G O C A

SUSPENSION TESTER SPECIFICATIONS
(SPECSUS2010)

GOCA

Project Office
R & D Department Periodic Technical Inspection

SUSPENSION TESTER SPECIFICATIONS (2010)

1 Contents

13/1/2011

2 Introduction

General

These specifications are based on the EUSAMA recommendations and the SAE Technical Paper 960735, 1996, Tsymberov A., adapted for application in the Belgian Periodic Technical Inspection (PTI) after a study program carried out in 2010.

The EUSAMA suspension testers utilized by GOCA before these specifications are although designed to work within the frequency domain, up till however they have been limited to the magnitude response of the suspension system. This result, a EUSAMA value, usually referred to as "road" adhesion, is indicative of the safety of the vehicle; however, it is unreliable in determining the performance of the dampers. The present specification provides, along with the magnitude response (adhesion), the phase response of the wheel versus the movements of the excitation plate. The EUSAMA frequency function (established by a flywheel) is made variable by a frequency inverter in order to increase testing time in the neighbourhood of the unsprung mass frequencies, thus enabling a more correct measurement by exciting more energy.

The suspension tester must comply with the specifications at the time of approval (par. 6), of purchase as well as at the time of putting into service witch includes the first inspection by the supervisory body recognized by the FOD, as has been the case for each and every suspension tester which has already been approved by version TCDI051D dated 25.09.90 and addendum dated 14.06.91.

Given that these specifications describe new approval criteria small modifications to the procedure and the software are possible when this inspection starts. The suppliers are to guarantee definite flexibility for possible software and hardware adaptations for at least up to 2 years after the publication date of these specifications or up to 1 year after the imposing, by Royal Decree, of inspection of the suspension test combined EUSAMA / minimum phase shift.

The information which is to be supplied by this equipment gives indications concerning the condition, the damping capacity and the "road" adhesion capacity of the suspension system of a vehicle. These indications do not necessarily correlate to suspension tests results obtained in road trials.

general use for vehicle inspection

Measurement method and testing devices need to be suitable for vehicles of the categories M1 and N1. Testing devices have to be capable to measure axle loads of up to 1700kg. The test procedure has to be performed within an appropriate time.

method of measurement

The evaluation is based on introducing forces/energy into the suspension system and look for characteristics of the whole suspension and the damping. The efficiency is evaluated per wheel in order to arrive at the evaluation of the suspension system in total (as this is a check without dismantling, malfunctioning cannot be related to individual parts).

3 Definitions and principal requirements

3.1 Definitions

Adhesion is in the context of this suspension test the minimum percentage of remnant vertical tire contact force between the tire and the vibrating plate during vertical oscillation of the wheel. This percentage is obtained by calculating the ratio of the minimum remnant vertical load to the static weight (vertical tire contact force) on the suspension tester.

The minimum adhesion is the lowest value of adhesion throughout the test.

The sprung mass is all mass supported by the suspension system, including portions of the suspension members. The sprung mass comprises the mass of the vehicle frame, body and load.

The unsprung mass is the mass of the wheel and components that are supported directly by the wheel, and considered to move with the wheel, but not carried by the suspension system. These components include mostly the wheels, tires, brakes, parts of the axle, suspension links, suspension springs, dampers, and other associated suspension components.

The phase shift ϕ is the angular difference between the absolute "sinusoidal" position of the suspension tester platform and the "sinusoidal" vertical tire contact force between the tire and the suspension tester platform.

In practice the phase shift is calculated from the top position of the compensated force signal and the top position of the plate.

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> The Top position of the plate will be measured on a direct way. The Top position of the compensated force signal should be calculated as the middle of the intersection of the compensated force signal and the static weight, when this intersection is available and statique weight is in some range related to max and min. (Parameter: RSWfMAX = 25% means 25% from the top force measurement to the static weight, RSWfMIN= 25% means 25% from the bottum force measurement to the static weight)
>
> For phase shift calculation (into the range of 20Hz to 5Hz) the compensated force signal has to be digitally filtered with such a filter, that doesn't change compensated force signal phase and that removes all parasitic influences.
> Minimum phase shift has to be detected on frequency that is DeltaF (parameter: DeltaF = 3Hz) below the Eusama frequency. When the force signal goes under 0 Eusama (underflow), the Eusama Frequence should be taken at the maximum upper envelope of

the Force signal in the area where the force signal is 0. When the force signal goes under 0 Eusama (underflow) and goes above the limit of the fysical registration of these forse signal (overflow), so that the sinus waves are cut off, this deltaF has to be taken from the first waveform where signal gets back within systems hardware range.

Each supplier is to present his method used in order to determine the minimum phase shift $\phi_{min\ i,j}$ in detail for approval and for the attention of the R&D department of GOCA.
It should be possible to evaluate the used filter(s) of the signals by providing a tool where a output signal can be evalauated regarding an introduced input signal.

