CEP Guideline for ISO 19880-1 FAT/SAT Tests

Version 2.1 13-10-2020 – for Heavy Duty

Based on the approval of a hydrogen refueling station by CEP, this document is issued to provide a guideline in applying the ISO 19880-1 Annex C FAT/SAT table to Heavy Duty hydrogen refueling stations. It also helps implementing the mandatory requirements of the EN 17127 in Europe.

The recommended procedure is to perform a FAT with associated report once per station/dispenser type. The quality management of the station, the site implementation and the software management then allow the station manufacturer to issue a statement of conformity to this FAT without performing again all tests.
The SAT is the mandatory testing on site for every station/dispenser. Whether the full SAT is mandatory for each nozzle or each nozzle type at one station must still be clarified.

Reminder: Trespassing a limit is having a value over/under or equal to the set value. Following SAE J2601, reproduced in ISO 19880-1 requirements the refueling must be stopped **as soon as possible** when trespassing the limit but within 5s. A tolerance not exceeding 1s is given to account for sensor perturbations and shall only occur exceptionally.

CSA HGV 4.3 can be consulted for help and indications how to exactly perform tests. Especially regarding MC method.

Pre-Tests

Test no. 1: Correct communication protocol – *adapted to HD protocol and if communication available*

This is a reception test to validate the functionality of the communication according to the implemented communication protocol. This test might be controlled with a notified body depending on the regulation.

Test no. 2: Correct table implementation – *adapted to HD protocol*

This is a reception test to validate that the implementation of the refueling table of the implemented HD protocol if applicable and, depending on the structure of this protocol, is properly done and checked through an independent verification. This test might be controlled with a notified body depending on the regulation.

Test no. 3: Accounting for sensor error – *adapted to HD protocol*

This is a reception test to validate that all sensor errors are taken into account when used for the implemented HD protocol. This test might be controlled with a notified body depending on the regulation. The FAT test shall be an extensive testing of all sensors, while the SAT might be a light version with calibration certificates and values plausibility verification.

Test no. 4: Cold Dispenser implementation – OPTION depending on HD protocol

This is a reception test to validate that the implementation of Cold Dispenser option has the required SIL Level. This test might be controlled with a notified body depending on the regulation.

Fault Tests

Test no. 5-6: Extreme ambient temperature

This is to check that station doesn't allow any refueling beyond the cold and hot extreme ambient temperatures as well as beyond its own limit. This must adjusted to be consistent with the hydrogen refueling station own limits. The manufacturer must check and guaranty it for both sets of limits. (Those values might superpose).
Formerly SAE J2601-2014 CEP acceptance tests n°1&2

Test no. 7-8: CHSS starting pressure
This is to check that station doesn't allow any refueling below and above the starting minimum and maximum pressure of the CHSS. This functionality must be validated on the dispenser pressure sensor, not allowing the main fueling to start after the pressure pulse. The station may also optionally fulfill this function through communication, this test is however specifically meant to test the dispenser pressure sensor function.
Test 8 will also be performed on site, to check the functionality and the pressure pulse capacity.
Formerly SAE J2601-2014 CEP acceptance tests n°3&4

Test no. 9: Maximum mass of hydrogen allowed during startup
This is to check that the 200g limit of hydrogen transferred during startup is not trespassed. This test shall be an observation of all the refuellings. The manufacturer must provide a reliable method to prevent this limit from being overpassed.

Test no. 10: Excess hydrogen flow rate – *adapted to HD protocol*
This is to check that the flow of hydrogen is never higher than the value allowed by the CHSS after the startup phase.
Formerly SAE J2601-2014 CEP acceptance tests n°5

Test no. 11: Absolute hydrogen delivery temperature – *adapted to HD protocol*
This is to check that the delivered hydrogen temperature is never below the value allowed by the CHSS, i.e. -40°C as an absolute value. Any averaging of the temperature is not allowed. It is recommended to avoid perturbation factors that the test is performed after the first 30s of refueling, the limit must however be effective at any time of the whole refueling phase.
Formerly SAE J2601-2014 CEP acceptance tests n°6

