

# هيئة التقييس لدول مجلس التعاون لدول الخليج العربية GCC STANDARDIZATION ORGANIZATION (GSO)

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الأحكام الموحدة المتعلقة بالموافقة على المركبات فيما يتعلق بنظام مراقبة ضغط  
الهواء في الإطارات (TPMS)

**Uniform provisions concerning the approval of vehicles with regard  
to their Tyre Pressure Monitoring Systems (TPMS)**

This document is a draft Gulf Standard circulated for comments. It is, therefore, subject to alteration and modification and may not be referred to as a Gulf Standard until approved by GSO.

هذه الوثيقة مشروع للائحة فنية خليجية تم توزيعها لإبداء الرأي والملاحظات بشأنها، لذلك فإنها عرضة للتغيير والتبديل، ولا يجوز الرجوع إليها كلائحة فنية خليجية إلا بعد اعتمادها من الهيئة.

## تقديم

هيئة التقييس لدول مجلس التعاون لدول الخليج العربية هيئة إقليمية تضم في عضويتها أجهزة التقييس الوطنية في الدول الأعضاء، ومن مهام الهيئة إعداد المواصفات القياسية واللوائح الفنية الخليجية بواسطة لجان فنية متخصصة.

قرر مجلس الإدارة لهيئة التقييس لدول مجلس التعاون لدول الخليج العربية في اجتماعه رقم .....  
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الخليجية رقم TC02/SC01 " اللجنة الفنية الفرعية الخليجية لمواصفات المركبات والإطارات" المدرجة في خطة  
دولة قطر " .

## Regulation No. 141

### Uniform provisions concerning the approval of vehicles with regard to their Tyre Pressure Monitoring Systems (TPMS)

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## 1. Scope

1. This Regulation applies to the approval of vehicles of category M<sub>1</sub> up to a maximum mass of 3,500 kg and N<sub>1</sub><sup>1</sup> when equipped with a tyre pressure monitoring system, except for vehicles fitted with dual wheels on an axle.

## 2. Definitions

For the purposes of this Regulation:

- 2.1. "*Approval of a vehicle*" means the approval of a vehicle type with regard to its tyre pressure monitoring system.
- 2.2. "*Vehicle type*" means vehicles which do not differ significantly in such essential aspects as:
  - (a) The manufacturer's trade name or mark;
  - (b) Vehicle features which significantly influence the performances of the tyre pressure monitoring system;
  - (c) The design of the tyre pressure monitoring system.
- 2.3. "*Wheel*" means a complete wheel consisting of a rim and a wheel disc;
- 2.4. "*Tyre*" means a pneumatic tyre, being a reinforced flexible envelope that is provided with, or forms in conjunction with the wheel on which it is mounted, a continuous, essentially toroidal, closed chamber containing a gas (usually air) or a gas and liquid, that is intended normally to be used at a pressure greater than atmospheric pressure;
- 2.5. "*Maximum mass*" means the maximum value of the vehicle stated by the manufacturer to be technically permissible (this mass may be higher than the "permissible maximum mass" laid down by the national administration);
- 2.6. "*Maximum axle load*" means the maximum value, as indicated by the manufacturer, of the total vertical force between the contact surfaces of the tyres or tracks of one axle and the ground and resulting from the part of the vehicle mass supported by that axle; this load may be higher than the "authorized axle load" laid down by the national administration. The sum of the axle loads may be greater than the value corresponding to the total mass of the vehicle;
- 2.7. "*Tyre Pressure Monitoring System (TPMS)*" means a system fitted on a vehicle, able to perform a function to evaluate the inflation pressure of the tyres or the variation of this inflation pressure over time and to transmit corresponding information to the user while the vehicle is running;
- 2.8. "*Cold tyre inflation pressure*" means the tyre pressure at ambient temperature, in the absence of any pressure build-up due to tyre usage;
- 2.9. "*Recommended cold inflation pressure (P<sub>rec</sub>)*" means the pressure recommended for each tyre position by the vehicle manufacturer, for the

