

Low Temp Test procedure for EVs and pure ICE vehicles

**Open topics to be discussed and concluded until March 4th
Revision 4**

Status: 26.02.2020

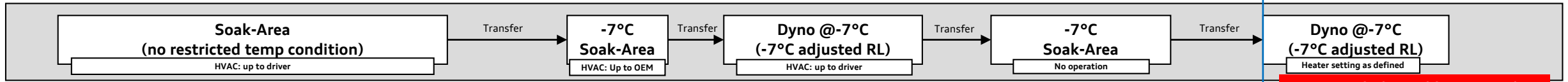
NOVC-HEVs and pure ICE

Low Temp Test Procedure proposal (rev.4)

Status: 26.02.2020

Test Procedure (NOVC-HEV and pure ICE vehicles) – Test Proposal for -7°C Procedure

Discussion points see below



Soak

- Fuel drain and refill (less than 16°C) @ fuel bay (but can be done after any event prior to 2nd soaking)

Report time

Soak

6-24h

1

First soak can be omitted as a manufacturers option.
 EC does not support to provide this option
 JPN supports to provide this option; if EC is not able to supported this option, JPN's position is to strike out first soak completely
 → Discussion and conclusion

Precon

1 WLTC

Two positions:
 JPN: allow precon at 23°C as manufacturers option
 EC: precon @-7°C
 → Discussion and conclusion

Soak

>=12h, max. 36h (report time)

reflecting overnight stay without charging

Forced cool down
 → see Open Topic list
 → Discussion and conclusion

Duration: 12 - 36 hrs

Vehicle outside the temperature tolerance (-7±3) during the transfer from soak to dyno for time "f":
 Additional soak time "g" on the dyno is required before the start of the cold start test which is calculated as follows: $g \geq 6 * f$
 → Discussion and conclusion

Cold Start Testing

Dyno @-7°C (-7°C adjusted RL)
 Heater setting as defined

EC requires facility modification according to last week comments on 4WD dyno
 → Discussion and conclusion

Test

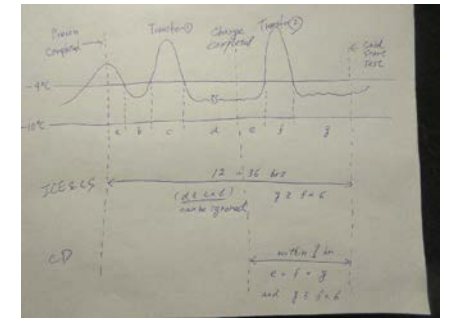
Test

Additional test:
 Procedure can be skipped until "Precon"

Input JPN
 → Discussion and conclusion

1 x WLTC

1 Leaving soak (-7°C) until starting test in test cell (-7/23°C): max.: [40] min (transfer: max. [20] min, preparation on dyno: max. [20] min)
 → Without any unjustified delay; vehicle shall not receive unjustified exposure to temperatures higher than -7°C; in case that is unavoidable, this shall not be longer than [20] min
 → Note: only max. [30] min between different tests on the dyno shall not be exceeded (only related to dyno warm-up)



