

# HRS Operational Acceptance Test according to EN 17127

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Toyota Motor Europe

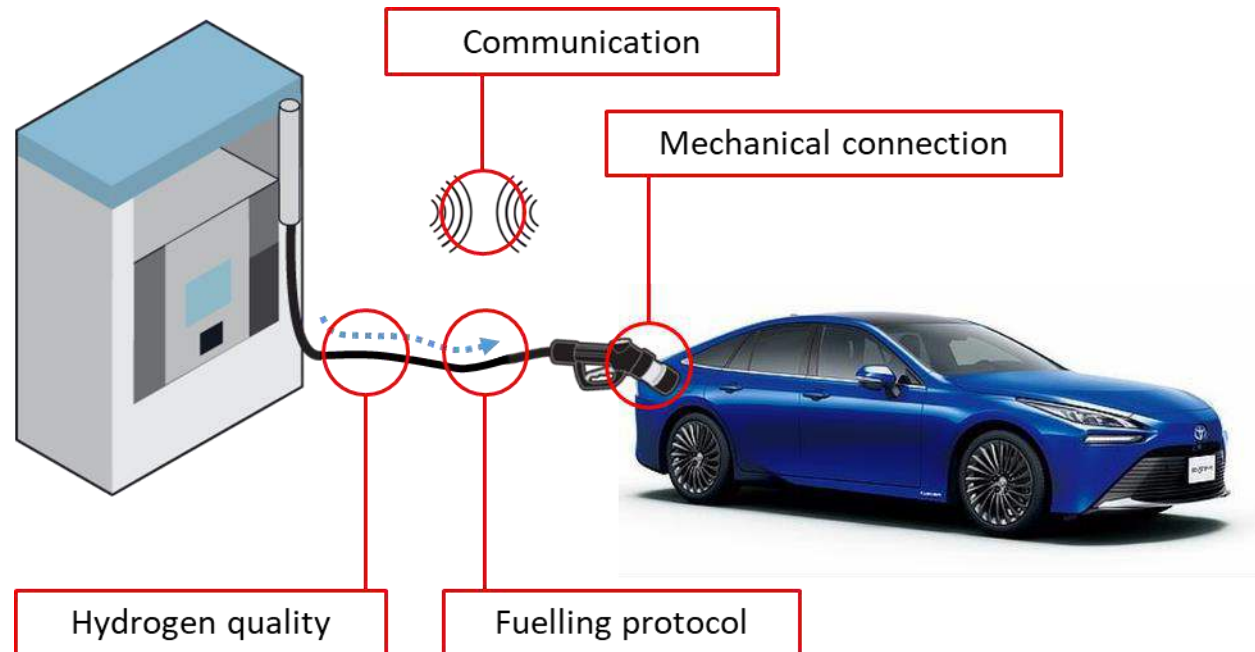
Hydrogen. What else?



**HONDA**



# Regulations in Europe concerning inter-operability between station and vehicle



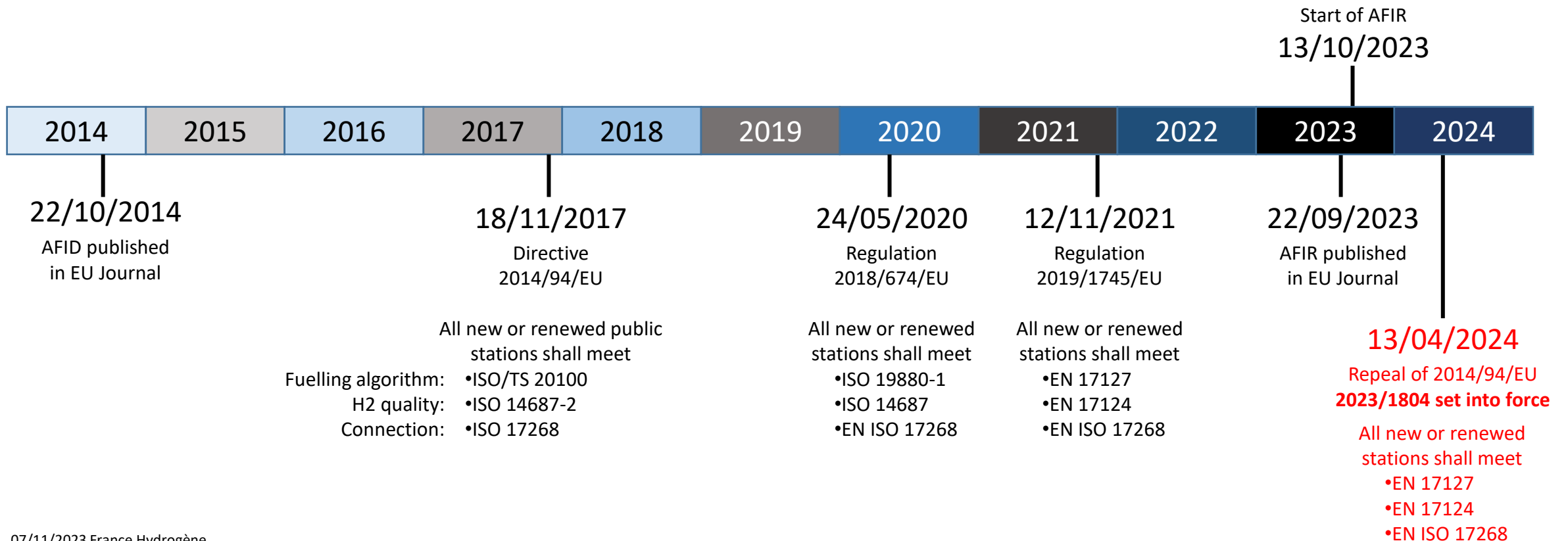
## Alternative Fuel Infrastructure Directive [AFID 2014/94/EU]

