Test Procedure of UN-R140 Electronic Stability Control Systems (ESC)

16, July, 2019

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Contents

1. Overview
2. Outrigger and test equipment
3. Test sequence (SIS/SWD)
4. Computer simulation
5. Alternative requirements
6. R13 EVSC test

Contents

Overview

- Performance requirements
  - Over steering intervention
    - Criteria : Yaw Rate Ratio and Lateral Displacement
  - Under steering intervention
    - Criteria : Technical documents
  - ESC malfunction tell-tale and ESC off tell-tale

- Test conditions

- Weather conditions

  Ambient temperature:0℃-45℃

  Wind speed:

  SSF >1.25 no greater than 10m/s

  SSF ≤1.25 no greater than 5m/s

- Road surface

  Nominal peak brake coefficient : 0.9

  Dry, solid-paved, no dips and large cracks

  Consistent slope between level and 1 per cent.

Overview

- Procedure
  - Conditioning

    Tire conditioning and brake conditioning

    

  - SIS test

    Determine the steering wheel angle in degrees that produces a steady state lateral acceleration of 0.3g for the test vehicle. “Quantity A

    

  - Conditioning

    Tire conditioning

    

  - SWD test

    Criteria checks

    Yaw Rate Ratio and Lateral Displacement

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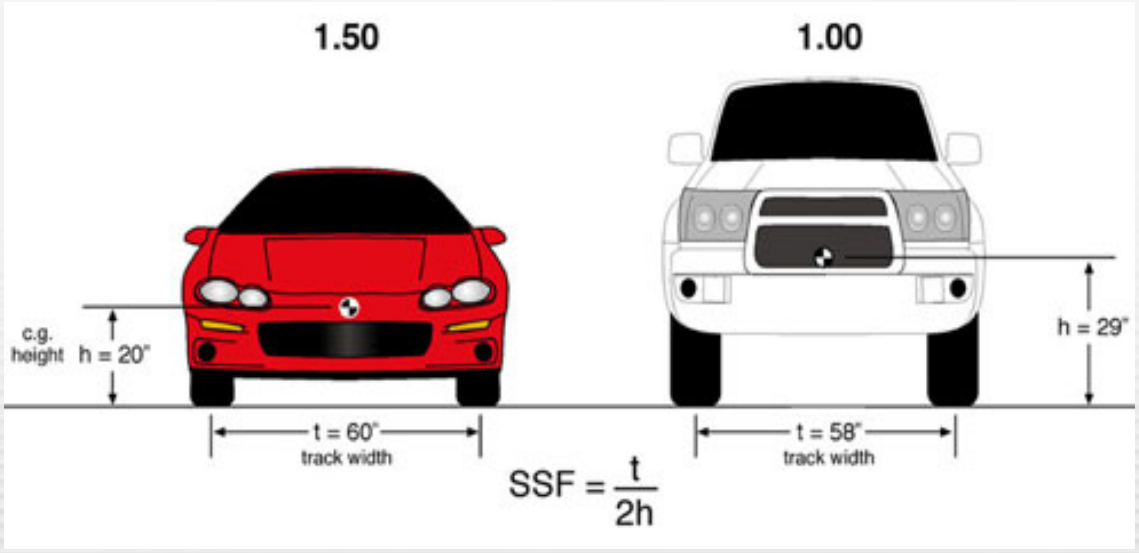
Outrigger usage

$$\text{SSF(Static Stability Factor)} = \frac{\text{track width}}{\text{height of the center of gravity}}$$

One of the primary means of assessing rollover risk
(Lower value, higher possibility of rollover risk)