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<sup>1</sup> As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.4, para. 2 - [www.unece.org/trans/main/wp29/wgs/wp29gen/wp29resolutions.html](http://www.unece.org/trans/main/wp29/wgs/wp29gen/wp29resolutions.html).

intended service conditions (e.g. speed and load) of the given vehicle, as defined on the vehicle placard and/or the vehicle owner's manual;

- 2.10. "*In service operating pressure ( $P_{warm}$ )*" means the inflation pressure for each tyre position elevated from the cold pressure ( $P_{rec}$ ) by temperature effects during vehicle usage;
- 2.11. "*Test Pressure ( $P_{test}$ )*" means the actual pressure of the tyre(s) selected for each tyre position after deflation during the test procedure.

### **3. Application for approval**

- 3.1. The application for approval of a vehicle type with regard to its tyre pressure monitoring system shall be submitted by the vehicle manufacturer or by his duly accredited representative;
- 3.2. It shall be accompanied, in triplicate, by a description of the vehicle type with regard to the items specified in Annex 1 to this Regulation:
- 3.3. A vehicle representative of the vehicle type to be approved shall be submitted to the Type Approval Authority or the Technical Service responsible for conducting the approval tests.
- 3.4. The Type Approval Authority shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.

### **4. Approval**

- 4.1. If the vehicle submitted for approval pursuant to this Regulation meets all the requirements of paragraph 5. below, approval of that vehicle type shall be granted.
- 4.2. An approval number shall be assigned to each type approved. Its first two digits (at present 00 for the regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the regulation at the time of issue of the approval. The same Contracting Party may not assign the same number to another type of vehicle.
- 4.3. Notice of approval or of extension or of refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Contracting Parties to the Agreement which apply this Regulation by means of a form conforming to the model in Annex 1 to this Regulation.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of:
  - 4.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which granted approval;<sup>2</sup>

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<sup>2</sup> The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.4, Annex 3 - [www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html](http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html).

- 4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the markings prescribed in paragraph 4.4.1.
- 4.5. If the vehicle conforms to a vehicle type approved, under one or more regulations annexed to the Agreement, in the country which granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. need not be repeated; in such a case, the regulation and approval numbers and the additional symbols for all the regulations under which approval has been granted in the country which granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.
- 4.6. The approval mark shall be clearly legible and be indelible.
- 4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 4.8. Annex 2 to this Regulation gives examples of approval marks.

## **5. Specifications and tests**

- 5.1. General
- 5.1.1. Any vehicle of categories M<sub>1</sub> up to 3,500 kg and N<sub>1</sub>, in both cases with all axles equipped with single tyres, and fitted with a tyre pressure monitoring system complying with the definition of paragraph 2.7. shall meet the performance requirements contained in paragraphs 5.1.2. to 5.5.5. of this Regulation over a wide range of road and environmental conditions encountered within the territory of the Contacting Parties.
- 5.1.2. The effectiveness of the tyre pressure monitoring system fitted on a vehicle shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by fulfilling the technical requirements and respecting the transitional provisions of Regulation No. 10 by applying:
- (a) The 03 series of amendments for vehicles without a coupling system for charging the Rechargeable Electric Energy Storage System (traction batteries);
  - (b) The 04 series of amendments for vehicles with a coupling system for charging the Rechargeable Electric Energy Storage System (traction batteries)
- 5.1.3. The system shall operate from a speed of 40 km/h or below, up to the vehicle's maximum design speed.
- 5.1.4. The vehicle shall fulfil the tests (puncture, diffusion and malfunction) as specified in Annex 3.
- 5.2. Tyre pressure detection for incident-related pressure loss.
- 5.2.1. The TPMS shall illuminate the warning signal described in paragraph 5.5. within not more than ten minutes of cumulative driving time after the in service operating pressure in one of the vehicle's tyres has been reduced by twenty per cent or it is at a minimum pressure of 150 kPa, whatever is higher.
- 5.3. Detection for a tyre pressure level significantly below the recommended pressure for optimum performance including fuel consumption and safety.