Test no. 12. : Corridor hydrogen delivery temperature – *if required by the HD protocol*
If there is a lower corridor limit according to the implemented refueling protocol, different from the Test n°11, it will be tested here. Formerly SAE J2601-2014 CEP acceptance tests n°12

Test no. 13: Hydrogen delivery temperature monitoring – *if required by the HD protocol*
This is to check that the station is taking the appropriate action, when the temperature goes higher than the corridor maximum temperature. This test can use a mass averaged temperature as specified by SAE J2601 and must be performed after the initial 30s, to give time to precooling to reach the specified corridor. The manufacturer must ensure that without pre-cooling fallback option activated, the refueling will stop, even if the precooling fallback is part of the process.
Formerly SAE J2601-2014 CEP acceptance tests n°11

Test no. 14: Invalid communication signal tests – *adapted to HD protocol and if communication available*
This is to check the functionality of the station communication to fault signals.

Test no. 15: Out of bounds test for CHSS size – *adapted to HD protocol and if communication available*
This is specifically oriented to test the volume control through communication. The station should then refuse the fueling in case the volumes are out of bounds. It should be done after the pressure pulse.

Test no. 16: Break in communication tests – *adapted to HD protocol and if communication available*
This test is meant to check the switch from communication to non-communication mode. In order to evaluate the performance in addition to the safety, this test can validate the switch to non-communication. Stopping the refueling is not preferred. The reaction to communication loss shall be clarified between station operator and manufacturer. Mandatory as a SAT test in Europe according to EN17127
Formerly SAE J2601-2014 CEP acceptance tests n°15

Test no. 17: Halt Signal
This test can be checked in principle, but is not a binding requirement. This test is obsolete.

Test no. 18: Communication Abort Signal – *if communication available*
This test is to check that the refueling is aborted, when the vehicle sends an "Abort" signal through the communication. The manufacturer must ensure that excepted in failure cases, the functionality is also available in non-communication mode, i.e. switching off in a controlled manner the communication must not switch off "Abort" signal response. Mandatory as a SAT test in Europe according to EN17127
Formerly SAE J2601-2014 CEP acceptance tests n°20

Test no. 19: CHSS max temperature – *if communication available*
This test is to check that in communication mode, the station will react properly to the CHSS temperature trespassing signal.

Test no. 20: CHSS and dispenser max pressure – *if communication available*
This test is to check that in communication mode, the station will react properly to the CHSS pressure trespassing signal.

Test no. 21: Max State of Charge (SOC) – *if communication available*
This test is to check that in communication mode, the station will calculate and react properly to an SOC trespassing.

Response Tests

Test no. 22: Cycle Control
This test is conception control that the counter preventing more than X times (according to the qualification of the heavy-duty components) stopping during refueling is properly implemented. The minimum flow shall be adjusted to the accuracy of flow measurement devices and maximum allowed flowrate.

Test no. 23: Hydrogen delivery pressure monitoring upper limit
This test is to check that trespassing the upper corridor of the (A)PRR, during any time of the main refueling phase will stop the fueling. The manufacturer must ensure that the functionality is working in communication as well as non-communication mode. This might require two separate tests if the com and non-com functions are independently implemented. The corridor might be defined according to the pressure ramp rate or the flow control.
Formerly SAE J2601-2014 CEP acceptance tests n°7 & 9

Test no. 24: Hydrogen delivery pressure monitoring lower limit
This test is to check that trespassing the lower corridor of the (A)PRR, during any time of the main refueling phase will stop the fueling. The manufacturer must ensure that the functionality is working in communication as well as non-communication mode. This might require two separate tests if the com and non-com functions are independently implemented. The corridor might be defined according to the pressure ramp rate or the flow control.
Formerly SAE J2601-2014 CEP acceptance tests n°8 & 10

Test no. 25.: Hydrogen delivery pressure target
This test is to check that the pressure target function is properly implemented. The proper end of fueling at target pressure is checked in non-communication mode.
Formerly SAE J2601-2014 CEP acceptance tests n°13