OVC-HEVs

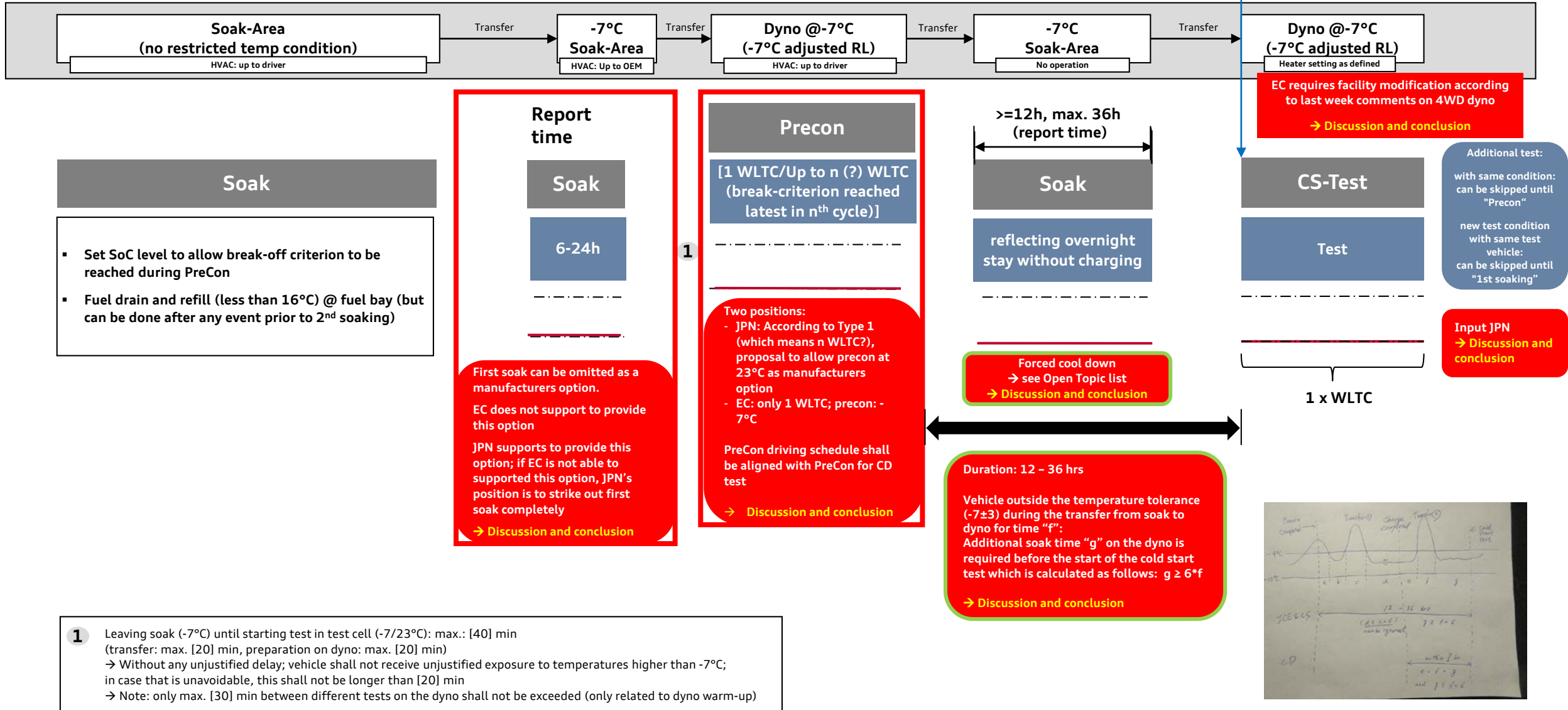
Low Temp Test Procedure proposal (rev.4)

