



European Commission



# STUDY ON TYRES ABRASION TEST METHOD & DURABILITY INVESTIGATION

VEHICLE METHOD – ACCELERATE CYCLE – PROVING GROUND

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August 2022

# CONTENTS

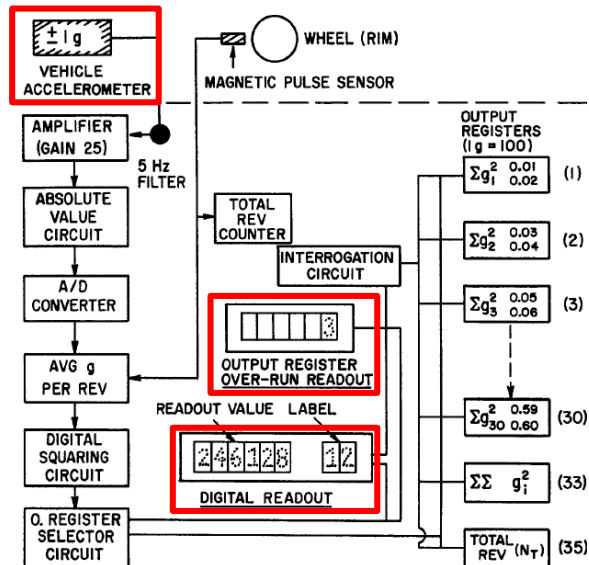
1. Objective
2. Driving Severity Number (DSN)
3. C1 Tyres
4. C3 Tyres
5. Next steps

- Study performed under contract for the European Commission
- Scope: C1, C2, C3 tyres
- Conclude a test method for measuring tyre abrasion using vehicle in Proving Ground:
  - ✓ Test track characterisation and tolerances
  - ✓ Vehicle preparation
  - ✓ Test cycle description
  - ✓ Tyre measurements and frequency
  - ✓ Abrasion rate calculation and run-in
- Investigate its connection with mileage
  - ✓ Abrasion rate
  - ✓ Tread depth
- Define classes for European Tyre labeling and limits for Euro 7

Driving Severity Measurement consists of an accelerometer for monitoring lateral accelerations, wheel revolution counter and a module for signal processing and read-out.

The basic task of the DSM is measurement of the average g-value per wheel revolution. It provides information regarding cornering intensity influenced by route terrain, vehicle speed and driver behaviour

The output of the system is an index called Drive Severity Number (DSN) which has direct correlation with tyre wear rate



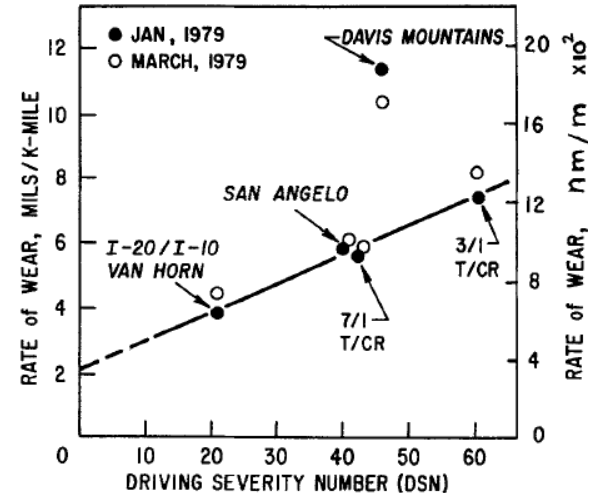
$$E_y^w = F_y^2 / (bC_{F\alpha})$$

$$F_{y\_vehicle} = W_{vehicle} / g \cdot V^2 / R = W_{vehicle} g_i$$

$$g_i = V^2 / (Rg)$$

$$DSN = \frac{1}{N} \sum \left( \frac{g_i}{100} \right)^2 \left( \frac{F_{z,R}}{F_{z,R}} \right)^2$$