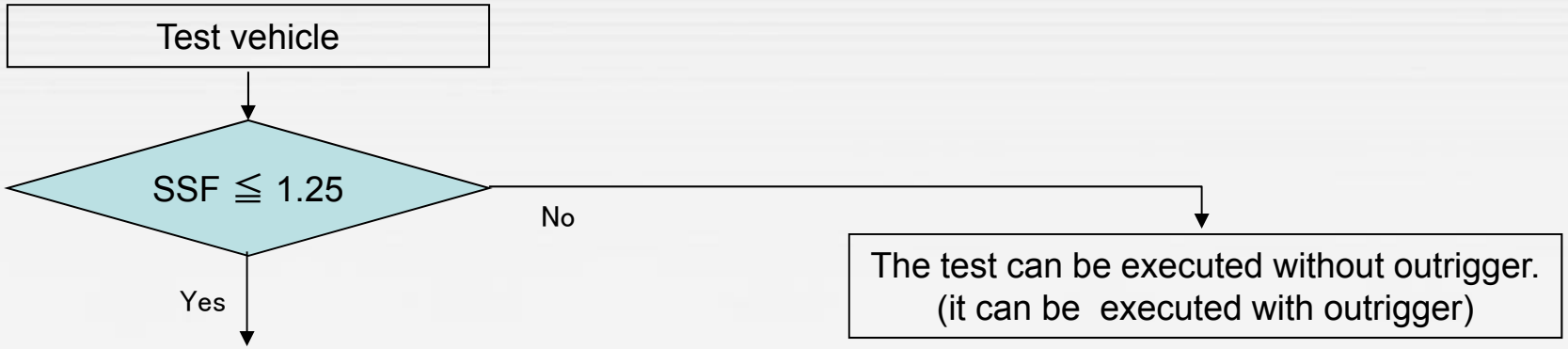
In case of SSF ≤1.25, outrigger may be used for testing safety.



Picture is from NHTSA document

Outrigger and mass setting

＜Outrigger＞



Outrigger selection			
Lightweight	27kg	:	A mass in running order ＜ 1588kg
Standard	32kg	:	1588kg ≦ A mass in running order ≦ 2722kg
heavy	39kg	:	2722kg ＜ A mass in running order

A mass in running order = The vehicle mass with 90% fuel ＋ A driver（75kg）

＜Mass settings＞

A mass without outrigger

＝ The mass which is loaded with 90% fuel ＋A driver（75kg）＋Test equipments

↪ 168kg : a total interior load

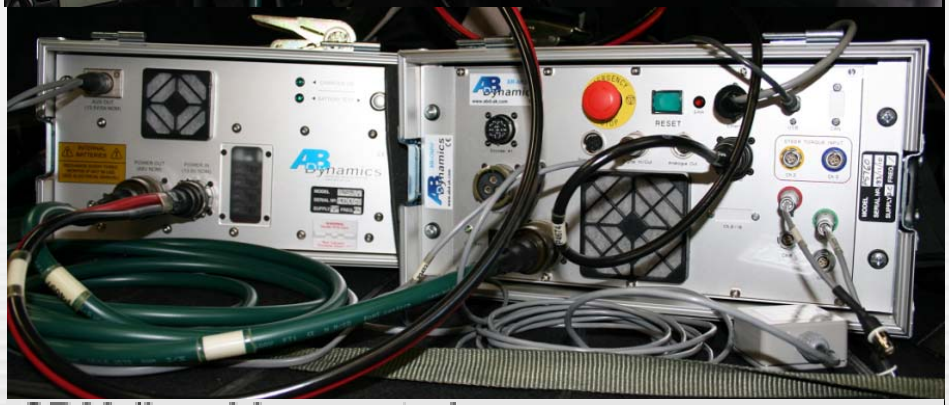
A mass with outrigger

＝ A mass without outrigger + outrigger ＋ Fitting tool for outrigger

↪ 27/32/39　　↪ Disclosed by manufacturers

Test equipment

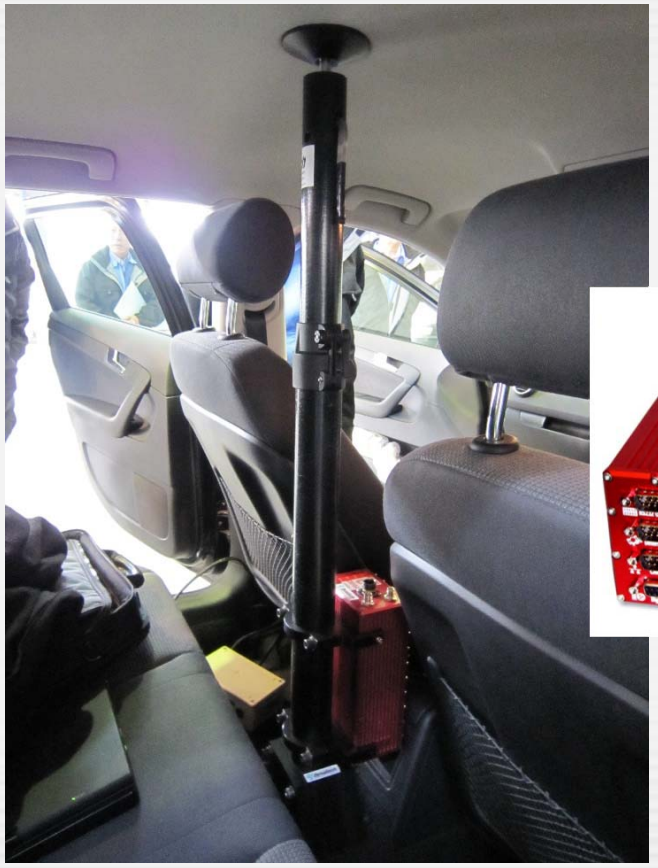
（Steering Robot）



SR60 (brushless motor)