- 5.3.1. The TPMS shall illuminate the warning signal described in paragraph 5.5. within not more than sixty minutes of cumulative driving time after the in-service operating pressure in any of the vehicle's tyres, up to a total of four tyres, has been reduced by twenty per cent or it is at a minimum pressure of 150 kPa, whatever is higher.
- 5.4. Malfunction detection.
- 5.4.1. The TPMS shall illuminate the warning signal described in paragraph 5.5. not more than 10 minutes after the occurrence of a malfunction that affects the generation or transmission of control or response signals in the vehicle's tyre pressure monitoring system.
- 5.5. Warning indication.
- 5.5.1. The warning indication shall be by means of an optical warning signal conforming to Regulation No. 121.
- 5.5.2. The warning signal shall be activated when the ignition (start) switch is in the "on" (run) position (bulb check). This requirement does not apply to tell-tales shown in a common space.
- 5.5.3. The warning signal must be visible even by daylight; the satisfactory condition of the signal must be easily verifiable by the driver from the driver's seat.
- 5.5.4. The malfunction indication may be the same warning signal as the one used to indicate under-inflation. If the warning signal described in paragraph 5.5.1. is used to indicate both under-inflation and a malfunction of the TPMS, the following shall apply: with the ignition (start) switch in the "on" (run) position the warning signal shall flash to indicate a malfunction. After a short period of time the warning signal shall remain continuously illuminated as long as the malfunction exists and the ignition (start) switch is in the "on" (run) position. The flashing and illumination sequence shall be repeated each time the ignition (start) switch is in the "on" (run) position until the malfunction has been corrected.
- 5.5.5. The tell-tale of the warning described in paragraph 5.5.1. may be used in a flashing mode in order to provide information about the reset status of the tyre pressure monitoring system in accordance with the owner's manual of the vehicle.

## **6. Supplementary information**

- 6.1. The owner's manual, if any, of the vehicle shall contain at least the following information:
  - 6.1.1. A statement that the vehicle is equipped with such a system (and information how to reset the system, if the actual system includes such a feature).
  - 6.1.2. An image of the tell-tale symbol described in paragraph 5.5.1. (and an image of the malfunction tell-tale symbol, if a dedicated tell-tale is used for this function).
  - 6.1.3. Additional information about the significance of the low tyre pressure warning tell-tale illuminating and a description of the corrective action to be undertaken if this happens.

- 6.2. If no owner's manual is supplied with the vehicle, the information required in paragraph 6.1. above shall be displayed in a prominent place on the vehicle.

## **7. Modifications and extension of approval of the vehicle type**

- 7.1. Every modification of the vehicle type as defined in paragraph 2.2. of this Regulation shall be notified to the Type Approval Authority which approved the vehicle type. The Type Approval Authority may then either:
- 7.1.1. Consider that the modifications made do not have an adverse effect on the conditions of the granting of the approval and grant an extension of approval;
- 7.1.2. Consider that the modifications made affect the conditions of the granting of the approval and require further tests or additional checks before granting an extension of approval.
- 7.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3. above to the Contracting Parties to the Agreement applying this Regulation.
- 7.3. The Type Approval Authority shall inform the other Contracting Parties of the extension by means of the communication form which appears in Annex 1 to this Regulation. It shall assign a serial number to each extension, to be known as the extension number.

## **8. Conformity of production**

- 8.1. The conformity of production procedures shall comply with those set out in Appendix 2 of the Agreement (E/ECE/324–E/ECE/TRANS/505/Rev.2), with the following requirements:
- 8.2. The Type Approval Authority which has granted type approval, may at any time verify the conformity of production in each production facility. The normal frequency of these verifications shall be at least once per year.

## **9. Penalties for non-conformity of production**

- 9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8 are not complied with.
- 9.2. If a Contracting Party to the Agreement, which applies this Regulation, withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "APPROVAL WITHDRAWN".