l'arrêté JORF No. 0287

<https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000036171677&dateTexte=20191206>

## Alternative Fuel Infrastructure Regulation [AFIR (EU) 2023/1804]

<https://eur-lex.europa.eu/eli/reg/2023/1804/oj>



## REGULATIONS

**REGULATION (EU) 2023/1804 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL  
of 13 September 2023  
on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU**

*Article 21*

**Common technical specifications**

1. The technical specifications set out in Annex II shall apply.

*ANNEX II*

**Technical specifications**

3. Technical specifications for hydrogen supply for road transport vehicles
  - 3.1. Outdoor hydrogen refuelling points dispensing gaseous hydrogen used as fuel on board motor vehicles shall comply at least with the interoperability requirements described in standard EN 17127:2020.
  - 3.2. The quality characteristics of hydrogen dispensed by hydrogen refuelling points for motor vehicles shall comply with the requirements described in standard EN 17124:2022. The methods to ensure that the hydrogen quality is met are also described in the standard.
  - 3.3. The fuelling algorithm shall comply with the requirements of standard EN 17127:2020.
  - 3.4. Once the process of certification of standard EN ISO 17268:2020 is concluded, connectors for motor vehicles for the refuelling of gaseous hydrogen shall comply at least with that standard.



## Article 2

### Definitions

- (45) ‘publicly accessible alternative fuels infrastructure’ means an alternative fuels infrastructure which is located at a site or premises that are open to the general public, irrespective of whether the alternative fuels infrastructure is located on public or private property, whether limitations or conditions apply in terms of access to the site or premise and irrespective of the applicable use conditions of the alternative fuels infrastructure;
- (11) Publicly accessible recharging or refuelling points include, for example, privately owned recharging or refuelling points accessible to the public that are located on public or private property, such as public parking areas or parking areas of supermarkets. A recharging or refuelling point located on private property that is accessible to the public should be considered to be publicly accessible also in cases where access is restricted to a certain general group of users, for example to clients. Recharging or refuelling points for car-sharing schemes should only be considered to be publicly accessible if they explicitly allow access for third party users. Recharging or refuelling points located on private property to which access is restricted to a limited and determinate group of persons, such as parking places in an office building to which only employees or authorised persons have access, should not be considered to be publicly accessible recharging or refuelling points.

## 6 Inspection and validation of hydrogen refuelling points

### 6.1 Inspection prior putting into service and periodical inspection

Before being opened to the public, the following aspects of the hydrogen refuelling point shall be confirmed:

- a) that the dispensing system, including the vehicle fuelling protocol, fulfils the requirements of 5.3.1;
- b) that the vehicle fuelling protocol fulfils the process limit requirements of 5.3.2;
- c) that, where applicable, the vehicle to refuelling point communications protocol fulfils the requirements of 5.3.3;
- d) that minimum Site Acceptance Test (SAT) refuelling validation test has been performed according to Table 1.

Same requirements as in SAE J2601.  
(Max. 85°C, max. 60 g/s,  $T_{\text{fuel}} \geq -40^\circ\text{C}$ , <200g pulse etc..)