Status: 26.02.2020

Test Procedure (OVC-HEV) – Charge Sustaining Test

Proposal for -7°C Procedure

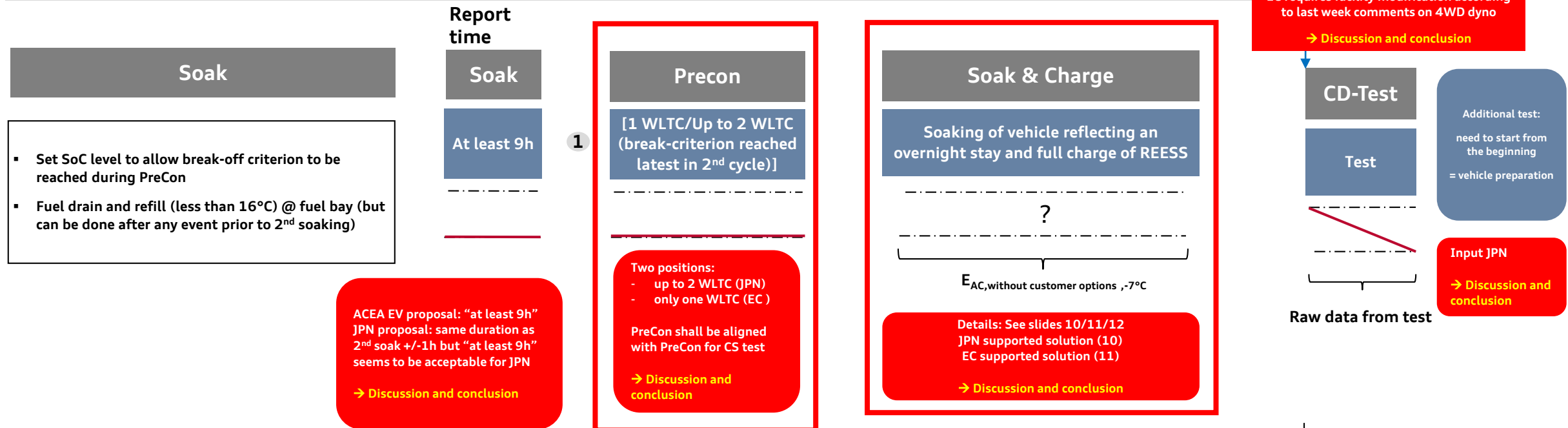
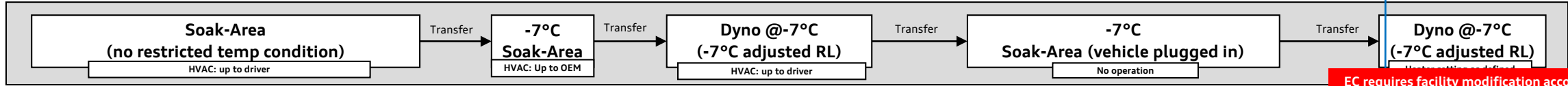
Discussion points see below



Test Procedure (OVC-HEV) – Charge Depleting Test

Discussion points see below

Proposal for -7°C Procedure – Base procedure with no customer based preconditioning action



ACEA EV proposal: "at least 9h"
JPN proposal: same duration as 2nd soak +/-1h but "at least 9h" seems to be acceptable for JPN

→ Discussion and conclusion

Two positions:

- up to 2 WLTC (JPN)
- only one WLTC (EC)

PreCon shall be aligned with PreCon for CS test

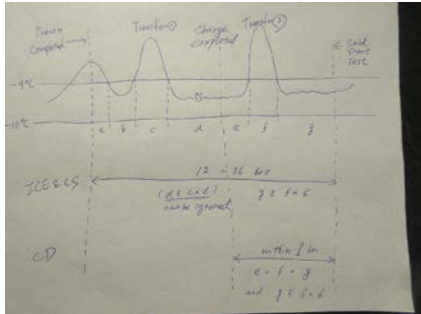
→ Discussion and conclusion

Duration: 12 – 36 hrs
Time between charge completed and cold start test: < 1h

At the option of the manufacturer:
Vehicle outside the temperature tolerance (-7±3) during the transfer from soak to dyno for time "f":
An additional soak time "g" on the dyno is required before the cold start test which is calculated as follows: $g \geq 6 \cdot f$

→ Discussion and conclusion

1 Leaving soak (-7°C) until starting test in test cell (-7/23°C): max.: [40] min
(transfer: max. [20] min, preparation on dyno: max. [20] min)
→ Without any unjustified delay; vehicle shall not receive unjustified exposure to temperatures higher than -7°C; in case that is unavoidable, this shall not be longer than [20] min
→ Note: only max. [30] min between different tests on the dyno shall not be exceeded (only related to dyno warm-up)