The minimum phase shift ϕ_{min} is the lowest value of the phase shift ϕ determined during the test between the sprung and unsprung mass resonant frequencies.

3.2 The principal components of the system are

This combined suspension tester comprises two sets of the following main hardware components eg:

- AC Motor, shaft(s), flywheel and chain / belt / ... drive
- Metal plate designed for vibrating in the range of [25 - 5] Hz with a peak to peak amplitude of 6 mm
- Weight measuring points per plate to detect and monitor the wheel position on the plate (before the vibration) and fulfil the basic need of force measurement (during the vibration).
- Sensor to detect the plate's vertical position; allowing to compensate for the plate and the transducer dynamic contribution and calculate phase shift.
- A frequency variator in order to have a more correct measurement by dissipating more energy in the proximity of the unsprung mass resonance frequency.

A system for the centralisation, processing and display of measurement results. This system will be discussed in detail in parts 4.3 and 4.4;

The required calibration equipment. The calibration equipment is to comply with the requirements which are imposed by the standard ISO 17025.

3.3 The characteristics of the system must allow the following elements to be determined at least

The **vertical force $N_{i,j}$ [N],** defined as the vertical force of a wheel, exercised on the platform. This force must be able to be measured statically **($N_{i,j}$ static)** as well as dynamically **($N_{i,j}$ dyn).**
$N_{i,j}$ dyn min is the minimum dynamic registered vertical force.
The subscripts define the wheel: i stands for the tested axle (1,2,... with 1 as the front axle) and the j for the vehicle side (l = left and r = right);

The **vertical force N_i [N] of an axle,** defined as the sum of the vertical forces, of the wheels of one and the same axle of the vehicle. The subscripts define the wheel: i stands for the tested axle (1,2,... with 1 as the front axle);

The **EUSAMA value $EUS_{i,j}$ [%],** defined as the minimum percentage of remnant vertical tire contact force between the tire and the platform during vertical oscillation of the wheel. The subscripts define the wheel: i stands for the tested axle (1,2,... with 1 as the front axle) and the j for the vehicle side (l = left and r = right);

$$\text{EUSAMA VALUE (\%)} = \frac{\text{Ni,j dyn min}}{\text{Nl,J Static}} * 100\ (\%) \qquad [1]$$

The **unbalance of the EUSAMA values $D_{EUS,i}$ [%] for each axle**, defined as the ratio of the difference in absolute value of the left and the right EUSAMA value to the greatest EUSAMA value of the left - of right wheel of this axle.

The **minimum phase shift $\phi_{min\ i,j}$ [°],** defined as the minimum phase shift of a wheel. The subscripts define the wheel: i stands for the tested axle (1,2,... with 1 as the front axle) and the j for the vehicle side (l = left and r = right);

The **unbalance of the minimum phase shifts $D_{\phi min,i}$ [%] for each axle,** defined as the ratio of the difference in absolute value of the left and the right minimum phase shift to the greatest minimum phase shift of the left of the right wheel of this axle.

The **EUSAMA and Minimum phase shift-graphs** are the graphs of the phase shift ϕ and the EUSAMA value EUS in function of the frequencies from 25 Hz down to 5 Hz.

The vertical **position of the oscillating platform** is to be determined by at least one point per cycle.

The suspension tester shall indicate if the **rigidity of the tire** (measured by a frequency between the resonance frequencies of the suspension and these of the tire; this means by 25Hz) is sufficient and this with the purpose of having an idea of the tire pressure.

3.4 EUSAMA-method

Origin

In the August/September 1976 venue of the ImechE Journal, the following paper: "Suspension Performance Testing" could be read. The authors are working for the **EU**ropean **S**hock **A**bsorber **M**anufacturer **A**ssociation (EUSAMA). This organisation doesn't exist any more.

Test principle

At the resonant frequency of the unsprung mass the displacement between the unsprung mass and the suspension tester platform is at maximum, or adhesion is at minimum. Unsprung mass resonance can be seen graphically as the minimum inflection point on the adhesion verse's frequency graph. The EUSAMA value is calculated as mentioned in formula [1]. If the wheel stops making contact with the platform during a test, the minimum adhesion is zero. Low percentages describe low performing suspension, high values good performing suspension.

3.5 Minimum phase angle method

Origin

In the SAE Technical Paper 960735, 1996: "An improved Non-Instrusive Automotive Suspension Testing Apparatus with Means to Determine the Condition of Dampers" could be read. The author was Tsymberov A.

Test principle

The minimum phase angle value is indicative of the strength of the damping. The minimum phase angle is the lowest value of the phase angle determined during the test between the sprung and unsprung mass resonant frequencies. When adequate damping is present in the suspension system there will be a smoother response delay of the wheel to the moving platform at the unsprung mass resonant frequency.

3.6 The frequency variator function from 25 Hz down to 5 Hz

The platform has been excitated by a frequency variation (0Hz - 25Hz – 18Hz – 8Hz - 5Hz – 0Hz), according to the Frequency Variation Function from Figure 1, and constant amplitude (+/- 3 mm) sine function.

