



MC Formula

Parallel session 2: Validation process

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Presentation at the Workshop Organized by CEP and Hydrogen Europe, January 2021

MC Method Parallel session 2: Validation process

- Three options for next 30 minutes
 - Discuss more details on validation process in HGV 4.3
 - Show how MC Method calculator is used
 - Q&A

CSA HGV 4.3 MC Formula Validation

- Confirms if station is applying SAE J2601 properly
- Each version of HGV 4.3 linked to version of SAE J2601
 - SAE J2601 2014 → CSA HGV 4.3 2016
 - SAE J2601 2016 → CSA HGV 4.3 2019
 - SAE J2601 2020 → CSA HGV 4.3 2021 (currently being worked on)
- CSA HGV 4.3 2019 Added MC Method
 - This presentation focuses on HGV 2019

CSA HGV 4.3 MC formula validation

• Fault

- Makes sure that station reacts properly to a out-of-specification condition
- General (applies to all fueling protocol)
 - CHSS capacity, Fuel deliver temperature, CHSS pressure
- Protocol Specific
 - Upper/lower APRR
 - Maximum MAT30 Temperature

Table 18
List of all tests required to pass CSA/ANSI HGV 4.3
(See Clauses 10.2 and 10.3.)

Test	Clause	No. of tests	Pre-installation testing allowed**
General fault tests			
CHSS capacity range	8.3	1	Y
Ambient temperature	8.4	1	Y
Minimum fuel delivery temperature	8.5	1	Y
Maximum CHSS gas temperature	8.6	1	Y
Initial CHSS pressure	8.7 and 8.8	1	Y
Maximum CHSS pressure	8.8	1	Y
Maximum CHSS pressure test (with communication)	8.9	1	Y
Maximum state of charge	8.10	1	Y
MC formula-based fault testing			
Upper pressure corridor limit	10.6.5	1	Y
Lower pressure corridor limit	10.6.6	1	Y
Maximum MAT ₃₀ temperature	10.6.7	1	Y

CSA HGV 4.3 MC formula validation

- Communications
 - Ensures that communications work properly
- Protocol Function
 - Makes sure station implements (calculates) MC control parameters properly
 - Intended to be simulated, but can be physically tested
- Protocol evaluation
 - Verify that the station can successfully complete fills
 - Factory and site testing

MC formula-based communications testing			
Abort signal test	9.8.2	1	N
Halt signal test	9.8.3	1	N
Data loss test and then resumed fueling test	9.8.4	1	N
Invalid CRC communication test	9.8.5	3	N
Invalid defined data value test	9.8.6	7	N
MC formula-based fueling protocol function testing			
P_{limit_high} and P_{limit_low} within tolerance	10.9.3	6*	Y
$P_{target_non_comm}$ value within tolerance	10.9.3 or 10.9.4	†	Y
P_{target_com} value within tolerance			
P_{limit_com} value within tolerance			
MC formula-based fueling protocol evaluation testing			
Non-comm fueling ending pressure within tolerance	10.10.2	‡ 2-3 (H35)	N
Communication fueling ending SOC within tolerance		3-4 (H70)	
$P_{station} < P_{limit_high}$			
$P_{station} > P_{limit_low}$			
$T_{fuel} \geq 233.15$ K			
$MAT_{30} \leq 255.65$ K when $n > 30$			
Station fuel delivery temperature category designation			
Cold dispenser test [§]			