SAT

Where appropriate, testing to cover points a, b and c above can be performed as Factory Acceptance Tests (FAT) and accepted without the need for replication when the station is installed on-site, unless the tests are included in Table 1 below. If specific tests at FAT are not possible, these tests shall be performed as Site Acceptance Testing (SAT).

FAT

Tests performed within the FAT testing may be covered in a type approval process.

The necessary documentation for SAT and FAT shall be prepared before testing.

Regular inspections relating to interoperability shall be carried out.

Appropriate inspections shall be performed after modification or maintenance that can affect the interoperability of the hydrogen refuelling point as defined within this document.

NOTE Refer to ISO 19880-1:2020 Annex C for an example of a test procedure to verify SAE J2601.

# ISO 19880-1 Table C2

Table C.2 — Recommended FAT and SAT matrix for the validation of a dispensing system using the SAE J2601:2016 protocol

Category	Test no.	Function	Preparation	Test info	Acceptable criteria	Safety (S)/Performance (P)	FAT	SAT <sup>a</sup>
Pre tests	1	Correct communications protocol	Tests according to SAE J2799	Check functionality of all IrDa signals according to SAE J2799	Able to send and receive all IrDa commands, as defined in SAE J2799	S	YES	YES
	2	Correct table implementation	Confirmation report of software implementation	Confirmation in writing using "independent verification"	Table-based protocol: Correct values for all implemented tables (including communications, non-communications and optional cold dispenser)  MC formula protocol: Correct values for all imple-	S	YES	NO
SAT fuelling tests	36	Non com fuelling validation	Two different starting conditions <sup>d</sup>	Two tests	Fuelling did not exceed any process limits, fuelled at the correct APRR and terminated the fuelling at the non-comm pressure target $\pm 2$ MPa	S	NO	YES
	37	Com fuelling validation	Two different starting conditions <sup>d</sup>	Two tests, one of which is below 2 MPa start <sup>e</sup>	Fuelling did not exceed any process limits, fuelled at the correct APRR and terminated the fuelling with an ending SOC in the HSTA of between 95 % to 100 %.	S	NO	YES

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Same requirements as in SAE J2601.  
(Max. 85°C, max. 60 g/s,  $T_{\text{fuel}} \geq -40^\circ\text{C}$ , <200g pulse etc..)

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NOTE Refer to ISO 19880-1:2020 Annex C for an example of a test procedure to verify SAE J2601.



## EN 17127: Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols

**TABLE 1: Minimum Site Acceptance Testing to ensure interoperability**

Copy/paste text from EN 17127:2020

Extra information

Test Name	Prep to be performed	Test info	Acceptable Test	ISO test number
Ambient, fuelling pressure and temperature sensor accuracy table	-	Verification of ambient and fuelling temperature sensor and fuelling readings, review of calibration	Sensors show value reasonable to state of the refuelling point; calibration certificates OK	3 (ISO 19880-1)
Fault: CHSS starting pressure	CHSS with starting pressure greater than the appropriate vehicle NWP to be refuelled (attempted)	Connect the CHSS to the HRS and initiate the refuelling. HRS shall recognize full CHSS and not start main part of refuelling	Main refuelling is not allowed to start.	8 (ISO 19880-1)
Communication break	Simulated communications and then a break in communication signal	Confirm that the refuelling switches to non-communication fuelling	Dispensing system switches to non-com refuelling or stops refuelling.	16 (ISO 19880-1)

## EN 17127: Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols

TABLE 1: Minimum Site Acceptance Testing to ensure interoperability

Copy/paste text from EN 17127:2020

Extra information

Test Name	Prep to be performed	Test info	Acceptable Test	ISO test number
Fault: Communication Abort Signal	Simulated communications Abort Signal, e.g. by manipulation of the signal loop	To be monitored even with non-communications refuelling (if applicable)	Refuelling Stop within 5 seconds of Abort Signal being sent	18 (ISO 19880-1)
Non-comm refuelling validation for each pressure level (H70 and H35)	2 different starting conditions	Two tests per hydrogen service level where applicable	$P_{target} \pm 2$ MPa without exceeding the fuelling protocol process limits	36 (ISO 19880-1)
Communication refuelling validation	2 different starting conditions, one of which is below 2 MPa starting pressure	Two tests per hydrogen service level where applicable	SOC or $P_{target}$ without exceeding the fuelling protocol process limits and with no abort signal received.	37 (ISO 19880-1)

The CEP has made a template available for easy use. You only need to fill in the yellow and green marks and add graphs.