The frequency inverter should be of the 'vector controlled' type (real vector control). The frequency inverter should be able to complete at least 800 entire cycles per day in order to guarantee long-time working without problems.

The vector controlled frequency inverter should be programmed as follows:

The power supply and the frequency Variator should be capable of driving the platform, when loaded to its maximum from rest position to its maximum frequency of about 25Hz in considerably less than 2,5 seconds. An overrun at 25Hz is allowed but should be minimized. In order to measure the rigidity of the tire by 25Hz the suspension tester will be at this frequency for 0,5 seconds after the stability of the vehicle is obtained minimum 2,5 s. A linear cost down should be obtained from 25Hz to 18Hz in order to minimize the test duration. Further going down from 18Hz to 5Hz with a linear pass-through of 7,5 s from 18Hz to 8Hz and continued until 5 Hz. After 5Hz the converter may brake the flywheel.

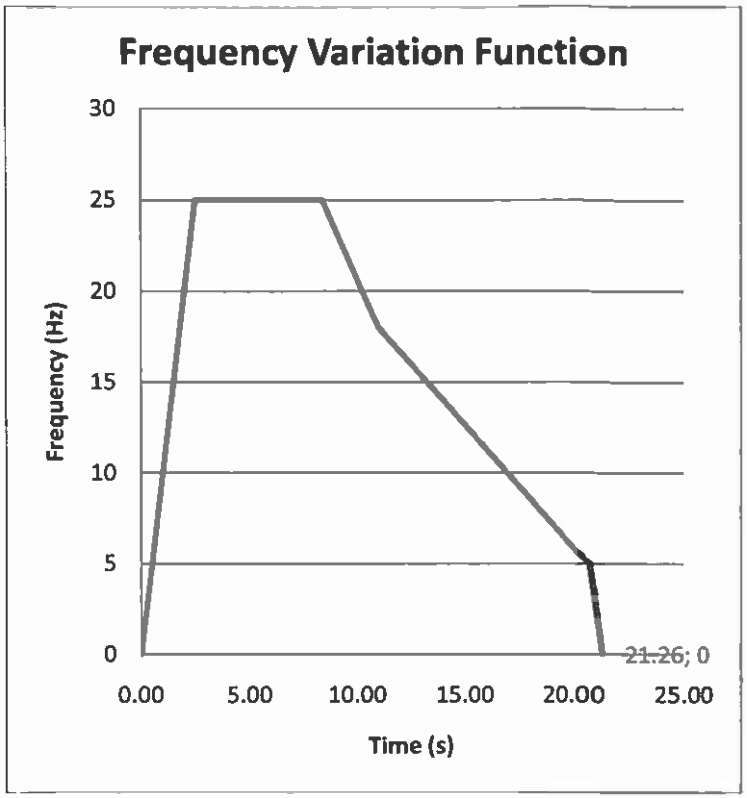

Fig 1 : Frequency Variation Function

3.7 PASS / FAIL criteria

In principle different types of pass/fail criteria can be established. They will be explained here as absolute or relative criteria.

Absolute criteria

The European Shock Absorber Manufacturers Association (EUSAMA) established the following guidelines for adhesion:

Adhesion Measured	EUSAMA Interpretation
61% to 100%	Excellent dynamic wheel contact
41% to 60%	Good dynamic wheel contact
21% to 40%	Fair dynamic wheel contact
1% to 20%	Poor dynamic wheel contact
0%	Bad dynamic wheel contact

Therefore the absolute criterion for EUSAMA is set up to 20% (parameter AC_{EUS} = 20% E).

A. Tsymberov wrote in his SAE paper that dampers with minimum phase angle less than 40 degrees, corresponding to damping ratio ζ_2 = 0.08 of the unsprung mass, are considered to be weak.

Therefore the absolute criterion for Minimum phase shift $\phi_{min\,i,l}$ is set up to 40° (parameter $AC_{\phi min}$= 40°)

Relative criteria

Relative criteria are based on comparing the set of results between the left and right wheel for each axle of a vehicle, e g unbalance of the results for one axle. Without any doubt it is clear that the same level of suspension is intended for the wheels of an axle of a vehicle. Significant differences will identify a defect of the system.

The relative criteria for EUSAMA value and Minimum phase shift $\phi_{min\,i,l}$ is set up to 50%, (parameters RC_{EUS} = 50% and $RC_{\phi min}$= 50%).

The unbalance for EUSAMA value is set up to 50% for so far that the Eusama values of both axles are more than the absolute criterion for EUSAMA AC_{EUS} = 20%:

- General relative criterion Eusama: the unbalance left/right <= 50% of the highest value;
- When both the Eusama values of one axle are less than the absolute criterion for EUSAMA (AC_{EUS} = 20%E), than the difference between both values may not be more than 10% Eusama (parameter $RC_{EUS < ACEUS}$ = 10%).