Maximum torque:	70Nm at up to 580°/s
Max. continuous torque:	60Nm at up to 1000°/s
Max. speed:	2500°/s at up to 24Nm
Motor mass:	12.5kg

(Inertial + GPS Navigation Systems)



Parameter	RT2500/ RT2500-250	RT2502/ RT2502-250
Positioning	SPS / SBAS	SPS / SBAS
Position Accuracy	3.0mCEP SPS 2.0mCEP SBAS	3.0mCEP SPS 2.0mCEP SBAS
Velocity Accuracy	0.2 km/h RMS	0.2 km/h RMS

Test equipment(Steering robot installtion)

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Test sequence (Conditioning)

- Test sequence (1)

- Brake conditioning

	Speed (km/h)	Procedure	Time	ABS
1	56	Braking around 4.91m/s^2	10 stops	Not activated
2	72	Braking higher than 4.91m/ s^2	3 stops	Activate
3	72	Coast driving	5 min	-

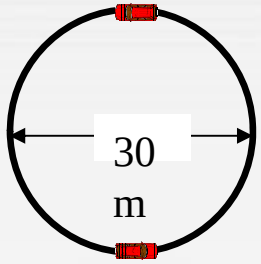
- Tire conditioning

	Speed (km/h)	Procedure	Lateral acceleration (m/s^2)
1	Vehicle speed corresponding to lateral deceleration	Driven around a 30m circle (CW:3 ACW :3)	4.91 ~ 5.89
2	56	1Hz sinusoidal input (10 times ×4 pass)	

Test sequence (Conditioning)

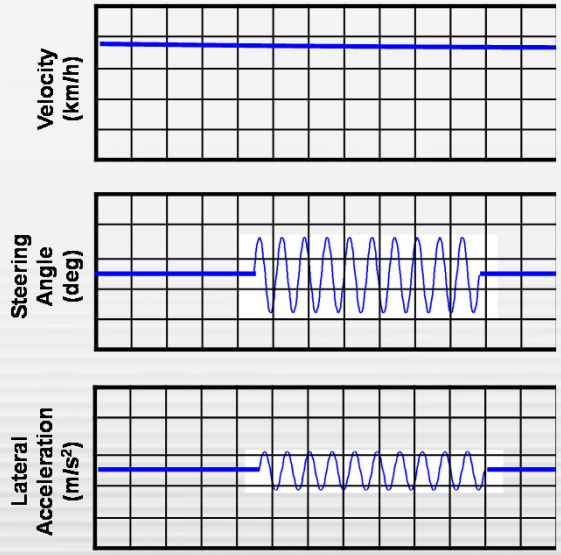
- Contents of tire conditioning

- Tire conditioning-1



- Tire conditioning-2

The steering wheel angle amplitude of the final cycle of the final pass shall be twice that of the other cycles.

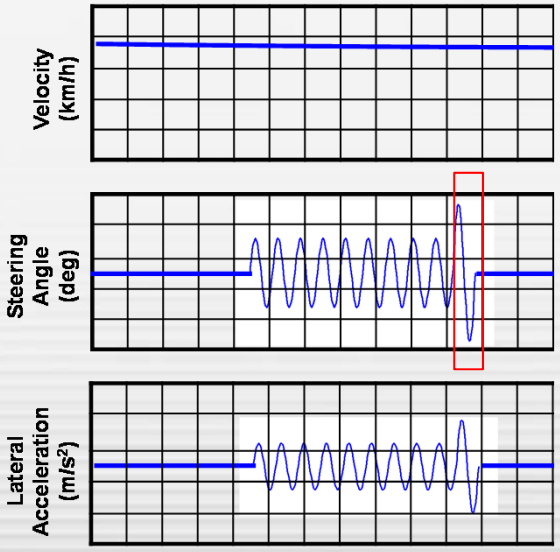


1 ~ 3 pass

test speed is 56km/h

sinusoidal steering pattern at a frequency of 1 Hz

wheel angle amplitude corresponding to a peak lateral acceleration of 0.5 to 0.6g