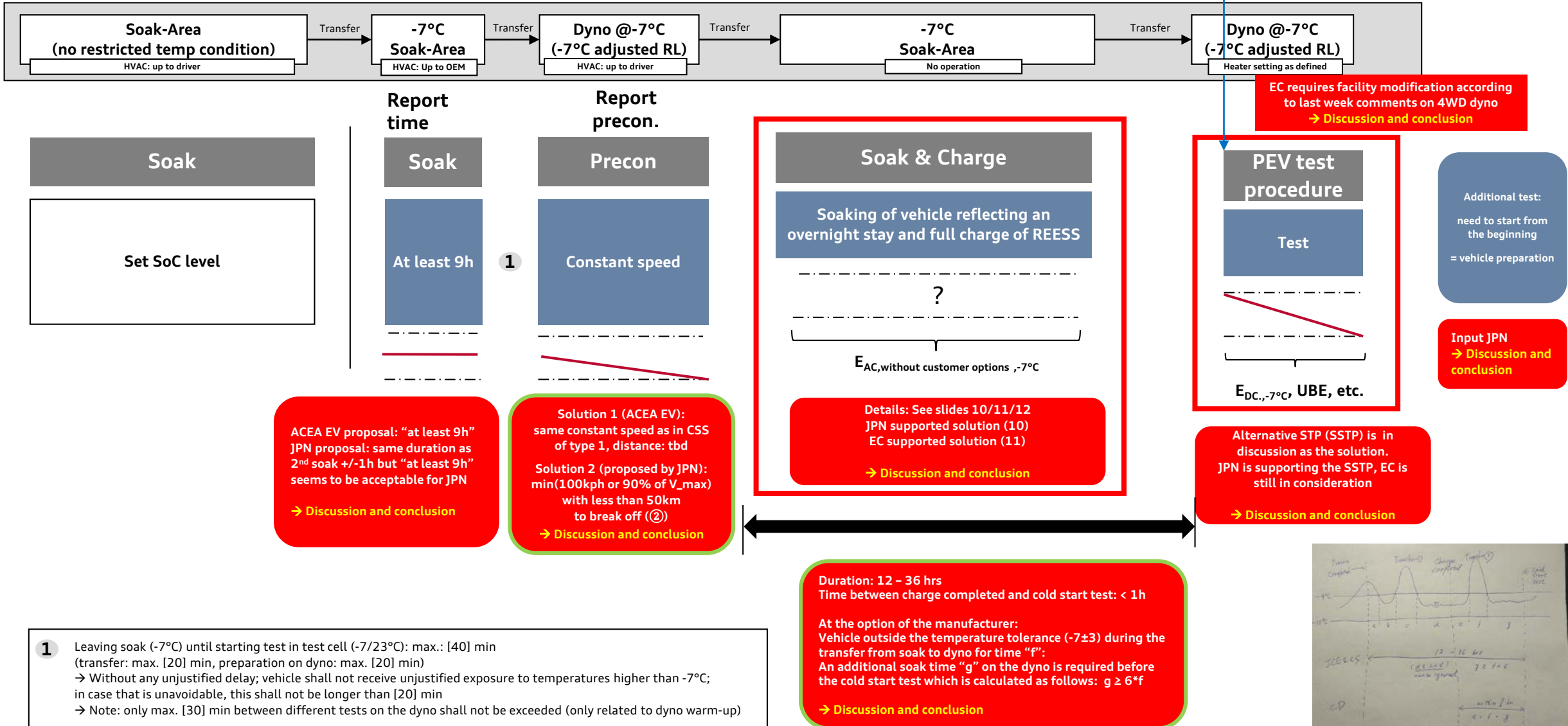
Pure electric vehicles

Low Temp Test Procedure proposal (rev.4)

Status: 26.02.2020

Test Procedure (PEV) – STP, CCP, SSTP (to be discussed) Discussion points see below

Proposal for -7°C Procedure – Base procedure with no customer preconditioning action