CEP No Test: ISO 15850-1 / CEP Site Acceptance Tests Page 1 of 17  
 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### HYDROGEN REFUELLING STATION ISO 15850-1 Site Acceptance Tests

**Test responsible:**  
 Zmarini for Sternentzüge- und Wasserstoff-Forschung Baden-Württemberg  
 Tel. +49 (0) 7141 9550-221 Fax +49 (0) 7141 9490-434 Fax +49 (0) 714 9433-446

**Measurements & Records**

Done by	Date

**Evaluation & Report**

Version	Done by	Date	Remarks

**Approval & Distribution**

Version	Approved by	Date	Receipts	Date

BUSINESS CONFIDENTIAL INFORMATION

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 Provider: **xxx** HPS: **xxx** Operator: **xxx**

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**ANNEX** ..... 17

**Note:**  
**xxx** Input from the station manufacturer according to the used protocol on the test conditions  
**xxx** Output results from the testing

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### 1 Introduction

The CEP (Clean Energy Partnership) defined 9 site acceptance tests, according to ISO 15850-1:2020 Chapter 10.3 Table 2, which should be performed during the commissioning and start-up of a hydrogen refueling station (HRS). The tests are defined to verify the safety of the station and the overall performance, thus complying with EN 17127 legal requirements (except test 9). This report presents the test results for the HRS, located at **XXXXXXX XXXX** mentioned above.

Probably by this report the station manufacturer has provided a FAT report certificate according to ISO 15850-1 Annex C Table C2, document name: **XXX**. The tests presented here are performed on-site with a Hydrogen Station Testing Apparatus (HSTA) by **xxx**.

The tests here are defined for an **SAE J2801-2020 H70 F40 station**. The report shall be adjusted, especially the performance tests according to the type and location of the installation. The test numbering in following the ISO 15850-1 nomenclature.

### 2 Reference Documents

ISO 15850-1:2020 Gaseous hydrogen – Fueling stations – Part 1. General requirements  
 SAE J2801-2020 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles  
 SAE J2801-2020 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles

*Documents referenced since this report always refer to the latest version.*

### 3 Station specification

#### 3.1 Technical specification

Dispenser (S20 bar / 750 bar)	<b>100 bar</b>
Station ambient temperature	<b>40°C to 50°C</b>
Hydrogen level	<b>100 kg to 100 kg (H2)</b>
Fueling hoses fixed	<b>YES (no combination hoses available for reusable hose T1/T2)</b>
Breakaway connector fixed	<b>YES (H2 70 MPa (H2))</b>
Inlet filter fixed	<b>5 um</b>
Outlet filter fixed	<b>5 um</b>
High-pressure ambient	<b>SAE J2801-2020 MC Flammable</b>
Pressure range	<b>100</b>
Implemented SAE J2801 features	<b>100</b>
Close Valve feedback	<b>YES</b>
Top-off	<b>YES</b>
Cold dispenser	<b>NO</b>
Precooling feedback	<b>YES</b>

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CEP No Test: ISO 15850-1 / CEP Site Acceptance Tests Page 4 of 17  
 Provider: **xxx** HPS: **xxx** Operator: **xxx**

**Flow measurement** **OK: Accurate**

Vehicle volume determination: With IR cone: **optional defined with communication**  
 Without IR cone: **most conservative values used**

SAE J2801 categories implemented in the software:	A: 3B B: 13 C: 13 D: 13
Hardware capacity according to SAE J2801 categories:	A: 3B B: 13 C: 13 D: 13

Maximum single refueling capacity: **Category A-B-C: 20 kg Category D: 10 kg**

Is fueling achieved by connectivity? **NO**

Back-to-back refueling capability: **2 + 5 kg with 3 min handling time (max. 10°C, inlet pressure: 1100 bar, max. H2 bar: 100 MPa/SOC) - see HDM specification**

Table 1: Technical specification

#### 3.2 Operational and safety related shut down criteria

End of fueling after threshold transgression	Stop within 5s
Temperature monitoring	1070 140 1070 130
Liquid controller monitoring	30 s after refueling start
Upper abort line without preceding fallback	-35 °C -17.5 °C
Upper abort line with preceding fallback	-35 °C -17.5 °C
Pressure lower abort line	-50 °C -15 °C

Table 2: Operational and safety related shut down criteria

#### 3.3 Location of the sensors

End of fueling after threshold transgression	within 5 s of transgression
Dispenser pressure sensor	within 5 s of transgression
Dispenser temperature sensor	within 5 s of transgression
Dispenser flow meter	3.0 s transgression

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 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### 4 Tests

FAT testing has been performed beforehand by the station manufacturer.