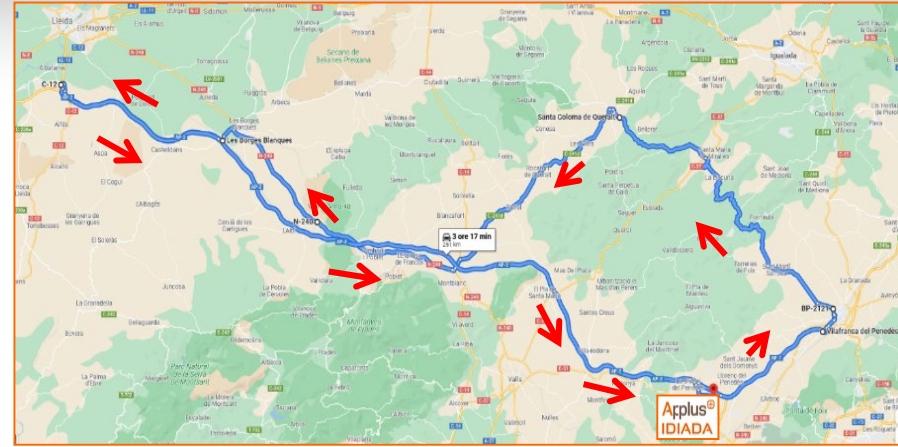
$$DSN_T = \frac{[\sum \left( \frac{g_i}{100} \right)_y^2 + 0.2 \sum \left( \frac{g_i}{100} \right)_x^2 \left( \frac{F_{z,R}}{F_{z,R}} \right)^2]}{N}$$



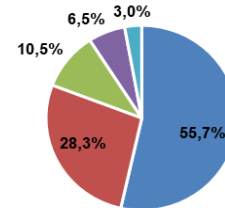
## C1 Public Road Testing

Objective: Abrasion values under EU real driving conditions

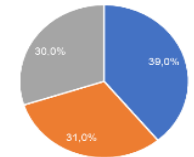
- Tyres under test :
  - ✓ SRTT 16"
  - ✓ Goodyear Efficient Grip Performance 2
  - ✓ Continental Premium Contact 6
- 3x C-Segment SUV reference vehicle
- Mileage accumulation  $\approx 7.500$  km  $\approx 25\%$  tire life
- Public road route
- Road distribution: City / Country road / Motorway
- Loading condition: Driver + 1 passenger



ROAD DISTRIBUTION		
Road type	Km	%
City road	92	27 %
Country/Mountain	117	34 %
Highway	135	39 %



- Driver
- 2 Passengers (Driver + 1)
- 3 Passengers (Driver + 2)
- 4 Passengers (Driver + 3)
- 5 Passengers (Driver + 4)



■ Motorway ■ Country road ■ City



## C1 Public Road Testing

Measurements on tyres during inspection intervals

- C: Complete inspection = weight + groove depth + hardness + Heel & Toe
- P: Partial inspection = weight

Wheel weight [g]						
C0	P2	P4	P8	P12	P16	C20
0 km	642 km	1.356 km	2.654 km	3.995 km	5.392 km	6.837 km

