visual error on EV UI, session ends.		Met (1pt)
	Stretch Goal A: EVSE "ConnectorLockFailure" or "ProximityFault" MREC thrown.		Met (5pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"ConnectorLockFailure" or "ProximityFault"		
Possible MRECs/Errors:	"Invalid Sequence", Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS7: Press latch to attempt stop during PT

Test Identifier:	TS7		
Test Name:	Press LATCH to attempt stop charge during PT		
Test Type:	Stop Methods (Error stop)		
Test Category:	Power Transfer (PT)		
Purpose:	To ensure latch cannot be pressed during PT, but if it can be pressed it will terminate charge session. To ensure appropriate error codes & UI instructions are provided upon error.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
	Stop Method:	Latch press	
Steps:	1	Set EVSE authentication option to **'Authentication Type'.**	
	2	Plug-in EV.	
	3	Within 30 seconds provide **'Authentication Type'.**	
	4	Observe session initialization stages.	
	5	Attempt to terminate charge session 30-60 seconds into power transfer using **'Stop Method'**.	
	6	If session does not terminate, use any other preferred **'Stop Method'**.	
	7	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Connector Latch cannot be pressed to end session.		Met (3pt)
	EVSE #2: Visual "Connector Lock" or "Proximity" error on EVSE UI, session ends.		Met (3pt)
	EVSE #3: Visual generic error on EVSE UI, session ends.		Met (2pt)
	EVSE #4: No visual error on EVSE UI, session ends.		Met (1pt)
	EV #1: Connector Latch cannot be pressed to end session.		Met (3pt)
	EV #2: Visual "Connector Lock" or "Proximity" error on EV UI, session ends.		Met (3pt)
	EV #3: Visual generic error on EV UI, session ends.		Met (2pt)
	EV #4: No visual error on EV UI, session ends.		Met (1pt)
	Stretch Goal A: EVSE "ConnectorLockFailure" or "ProximityFault" MREC thrown.		Met (5pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"ConnectorLockFailure" or "ProximityFault"		
Possible MRECs/Errors:	"Invalid Sequence", Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS8: Press EVSE emergency stop during PT

Test Identifier:	TS8		
Test Name:	Press EVSE Emergency Stop to attempt stop charge during PT		
Test Type:	Stop Methods (Error stop)		
Test Category:	Power Transfer (PT)		
Purpose:	To ensure Emergency Stop can be pressed during PT to terminate charge session. To ensure appropriate error codes & UI instructions are provided upon error.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
	Stop Method:	EVSE Emergency Stop	
Steps:	1	Set EVSE authentication option to **'Authentication Type'.**	
	2	Plug-in EV.	
	3	Within 30 seconds provide **'Authentication Type'.**	
	4	Observe session initialization stages.	
	5	Attempt to terminate charge session 30-60 seconds into power transfer using **'Stop Method'**.	
	6	If session does not terminate, use any other preferred **'Stop Method'**.	
	7	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Visual "Emergency Stop" error on EVSE UI, session ends.		Met (3pt)
	EVSE #2: Visual generic error on EVSE UI, session ends.		Met (2pt)
	EVSE #3: No visual error on EVSE UI, session ends.		Met (1pt)
	EV #1: Visual "Emergency Stop" error on EV UI, session ends.		Met (3pt)
	EV #2: Visual generic error on EV UI, session ends.		Met (2pt)
	EV #3: No visual error on EV UI, session ends.		Met (1pt)
	Stretch Goal A: EVSE ""Emergency Stop" or "PowerLoss" MREC thrown.		Met (5pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"Emergency Stop" or "PowerLoss"		
Possible MRECs/Errors:	Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS9: Press EV UI "Stop" during PT