**General values**

For each test, the following values are recorded (measured), calculated or taken from a table. To save in standardized review of the tests results it is recommended to record all these values in the new data file of each test:

- T: Time in seconds (in scale)
- P<sub>disp</sub>: H2 pressure in dispenser in MPa
- T<sub>disp</sub>: H2 temperature in dispenser in °C
- T<sub>amb</sub>: Mean averaged H2 temperature in dispenser in °C, if applicable
- P<sub>flow</sub>: H2 flow in dispenser in g/s
- SOC<sub>disp</sub>: State of charge (fuel level) in %, calculated with P<sub>disp</sub> and T<sub>disp</sub>
- P<sub>flow</sub>: H2 pressure in hydrogen surface vehicle (fuel cell car or HSTA) in MPa
- SOC<sub>veh</sub>: State of charge (fuel level) in %, calculated with P<sub>flow</sub> and T<sub>disp</sub>
- T<sub>amb</sub>: Ambient temperature value in °C, measured by the HRS
- T<sub>amb</sub>: Ambient temperature value in °C, measured by the HRS / HSTA if applicable
- IR: Pressure in dispenser at t<sub>start</sub> in MPa
- P<sub>target</sub>: Target pressure in the dispenser according to SAE J2801 (P2) in MPa
- P<sub>close</sub>: Top-Off target pressure in the dispenser in MPa if applicable
- Start: Start push button information (0 if not pressed / 1 if pressed)
- IR com: IR communication (0 if not used / 1 if used)
- Abort: Abort signal (0 if not used / 1 if used)
- CD: Cold dispenser flag (0 if not used / 1 if used)
- t<sub>start</sub>: Time when fueling starts (= "start of fueling time" in SAE J2801 (P2), Figure 1)
- t<sub>stop</sub>: Actual fueling time measured from t<sub>start</sub>
- t<sub>fuel</sub>: Total fueling time (= "total fueling time" in SAE J2801 (P2), Figure 1)
- APRR: (P<sub>flow</sub> - P<sub>target</sub>) / t<sub>fuel</sub>, Average pressure ramp rate in MPa/s
- APRR: t<sub>fuel</sub> = target pressure ramp for the fueling according to SAE J2801 (P2)
- P<sub>flow</sub> = P<sub>1</sub> + APRR \* t<sub>fuel</sub> + t<sub>fuel</sub>, with t<sub>fuel</sub> = 17 MPa
- P<sub>flow</sub> = P<sub>1</sub> + APRR \* t<sub>fuel</sub> + t<sub>fuel</sub>, with t<sub>fuel</sub> = 23 MPa
- T<sub>amb</sub> = -32°C / 26°C / 130 here SAE J2801 (P2)
- T<sub>amb</sub> = -47°C / 33°C / 140 / 130 here SAE J2801 (P2)

*\* Can be APRR or PMRR (back-back pressure ramp rate) or top-off APRR or cold-dispenser APRR*

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 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### Parameter check

For each testing the following parameters are checked:

- Non fueling cover P<sub>flow</sub> < 0.5 g/s shall not happen more than 10 times in one fueling process.
- Total mass of hydrogen transferred to the vehicle during starting (pressure pulse) < 200 g
- T<sub>amb</sub> = T<sub>amb</sub> within 30 s after start of testing
- T<sub>amb</sub> = T<sub>amb</sub> - T<sub>amb</sub> during fueling (1 fallback allowed if precooling fallback implemented)
- Max(P<sub>flow</sub> / P<sub>flow</sub>) < P<sub>flow</sub> + P<sub>flow</sub>
- Without IR com: fueling stops when P<sub>flow</sub> = P<sub>target</sub>
- With IR com: fueling stops when P<sub>flow</sub> = P<sub>target</sub> or SOC<sub>disp</sub> = 100% is fuel reached.

**Graphs**

- Pressure in MPa
- APRR in MPa/min
- Flammable in g/s
- Right axis:
- Temperature in °C

BUSINESS CONFIDENTIAL INFORMATION

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 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### 1) (ES) No. 3: Sensor Calibration

The preliminary tests led to check the calibration and accuracy of all relevant sensors for the refueling and confirm the validity of FAT testing. This is a feasibility test rather than a calibration test. Can be done during any of the test tests.

