GRRF TPMS Task Force Conclusions

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BACKGROUND

Task Force Members

Contracting Parties
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- Hiroshi Nagaoka (JP, Nissan)
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- Eddy de Haes (NL, RDW)
- Ian Knowles (EC)
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- Riccardo Giovannotti (Bridgestone)
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- Günter Heeß (Daimler Trucks)
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- Peter Saeger (Conti VDO)
- Paul Jennison (Knorr Bremse)
- Karl Perras (TRW)
- Jochen Schaefer (BOSCH)
- Wim Verhoeve (CLEPA) - Chair

Objective of the Task Force

The Force Group (TFG) agrees on the following objective of the TF:
- Collect figures and data about the number of vehicles which are driven with under-inflated tyres, the number of under-inflated tyres on each vehicle and the degree of under-inflation and the effect of this on the fuel consumption, tyre wear, CO2 emission, safety etc.
- Measure the effect of TPMS and other solutions
- Review & validate available data.
- Define ‘under-inflation’ and how to measure it.
- Agree on the values to be used for the GRRF TPMS Informal WG meeting.
- Estimate the cost for the vehicle manufactrers.
- Calculate the cost/benefit.

Task Force meetings

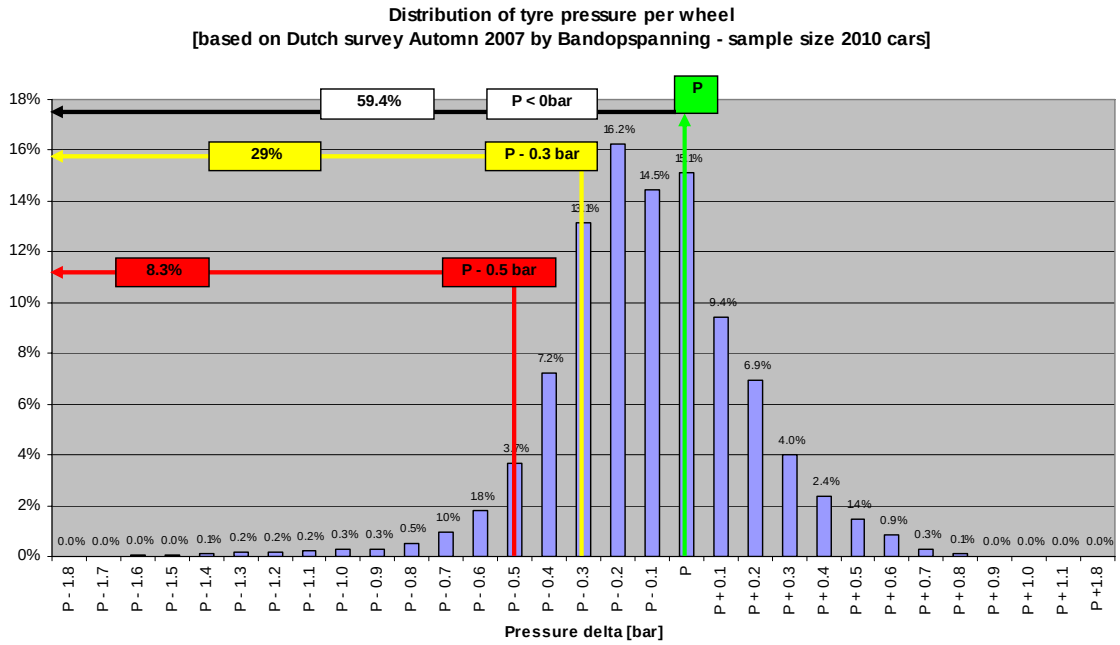
The Force Group (TFG) held the following meetings:
1. 12 February 2008, Brussels (CLEPA Offices)
2. 11 March 2008, Brussels (CLEPA Offices)
3. 18 April 2008, Brussels (CLEPA Offices)
4. 25 April 2008, Conference call
5. 19 May 2008, Conference call
6. 27 May 2008, Brussels (CLEPA Offices)
7. 9 June 2008, Conference call

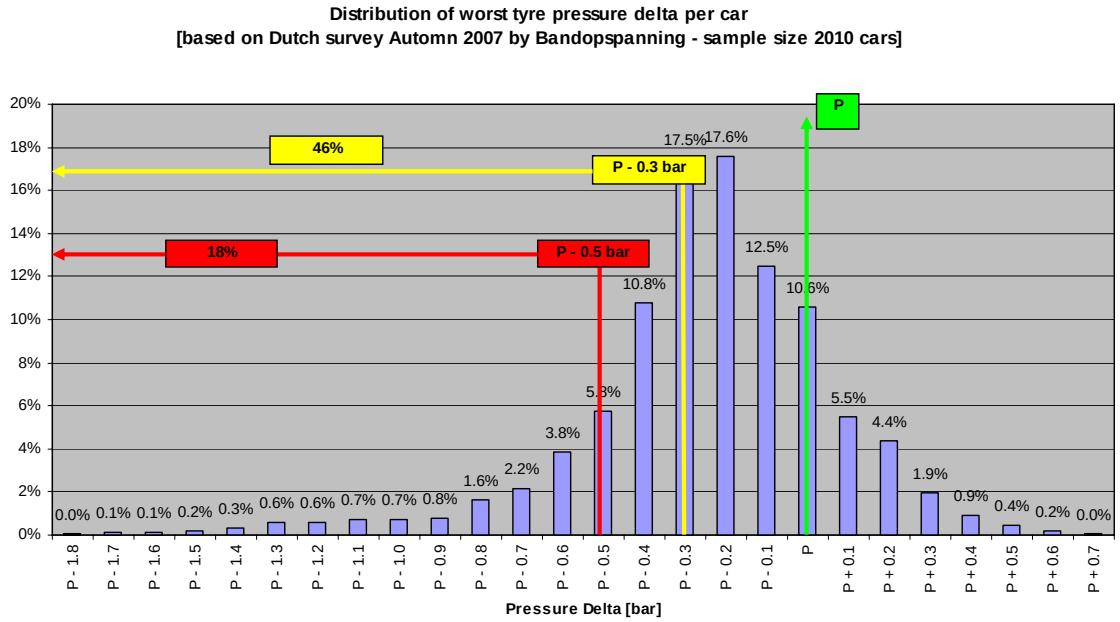
SECION A: Passenger Cars (PC)

1. Distribution of actual tyre pressure on the road

The Task Force Group (TFG) agrees that the following data coming from the Netherlands (NL), Michelin (UK & F) and JASIC (JP) is representative for the real tyre pressure distribution on the road and can be used for the cost/benefit calculations.
The histograms below give a summary of the tyre pressure distribution for each of the data sets:

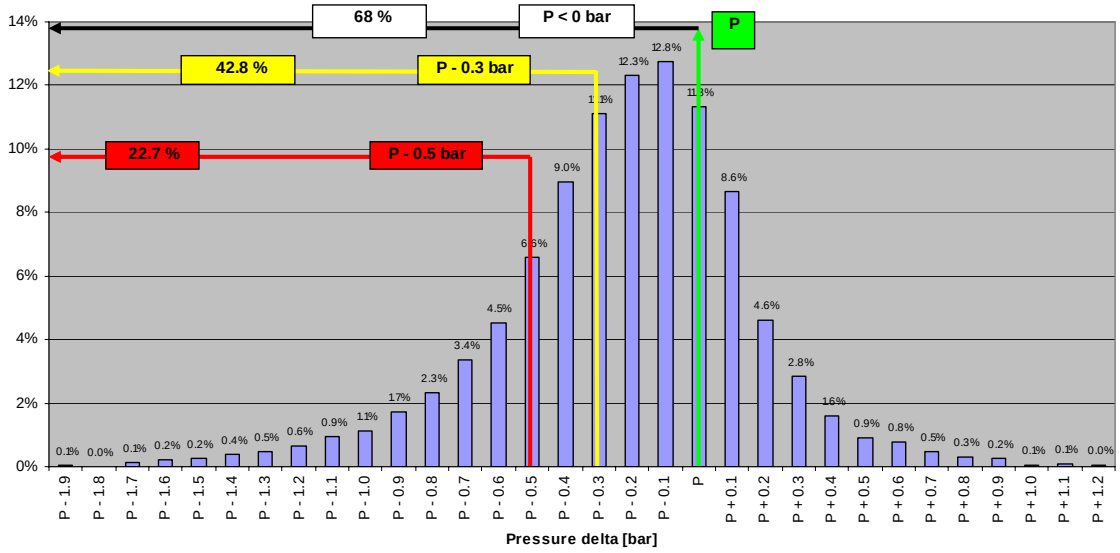
1.1. The Netherlands data (NL)



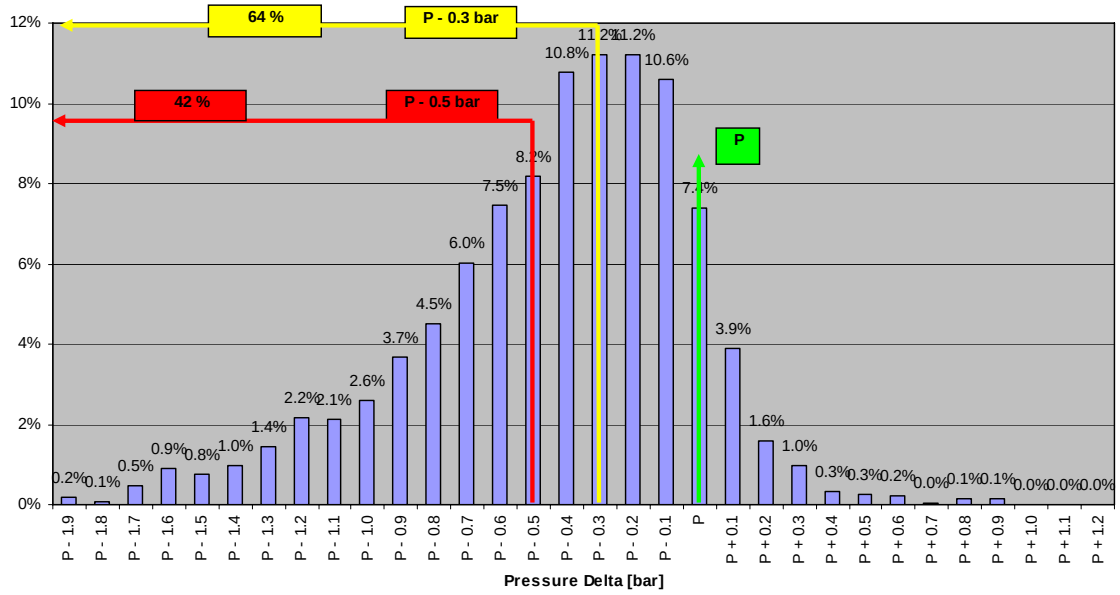


1.2. The Michelin data (UK)

Distribution of tyre pressure per wheel
[based on UK survey 2007 by Michelin with 0.2bar offset instead of 0.3bar - sample size 2373 cars]

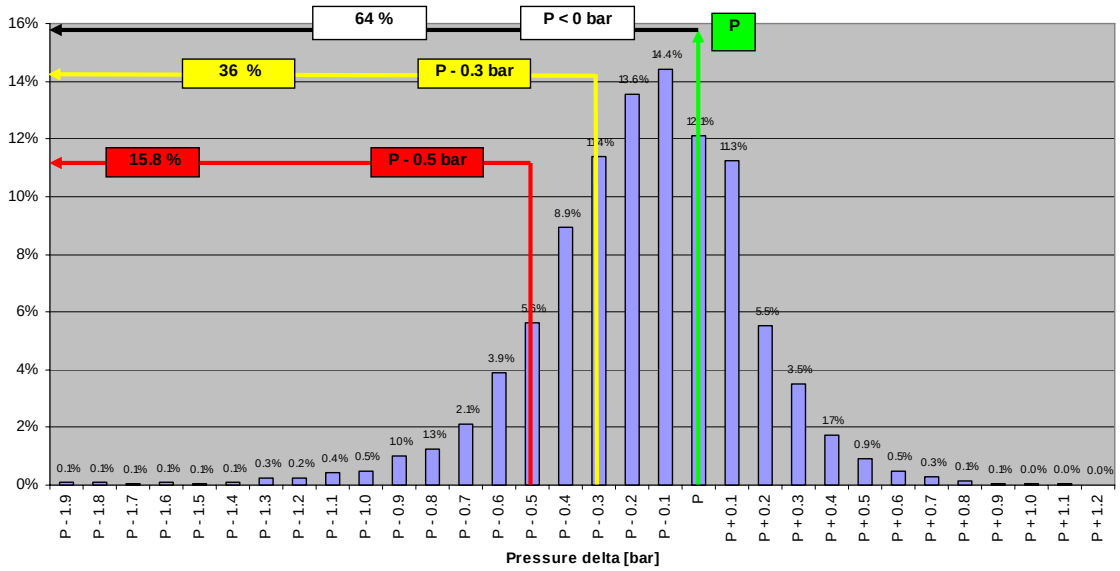


Distribution of worst tyre pressure delta per car
[based on UK survey 2007 by Michelin with 0.2bar offset instead of 0.3bar - sample size 2373 cars]