BACK UP

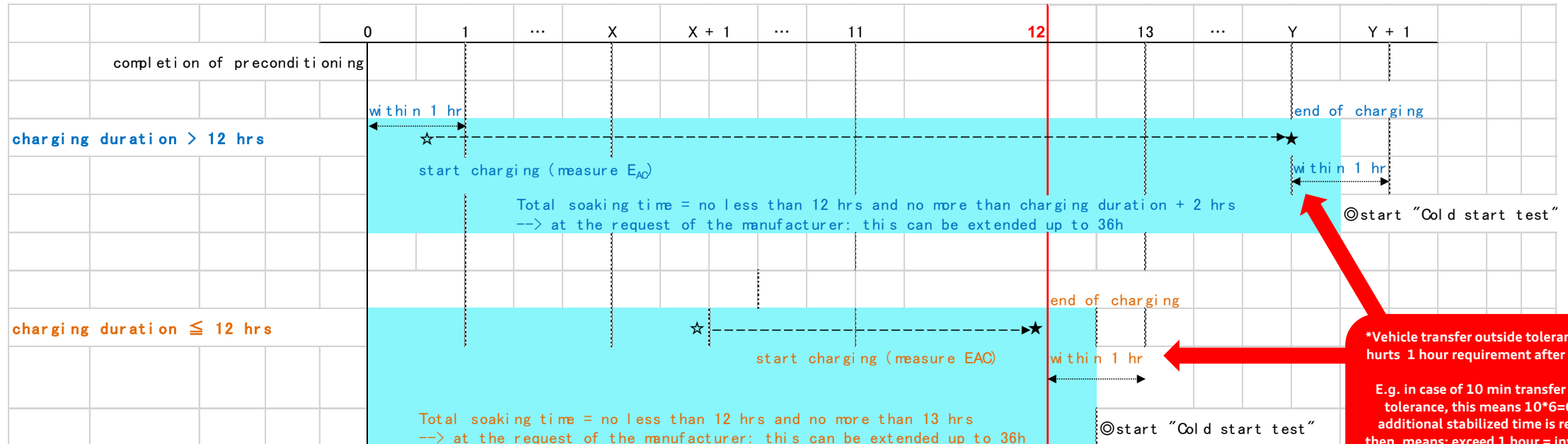
**Second soak and Charge
(PEVs and CD-test of OVC-HEVs)**

Test Procedure (PEV and CD-test of OVC-HEVs) – Second Soak with Charge

Two solutions on the table

Solution supported by JPN:

- End of charging shall correspond with end of second soak
- Soak time of 12h which need to be extended if charging is not finished after 12h until the point in time charging is finished
At request of manufacturer, the resulting charging time of 12h (or more if charging not finished) can be extended up to 36h
- If charging time < soaking time, start of charging shall be delayed → so end of charging corresponds to end of second soak
- Test start after end of soak/end of charging (which means de-plugging of vehicle from the grid) within 1h*



*Vehicle transfer outside tolerance (-7 ± 3) hurts 1 hour requirement after soak end.

E.g. in case of 10 min transfer outside tolerance, this means $10 \times 6 = 60$ min additional stabilized time is required. then, means: exceed 1 hour = invalid test.