4 pass

Test sequence (Tire conditioning)

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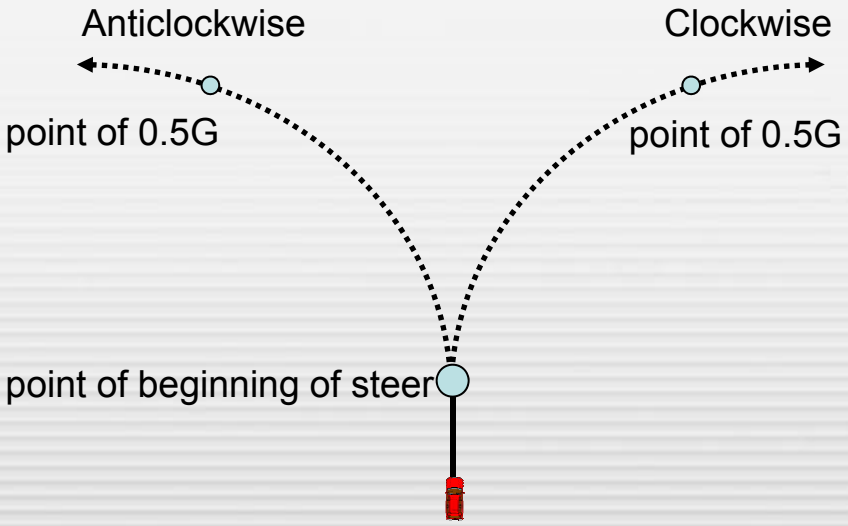
Test sequence (SIS test)

- Test sequence (2)

  - SIS (Slowly increasing steer) test

	Speed (km/h)	Increasing steering rate (deg/sec)	Time	Steering Direction
1	80 ±2	13.5	3	Anticlockwise
2	80 ±2	13.5	3	Clockwise
3	From 6 data avobe, determine “Quantity A” which is steering wheel angle that produces a steady state lateral acceleration of 0.3g for the test vehicle.			