Preparation: Calibration tool / report  
 Sensor already installed

Method: follow the calibration and check the measured value of:  
 - All ambient temperature sensors used for table calculation  
 Expected results:  
 - Dispenser pressure sensor(s)  
 - Dispenser temperature(s)

Tested by: Third party / Site Acceptance Test  
 Expected results: All values and calibration are consistent  
 Measured results: **Station's flow value reasonable to state of the station; calibration certificate provided as OK.**

Remarks: **xxx**

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CEP No Test: ISO 15850-1 / CEP Site Acceptance Tests Page 8 of 17  
 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### 2) (ES) No. 8: O2/S2 Starting pressure

The target of this test is to check that no fueling is possible on a full tank and that the station can perform a pressure pulse at the pressure. The test must be checked on the dispenser pressure sensor after pulses and not on the pressure from the IR.

Preparation: P<sub>flow</sub> > 70 MPa before starting  
 Tank capacity = not defined but within **SAE J2801** (H2) category  
 IR com = No  
 \* (station manufacturer's information)

Method: Start fueling  
 Tested by: Third party / Site Acceptance Test

Expected results: Fueling is stopped after pressure pulse and pressure pulse is successful

Conditions: P<sub>flow</sub> initial > 70 MPa, T<sub>amb</sub> initial < 30°C

Date / Time: **xx.xx.20xx xx:xx**

Measured results: **xxx (flow IV)**

Remarks: **xxx**

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CEP No Test: ISO 15850-1 / CEP Site Acceptance Tests Page 9 of 17  
 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### 3) (ES) No. 16: Communication Check

The target of this test is to check the proper switch to non-communication fueling the test can be used on test No. 30a

Preparation: P<sub>flow</sub> = 8 MPa +/- 2 MPa before starting  
 Tank capacity = not defined  
 IR com = yes  
 Start fueling: Incomplete IR com after 40 - 50 s

Method: Third party / Site Acceptance Test

Tested by: P<sub>flow</sub> remains in same APRR. Fueling stops if non-com P<sub>flow</sub> defined in SAE J2801 (P2). Switch to Non-Com fuel

Expected results: P<sub>flow</sub> stays > 8 MPa, T<sub>amb</sub> initial < 30°C, P<sub>flow</sub> < 8 MPa after Com loss.

Conditions: **xx.xx.20xx xxx:xx**

Date / Time: **xx.xx.20xx xx:xx**

Used tank size: 8 kg (type IV)

Measured results: APRR does not change, fueling stops at **xxx** MPa (see Diagram)

Remarks: **xxx**

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CEP No Test: ISO 15850-1 / CEP Site Acceptance Tests Page 10 of 17  
 Provider: **xxx** HPS: **xxx** Operator: **xxx**

### 4) (ES) No. 18: Communication Abort Signal

The target of this test is to check the proper termination of refueling when receiving an Abort Signal

Preparation: P<sub>flow</sub> = 8 MPa +/- 2 MPa before starting  
 Tank capacity = not defined  
 IR com = yes  
 Start fueling: After 40 - 50 s send abort signal from HSTA.

Method: Third party / Site Acceptance Test

Tested by: Third party / Site Acceptance Test

Expected results: When the abort signal is sent fueling stops as soon as possible with 5s.

Conditions: P<sub>flow</sub> stays > 8 MPa, T<sub>amb</sub> initial < 30°C

Date / Time: **xx.xx.20xx xxx:xx**

Used tank size: 8 kg (type IV)

Measured results: **xxx** kg

Measured results: Fueling stops **xxx** s after sending the abort signal (see Diagram)