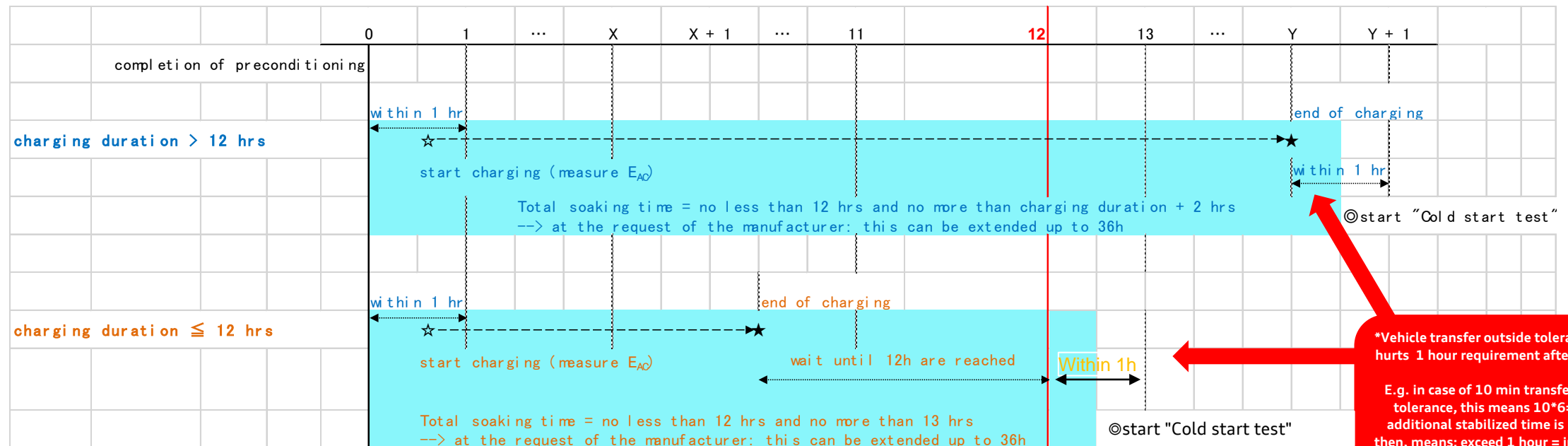
→ Needs further consideration

Test Procedure (PEV and CD-test of OVC-HEVs) – Second Soak with Charge

Two solutions in discussion

Solution supported by EC/JRC:

- Start of Charging with start of second soak
- Soak time of 12h which need to be extended if charging is not finished after 12h until the point in time charging is finished
At request of manufacturer, the resulting charging time of 12h (or more if charging not finished) can be extended up to 36h
- Test start after end of soak (which means de-plugging of vehicle from the grid) within 1h*



*Vehicle transfer outside tolerance (-7±3) hurts 1 hour requirement after soak end.

E.g. in case of 10 min transfer outside tolerance, this means 10*6=60 min additional stabilized time is required. then, means: exceed 1 hour = invalid test.

→ Needs further consideration

Test Procedure (PEV and CD-test of OVC-HEVs) – Second Soak with Charge

Two solutions on the table

Solution supported by EC/JRC	Solution supported by JPN
<ul style="list-style-type: none"> ▪ Reflects the worst case (with no delayed charging, when vehicle starts charging immediately after being connected to the grid) ▪ If charging time < soaking time: <ul style="list-style-type: none"> ▪ REESS will cool down at the end of the soaking time when REESS is not charged any more and if there is no REESS heating application running ▪ Depending on the difference between charging time and soaking time, the REESS will cool down the more the bigger this difference is 	<ul style="list-style-type: none"> ▪ Reflects a customer which is delaying the start of charging so REESS is fully charged when customer wants to drive to work ▪ Delay of the start of charging is related to the difference between charging time and soak time ▪ End of charge is always connected to the end of soak ▪ As cold start test will always be starting within 1h after the end of the soak, REESS will be most likely warmer compared to the EC/JRC supported proposal
<p>Results out of EC/JRC supported solution:</p> <ul style="list-style-type: none"> ▪ In case charging time < soaking time, the results are depending on the charging time: The bigger the difference between those times is, the longer the time after end of charge and beginning of cold start test will be 	<p>Results out of JPN supported solution</p> <ul style="list-style-type: none"> ▪ Results are independent from the charging time as stable time difference (1h) between end of charge and start of cold test ▪ Results from JPN supported solution will better as from EC/JRC supported solution as REESS temperature will be higher

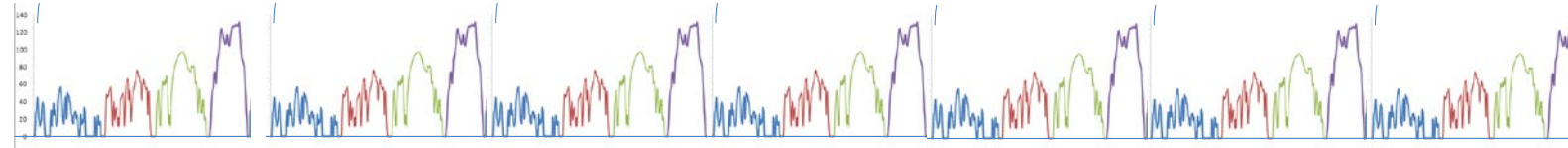
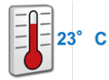
BACK UP