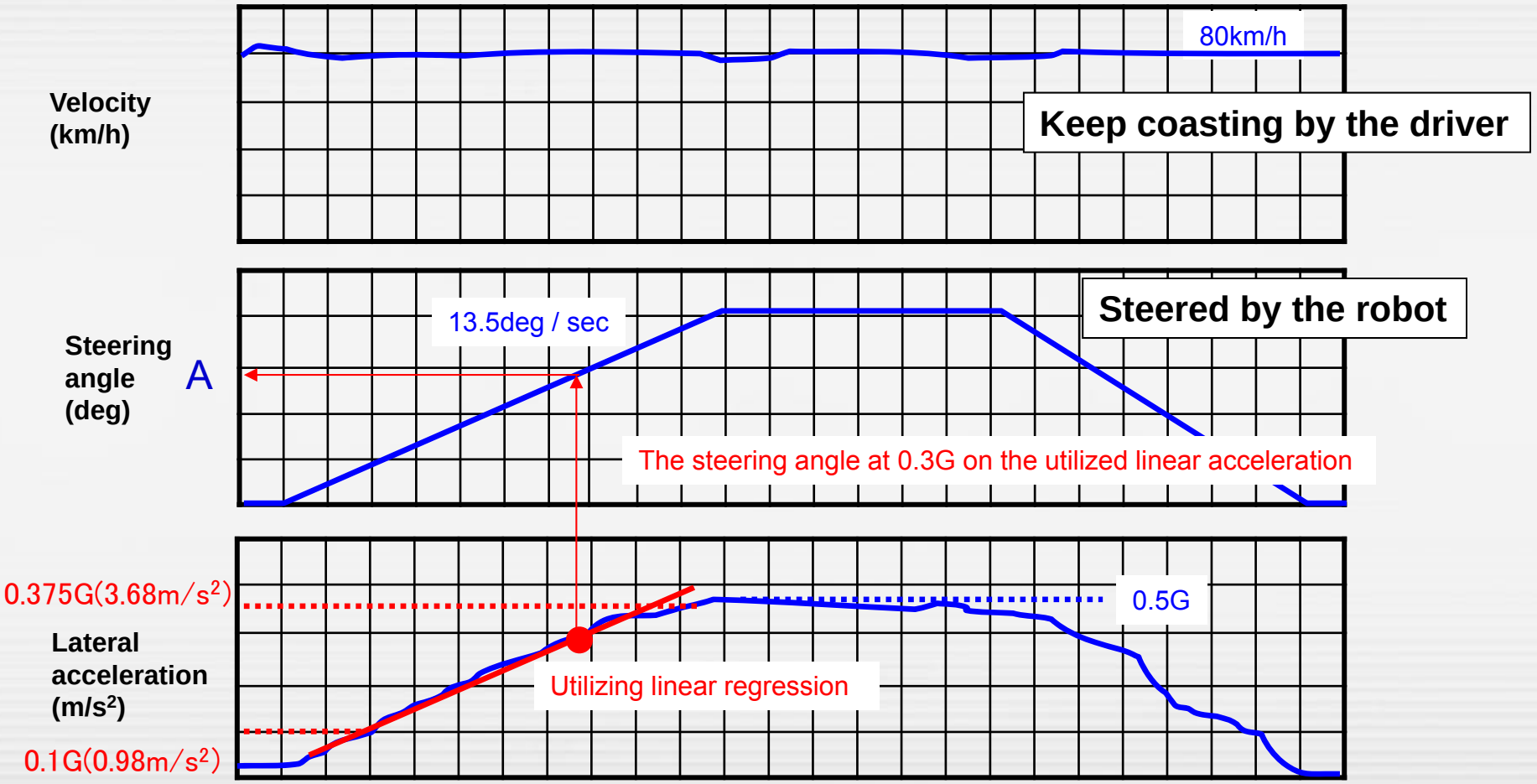


Data shall be measured until a lateral acceleration of approximately 0.5g is obtained

The maximum time permitted between each test run is five minutes.

Test sequence (SIS test)

- A sample of SIS data



The absolute value of the six A values calculated is averaged and rounded to the nearest 0.1 degrees to produce the final quantity

⇒ the quantity "A" is determined