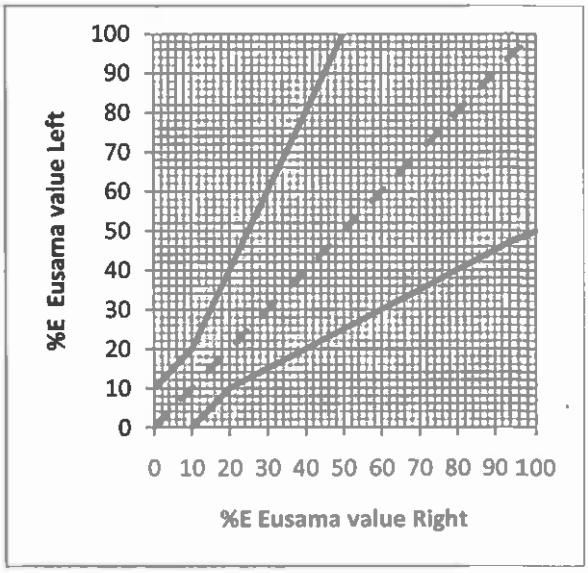

Fig 2 : Relative Criteria Eusama

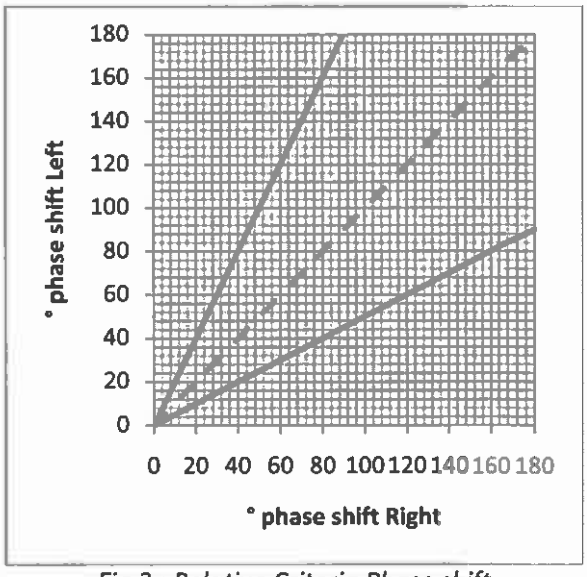

Fig 3 : Relative Criteria Phase shift

4 Requirements for inspection devices

4.1 Technical requirements for testing devices

4.1.1 General

Any suspension testing device should be capable to evaluate values for suspension characteristics per wheel for vehicles N1 and M1. The operation of a suspension testing device should not extend the time for PTI (Periodic Technical Inspection) significantly. Testing devices have to be built on good engineering standards, covering all applying requirements for technical devices in general (e g directives to product safety, ...).
The construction and functioning of test devices should be designed in a way that will not cause any damages to tested vehicles but which is easy to operate with low maintenance costs and may be prepared for automatic data transfer.

1. The suspension tester should be capable of testing, without any adjustment vehicles with:
    - Static wheel loads of from 100 up to at least 850 kg
    - Tracks from 1000 to 1700 mm
    - Wheelbases varying from left to right by up to 100 mm on the same vehicle;

2. The installation must, without suffering any damage or adverse effects on its metrological or other qualities, and for over at least 5 years, be able to tolerate the loading, the impacts and the vibrations which are exercised or caused by the wheels on the platform during normal operation of the bench in the abovementioned loading conditions. By normal operation is meant a usage of a minimum of 300 measurements (a= axles) per day.

3. The normal operation of the equipment has to be guaranteed for an environmental temperature of between -5 °C and 35 °C.

4. A simple selection should allow the suspension tester to be put in the automatic (normal) cycle. The operation for this selection must be easily accessible.

5. Sufficient measures need to be taken in order to ensure that no negative effects can come about due to condensation of damp;

6. The suspension tester also has to be protected against normal atmospheric circumstances, against corrosion and against the penetration of foreign (abrasive) materials in the bearings or moving parts; It also has to be protected against floor cleaning products and dirt and (salt) water falling from the vehicles during tests.

7. The measures which the manufacturer has taken in order to comply with points 4.3 and 4.4 of this paragraph are to be described in the Technical Dossier

8. The means of measurement or the means of measurement of the vertical loading must be provided with an adjustment device which is moreover secured against arbitrary manipulation. The calibration and adjustment must be able to take place within an

acceptable time frame (less than 120 minutes) and it must be easy to dismantle these when required.

9. The suspension tester must start up automatically, after positioning of the vehicle and when a considerable stable static vertical force is measured.

10. The means of measurement must carry the CE mark. All obligations are to be complied with within the context of CE marking and the machine guidelines are wholly the responsibility of the supplier of the suspension tester.

11. All parameters (see point 5 (parameter)) which are governed by software have to be secured, and it must be possible for an authorized user to adjust and secure these easily. All parameters have to be retained and it must be possible at all times to print out the valid settings on a dated print-out.