Test Identifier:	TS9		
Test Name:	Press EV UI "Stop" button during PT		
Test Type:	Stop Methods (Intentional stop)		
Test Category:	Power Transfer (PT)		
Purpose:	To ensure EV UI "Stop" can be pressed during PT to terminate charge session. To ensure appropriate error codes & UI instructions are provided if necessary.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
	Stop Method:	EV UI "Stop"	
Steps:	1	Set EVSE authentication option to '**Authentication Type'.**	
	2	Plug-in EV.	
	3	Within 30 seconds provide '**Authentication Type'.**	
	4	Observe session initialization stages.	
	5	Attempt to terminate charge session 30-60 seconds into power transfer using **'Stop Method'**.	
	6	If session does not terminate, use any other preferred **'Stop Method'**.	
	7	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Visual "EV Shutdown" error/indication on EVSE UI, session ends.		Met (3pt)
	EVSE #2: Visual generic error/indication on EVSE UI, session ends.		Met (2pt)
	EVSE #3: No visual error/indication on EVSE UI, session ends.		Met (1pt)
	EV #1: Visual "EV Shutdown" error/indication on EV UI, session ends.		Met (3pt)
	EV #2: Visual generic error/indication on EV UI, session ends.		Met (2pt)
	EV #3: No visual error/indication on EV UI, session ends.		Met (1pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	None		
Possible MRECs/Errors:	"EV Shutdown", Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS10: Press EVSE UI "Stop" during PT,

Test Identifier:	TS10		
Test Name:	Press EVSE UI "Stop" button during PT		
Test Type:	Stop Methods (Intentional stop)		
Test Category:	Power Transfer (PT)		
Purpose:	To ensure EVSE UI "Stop" can be pressed during PT to terminate charge session. To ensure appropriate error codes & UI instructions are provided if necessary.		
Pre-Test Conditions:	Authentication Type (choose):	· Credit Card INSERT · Credit Card TAP · RFID · App · Other EIM	
	Plug-in or Authenticate first:	Plug-in	
	HLC protocol:	J1772, DIN 70121, ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP	
	Stop Method:	EVSE UI "Stop"	
Steps:	1	Set EVSE authentication option to '**Authentication Type'.**	
	2	Plug-in EV.	
	3	Within 30 seconds provide '**Authentication Type'.**	
	4	Observe session initialization stages.	
	5	Attempt to terminate charge session 30-60 seconds into power transfer using **'Stop Method'**.	
	6	If session does not terminate, use any other preferred **'Stop Method'**.	
	7	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (3pt)
	EVSE #1: Visual "EVSE Shutdown" error/indication on EVSE UI, session ends.		Met (3pt)
	EVSE #2: Visual generic error/indication on EVSE UI, session ends.		Met (2pt)
	EVSE #3: No visual error/indication on EVSE UI, session ends.		Met (1pt)
	EV #1: Visual "EVSE Shutdown" error/indication on EV UI, session ends.		Met (3pt)
	EV #2: Visual generic error/indication on EV UI, session ends.		Met (2pt)
	EV #3: No visual error/indication on EV UI, session ends.		Met (1pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	None		
Possible MRECs/Errors:	"EVSE Shutdown", Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS11: Plug&Charge Valid EV and EVSE Certificates

Test Identifier:	TS11		
Test Name:	Plug&Charge Valid EV and EVSE Certificates		
Test Type:	Certificate Validity Tests		
Test Category:	Single PKI		
Purpose:	To ensure Plug&charge payment method is accepted. To ensure EV and EVSE certificates are valid, multiple certificate types can be used.		
Pre-Test Conditions:	Authentication Type (choose):	· Plug&Charge ~~Credit Card INSERT~~ ~~Credit Card TAP~~ ~~RFID~~ ~~App~~ ~~Other EIM~~	
	Certificate Type:	Private Certificate, CharIN Provided Certificate	
	HLC protocol:	ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP, Certificate Authority	
Steps:	1	Ensure EV Contract certificate is valid, sourced by **'Certificate Type'**.	
	2	Ensure EVSE Leaf certificate is valid, sourced by **'Certificate Type'**.	
	3	Set EVSE HLC highest priority to **'HLC Protocol'**.	
	4	Set EVSE authentication option to **'Authentication Type'.**	
	5	Plug-In EV.	
	6	Observe session initialization stages.	
	7	Terminate charge session 30-60 seconds into power transfer.	
	8	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for*	ATTEMPT: Test scenario was attempted.		Met (4pt)
	EVSE #1: EVSE Leaf certs are valid, EVSE accepts valid EV certificates, session begins.		Met (3pt)
	EV #1: EV accepts & uses valid EV certificates, session begins.		Met (3pt)
	Stretch Goal A: EVSE uses valid CharIN Provided Certificates as **'Certificate Type'**		Met (2pt)
	Stretch Goal B: EV uses valid CharIN Provided Certificates as **'Certificate Type'**		Met (2pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	None		
Possible MRECs/Errors:	Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS12: Plug&Charge Expired EV Contract Certificate - Session Terminates