Alternative STP results

Test Procedure (PEV) – comparison between CCP, STP and SSTP

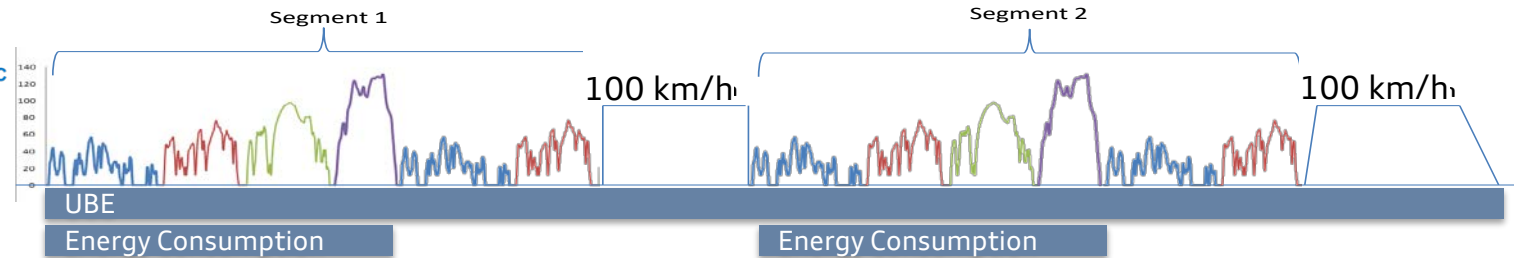
23°C test result findings as reference

CCP:



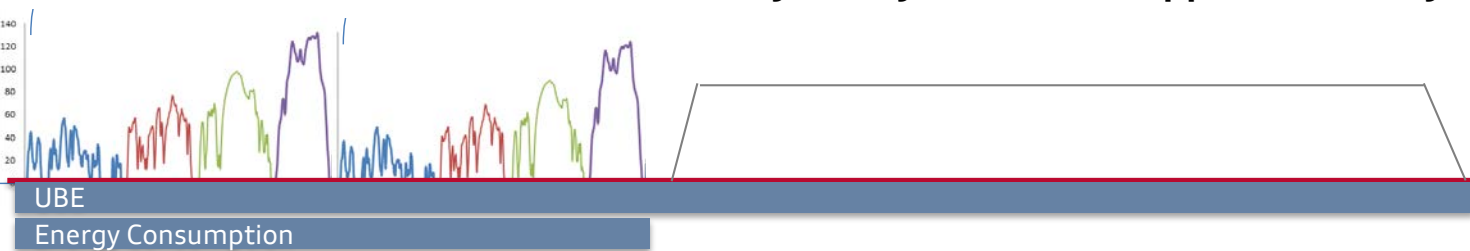
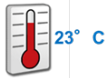
- Range: 170.33 km
- EC_{DC}: 196 Wh/ km

STP:



- Range: 169.61 km
- EC_{DC}: 196 Wh/ km

Alternative STP (SSTP) – in this case shown here only two cycles, in the supported case by JPN, it's three cycles