12. The equipment must, for initial scale maintenance, be easily accessible and one should be able to clean them easily, so that this maintenance can be carried out within a reasonable time scale.

13. The equipment must be provided with an **emergency stop function.** The emergency stop function must be located in the vicinity of the suspension tester, PC or console ;

14. The means of measurement has to comply with all the conditions as laid down in the Flemish, Wallonian, Brussels, Belgian and European laws, regulations, guidelines and standards valid at the time of purchase with regard to safety, hygiene, working conditions (amongst other. Belgian Law on Welfare 04/08/1996, ARAB, CODEX, AREI, ...) and the environment, in particular, amongst others:

    - machines (guideline EEG 2006/42 and adaptations – K.B. 12.08.2008),
    - low voltage (guideline 2006/95 and adaptations – K.B. 10.1.97),
    - EMC, ElectroMagnetic Compatibility (guideline 2004/108 and adaptations – K.B. 28.2.07),
    - Personal protective gear (guideline 89/686 and adaptations – K.B. 31.12.92 and modifications),
    - Working methods (guideline EEG 89/655 and adaptations – K.B. 12.08.1993, included in CODEX).

15. The electrical signals of the vertical forces and the vertical position of the oscillating platform measurements must be filtered so as to allow a correct evaluation of these direct measurements, as well as of the derived quantities relating to damping capacity and unbalance. The response times of the different quantities measured should be very small. The filtering processes and the response times for the different direct measurements should always remain coherent, so that these measurement results themselves as well as the derived quantities are always based on measurements which have taken place at the same time or measurements taken within the same time interval. The definitions and characteristics of these filters should be notified to GOCA. These filters should preferably be adjustable by setting the parameters via the software.

16. The devices will protect against false operations and against excessive variations of voltage supply. The unit will be provided with a three-phase power supply 220/380V AC 50Hz. Fluctuation of the power supply by + / -15% will not affect the accuracy of the measurements or disrupt the automatic operation.

4.1.2 Operation and characteristics of the suspension tester

1. The devices will allow the measurement by successive independent sequences of left and right suspension from the same axle without having to manoeuvre the vehicle.

2. The tests will require no action on the vehicle.

3. The platform should be generally flat and should be subjected to a substantially sinusoidal vertical oscillation of 6 mm (+/- 0,2 mm) total amplitude over all of its supporting surface;

4. The suspension tester should be conceived so that one operator in the driving seat can perform the whole test of the four suspensions, including the displacements and the total average time for testing the four suspensions should not exceed 2,5 minutes;

5. It must be possible to start and stop the suspension tester both automatically and manually. A system has to be provided to limit the motor starting current.

   The installation must be possible to provide with a control whereby the platform can be activated manually in order to retest an axle.

   Starting the motor will be secondary to the response of a safety device that is sensitive to the positioning of the stationary vehicle.

The starting of suspension tester is only possible if on each of both platforms the wheel of an axle is placed. The tester starts after both the wheels are well placed on the platform and after a time delay of 1 to 3 seconds. When a displacement of the tested wheel is detected during the test, the test should be reperformed. (Each supplier is to present his method used in order to determine displacement in detail for approval and for the attention of the R&D department of GOCA). It is only in the case of a test program that the motors can be started manually.

4.1.3 Measurement device for vertical forces

<u>Type of measurement of vertical forces</u>

The vertical force measured is only to be displayed after the measurement value is stable. The measurement of the vertical force must only be minimally influenced by the horizontal forces. In the technical dossier the manufacturer is to define his value for "stable". The the R&D department of GOCA will accept or reject the defined tolerance.

The static vertical force will be measured at total standstill of the vehicle on the tire support platform before and after the test. The difference should not exceed 25 kg.

Measurement range and maximum permissible errors of measurement of vertical forces
The lower limit of the measurement range must be smaller than or equal to 100 daN static weight per wheel. The upper limit of the measurement range must not be less than 850 daN static weight per wheel. **The resolution should be at least 1daN.**
The measurement device must be able to take up a dynamic load of 1700 daN per wheel without damage, in order to make it possible for the vehicle to drive on and off at normal speed.

Within the measurement area the maximum allowable total error for the statical vertical force (inaccuracy, linearity and reading error included) is defined as follows:

- **From 100 daN up to 250 daN vertical force : 7,5 daN**
- From 250 daN up to 850 daN vertical force : ± 3 % of the measured value
- From 100 daN up to 850 daN vertical force : +/-3 % for hysteresis

Zero point
The system for measurement of the vertical forces must be provided with a device which allows the zero point to be quickly adjusted. This device must be such that any unwanted handling of this can be avoided.
The zero setting and the setting of the sensitivity of the vertical forces must be independent of one another, in other words after the zero point is modified the calibration of the vertical forces must not be lost.
If no force is applied to the tire support platform it should be possible to show the zero reading.