Test sequence (SIS test)

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Test sequence (Re-conditioning)

- Test sequence (3)
  - Tire re-conditioning

	Speed (km/h)	Procedure	Lateral acceleration
1	(Around 31 -34)	Driven around a 30m circle (CW:3 ACW :3)	4.91-5.89m/s^2
2	56	1Hz sinusoidal input (10 times ×4 set)	

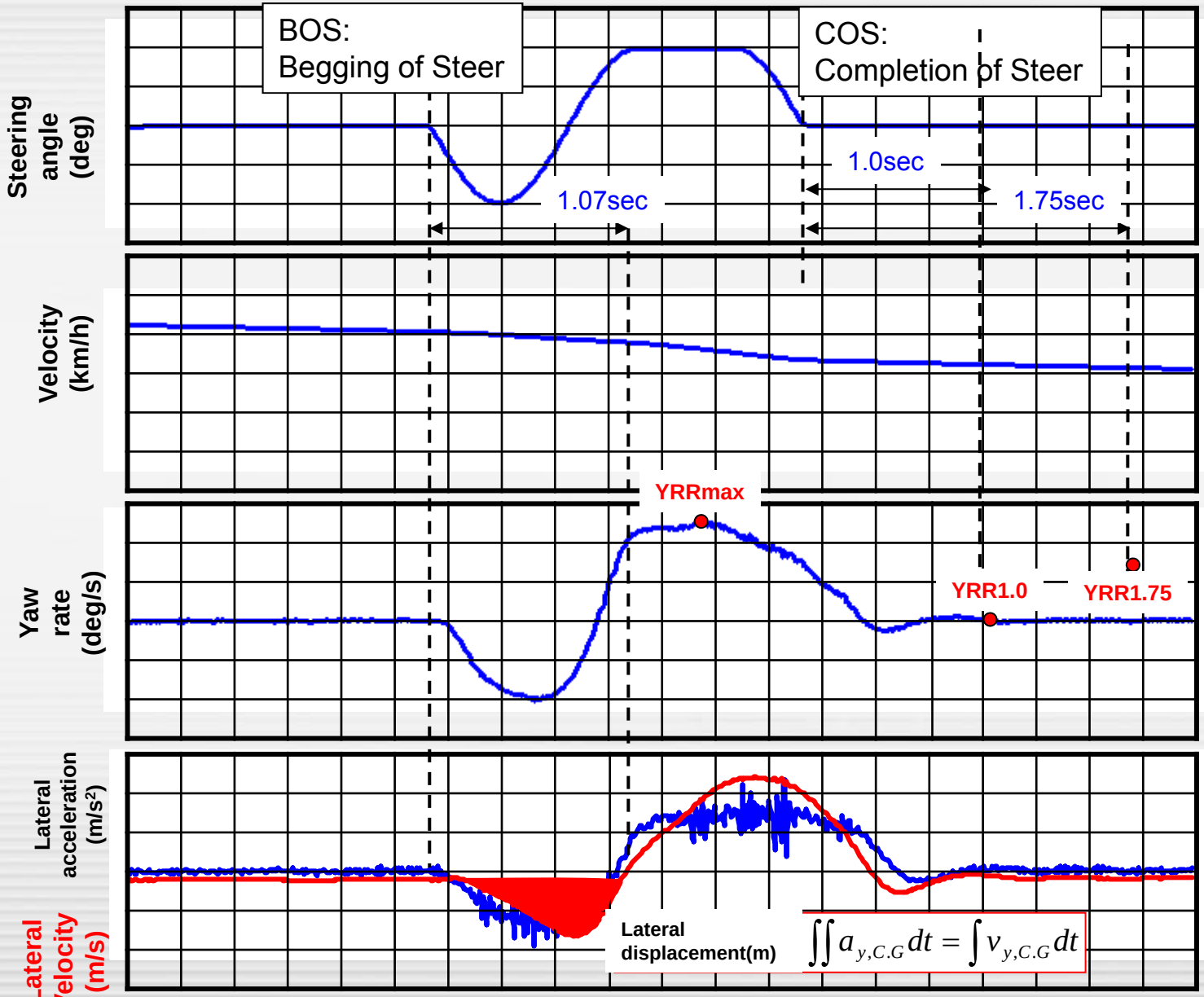
Test sequence (SWD test)