Test Identifier:	TS12		
Test Name:	Plug&Charge Expired EV Contract Certificates - Session Terminates		
Test Type:	Certificate Validity Tests		
Test Category:	Single PKI		
Purpose:	To ensure Plug&charge payment method is not accepted when using expired certificated. To ensure that for EV and EVSE, multiple certificate types can be used.		
Pre-Test Conditions:	Authentication Type (choose):	· Plug&Charge ~~Credit Card INSERT~~ ~~Credit Card TAP~~ ~~RFID~~ ~~App~~ ~~Other EIM~~	
	Certificate Type:	Private Certificate, CharIN Provided Certificate	
	HLC protocol:	ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP, Certificate Authority	
Steps:	1	Ensure EV Contract certificate is expired, sourced by **'Certificate Type'**.	
	2	Ensure EVSE Leaf certificate is valid, sourced by **'Certificate Type'**.	
	3	Set EVSE HLC highest priority to **'HLC Protocol'**.	
	4	Set EVSE authentication option to **'Authentication Type'.**	
	5	Plug-In EV.	
	6	Observe session initialization stages.	
	7	If session ends, unplug EV.	
	8	If session does not end, Terminate charge session 30-60 seconds into power transfer.	
	9	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (4pt)
	EVSE #1: EVSE Leaf certs are valid, EVSE rejects expired EV certificates, session terminates.		Met (3pt)
	EV #1: EV accepts & attempts to use expired EV certificates, session terminates.		Met (3pt)
	EV #2: EV does not accept and/or attempt to use expired EV certificates, session can not be attempted.		Met (3pt)
	Stretch Goal A: EVSE uses valid CharIN Provided Certificates as **'Certificate Type'**		Met (2pt)
	Stretch Goal B: EV uses expired CharIN Provided Certificates as **'Certificate Type'**		Met (4pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"InvalidPayment"		
Possible MRECs/Errors:	Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