**10. Production definitively discontinued**

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Contracting Parties to the Agreement applying this Regulation by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "PRODUCTION DISCONTINUED".

**11. Names and addresses of Technical Services responsible for conducting approval tests, and of Type Approval Authorities**

The Contracting Parties to the Agreement which apply this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.

## Annex 1

### Communication

(maximum format: A4 (210 x 297 mm))

issued by: Name of administration:

.....  
.....  
.....



concerning:<sup>2</sup>

- Approval
- Approval extended
- Approval refused
- Approval withdrawn
- Production definitively discontinued

of a vehicle type with regard to its tyre pressure monitoring system pursuant to Regulation No. 141.

Approval No.: ..... Extension No.: .....

1. Trade name or mark of the vehicle:  
.....
2. Vehicle type (if applicable, variants that are included):
3. Manufacturer's name and address: .....
4. If applicable, name and address of the manufacturer's representative:  
.....
5. Vehicle submitted for approval on: .....
6. Technical Service responsible for conducting approval tests: .....
7. Date of test report: .....
8. Number of test report: .....
9. Brief description of the vehicle type: .....

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<sup>1</sup> Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the regulation).

<sup>2</sup> Strike out what does not apply.

- 9.1. Mass of the vehicle when tested:  
Front axle: .....  
Rear axle: .....  
Total: .....
- 9.2. Marking and wheel size(s) of standard unit equipment: .....
- 9.3. Brief description of the tyre pressure monitoring system .....
10. Result of the tests:

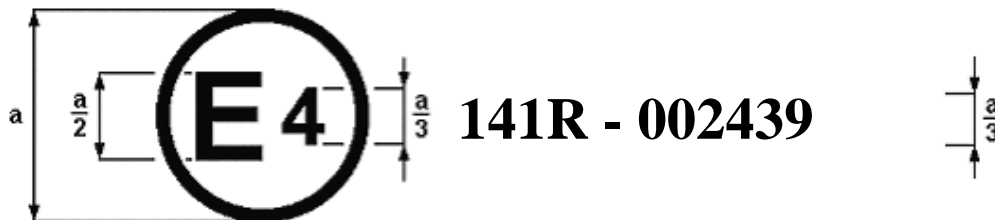
	<i>Measured Time to warning (mm:ss)</i>
"Puncture test"	
"Diffusion test"	
"Malfunction test"	

11. Position of approval mark: .....
12. Reason(s) of extension (if applicable): .....
13. Approval granted/refused/extended/withdrawn<sup>2</sup> .....
14. Place: .....
15. Date: .....
16. Signature: .....
17. The list of documents deposited with the Type Approval Authority which has granted approval is annexed to this communication and can be obtained upon request.

## Annex 2

### Arrangements of approval marks

(See paragraph 4.4. of this Regulation)



$a = 8 \text{ mm min.}$

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the equipment of a tyre pressure monitoring system, been approved in the Netherlands (E 4), pursuant to Regulation No. 141 under approval number 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No. 141 in its original form.

## Annex 3

### Tests for Tyre Pressure Monitoring Systems (TPMS)

1. Test conditions
  - 1.1. Ambient temperature.

The ambient temperature shall be between 0 °C and 40 °C.
  - 1.2. Road test surface.

The road shall have a surface affording good adhesion. The road surface shall be dry during testing.
  - 1.3. The tests shall be conducted in an environment free of interferences from radio wave.
  - 1.4. Vehicle conditions.
    - 1.4.1. Test weight.

The vehicle may be tested at any condition of load, the distribution of the mass among the axles being that stated by the vehicle manufacturer without exceeding any of the maximum permissible mass for each axle.

However, in the case where there is no possibility to set or reset the system, the vehicle shall be unladen. There may be, in addition to the driver, a second person on the front seat who is responsible for noting the results of the tests. The load condition shall not be modified during the test.
    - 1.4.2. Vehicle speed.