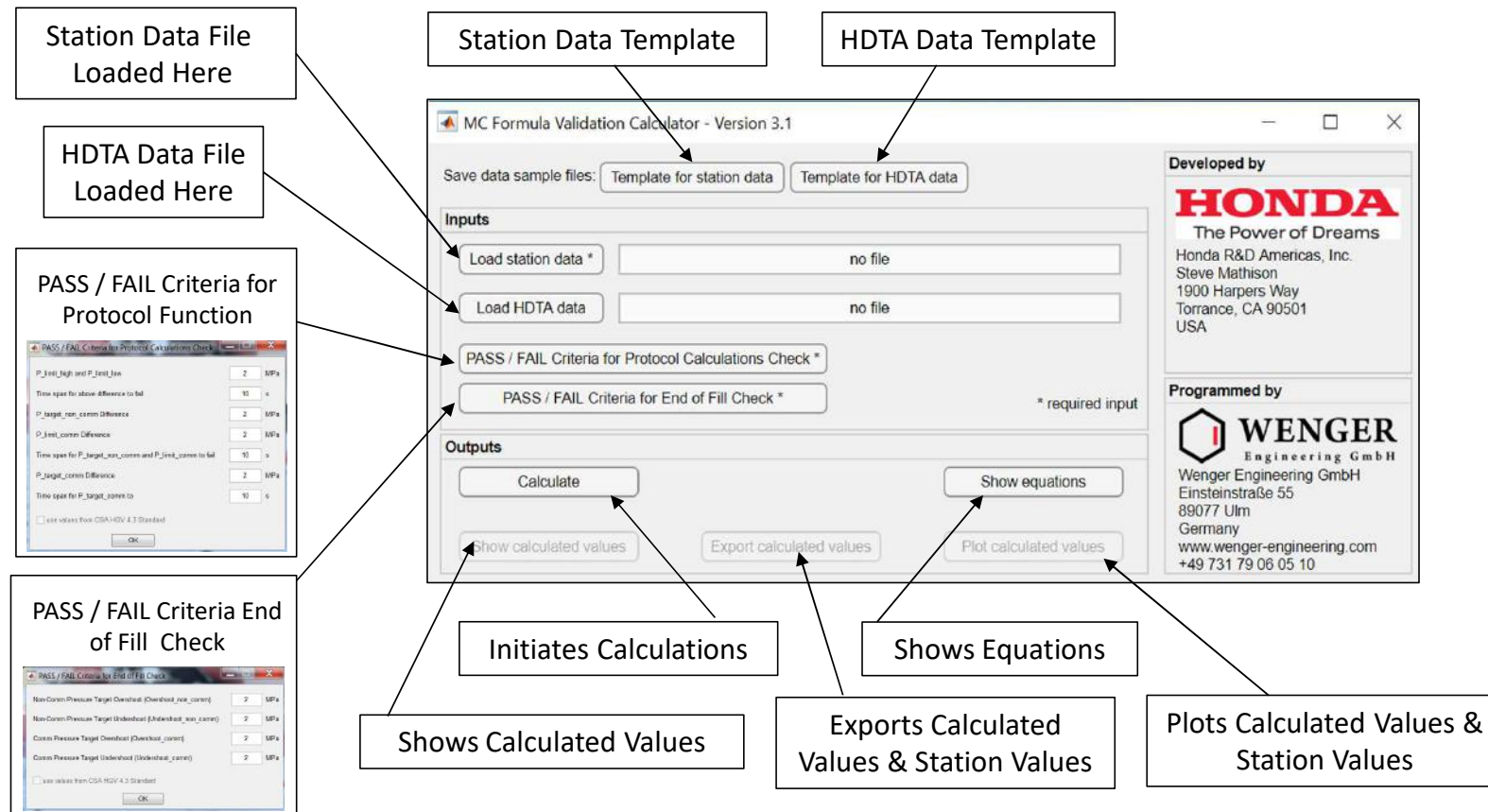
Pre-installation testing/Factory acceptance testing

- HGV 4.3 2019 allowed for pre-installation testing
- HGV 4.3 2021 is moving to factory (FAT) and site (SAT) acceptance testing
 - All tests can be done in factory or on site
 - A minimum number of tests must be performed on site
 - Fault: Maximum pressure tests
 - Communications: Abort, data loss, invalid CRC, invalid data
 - Fueling evaluation tests

MC Formula Validation Calculator

MC Formula: Validation Calculator (MCFVC)

The Tool is programmed in MATLAB, but it is an executable Windows File which can run on any PC



There are two versions of the MCFVC – V2.3 aligns with the 2016 SAE J2601 and V3.1 aligns with the 2020 SAE J2601
 MCFVC is available for free here → <https://www.wenger-engineering.de/mc-formula-validation-calculator-login/>

Backup

CSA HGV 4.3 Table Based Tests

Table 6
List of all tests required to pass CSA/ANSI HGV 4.3
(See Clauses 9.2 and 9.3.)

Test	Clause	No. of tests	Pre-installation testing allowed [#]
General fault tests			
CHSS capacity range	8.3	1	Y
Ambient temperature	8.4	1	Y
Minimum fuel delivery temperature	8.5	1	Y
Maximum CHSS gas temperature	8.6	1	Y
Initial CHSS pressure	8.7 and 8.8	1	Y
Maximum CHSS pressure	8.8	1	Y
Maximum CHSS pressure test (with communication)	8.9	1	Y
Maximum state of charge	8.10	1	Y
Table-based fault testing			
Upper pressure tolerance	9.5.1	1 or 2	Y
Lower pressure tolerance	9.5.2	1 or 2	Y
Table-based communications testing			
Abort signal test	9.8.2	1	N
Halt signal test	9.8.3	1	N

Test	Clause	No. of tests	Pre-installation testing allowed [#]
Data loss test and then resumed fueling test	9.8.4	1	N
Invalid CRC communication test	9.8.5	3	N
Invalid defined data value test	9.8.6	7	N
Table-based fueling protocol testing			
Fueling test without communications	9.10.1	*	N
Fueling test with communications	9.10.2	*	N
Additional tests — repeated table test	9.9.6	1†	N
Additional tests — non-communication volume measurement test	9.9.7	2	Y
Additional tests — no fueling (NF) test	9.9.8	1†	Y
Additional tests — high pressure (HP) capacity test	9.9.9	1†	N
Additional tests — pre-cooling (PC) test	9.9.10	1†	N
Fuel delivery temperature fallback test	9.10.3	1	N
Top-off fueling	9.10.4	1	N
Cold dispenser test	9.10.5	1	N