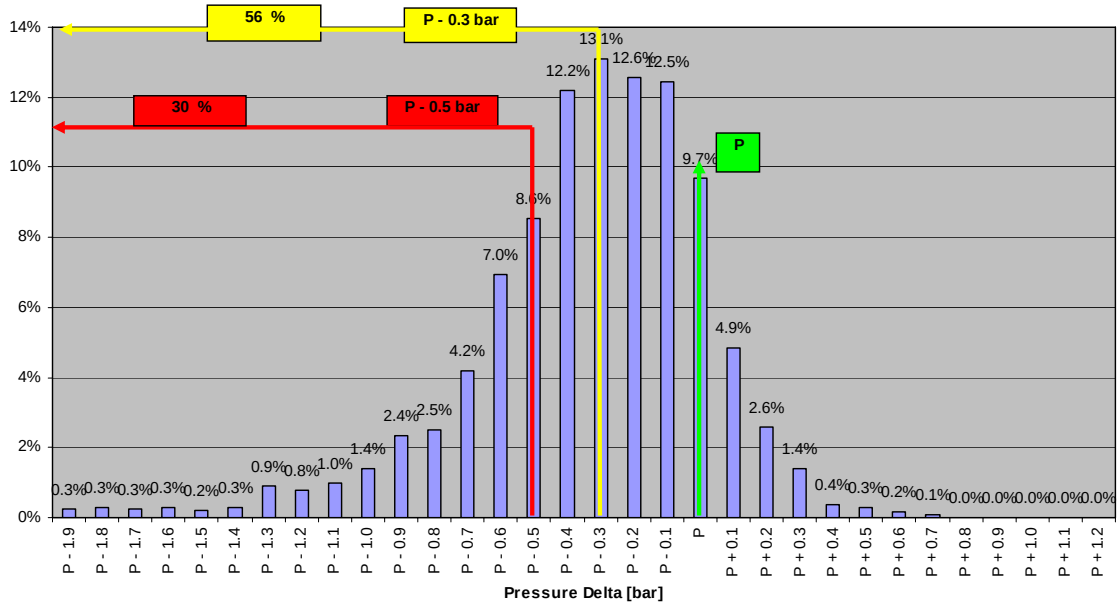


1.3. The Michelin data (F)

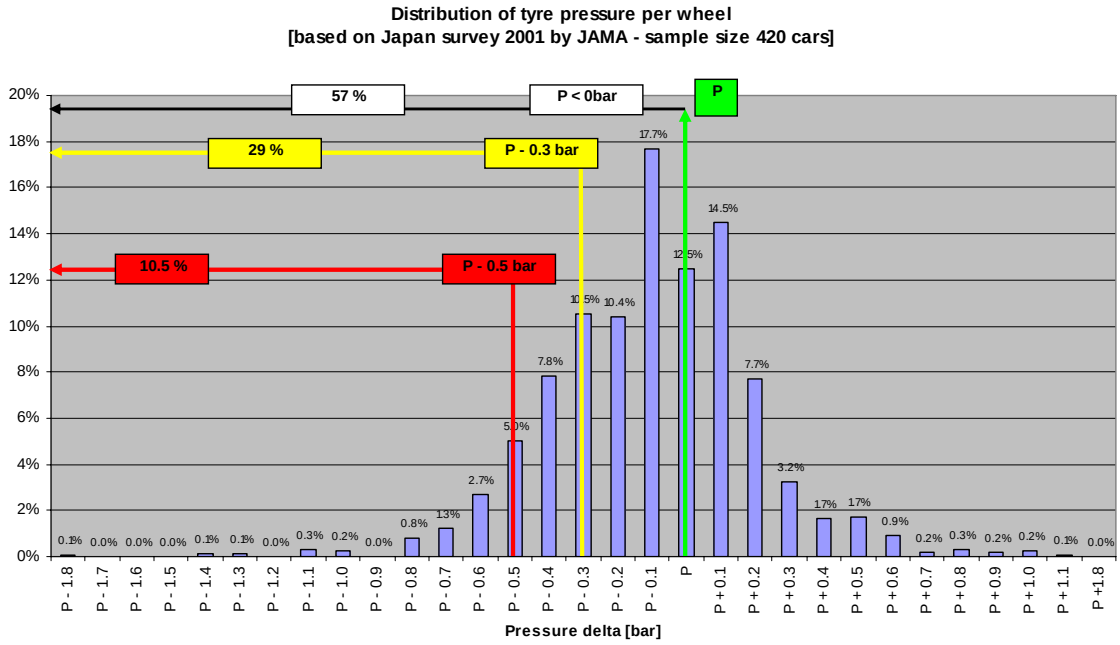
Distribution of tyre pressure per wheel
[based on France survey 2007 by Michelin with 0.2bar offset instead of 0.3bar - sample size 2013 cars]

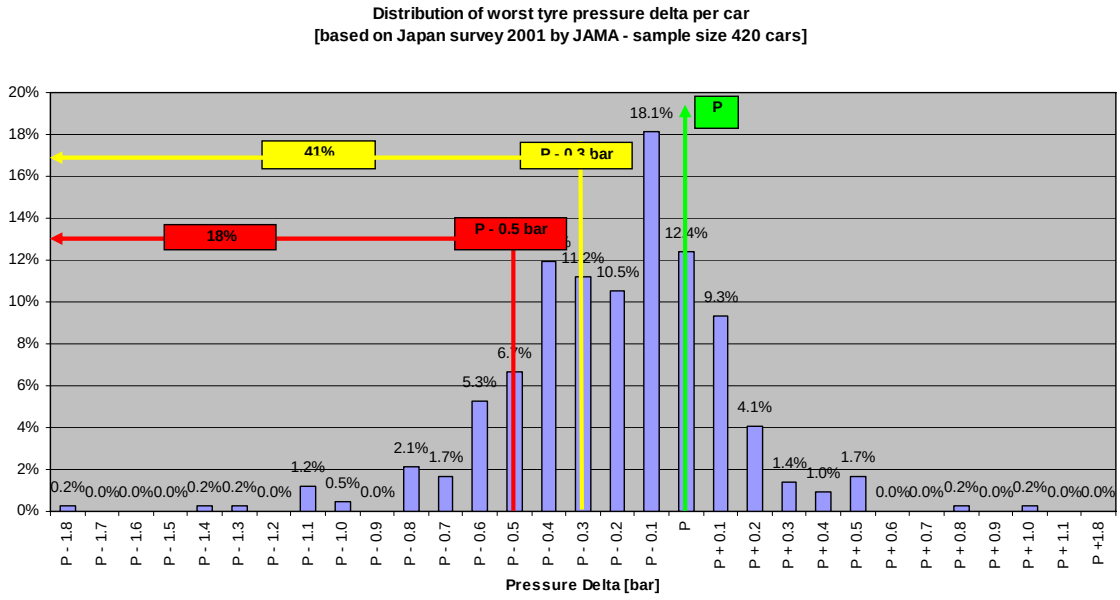


Distribution of worst tyre pressure delta per car
[based on France survey 2007 by Michelin with 0.2bar offset instead of 0.3bar - sample size 2013 cars]