Weight: Tyre + rim



Tread depth

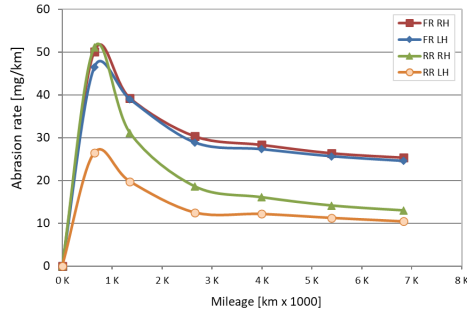


# C1 TYRES

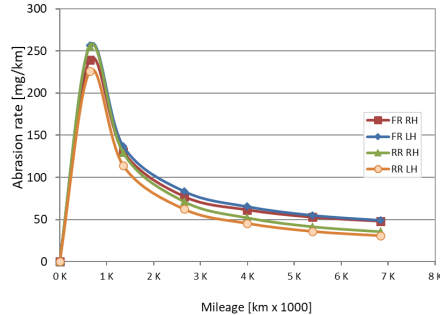
ABRASION RATE OPEN ROAD

## C1 Public Road Testing

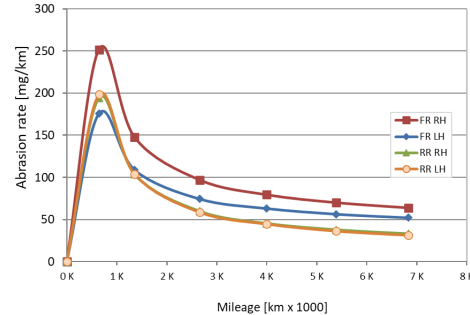
Abrasion rate SRTT



Abrasion rate GOODYEAR



Abrasion rate CONTINENTAL



## RESULTS:Tyre weight

UNIROYAL TIGERPAW SRTT 225/60R16 97 S								
	Tyre Abrasion Rate [mg/km]							Avg. Stab.
FR RH	0	50	39	30	28	26	25	<b>28</b>
FR LH	0	46	39	29	27	26	25	<b>27</b>
RR RH	0	51	31	19	16	14	13	<b>15</b>
RR LH	0	26	20	13	12	11	10	<b>12</b>
GOODYEAR EFFICIENTGRIP 205/55R16 91V								
	Tyre Abrasion Rate [mg/km]							Avg. Stab.
FR RH	0	239	131	77	62	53	48	<b>60</b>
FR LH	0	256	137	84	65	55	49	<b>63</b>
RR RH	0	255	129	71	52	42	36	<b>50</b>
RR LH	0	226	114	62	46	36	31	<b>44</b>
CONTINENTAL PREMIUM CONTACT 6 205/55R16V								
	Tyre Abrasion Rate [mg/km]							Avg. Stab.
FR RH	0	252	147	97	79	70	64	<b>78</b>
FR LH	0	176	109	74	63	56	52	<b>62</b>
RR RH	0	194	104	60	46	38	33	<b>44</b>
RR LH	0	198	104	59	45	36	31	<b>43</b>

## C1 Accelerated Test Cycle

Target: to accelerate the public road cycle with same abrasion results using proving ground test tracks

- Tyres under test :
  - ✓ SRTT 16"
  - ✓ Goodyear Efficient Grip Performance 2
  - ✓ Continental Premium Contact 6
- 3x C-Segment reference vehicle
- Mileage accumulation ≈2.000 km
- Proving ground IDIADA (Test tracks)
- Loading condition: Driver + 1 passenger



### Test cycle:

The test cycle is defined as 3 times the combination described below.  
Total distance: 240 kms

Test Cycle: 240 km		
C1	C2	C3
80 km	80 km	80 km

### Combination:

The following sequences shall be repeated according to the following order:

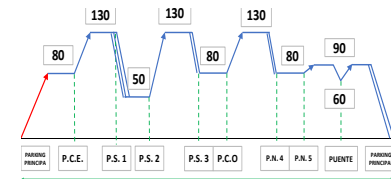
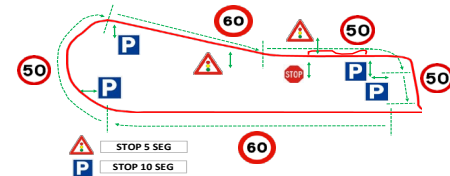
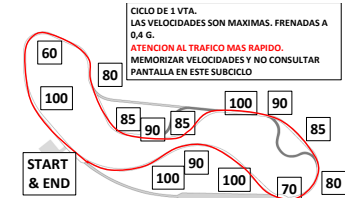
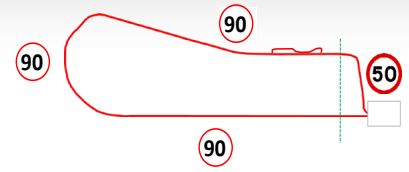
C: 80 km					
S1	S2	S1	S2	S3	S4
15 km	15 km	15 km	15 km	5 km	15 km



### C1 Accelerated Test Cycle definition

#### Driving sequences:

- Sequence 1 (S1): Track 1 → normal driving at speed between 50 km/h and 90 km/h during 15 km with no stopping
  - ✓ DSN longitudinal:  $0,36 \pm 0,1$       max. longitudinal acceleration:  $\pm 0,26$
  - ✓ DSN lateral:  $1,28 \pm 0,1$       max. lateral acceleration:  $\pm 0,50$
  - ✓ Tolerance of  $\pm 0,2$  is acceptable for maximum 10% sequence distance
- Sequence 2 (S2): Track 2 → continuous driving at speed between 60km/h and 100 km/h during 15 kms performing 0,3g brake at corners
  - ✓ DSN longitudinal:  $0,49 \pm 0,1$       max. longitudinal acceleration:  $\pm 0,30$
  - ✓ DSN lateral:  $0,65 \pm 0,1$       max. lateral acceleration:  $\pm 0,45$
  - ✓ Tolerance of  $\pm 0,2$  is acceptable for maximum 10% sequence distance
- Sequence 3 (S3): Track 1 → city simulation including brake events at speed between 50 km/h – 60 km/h to 0 km/h during 5 km. It should include 3 stop events of 5 sec. at 0,2g and 4 stop events of 10 sec. at 0,2g
  - ✓ DSN longitudinal:  $1,18 \pm 0,1$       max. longitudinal acceleration:  $\pm 0,40$
  - ✓ DSN lateral:  $17,00 \pm 0,1$       max. lateral acceleration:  $\pm 0,80$
  - ✓ Tolerance of  $\pm 0,2$  is acceptable for maximum 10% sequence distance
- Sequence 4 (S4): Track 3 → Highway sequence including brakes events at high speed and length during 15 kms following the graph on the right:
  - ✓ DSN longitudinal:  $0,78 \pm 0,1$       max. longitudinal acceleration:  $\pm 0,45$
  - ✓ DSN lateral:  $0,79 \pm 0,1$       max. lateral acceleration:  $\pm 0,30$
  - ✓ Tolerance of  $\pm 0,2$  is acceptable for maximum 10% sequence distance