The TPMS shall be calibrated and tested:

      - (a) In a speed range from forty km/h and 120 km/h or the vehicle's maximum design speed if it is less than 120 km/h for the puncture test to verify the requirements of paragraph 5.2. to this Regulation; and
      - (b) In a speed range from forty km/h and 100 km for the diffusion test to verify the requirements of paragraph 5.3 to this Regulation and for the malfunction test to verify the requirements of paragraph 5.4. to this Regulation.

The whole speed range shall be covered during the test.

For vehicles equipped with cruise control, the cruise control shall not be engaged during testing.
    - 1.4.3. Rim position.

The vehicle rims may be positioned at any wheel position, consistent with any related instructions or limitations from the vehicle's manufacturer.
    - 1.4.4. Stationary location.

When the vehicle is parked, the vehicle's tyres shall be shaded from direct sun. The location shall be shielded from any wind that may affect the results.

- 1.4.5. Brake pedal application.  
Driving time shall not accumulate during service brake application while the vehicle is moving.
- 1.4.6. Tyres.  
The vehicle shall be tested with the tyres installed on the vehicle according to the vehicle manufacturer's recommendation. However, the spare tyre may be utilised for testing TPMS malfunction.
- 1.5. Accuracy of pressure measurement equipment.  
Pressure measurement equipment to be used for the tests contained in this annex shall be accurate to at least  $\pm 3\text{kPa}$ .
2. Test procedure  
The test shall be performed at a test speed within the range in accordance with paragraph 1.4.2. to this annex, at least once for the test case according to paragraph 2.6.1. to this annex ("puncture test"), and at least once for each test case according to paragraph 2.6.2. to this annex ("diffusion test").
- 2.1. Before inflating the vehicle's tyres, leave the vehicle stationary outside at ambient temperature with the engine off shaded from direct sunlight and not exposed to wind or other heating or chilling influences for at least one hour. Inflate the vehicle's tyres to the vehicle manufacturer's recommended cold inflation pressure ( $P_{\text{rec}}$ ), in accordance with the vehicle manufacturer's recommendation for the speed and load conditions, and tyre positions. All pressure measurements shall be carried out using the same test equipment.
- 2.2. With the vehicle stationary and the ignition locking system in the "Lock" or "Off" position, activate the ignition locking system to the "On" or "Run" position. The tyre pressure monitoring system shall perform a check of lamp function for the low tyre pressure tell-tale as specified in paragraph 5.5.2. of this Regulation. This last requirement does not apply to tell-tales shown in a common space.
- 2.3. If applicable, set or reset the tyre pressure monitoring system in accordance with the vehicle manufacturer's recommendations.
- 2.4. Learning phase.
- 2.4.1. Drive the vehicle for a minimum of twenty minutes within the speed range in paragraph 1.4.2. to this annex, and with an average speed of eighty km/h ( $\pm 10\text{ km/h}$ ). It is allowed to be outside the speed range for a maximum cumulative time of two minutes during the learning phase.
- 2.4.2. At the discretion of the Technical Service, where the driving test is undertaken on a track (circle/oval) with only turns in a single direction, then the driving test in paragraph 2.4.1. above should be equally split ( $\pm 2$  minutes) in both directions.
- 2.4.3. Within the five minutes of completing the learning phase, measure the warm pressure of the tyre(s) to be deflated. The warm pressure shall be taken as the value  $P_{\text{warm}}$ . This value will be used for subsequent operations.