TS13: Plug&Charge Expired EV Contract Certificate - Fallback Methods Utilized

Test Identifier:	TS13		
Test Name:	Plug&Charge Expired EV Contract Certificates - Fallback Methods Utilized		
Test Type:	Certificate Validity Tests		
Test Category:	Single PKI & Seamless Retry		
Purpose:	To ensure Plug&charge payment method is not accepted when using expired certificated. To ensure fallback mechanisms are implemented when Plug&Charge fails. To ensure that for EV and EVSE, multiple certificate types can be used.		
Pre-Test Conditions:	Authentication Type (choose):	· Plug&Charge ~~Credit Card INSERT~~ ~~Credit Card TAP~~ ~~RFID~~ ~~App~~ ~~Other EIM~~	
	Certificate Type:	Private Certificate, CharIN Provided Certificate	
	HLC protocol:	ISO 15118-2, or ISO 15118-20	
	Involved Systems:	EV, EVSE, CSMS/OCPP, Certificate Authority	
	Fallback Method:	EIM J1772, EIM DIN 70121, EIM ISO 15118-2, EIM ISO 15118-20	
Steps:	1	Ensure EV Contract certificate is expired, sourced by **'Certificate Type'**.	
	2	Ensure EVSE Leaf certificate is valid, sourced by **'Certificate Type'**.	
	3	Set EVSE HLC highest priority to **'HLC Protocol'**.	
	4	Set EVSE authentication option to **'Authentication Type'.**	
	5	Plug-In EV.	
	6	Observe session initialization stages & **'Fallback Method'** after Plug&Charge failure.	
	7	Provide any other preferred **'Authentication Type'.**	
	8	Observe session initialization stages into power transfer.	
	9	Terminate charge session 30-60 seconds into power transfer.	
	10	Unplug EV.	
Pass Criteria: *[Only 1 pass criteria for EVSE & EV can be met (choose highest), multiple pass criteria can be met for stretch goal (SG) criteria]*	ATTEMPT: Test scenario was attempted.		Met (5pt)
	EVSE #1: EVSE Leaf certs are valid, EVSE rejects expired EV certificates, EVSE attempts fallback method and session begins.		Met (5pt)
	EVSE #2: EVSE Leaf certs are valid, EVSE rejects expired EV certificates, EVSE attempts fallback method but fails, session doesn't begin.		Met (2pt)
	EV #1: EV accepts & attempts to use expired EV certificates, EV attempts fallback method and session begins.		Met (5pt)
	EV #2: EV does not accept and/or attempt to use expired EV certificates, session can not be attempted.		Met (2pt)
	EV #3: EV does not accept and/or attempt to use expired EV certificates, EV attempts fallback method but fails, session doesn't begin.		Met (2pt)
	Stretch Goal A: EVSE uses valid CharIN Provided Certificates as **'Certificate Type'**		Met (2pt)
	Stretch Goal B: EV uses expired CharIN Provided Certificates as **'Certificate Type'**		Met (4pt)
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, EVSE Error Codes		
Intended MRECs/Errors:	"InvalidPayment"		
Possible MRECs/Errors:	Other		
Recorded Test Results:	· Pass Criteria Met · Point of failure (if applicable)		