1.4. The JASIC data (JP)





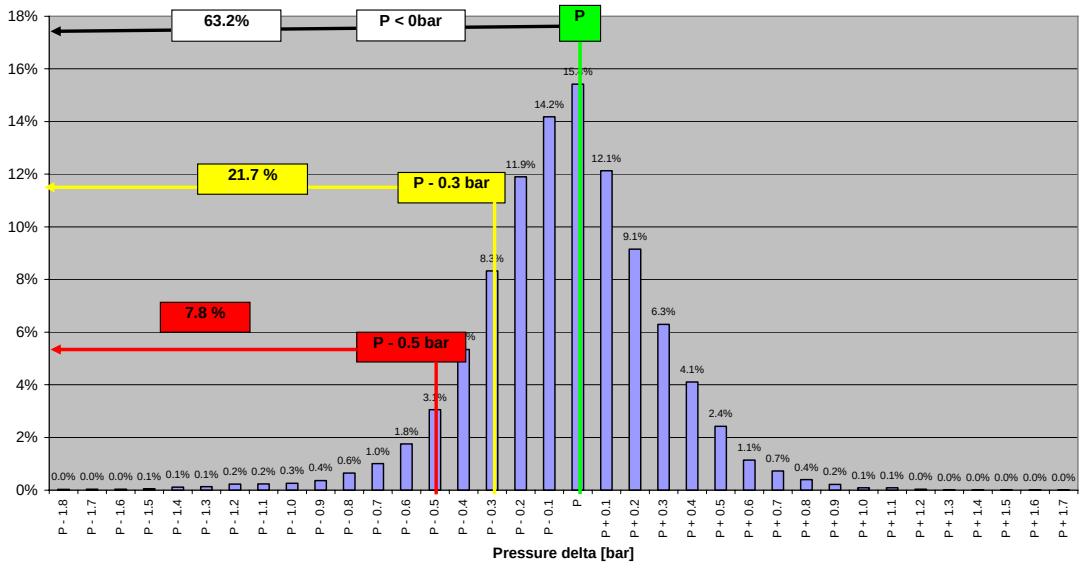
This data can be divided in 3 groups with a total of 228 million vehicles in Europe:

1. JP & NL 45% of all vehicles
2. F 30% of all vehicles
3. UK 25% of all vehicles

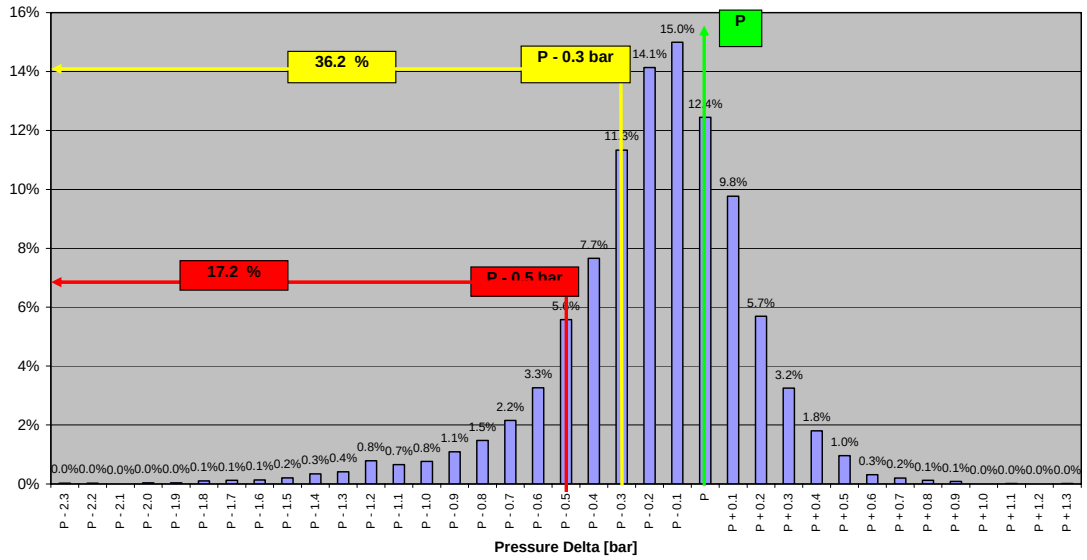
1.5. New RDW data (NL)

NL (RDW) completed another survey: 8250 cars, among which 5664 VIN numbers could be identified. This survey was completed between Nov 07 and Jan 08, in the same conditions as the first one, mostly on company cars (new and well maintained vehicles).

Distribution of tyre pressure per wheel
[based on New RDW NL survey Nov 07- Jan 08 - sample size 8250 cars]



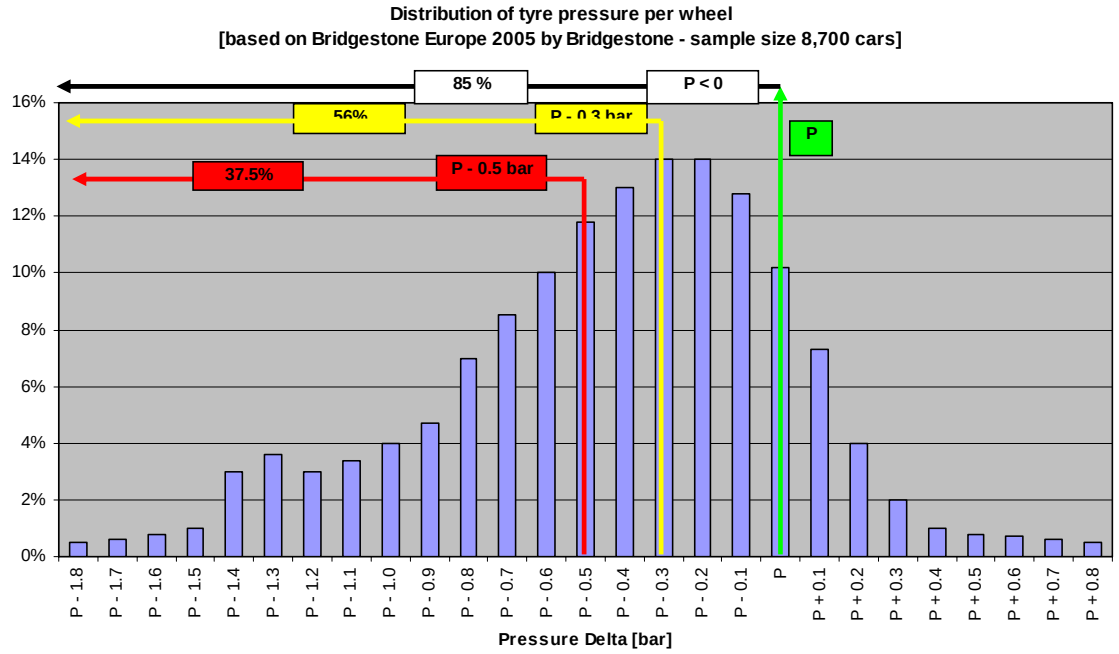
Distribution of worst tyre pressure delta per car
[based on New RDW NL survey Nov 07- Jan 08 - sample size 8250 cars]