- Test sequence (4)

  - SWD (Sine with dwell) test

	Speed (km/h)	Steering amplitude	Max.	CW/ACW
1	80 ±2	From 1.5 A, increasing by 0.5A	6.5A or 270 deg	ACW
2	80 ±2	From 1.5 A, increasing by 0.5A	6.5A or 270 deg	CW
3	By using above data, calculate values as follows. Yaw Rate Ratio (1s &1.75s after completion of steering wheel input) Lateral Displacement(1.07s after steering wheel input)			

Test sequence (Each series of SWD evaluation)



Initiation of the first SWD test series shall begin within two hours after completion of SIS test

Criteria

■Yaw rate ratio from 1.5A to Final A

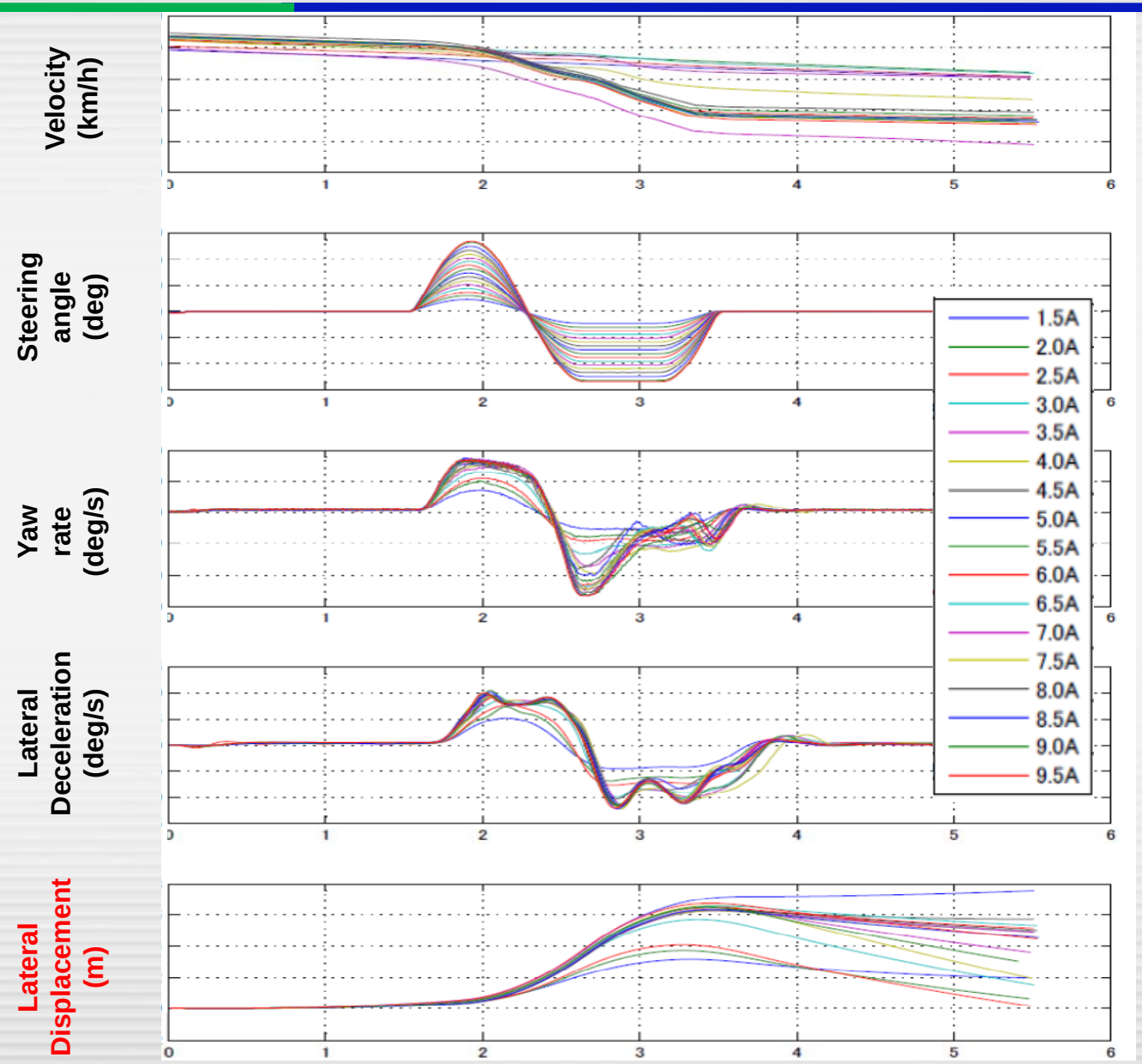
$$\frac{YRR1.0}{YRRmax} \leqq 0.35$$

$$\frac{YRR1.75}{YRRmax} \leqq 0.20$$

■Lateral displacement from 5A to Final A

- 1.83m（GVW≦3.5t）
- 1.52m（GVW≧3.5t）

Test sequence (Example of SWD data)



Reference (steering amplitude for each series)

	Quantity "A"												
	20	25	30	35	40	45	50	55	60	65	70	75	80
1.5A	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120
2.0A	40	50	60	70	80	90	100	110	120	130	140	150	160
2.5A	50	62.5	75	87.5	100	112.5	125	137.5	150	162.5	175	187.5	200
3.0A	60	75	90	105	120	135	150	165	180	195	210	225	240
3.5A	70	87.5	105	122.5	140	157.5	175	192.5	210	227.5	245	262.5	280
4.0A	80	100	120	140	160	180	200	220	240	260	280	300	300
4.5A	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	300		
5.0A	100	125	150	175	200	225	250	275	300	300			
5.5A	110	137.5	165	192.5	220	247.5	275	300					
6.0A	120	150	180	210	240	270	300						
6.5A	130	162.5	195	227.5	260	292.5							
7.0A	140	175	210	245	270								
7.5A	150	187.5	225	262.5									
8.0A	160	200	240	270									
8.5A	170	212.5	255										
9.0A	180	225	270										
9.5A	190	237.5											
10.0A	200	250											
10.5A	210	262.5											
11.0A	220	270											
12.0A													
12.5A													
13.0A	260												
13.5A	270												

Lateral displacement shall be evaluated greater than 5.0 A

Quicker behavior

Slower behavior

Test sequence (SWD test)

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Computer simulation(1)

Use of the dynamic stability simulation

7. Performance requirements

"Where a vehicle has been physically tested in accordance with paragraph 8.(Test conditions), the compliance of versions or variants of that same vehicle type may be demonstrated by a computer simulation, which respects the test conditions of paragraph 8. and the test procedure of paragraph 9.9(Sine with Dwell test). The use of the simulator is defined in Annex 3 to this Regulation."

Annex 3. 1.1.

"The vehicle stability function shall be demonstrated by the vehicle manufacturer to the Type Approval Authority or Technical Service by simulating the dynamic manoeuvres of paragraph 9.9. of this Regulation.

Computer simulation(2)

Dynamic stability simulation tool and its validation

Annex 4 2.1.

"The validity of the applied modelling and simulation tool shall be verified by means of comparisons with practical vehicle tests. The tests utilized for the validation shall be the dynamic manoeuvres of paragraph 9.9. of this Regulation.

Annex 4. 2.2.