Test no. 26.: Hydrogen delivery pressure target – *if communication available*
This test is to check that the pressure target function is properly implemented. Disregarding any other target such as SOC, the proper end of fueling at target pressure is checked in communication mode.
Formerly SAE J2601-2014 CEP acceptance tests n°14

Test no. 27: CHSS size determination
This test is to check the functionality of determining the CHSS volume. In case the test is not fully reachable, the volume determination can occur through communication and the manufacturer must ensure through this test that without appropriate communication, the station is switching to the most conservative ramp.
Formerly SAE J2601-2014 CEP acceptance tests n°20

Optional Implementation Tests – Please refer to contract requirements – to be adapted if present in HD protocol

Depending on the protocol, the station shall test the possibility to switch to a more conservative refueling in case the cooling performance can't be maintained. Following aspects should be taken into account: proper switch to conservative refueling, reaction if going back to original pre-cooling capacity, reaction in case of further loss of pre-cooling capacity and interaction with communication aspects.

Test no. 28: Pre-cooling Fallback – Optional if functionality not implemented
This test is to check that pre-cooling fallback procedure is properly working, during a temperature corridor change. The testing should ignore SOC target for communication fueling to check that the new fallback target was properly taken into account. Safety measures may be taken to prevent overfill of the test bench and shall be clearly explained.
Formerly SAE J2601-2014 CEP acceptance tests n°16

Test no. 29: Pre-cooling Fallback – Optional if functionality not implemented
This test is to check that pre-cooling fallback is not switching back to normal ramp rate, in case the original temperature corridor is reached again. The testing should ignore SOC target for communication fueling to check that the new fallback target was properly taken into account. Safety measures may be taken to prevent overfill of the test bench and shall be clearly explained.
Formerly SAE J2601-2014 CEP acceptance tests n°17

Test no. 30: Pre-cooling Fallback – Optional if functionality not implemented
This test is to check that the station is properly switching off, when after pre-cooling fallback switch the temperature is further increasing and exceeding the upper limit of the pre-cooling fallback corridor.
Formerly SAE J2601-2014 CEP acceptance tests n°18

Test no. 31: Pre-cooling Fallback – Optional if functionality not implemented *– depending on communication*
This test is to check that the station is properly switching off, when after pre-cooling fallback switch a disruption/ loss of the communication signal occurs.
Formerly SAE J2601-2014 CEP acceptance tests n°19

Test no. 32: Top-off – Optional if functionality not implemented
This test is to check that top-off procedure is properly working, with a low initial CHSS pressure. Depending on the HD refueling protocol, a top-off is a function to improve the fueling speed for low initial CHSS pressure.
Formerly SAE J2601-2014 CEP acceptance tests n°21

Test no. 33: Cold Dispenser – Optional if functionality not implemented
This test is to check that cold dispenser procedure is properly working.
Formerly SAE J2601-2014 CEP acceptance tests n°22

Capacity Tests

Test no. 34: Pre-cooling capacity test – *please refer to SAT template document*
This is to evaluate the pre-cooling capacity of the station. This test is here to ensure that the pre-cooling available is sufficient to perform refueling of CHSS volumes within the whole range of the station. This is also to confirm the capacity of the station to perform a back to back refueling. Depending on the site testing conditions, it is required to perform the test at an ambient temperature ensuring at least 75% of the max APRR of the implemented HD protocol used.

Test no. 35: Pre-cooling capacity test
This is to evaluate the capacity of the installation to refuel all specified tanks category of the station, testing at least one of each category. This test might be done on a simplified version on site but is mainly part of the FAT qualification of the station

SAT fueling Tests

Test no. 36: Non-Com Fueling validation – *please refer to SAT template document*
This is a site test to validate capacity of the station to perform properly non-communication refuellings.

Test no. 37: Com Fueling validation – *please refer to SAT template document if communication available*
This is a site test to validate capacity of the station to perform properly communication refuellings.