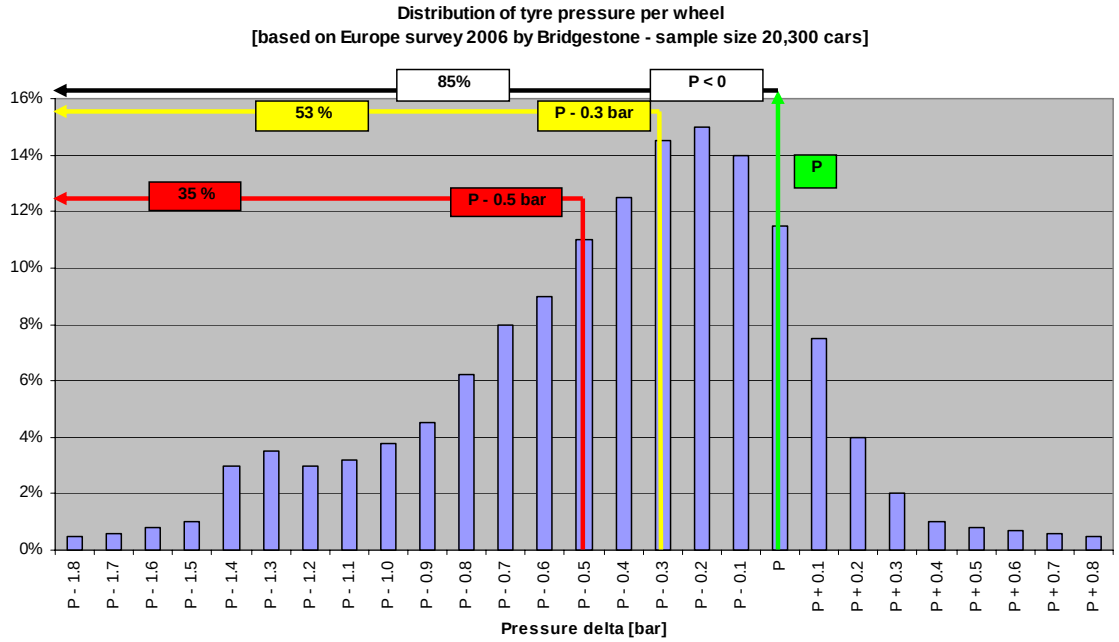


The Task Force Group (TFG) could not reach an agreement to use the Bridgestone data for the calculations (present below) because the raw data is not made publicly available to the group.

1.6. The Bridgestone data (EU – 19 countries)

Note: raw data not publicly available

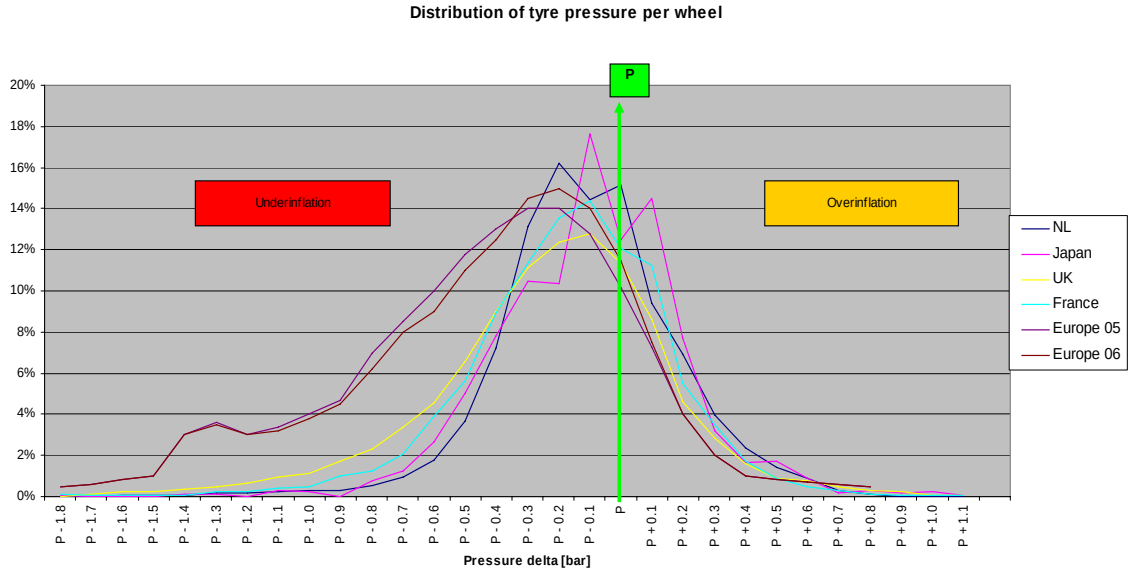




2. Detailed analysis of the data

2.1. Comparison of the data

When comparing the data under the form of a Gaussian Curve (see graph below), it is clear that all the data sets are comparable, except for the Bridgestone data (Europe 05 and Europe 06).



The TFG concludes to apply the calculation on the 5 selected data sets (paragraph 1.1 to 1.5).

2.2. In depth analysis of the NL data

For the 2 Dutch data sets, the actual “Vehicle Identification Numbers” (VIN) of each tested vehicle is available. This information allows confirming the presence of a TPMS system and if so, its type and threshold value.