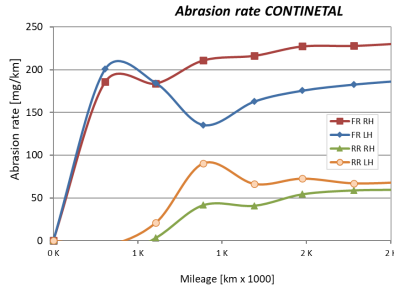
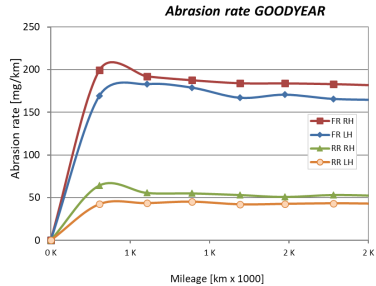
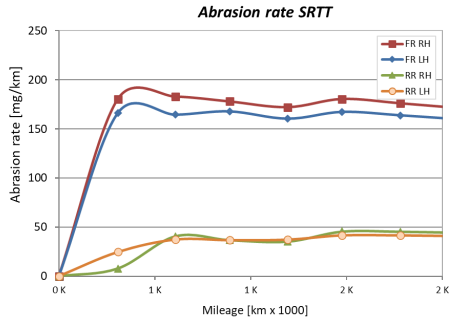


# C1 TYRES

ABRASION RATE ACCELERATED CYCLE ON PG

## C1 Proving ground Testing

## RESULTS:Tyre weight



UNIROYAL TIGERPAW SRTT 225/60R16 97 S										
	Tyre Abrasion Rate [mg/km]								Avg. Stab.	
FR RH	0	180	183	178	172	180	176	171		<b>175</b>
FR LH	0	166	164	168	160	167	164	160		<b>163</b>
RR RH	0	8	41	37	35	46	46	45		<b>43</b>
RR LH	0	25	38	37	37	42	42	41		<b>41</b>

GOODYEAR EFFICIENTGRIP 205/55R16 91V										
	Tyre Abrasion Rate [mg/km]								Avg. Stab.	
FR RH	0	199	192	188	184	184	183	181		<b>183</b>
FR LH	0	169	183	179	167	171	166	164		<b>167</b>
RR RH	0	64	56	55	53	51	53	52		<b>52</b>
RR LH	0	42	43	45	42	43	43	43		<b>43</b>

CONTINENTAL PREMIUM CONTACT 6 205/55R16V										
	Tyre Abrasion Rate [mg/km]								Avg. Stab.	
FR RH	0	186	184	211	216	227	228	231		<b>229</b>
FR LH	0	201	185	135	163	176	183	188		<b>182</b>
RR RH	0	-23	3	42	41	54	59	60		<b>58</b>
RR LH	0	-6	21	90	66	72	67	68		<b>69</b>

## C1 conclusions:

- SRTT is showing good correlation between open road test and accelerated test cycle on proving ground. Same abrasion rate is obtained.
- SRTT should be used to validate the test cycle in each different Proving Ground
- Candidate tyres will have to be tested and compared with SRTT tyres
- Higher abrasion rate may occur during the first 300 kms of test due to tyre production process

# C3 TYRES

## PUBLIC ROAD

**Vehicle:** Heavy duty tractor truck  
**GMW:** 18.000 kg



### Loading Conditions:

Criteria: 80% of the tyre load index  
 SRTT 315/70 R22.5-> Load index (154) 3.750 Kg> Wheel weight requested  $\approx$  3.000 kg / wheel