- 2.5. Deflation phase.
- 2.5.1. Procedure for the puncture test to verify the requirements of paragraph 5.2. to this Regulation.
- Deflate one of the vehicle's tyres within five minutes of measuring the warm pressure as described in paragraph 2.4.3. above, until it is at  $P_{\text{warm}} - 20$  per cent, or it is at a minimum pressure of 150 kPa, whichever is higher, namely  $P_{\text{test}}$ . Following a stabilisation period of between two and five minutes the pressure  $P_{\text{test}}$  shall be rechecked and adjusted if necessary.
- 2.5.2. Procedure for the diffusion test to verify the requirements of paragraph 5.3. to this Regulation.
- Deflate all four tyres within five minutes of measuring the warm pressure as described in paragraph 2.4.3. above, until the deflated tyres are at  $P_{\text{warm}} - 20$  per cent plus a further deflation of 7 kPa, namely  $P_{\text{test}}$ . Following a stabilisation period of between two and five minutes the pressure  $P_{\text{test}}$  shall be rechecked and adjusted if necessary.
- 2.6. Low tyre pressure detection phase.
- 2.6.1. Procedure for the puncture test to verify the requirements of paragraph 5.2. to this Regulation.
- 2.6.1.1. Drive the vehicle along any portion of the test course (not necessarily continuously). The sum of the total cumulative drive time shall be the lesser of 10 minutes or the time at which the low tyre pressure tell-tale illuminates.
- 2.6.2. Procedure for the diffusion test to verify the requirements of paragraph 5.3. to this Regulation.
- 2.6.2.1. Drive the vehicle along any portion of the test course. After not less than twenty (20) minutes and not more than forty (40) minutes bring the vehicle to a complete standstill with the engine switched off and the ignition key removed for not less than one (1) minute or more than three (3) minutes. Resume the test. The sum of the total cumulative drive time shall be the lesser of sixty (60) minutes of cumulative driving under the conditions set out in paragraph 1.4.2. above or the time at which the low tyre pressure tell-tale illuminates.
- 2.6.3. If the low tyre pressure signal did not illuminate, discontinue the test.
- 2.7. If the low tyre pressure tell-tale illuminated during the procedure in paragraph 2.6. above, deactivate the ignition locking system to the "Off" or "Lock" position. After a five minutes period, reactivate the vehicle's ignition locking system to the "On" ("Run") position. The tell-tale must illuminate and remain illuminated as long as the ignition locking system is in the "On" ("Run") position.
- 2.8. Inflate all of the vehicle's tyres to the vehicle manufacturer's recommended cold inflation pressure. Reset the system in accordance with the instructions of the vehicle manufacturer. Determine whether the tell-tale has extinguished. If necessary, drive the vehicle until the tell-tale has been extinguished. If the tell-tale does not extinguish, discontinue the test.

- 2.9. Repetition of the deflation phase.
- The test may be repeated, at the same or different loads, using the relevant test procedures in paragraphs 2.1. to 2.8. above, with the relevant tyre(s) on the vehicle under-inflated, in accordance with the provisions of paragraph 5.2. or 5.3. to this Regulation, whichever is relevant.
3. TPMS malfunction detection
- 3.1. Simulate a TPMS malfunction, for example, by disconnecting the power source to any TPMS component, disconnecting any electrical connection between TPMS components, or installing a tyre or wheel on the vehicle that is incompatible with the TPMS. When simulating a TPMS malfunction, the electrical connections for the tell-tale lamps shall not be disconnected.
- 3.2. Drive the vehicle for up to ten minutes of cumulative time (not necessarily continuously) along any portion of the test course.
- 3.3. The sum of the total cumulative drive time under paragraph 3.2. shall be the lesser of ten minutes or the time at which the TPMS malfunction tell-tale illuminates.
- 3.4. If the TPMS malfunction indicator did not illuminate in accordance with paragraph 5.4. to this Regulation, as required, discontinue the test.
- 3.5. If the TPMS malfunction indicator is illuminated or illuminates during the procedure in paragraphs 3.1 to 3.3 above, deactivate the ignition locking system to the "Off" or "Lock" position. After five minutes, reactivate the vehicle's ignition locking system to the "On" ("Run") position. The TPMS malfunction indicator shall again signal a malfunction and remain illuminated as long as the ignition locking system is in the "On" ("Run") position.
- 3.6. Restore the TPMS to normal operation. If necessary, drive the vehicle until the warning signal has extinguished. If the warning lamp has not extinguished, discontinue the test.
- 3.7. The test may be repeated using the test procedures in paragraphs 3.1. to 3.6. above, with each such test limited to simulation of a single malfunction.
-