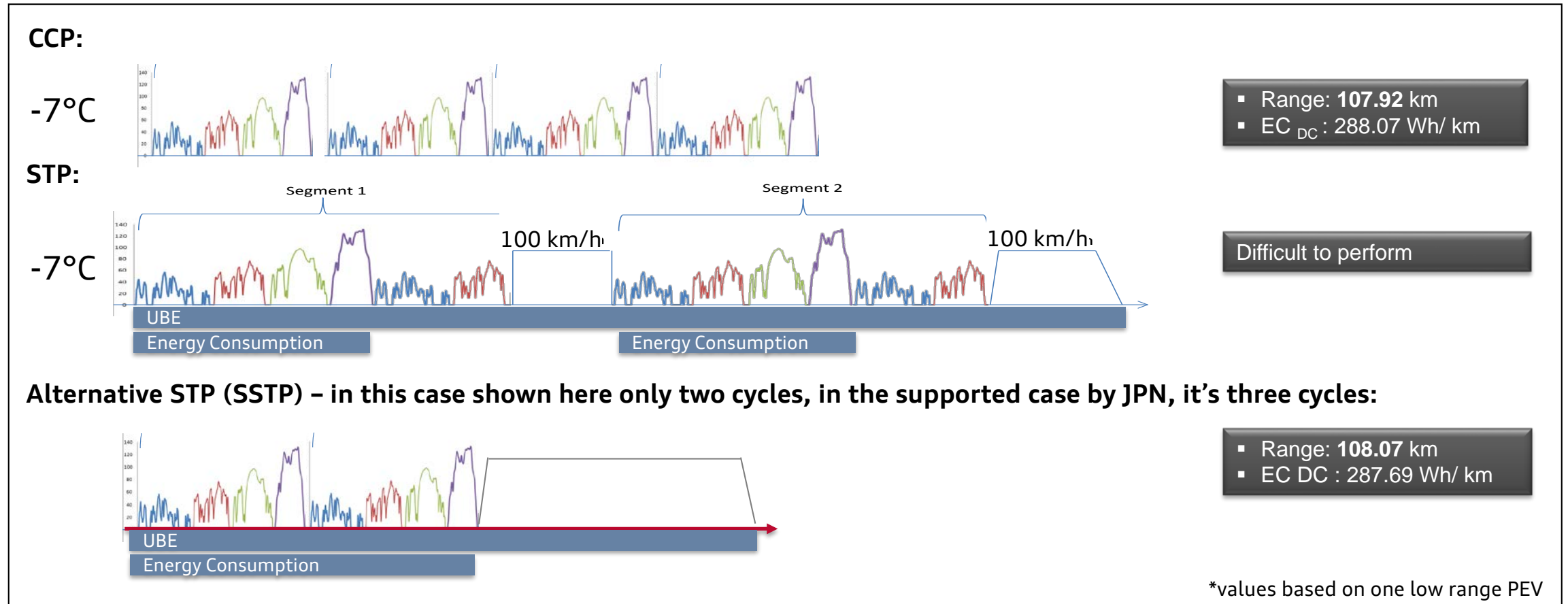
- Range: 167.99 km
- EC_{DC}: 197 Wh/ km

*values based on one low range PEV

- CCP and STP are providing the same test results, to avoid cherry picking regulation defined a threshold concept when which procedure shall be selected
- For comparison, an alternative set up of STP is provided above at the bottom of the box
- All procedure set ups provide the same test results which is important regarding the -7°C test procedure set up

Test Procedure (BEV) – comparison between CCP, STP and SSTP

Low Temp test result findings of one vehicle to show equivalency (more need to be provided)



- STP might be difficult to perform at -7°C (even if done at 23°C) due to the higher electric energy consumption
- To avoid the situation to run into problems, proposal is to drive the dynamic segments at the beginning and the constant speed segments in 1 piece at the end → UBE can be measured at -7°C

Test Procedure (PEV) – comparison between CCP, STP and SSTP

Low Temp test result findings to show equivalency

		CCP -7degC	STP -7degC	SSTP -7degC	Type I*
Key Parameters	Estimated PER	Apply same scenario as Type I, but need to accept the different test procedure between Type I and VI in case		Cover both CCP and STP (no criteria is necessary anymore)	YES
	EC _{DC}	218 Wh/km	216 Wh/km	219 Wh/km	
		✓ CCP and SSTP are identical			
	E _{AC}	✓ E _{AC} shall be measured before "cold start testing" to evaluate the consumed energy for battery heating (SG EV agreement) ✓ To obtain robust E _{ACr} (1) battery temperature before charge start shall be well maintained (2) interval between charge completion and cold start test shall be well specified			YES *1
	UBE	34.4 kWh	34.8 kWh (37.1 kWh @ Type I)	34.1 kWh	
		✓ Not able to apply UBE derived during Type I (SG EV agreement) ✓ CCP and SSTP are identical			YES *2
	k factor	EC _{DC} becomes stable after end of 2 cycles (4 phases cycle) 261@1 st → 214@2 nd → 209@3 rd → 208@4 th → 207@5 th → 207@6 th (Wh/km)			
	Need to modify the calculation formula	may be "no solution"	✓ At least 3 cycles need to be tested, then apply unique factor to each cycle	YES *3	

*) possibility to apply also Type I (later stage)

*1 : battery temperature control is not factor to be considered

*2 : definition of UBE family needs further discussion

*3 : apply same concept, but calculation formula may be modified