Tractor weight	Wheel weight Left Hand/ Tyre Pressure*	Wheel weight Right Hand / Tyre Pressure*
Front Axle	3095 Kg / 7,1 bar	3026 Kg / 6,9 bar
Rear Axle	3001 Kg / 6,8 bar	3026 Kg / 6,9 bar

# C3 TYRES

## MEASUREMENTS

Inspection Interval on C3 Public Road Testing										
C0	P1	P3	P5	P7	P9	C12	P18	C24	P30	C36
0 km	420 km	1.260 km	2.100 km	2.940 km	3.780 km	5.040 km	7.560 km	10.080 km	12.600 km	15.120 km

- C: Complete inspection = weight + groove depth + hardness
- P: Partial inspection = weight

Weight: Tyre + rim



Tread depth



# C3 TYRES

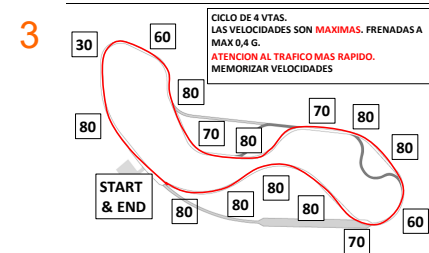
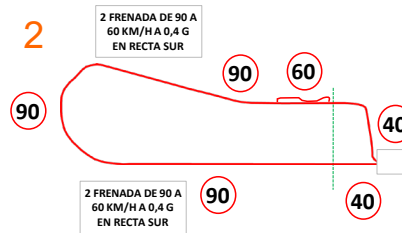
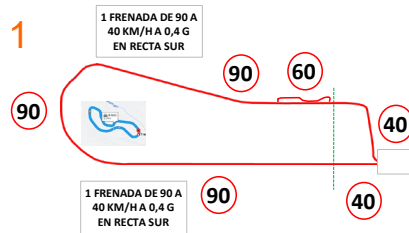
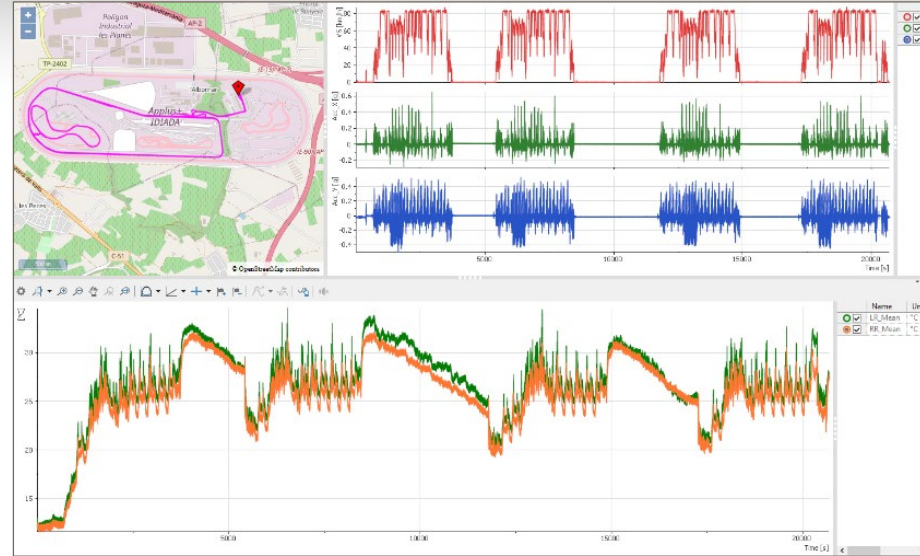
## ACCELERATE TEST CYCLE ON PROVING GROUND

Accelerated test cycle for C3 tyres consist of 3 different sequences with different repetitions of each one.

**Sequence 1:** General sequence including brakes events from 90 to 40 kph.

**Sequence 2:** General sequence including brakes events from 90 to 60 kph.

**Sequence 3:** Mountain sequence simulation on handling track.



### Next Steps:

- Finish the C3 tyres testing (open road + proving ground accelerated)
- Final description of the test sequences for C3 tyres
- Define the final calculation method for abrasion rate and interpretation of the results
- Estimation of tyre milage using tread depth reduction evolution data



THANK YOU  
FOR YOUR KIND ATTENTION



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