1st set of NL data

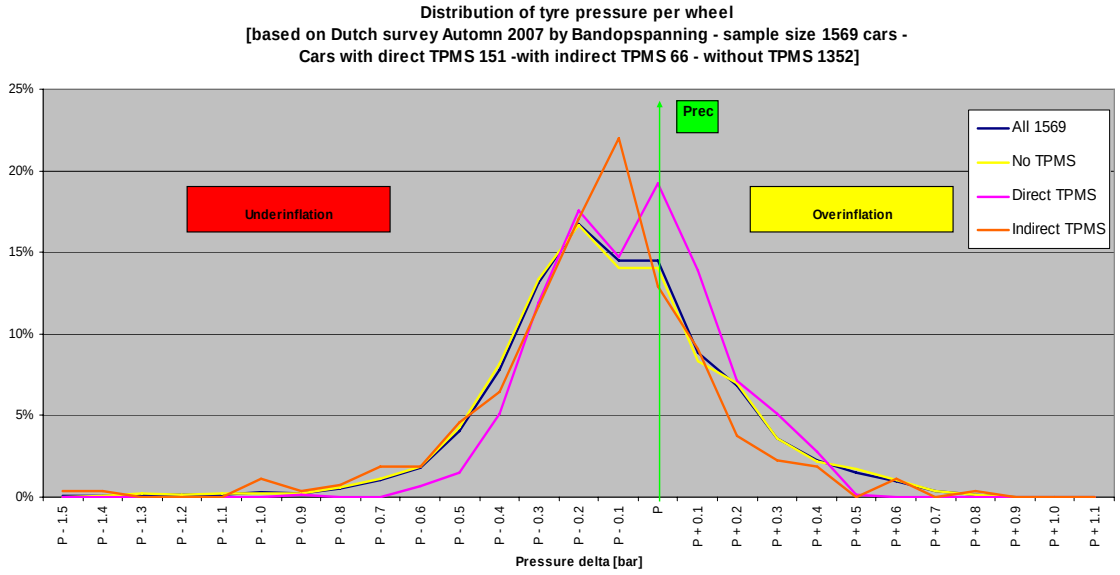
On the 1st NL survey the VIN numbers details are available for 1569 out of 2010 vehicles.
So the following information on equipment type of each car is available:

- No TPMS system (1352 cars)
- Direct system (151 cars)
- Indirect system (66 cars)

Analysis of the tyre pressure distribution (breakdown per system):

	Overall (1569)	Without TPMS	With Direct TPMS	With Indirect TPMS
At least 1 tyre Under inflated by 0.3 bar and more	47.7 %	49.3 %	35 %	44 %
At least 1 tyre Under inflated by 0.5 bar and more	18.2 %	19.5 %	5.3 %	21.2 %
% wheels under inflated by 0.3bar and more	29.5 %	30.7 %	19.4 %	29.6 %
% wheels under inflated by 0.5bar and more	8.6 %	9.2 %	2.3 %	11. 4%

The data allows representing the tyre pressure distribution (per wheel) in order to compare the effect of each system:



2nd set of NL data

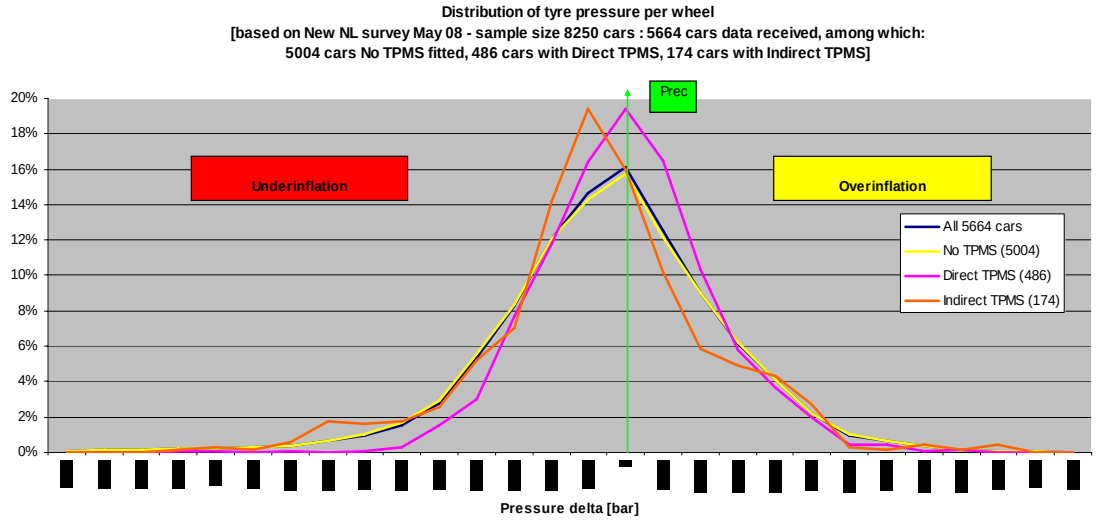
On the 2nd NL survey the VIN numbers details are available for 5664 out of 8250 vehicles.
So the following information on equipment type of each car is available:

- No TPMS system (5004 cars)
- Direct system (486 cars)
- Indirect system (174 cars)

Analysis of the tyre pressure distribution (breakdown per system):

	Overall (5664)	Without TPMS	With Direct TPMS	With Indirect TPMS
At least 1 tyre Under inflated by 0.3 bar and more	35 %	35.9 %	27.4 %	30.5 %
At least 1 tyre Under inflated by 0.5 bar and more	16 %	17.2 %	5.1 %	13.2 %
% wheels under inflated by 0.3bar and more	21 %	21.7 %	12.8 %	21 %
% wheels under inflated by 0.5bar and more	7.4 %	7.8 %	2.2 %	8.8 %

The data allows representing the tyre pressure distribution (per wheel) in order to compare the effect of each system:



3. Effect of under-inflation

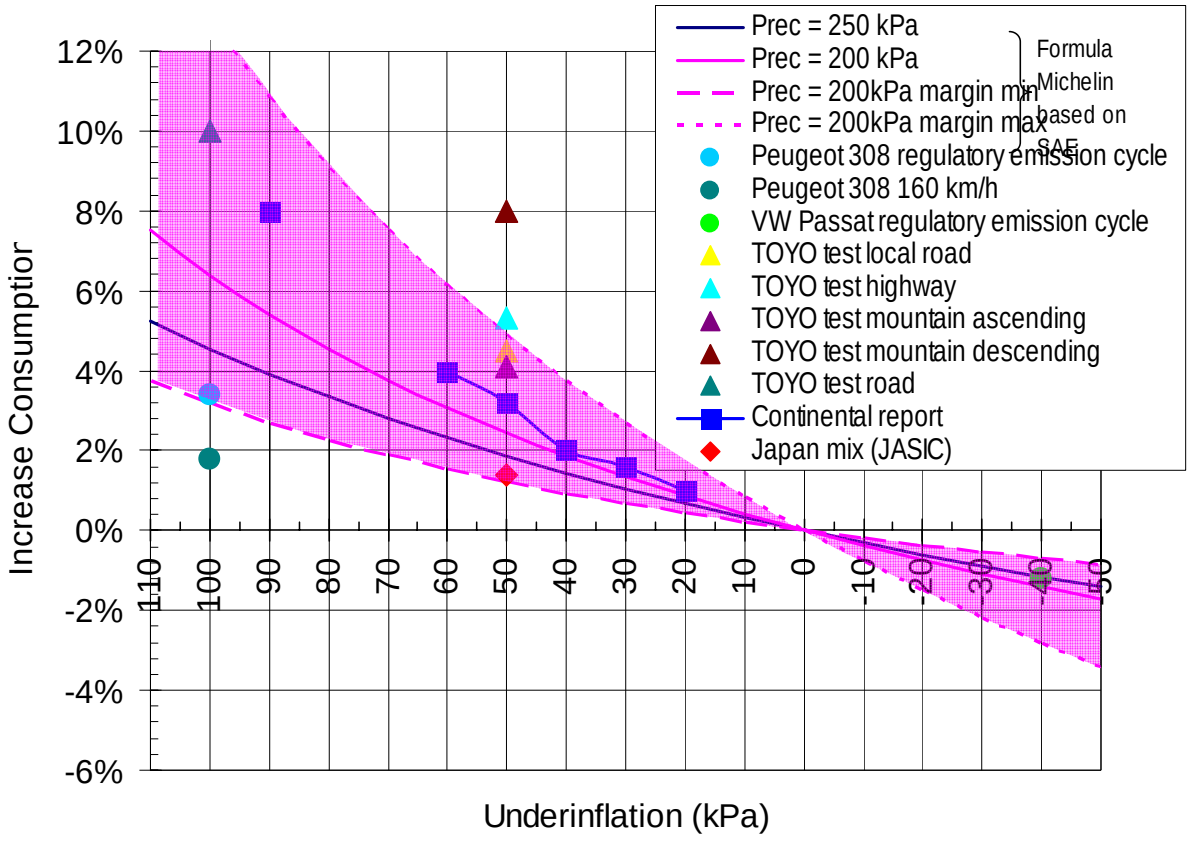
3.1. Fuel consumption

Test methods

There is data available obtained by basically different 2 test methods:

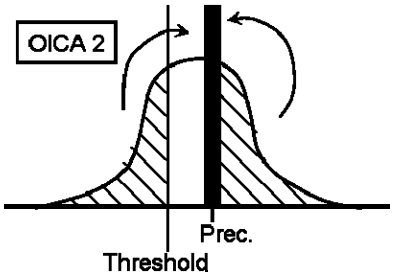
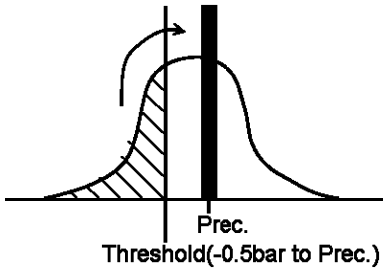
Method	Drawback
Measuring fuel consumption while driving on a road.	Speed profile not exactly repeatable.
Measuring fuel consumption by using the standard homologation test cycle on a test bench.	Test does not take into account all road conditions (e.g. tyre behavior in curves).

The TFG agrees to use a formula based on the test results obtained with the standard homologation test cycle and add a margin to the obtain a curve to compensate for the real life conditions based on the tests performed on the road.



Calculation methods

The TFG evaluated 2 different methods regarding the application of the above formula on the selected data sets of paragraph 1:

Method 1 (OICA)	Method 2 (CLEPA)
Take into account real world distribution of all vehicles that contribute to CO2 emissions (all kinds of inflation pressure, independent whether <, = or > to the recommended cold inflation pressure. Compare the average inflation pressure of vehicles equipped with TPMS to the average inflation pressure of vehicles without TPMS and calculate the difference for CO2 emissions.	Split the under inflated vehicles from the over inflated ones, as the TPMS system only gives a warning when under inflated. Compare the total effect of under inflated cars with the total effect, when all cars with a pressure below the system threshold (to be defined) are set to the recommended cold inflation pressure.
	

The TFG concluded that:

- Each of these data sets have strong and weak points:
  - The NL data is the most accurate and most detailed
  - The F, UK and JP data are covering a wider variety of vehicles and regions.
- Each calculation method has strong and weak points:
  - The OICA method is comparing the actual situation in the market, but can only be applied on a part of the Dutch study.
  - The CLEPA method is based on assumptions, but can be applied to all 4 data sets.

Comparison of the calculation methods using the (new) Dutch Data

In order to compare both calculation methods, the TFG applied the 2 method on exactly the same data set (vehicles of the new Dutch data set that are identified with/without TPMS system). This resulted in the following conclusion:

- In order to get a valid comparison analysis between the OICA and CLEPA approach, only the data where the TPMS population have a representative sample size (approx 100 min) should be considered. This is the case for Make 1 and Brand 3 data:

Make	Method 1 (OICA)	Method 2 (CLEPA)
Make 1 - 40 kPa Threshold (No TPMS pop 439)	0.55%	0.45%
Brand 3- 40 kPa Threshold (No TPMS pop 96)	0.48%	0.46%

- For these two brands, the results in fuel saving due to TPMS found by CLEPA method are very close to OICA method.
  They are even more conservative (by 5% to 20%)
- The results obtained across these 2 makes for the same threshold (40kPa) in the 2 different surveys are very similar (using CLEPA and OICA method).
- The results for the other makes/ brands are not considered statistically representative, since the sample size on which OICA based their comparison between TPMS / No TPMS is very small , and therefore don't lead to any conclusion.

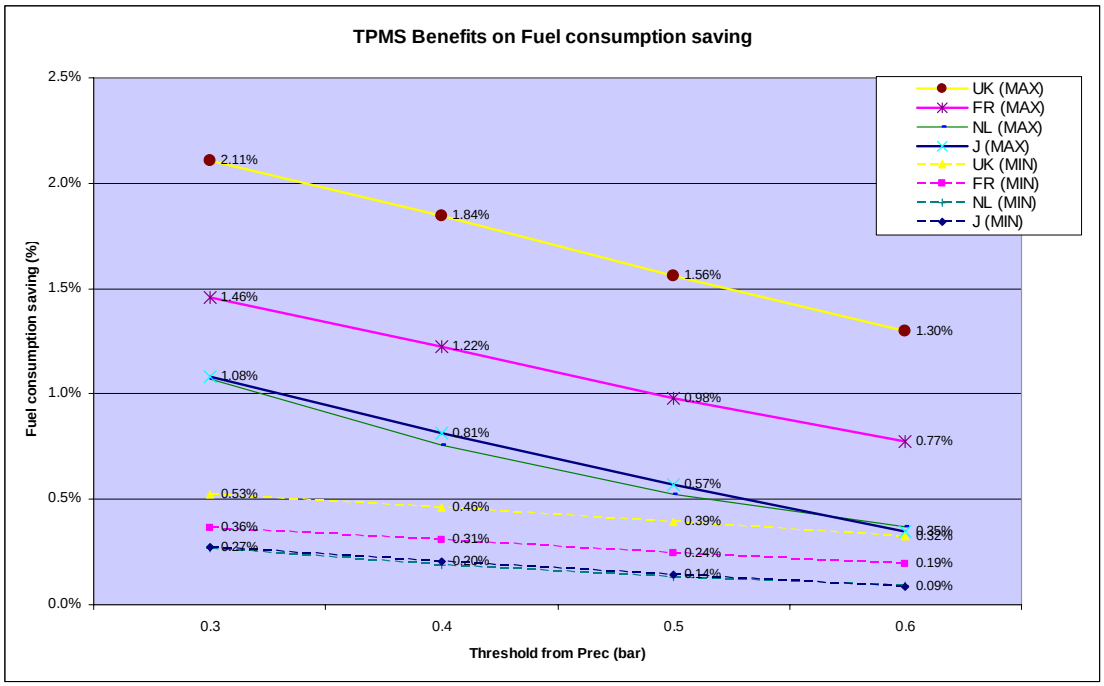
Application of method 2 to all the data sets