Remarks: **xxx**

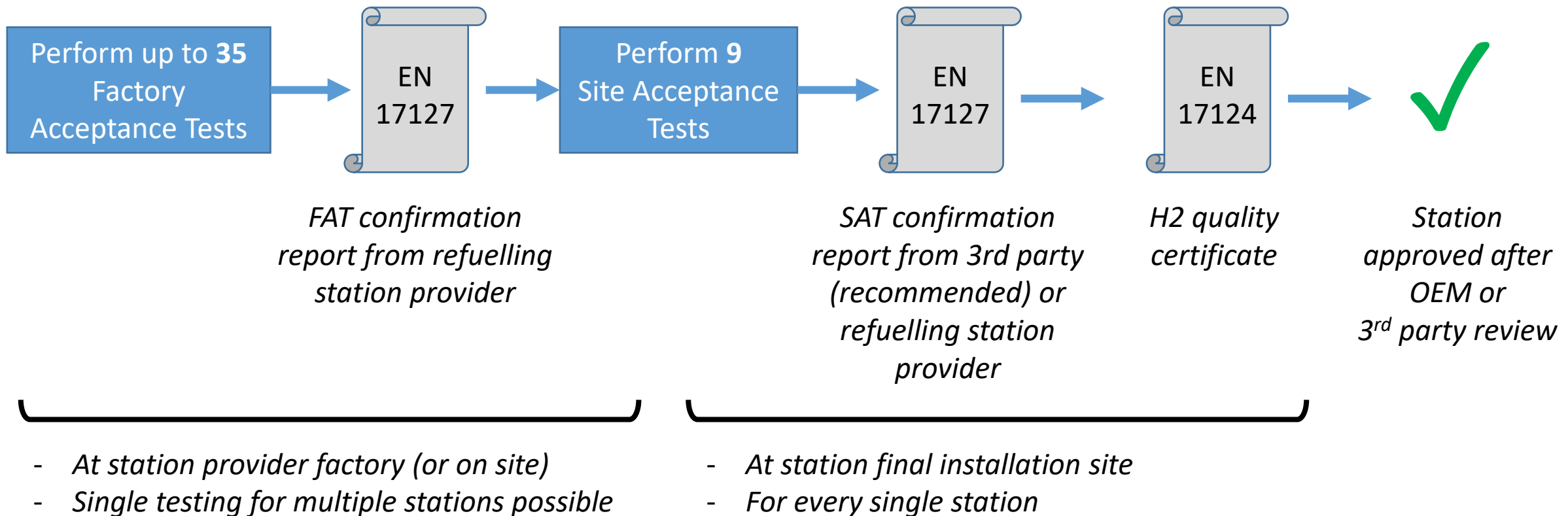
BUSINESS CONFIDENTIAL INFORMATION

07/11/2023 France Hydrogène

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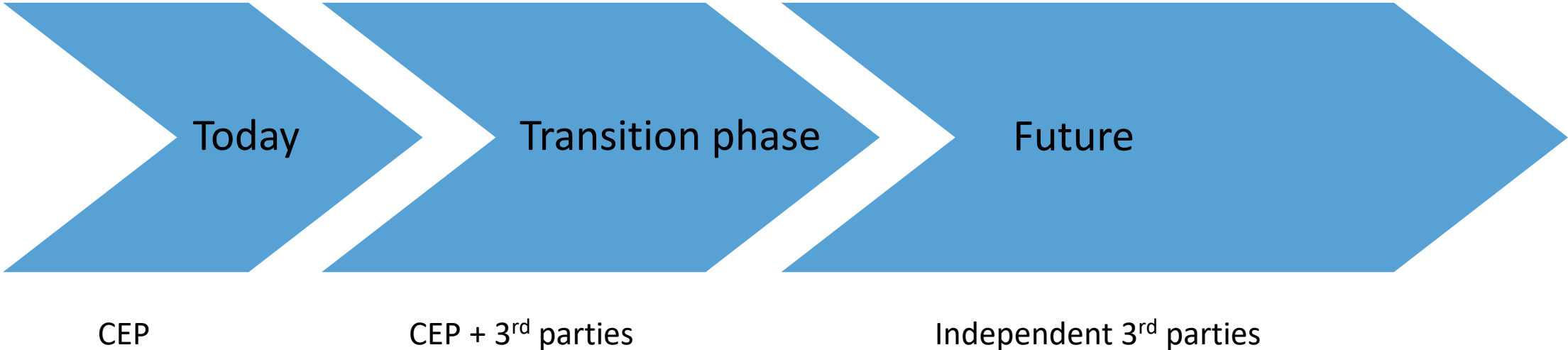
# Proposed validation steps