4.1.4 Measurements to be carried out

When a suspension test is carried out on a vehicle evaluation of the following must be possible:

- $N_{i,l\ static}$ for each wheel
- $EUS_{i,l}$, EUSAMA value for each wheel
- ϕ_{min}, Minimum phase shift for each wheel
- EUSAMA and Minimum phase shift-graph for each wheel
- $D_{EUS,l}$, value of the EUSAMA value unbalance for each axle
- $D_{\phi min,l}$, value of the Minimum phase shift unbalance for each axle
- Rigidity of the tire for each wheel

4.1.5 Reproducibility, reliability

The evaluation of the suspension characteristics has to be based on a robust test procedure with low or controlled influence of environmental factors (temperature, load, tire, tire air pressure, ...). Where influences need to be controlled, this should be explained clearly in the manuals for these testing devices. Reproducibility and accuracy need to be on an appropriate level to ensure reliable results.

1. The test reading must be repeatable under identical conditions with a permitted maximum tolerance of +/- 1% Eusama percent;
2. The test reading must not vary by more than +/-2% Eusama percent for different positions of the tire on the test platform;
3. The test reading must have a maximum permitted tolerance from the real percentage remnant dynamic vertical tire force of +/- 3,5% Eusama percent;

4. The test reading must be repeatable under identical conditions with a permitted maximum tolerance of +/- 2° phase shift;
5. The test reading must not vary by more than +/- 3° phase shift for different positions of the tire on the test platform;
6. The test reading must have a maximum permitted tolerance from the phase shift of +/- 6° phase shift;

4.1.6 Calibration

Periodical traceable calibration of test devices has to be ensured. The calibration interval is intended to be 12 months, but not longer than 24 months. The drift of the system for the various direct measurements must be minimal. Therefore the direct measurements must fur fill the following at the periodic calibration:

- the peak to peak amplitude is 6 mm (+/- 0,25 mm) total;
- The test reading must have a maximum permitted tolerance from the real percentage remnant dynamic vertical tire force of +/- 3,5% Eusama percent;
- The test reading must have a maximum permitted tolerance from the phase shift of +/- 6° phase shift;

It will be possible to change the key values and / or adjust them with a resolution of 1% of the measuring scale for EUSAMA-percentage.

The signal of the force over time must be registrable during one of the verification checks on the proper functioning of the device.

4.1.7 Versions of offers: version A and version B

The unit will be offered in two versions. The version B will be equipped with a protective device in order to have the possibility to pass over the device at rest with a load of minimum 6 t per wheel. The version A will not have this protective device. This protective device will consist of an intrinsic safety system to prevent any damage to the equipment.

The testing platforms will be at the level of the floor during the test. Any required height of the protective devices of the version B will not exceed 50 mm.

4.2 Device for the centralisation and display of measurement results

The **values which are reproduced by the printer or on the screen** must have the appropriate units.

The supplier is to make a proposal for the reproduction of the results on paper and on screen for approval by GOCA, for the attention of the technical commission. The measurement results have to be retained. The protocol of the data is described in point 4.3.2..

4.2.1 The following parameters must be displayed

Before starting the test (test of one wheel):

- $N_{i,r}$ or $N_{i,l}$, measured before the start of the test.

During or at the end of the test of one wheel:

- $N_{i,l\ static}$ for each wheel
- $EUS_{i,l}$, EUSAMA value for each wheel
- $\phi_{min,}$ Minimum phase shift for each wheel
- Rigidity of the tire for each wheel

At the end of the test (test of one axle):

- $N_{i,l\ static}$ for each wheel
- $EUS_{i,l}$, EUSAMA value for each wheel
- $\phi_{min,}$ Minimum phase shift for each wheel
- $D_{EUS,i,}$ value of the EUSAMA unbalance
- $D_{\phi min,i,}$ value of the Minimum phase shift unbalance
- Rigidity of the tire for each wheel

During or at the end of the test:

- EUSAMA and Minimum phase shift-graph

It is emphasized that the operator must be able to call once more and again the results for one axle back up without having to display all the results. It must be easy for the operator to read the displayed quantities from his workstation.

4.2.2 The following results should be possible to be printed by the operator after the test

The print-out is to fit onto a minimum number of A4 pages. The optimum is 1 * A4 which may if necessary be printed on the reverse.