Test Scenario #	Category, Test Type, Test Name, #Points for attempting	EVSE Pass Criteria	EV Pass Criteria	Additional "Stretch Goal (SG)" Pass Criteria	Min points	Max points	TOTAL w/ SG & Max points
TS1	Authentication Types, Intentional Charging, **TS1: Plug-first using DIN 70121 or J1772** (2pt)	• EVSE started charge using DIN 70121 or J1772 (2pt)	• EV started charge using DIN 70121 or J1772 (2pt)	–	2	6	6
TS2	Authentication Types, Intentional Charging, **TS2: Plug-first using ISO 15118-2** (2pt)	• EVSE started charge using ISO 15118-2 (3pt)	• EV started charge using ISO 15118-2 (3pt)	–	2	8	8
TS3	Authentication Types, Intentional Charging, **TS3: Plug-first using ISO 15118-20** (2pt)	• EVSE started charge using ISO 15118-20 (5pt)	• EV started charge using ISO 15118-20 (5pt)	–	2	12	12
TS4	Authentication Types & Methods, Timeouts, **TS4: Plug-first timeout** (3pt)	• EVSE timeout (not 120s +/-10s) occurred with visual timeout notification (3pt) • EVSE timeout (not 120s +/-10s) occurred without visual timeout notification (1pt)	• EV timeout (not 120s +/-10s) occurred with visual timeout notification (3pt) • EV timeout (not 120s +/-10s) occurred without visual timeout notification (1pt)	• 120 second (+/-10s) timeout time occurred (5pt) • EVSE "AuthorizationTimeout" MREC thrown (4pt)	3	9	18
TS5	Session Initialization (SI) Intentional Faults & Error Codes, **TS5: Disconnect PILOT @ EVSE, start charge** (3pt)	• EVSE visual "Pilot" error, session ends (3pt) • EVSE visual generic error, session ends (2pt) • EVSE no visual error, session ends (1pt)	• EV visual "Pilot" error, session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "PilotFault" MREC thrown (5pt)	3	9	14
TS6	Session Initialization (SI) Intentional Faults & Error Codes, **TS6: Holding connector lock, plug-in & start charge** (3pt)	• EVSE visual "Connector Lock" error, session ends (3pt) • EVSE visual generic error, session ends (2pt) • EVSE no visual error, session ends (1pt)	• EV visual "Connector Lock" session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "ConnectorLockFailure" MREC thrown (5pt)	3	9	14
TS7	Power Transfer (PT), Stop Methods (Error Stop), **TS7: Press latch to attempt stop during PT,** (3pt)	• EVSE latch cannot be pressed during PT (3pt) • EVSE visual "Prox Loss" or similar error, session ends (2pt) • EVSE visual generic error, session ends (2pt) • EVSE no visual error, session ends (1pt)	• EV does not allow latch to be pressed during PT (3pt) • EV visual "Prox Loss" or similar error, session ends (2pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "ProximityFault" MREC thrown if session ends OR EVSE "ConnectorLockFailure" MREC thrown if session ends (5pt)	3	9	14
TS8	Power Transfer (PT), Stop Methods (Error Stop), **TS8: Press EVSE emergency stop during PT,** (3pt)	• EVSE visual "Emergency Stop" or similar error, session ends (3pt) • EVSE visual generic error, session ends (2pt) • EVSE no visual error, session ends (1pt)	• EV visual "Emergency Stop" or similar error, session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	• EVSE "EmergencyStop" MREC thrown (5pt)	3	9	14
TS9	Power Transfer (PT), Stop Methods (Intentional Stop), **TS9: Press EV UI "Stop" during PT,** (3pt)	• EVSE visual "EV Shutdown" or similar error, session ends (3pt) • EVSE visual generic error, session ends (2pt) • EVSE no visual error, session ends (1pt)	• EV visual "EV Shutdown" or similar error, session ends (3pt) • EV visual generic error, session ends (2pt) • EV no visual error, session ends (1pt)	–	3	9	9
TS10	Power Transfer (PT), Stop Methods (Intentional Stop), **TS10: Press EVSE UI "Stop" during PT,** (3pt)	• EVSE visual "EVSE Shutdown" or similar reason, session ends (3pt) • EVSE visual generic error, session ends (2pt) • EVSE no visual error, session ends (1pt)	• EV visual "EVSE Shutdown" or similar reason, session ends (3pt) • EV visual generic reason, session ends (2pt) • EV no visual reason, session ends (1pt)	–	3	9	9
TS11	Single PKI, Certificate Validity Tests, **TS11: PnC Valid EV & EVSE Certificates,** (4pt)	• EVSE accepts valid EV certs, session begins (3pt)	• EV uses valid EV certs, session begins (3pt)	• CharIN provided certificate pool utilized for valid EVSE leaf certs (2pt) • CharIN provided certificate pool utilized for valid EV certs (2pt)	4	10	14
TS12	Single PKI, Certificate Validity Tests, **TS12: PnC Expired EV Contract Certificate - session terminates,** (4pt)	• EVSE declines expired EV certs, session terminates (3pt)	• EV attempts using expired EV certs, session terminates (3pt)	• CharIN provided certificate pool utilized for valid EVSE leaf certs (2pt) • CharIN provided certificate pool utilized for expired EV certs (4pt)	4	10	16
TS13	Single PKI & Seamless Retry, Certificate Validity Tests, **TS13: PnC Expired EV Contract Certificate - fallback methods utilized,** (5pt)	• EVSE declines expired EV certs, payment declined, EVSE falls back to EIM, prompts user for authentication, EVSE begins session (5pt)	• EV attempts using expired EV certs, payment is declined, EVSE falls back to EIM, prompts user for authentication, EV allows session to begin (5pt)	• CharIN provided certificate pool utilized for valid EVSE leaf certs (2pt) • CharIN provided certificate pool utilized for expired EV certs (4pt)	5	15	21

CHARGEX
consortium

About the ChargeX Consortium

The National Charging Experience Consortium (ChargeX Consortium) is a collaborative effort between Argonne National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, electric vehicle charging industry experts, consumer advocates, and other stakeholders. The ChargeX Consortium's mission is to work together to measure and significantly improve public charging reliability and usability by June 2025. For more information, visit **chargex.inl.gov**.

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