- Process description



# HRS approval process today & future

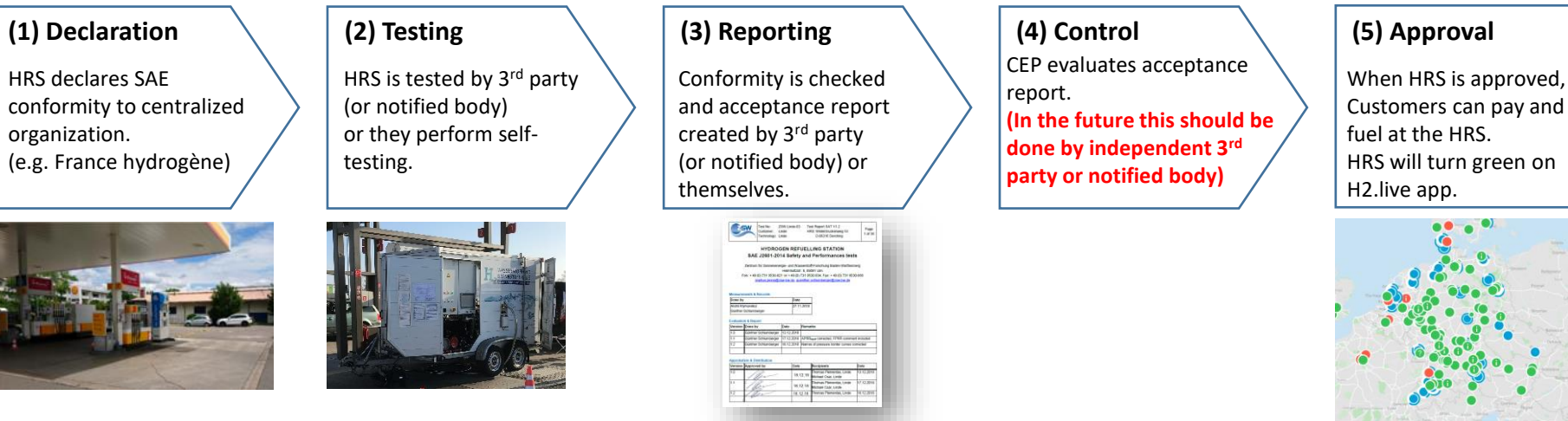
Transition to future HRS approval process will be done in two steps





# HRS approval process today

Procedure	Description	Responsibility
1. Declaration	The HRS supplier declares the SAE conformity of the system.	HRS-Operator
2. Testing	The HRS supplier is testing his HRS by himself, or a <b>qualified independent 3<sup>rd</sup> party</b> is doing the tests on behalf of the HRS operator/supplier in accordance with EN 17127 table 1. The results are documented in detail in an acceptance report.	HRS-Supplier / <b>3rd Party</b>
3. Reporting	The acceptance report and declaration of conformity are submitted to the OEMs, who check the conformity of the test results. Deviations to the standards are being discussed with the HRS supplier bi-laterally.	HRS-Supplier / <b>3rd Party</b>
4. Control	CEP evaluates acceptance report.	OEMs
5. Approval	Explicit approval of the acceptance reports by the OEMs.	OEMs



# ZSW Trailer Pictures





**HONDA**



**THANK YOU**

**Any questions?**

Q: Who do we need to contact if we want to have our FAT, SAT and H2 quality report approved?

A: You can contact our administrator [carsten.zeidler@spilett.com](mailto:carsten.zeidler@spilett.com)

Q: Can you provide us with some contacts for performing a H2 quality sampling and analysis.

A: See below some example laboratories that are able to sample and analyse all the EN 17124 contaminants.

## SGS

Arnaud BOILLE  
Oil, Gas & Chemical France  
Business Developer Hydrogène  
[arnaud.boille@sgs.com](mailto:arnaud.boille@sgs.com)  
SGS France  
29 Avenue Aristide Briand  
94111 Arcueil, France  
+33 (0)6 08 58 13 68

## CEMIAG/Air Liquide

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Directeur Laboratoire CEMIAG  
[nathalie.chramosta@airliquide.com](mailto:nathalie.chramosta@airliquide.com)  
Campus Innovation Paris - Les Loges  
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+33 (0)6 18 11 99 75

## NPL

Dr Thomas Bacquart  
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Gas and particulate metrology group  
[thomas.bacquart@npl.co.uk](mailto:thomas.bacquart@npl.co.uk)  
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## ZSW

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## ZBT

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Department Fuel Processing  
[c.spitta@zbt-duisburg.de](mailto:c.spitta@zbt-duisburg.de)  
ZBT GmbH, Carl-Benz-Str. 201  
D-47057 Duisburg / Germany  
  
+49 203 7598-4277

Q: Can you provide us with the contacts of the notified bodies that are already allowed to perform the FAT/SAT report evaluation on behalf of the CEP?

A: See contact details below

- TÜV Süd  
Raphael Mayer  
Phone: +49 89 5791 2346  
Mobile: +49 151 51701950  
Email: [raphael.mayer@tuvsud.com](mailto:raphael.mayer@tuvsud.com)
- TÜV Rheinland  
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