The supplier is to make a proposal for the reproduction of the results on paper for approval to GOCA, for the attention of the technical commission

- Reference number of the suspension tester;
- date and time;

- identification of operator (name or number, to be completed by the operator); identification of inspection station
- number plate and chassis number (to be completed by the operator);

Per wheel :

- $N_{i,l\ static}$ and $N_{i,l\ dyn\ min}$ for each wheel
- $EUS_{i,l}$, EUSAMA value for each wheel
- ϕ_{min}, Minimum phase shift for each wheel
- EUSAMA and Minimum phase shift-graph
- Rigidity of the tire for each wheel

Per axle :

- $D_{EUS,i,}$ value of the EUSAMA unbalance
- $D_{\phi min,i,}$ value of the Minimum phase shift unbalance

4.3 Other characteristics of the device for the centralisation and display of measurement results

4.3.1 General

- It must be possible to retain the results as described in section 4.2. .
- As an option, It should be possible to provide a back-up system . The supplier is to let the Technical Commission of GOCA have his description of his back-up procedure. This back-up must be able to produce a history of the inspections carried out (the results as per section 4.2. which have been retained) of each set, regardless of whether the set has been deposited in a GOCA network or not.
- The supplier / co-contractor is to be held liable for any shortcomings regarding the minimum configuration which is laid down below and with which the PCs in the inspection centre's environment have to comply;
    - The programme must operate with Windows 2000 / XP and should be able to evolve with new versions of this OS. If it cannot do this automatically then the programme must be adapted to the new OS.
    - The programme must function under a "normal" user and not under an administrator (whether local or domain)
    - The user and user's rights are to be managed by the IT division of the inspection centres.
    - Updates and installation of the application are to take place via local persons with authorization of the inspection centre's, and all rights concerning its administration belong to the IT division of the inspection centres.
- The axles of a vehicle will normally be tested beginning with the front axle and going to the rear axle. If this normal sequence is not adhered to then the sequence of the test must be entered and retained. It must be possible to be reproduced and confirmed the results for each axle. If the tests are successful for one axle and not for the following, not all axles need to be tested again.

- All functions of the suspension tester, including the emergency stop meter must be possible to be operated from the "measurement unit" as well as via a manual (small and wireless) remote control.

4.3.2 Coupling of the suspension tester with the GOCA network

As an option, It should be possible to couple the suspension tester with the GOCA network.

Purpose: This paragraph describes the following points:

- The data available in the inspection centre data base for the suspension test. This data base can be communicated via an ODBC driver.
- The data the suspension tester must supply to the inspection centre's application after the suspension test. Furthermore where this data is to be kept and for how long.

THE XSD

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
	<xs:element name="wheels">
		<xs:complexType>
			<xs:sequence>
				<xs:element ref="wheel" maxOccurs="unbounded"/>
			</xs:sequence>
		</xs:complexType>
	</xs:element>
	<xs:element name="wheel">
		<xs:complexType>
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				<xs:sequence>
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					<xs:element ref="weight"/>
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SUSPENSION TESTER SPECIFICATIONS (2010)

THE XML:


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- <suspensionTest xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
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  <id>3</id>
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</suspensionTest>

5 Symbols and parameters

Symbol	Designation	§ Specification	Type	Value	Unit
AC_{EUS}	Parameter for acceptance of the absolute criterion of the EUSAMA value	3.7.	parameter	20,00	% E
$AC_{\phi min}$	Parameter for acceptance of the absolute criterion of the minimum phase shift	3.7.	parameter	40,00	°
$D_{EUS,i}$	Unbalance of the EUSAMA values for each axle	3.3.	calculated	b	%
$D_{\phi min,i}$	Unbalance of the minimum phase shifts for each axle	3.3.	calculated	b	%
DeltaF	Frequency below the Eusama frequency where Minimum phase shift has to be detected	3.1.	Parameter	3,00	Hz
$EUS_{i,l}$	EUSAMA value	3.3.	calculated	b	% E
N_i	Vertical force of an axle	3.3.	calculated	b	N
$N_{i,l}$	Vertical force of a wheel	3.3.	measured	v	N
RC_{EUS}	Parameter for acceptance of asymmetry of the EUSAMA value	3.7.	parameter	50,00	%
$RC_{EUS < ACEUS}$	Parameter for acceptance of asymmetry of the EUSAMA value when both values have less than AC_{EUS} EUSAMA	3.7.	parameter	10,00	% E
$RC_{\phi min}$	Parameter for acceptance of asymmetry of the minimum phase shift	3.7.	parameter	50,00	%
RSWfMAX	Range related from the top force measurement to the static weight	3.1.	parameter	25,00	%
RSWfMIN	Range related from the bottum force measurement to the static weight	3.1.	parameter	25,00	%
ϕ	Phase shift	3.1.;3.3.	calculated	b	°
ϕ_{min}	Minimum phase shift	3.1.;3.3.	calculated	b	°

6 Delivery, installation and maintenance

The manufacturer is to supply the required recommendations for the installation together with the detailed plan for mounting it in. The installation has to be provided with the following at the time of supply:

- a manual in the national languages (Dutch, French and German) in which the actions and checks are described which the user has to undertake so as to ensure that the measurement results obtained are correct;
- Before it is put into use every new means of measurement has to be accepted as complying with the terms of supply by the body which is recognized by the Federal Authority for Mobility and Transport. The associated costs are to be met by the supplier;
- A calibration certificate from the body which is recognized by the Federal Authority for Mobility and Transport. This certificate has to be issued in accordance with the standard ISO 17025;
- a description of the checks to be carried out before or during the measurements;
- the procedures relating to the possible different operations; with an emphasis on the risks of incorrect use of the roller brake meter;
- the significance of a measurement result and the information required for a correct interpretation of this;
- description of any information messages which may be given by the instrument;
- Calibration and maintenance conditions and equipment (including planning), which comply with the requirements of the ISO 9001 standard. These include the definition of the equipment which is required for the current maintenance (may be supplied as an option);
- the operating diagrams, the technical specifications of the components, the wiring diagram and details of the method of calibration of the suspension tester have to be supplied;
- the EC declaration of compliance in the language of the original user instructions, accompanied by a translation into Dutch, French and German;
- a complete list of replacement parts and their prices at the time at supply;
- The warranty given by the manufacturer for the installed equipment for a minimum period of one year as from the date of putting into service.