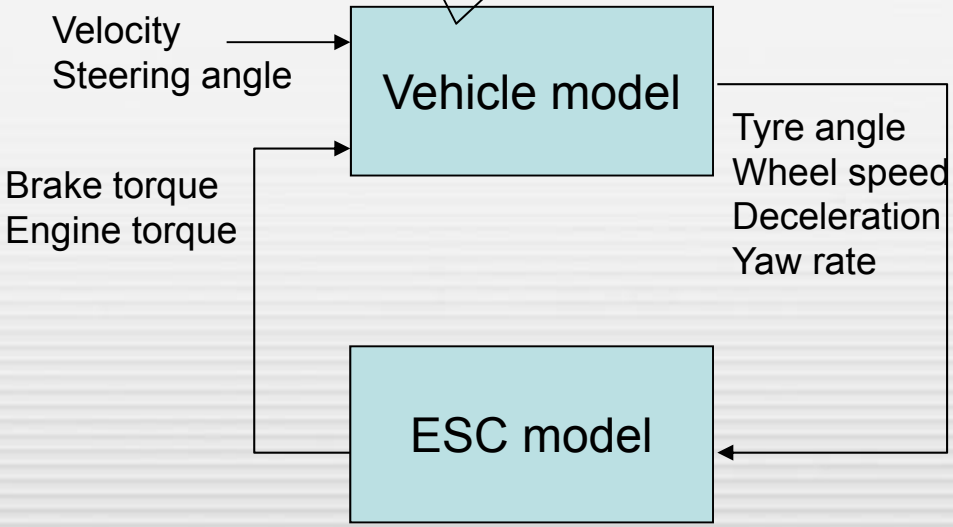
"The objective is to show that the simulated vehicle behaviour and operation of the vehicle stability function is comparable with that seen in practical vehicle tests."

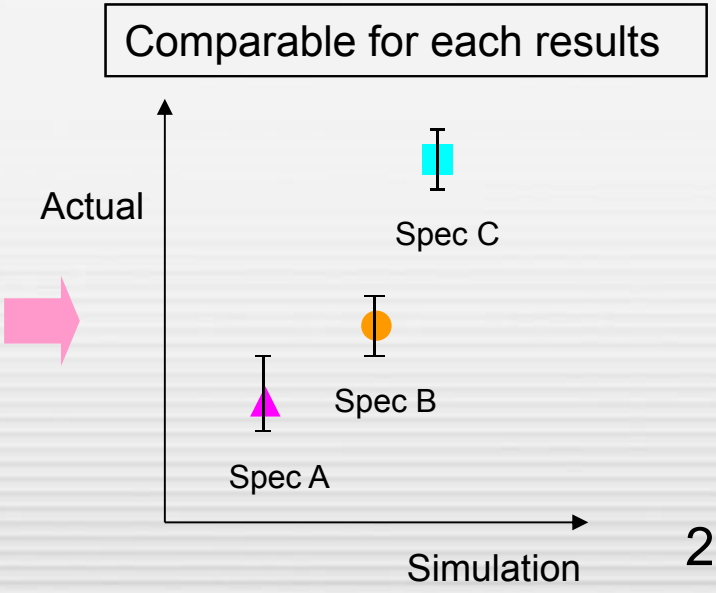
Computer simulation(3)

A example for the validation

Input parameter
- Vehicle specification
- Powertrain characteristic
- Drivetrain characteristic
- Suspension characteristic
- Brake characteristic
- Steering characteristic
- Tyre characteristic

What is “Comparable” ?
The simulation can be verified the specification difference taking into consideration the range of tolerance in the actual test.





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Alternative requirements

For vehicles of categories M1 and N1 with a mass in running order of more than 1,735 kg

In this case OEM can choose the one of the requirement as below.

■R140 requirement
Sine with dwell test

■R13 Annex 21 requirement
-Directional control function
-roll-over control function
The vehicle stability function shall be demonstrated to the Technical Service by dynamic manoeuvres. This may be realized by a comparison of results obtained with the vehicle stability function enabled and disabled for a given load condition. As an alternative to carrying-out dynamic manoeuvres for other vehicles and other load conditions, fitted with the same vehicle stability system, the results from actual vehicle tests or computer simulations may be submitted.

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EVSC test (R13)

- R13 annex 21

- EVSC (Electric Vehicle Stability Control)

Check EVSC by choosing one demonstration from each control in the following table.

Compare dynamic manoeuvres with ON / OFF

Directional control	Roll-over control
Reducing radius input	Steady state circular
Step steer input test	J-turn
Sine with dwell	
J-turn	
μ-split single lane change	
Reversed steering test or “fish hook” test	
Double lane change	

EVSC test (R13 Trailer)

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Thank very much for your attention.