As the results of the 2 methods are comparable, the TFG agrees to use method 2 and apply it on all the selected data sets of paragraph 1. This gives the following results:

Threshold (bar from Prec)	0.3 bar	0.4 bar	0.5 bar	0.6 bar
Japan				
MIN (factor 0.5)	0.27%	0.20%	0.14%	0.09%
MAX (factor 2)	1.08%	0.81%	0.57%	0.35%
Netherlands				
MIN (factor 0.5)	0.27%	0.19%	0.13%	0.09%
MAX (factor 2)	1.07%	0.76%	0.53%	0.37%
France				
MIN (factor 0.5)	0.36%	0.31%	0.24%	0.19%
MAX (factor 2)	1.46%	1.22%	0.98%	0.77%
United Kingdom				
MIN (factor 0.5)	0.53%	0.46%	0.39%	0.32%
MAX (factor 2)	2.11%	1.84%	1.56%	1.30%

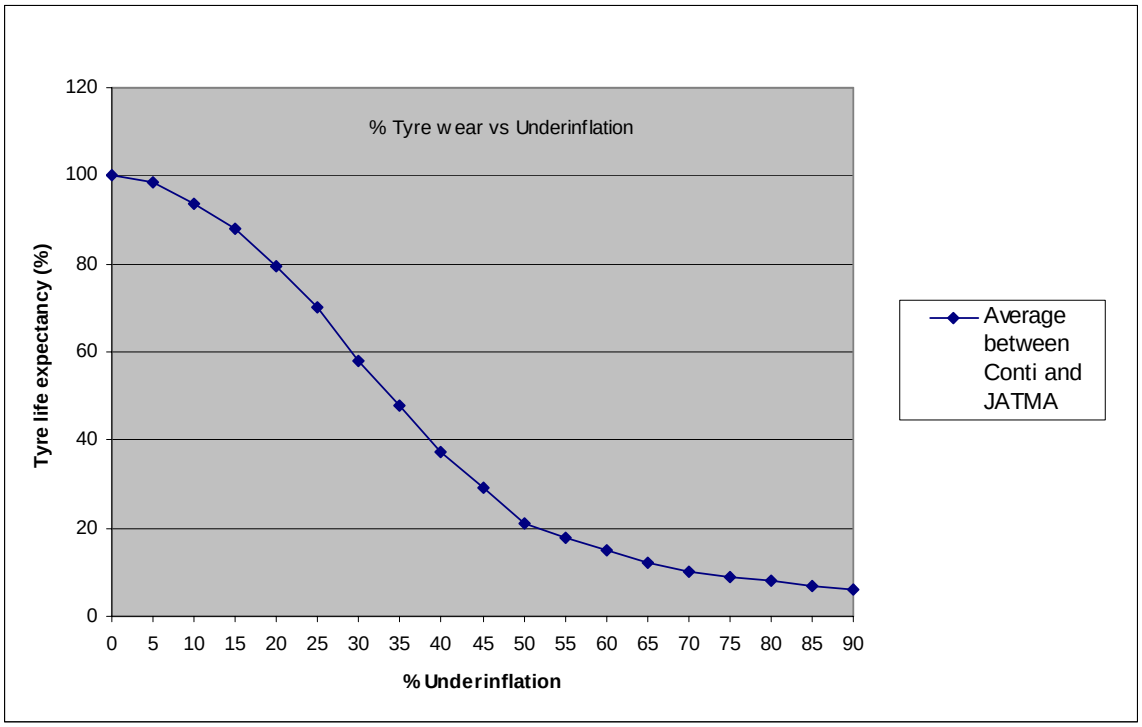
Conclusion: across Europe and Japan				
TPMS benefits range from:	**0.3% to 2.1%**	**0.2% to 1.8%**	**0.1% to 1.6%**	**0.1% to 1.3%**

Graphical presentation of the results:



3.2. Tyre wear

The TFG confirms the following graph based on the available data:



Using the above formula on the selected data sets of paragraph 1 gives the following tyre wear increase:

Tyre wear increase summary	Total
Dutch survey (%) - 4 wheels	8.17%
Japan survey (%) - 4 wheels	8.01%
UK survey (%) 4 wheels	16.06%
France survey (%) 4 wheels	11.82%
Average	*11.02%*

3.3 Road safety

The available data has a lot of variation depending on the country, the source etc. which makes it difficult to draw conclusions.

The TFG roughly estimates that:

- 0.1% to 1% of fatal accidents in Europe are caused by under inflation
- 0.1% to 1% of accidents having generated injuries in Europe are caused by under inflation

4. Causes of under-inflation

4.1. Tyre permeation

Taking into account the available data, the TFG concludes that the tyre pressure loss due to tyre permeation varies between 0.07 bar and 0.2 bar per month.

4.2. Other causes

The tyre pressure will also be reduced to other factors such as punctures (nails), damaged rims, leaky valves etc. The TFG concludes that the tyre pressure loss due to these miscellaneous factors can vary from 0.1 bar per month up to 0.1 bar per minute.

4.3. Control of tyre pressure

Taking into account the available data, the TFG concludes that 70% to 89% of the drivers admit they don't check their tyre pressure

5. Cost calculation

The TFG was unable to reach a conclusion regarding the cost estimation.
The latest version of the OICA cost calculation was distributed amongst the Task Force Members, but was not discussed in detail.

SECTION B: Commercial Vehicles (CV)

The group agrees to focus as a first priority on PC, and confirms that CV remain within the scope of work of the task force and will be analyzed in a second step.