Supplies are carriage paid, to an inspection centre in Belgium, including packaging and transport insurance. Unloading is to take place under the supervision of the supplier. Installation and putting into operation are to be effected by the technical staff of the supplier. All costs linked with this are to be met by the supplier.

The supplier is responsible for the warranty for the whole installation, including the components from sub-contractors. A full 12 month warranty is to apply for the whole installation which is to start from the date of definite acceptance. As an option, at the time of purchase the warranty can be extended for 24 months. This warranty applies for normal use of the installation (see § 4.1.1). The warranty applies for any defects with the exclusion of failures which are the result of incorrect usage or usage that does not comply with the instructions for the machine, and it covers all costs for components, labour, technicians, travel and lodging costs, despatch costs .....

In the case of a failure during the warranty period the supplier undertakes to arrange for technical intervention within 24 hours of notification, on working days.

Maintenance contracts can be concluded after the warranty period or at the time of supply.

The supplier guarantees the availability of replacement parts for 10 years after the date of putting into service of the equipment.

7 Acceptance procedure

Every supplier who proposes a new means of measurement or an adaptation of an existing means of measurement to GOCA, is to also submit to GOCA a complete technical dossier on the basis of the specifications. A fundamental adaptation of the software is regarded as an adaptation of the means of measurement and gives rise to a supplementary approval of this.

All modifications according to the optional provisions in these specifications do not form a part of the standard suspension tester. When the options which are described in these specifications are offered then these are to comply with these descriptions and must be approved by the body which is recognized by the Federal Authority for Mobility and Transport

The supplier tacitly undertakes, by the offer of a suspension tester and by allowing it to be approved in accordance with these specifications by the body which is recognized by the Federal Authority for Mobility and Transport, to do the following:

1. to use a quality plan for the manufacture and installation of the equipment and its components. This quality plan is to include at least:
    - the drawings of the different components and how these are assembled with an indication of the measurements and their respective tolerances;
    - identification of the critical dimensions of the components and the critical points for realization of the assembly;
    - the production process to follow for the manufacture and assembly of the components and the (whether static or not) way in which the production process is managed, whereby a record is kept for the critical dimensions;
    - a calibration plan for the measurement instruments used and the important installation tools;
    - details in writing of the procedure for management of modifications. This also includes the process for notification of adaptations made to hardware and / or software which have an impact on the approval by the body which is recognized by the Federal Authority for Mobility and Transport, the maintenance or repair of the equipment which is already installed at the inspection centre's.
    - An overview of the logistics process with consideration of the protection of the items with critical dimensions against damage, corrosion, ...

2. The supplier is to inform GOCAs Periodic Technical Inspection Department of the details of the (main) production plant where the equipment is manufactured. Any change in location is to be notified to this same division of GOCA.

3. The supplier is to permit an audit of the quality plan to be carried out by GOCA representatives in the production plant where the equipment is manufactured. Essentially this is following process : oriented audit with consideration of the approach taken to the system and which will involve inspection of the quality plan (and related documents), and also a visit to the production floor. Those working with the supplier and who are involved in production may also be audited. All of this is to take place also with respect also to internal agreements in safety and liability.

4. If deviations are ascertained during the audit or if equipment which is installed (with the recognized inspection centres) requires a large number of interventions then the supplier is to submit an action plan in writing to GOCA.

   Every new means of measurement has to be accepted by the body which is recognized by the Federal Authority for Mobility and Transport as far as compliance with specifications is concerned. The associated costs are to be met by the supplier.

   The software version which is relevant to the approval request is to be handed over to the checking body recognized by the FOD Mobility and Transport Authority in the form of a CDROM, EPROM, ... This software is to be used during the approval procedure for the purposes of analysis and also afterwards for reference if modifications are made to the approved model.

   A means of measurement is to be regarded as suitable by the Technical Commission of GOCA for the recognized inspection centre's after evaluation as well as the technical characteristics of the means of measurement, compliance with the specifications, as well as price and non-quantifiable factors such as user-friendliness, service etc. which also play a part.

   The Federal Mobility and Transport Authority make the final decision concerning the investment dossiers of the inspection centres and thus also whether or not the means of measurement is used by the recognized inspection centre's.

8 Bibliography

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