



## **Air Pumps at U.S. Gas Stations: Major Findings Regarding Availability, Reliability and Fees**

**Joseph Stevano, M.S., Ph.D.**

Tire manufacturers, auto manufacturers and experts in consumer safety all emphasize the importance of maintaining proper tire pressure for its positive effect on driver safety, fuel economy and tire longevity. Since the typical motorist owns neither an air pump nor a pressure measuring gauge, gas station air pumps and gauges play an important role with respect to driver safety and the conservation of scarce resources.

Accordingly, this study quantifies and analyzes the major components associated with the gas station provision of air pressure services. These components can be divided into two groups: those associated with the provision of air --whether an air pump is present, whether it works and whether a fee is charged for its use-- and those associated with the measurement of air pressure --whether a gauge is present and, if so, how accurately it performs its task. Hence, this study has been divided into five parts: pump availability; pump functionality; gauge availability; gauge accuracy; and pump fees.

### **Background**

In response to the rulemaking requirement of the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, the National Highway Traffic Safety Administration (NHTSA)'s National Center for Statistics and Analysis (NCSA) conducted the National Automotive Sampling System (NASS) Tire Pressure Special Study (TPSS) in February 2001. Although the main purpose of the TPSS was to quantify the prevalence and magnitude of tire under-inflation, information regarding air pump availability, functionality and whether a fee was charged for pump use was also collected from the gas stations in the sample. This information was supplemented by the NASS Air Pump Gauge Accuracy Special Study (APGAS) which went back (August 2001) to those gas stations identified in the TPSS study as having working air pumps equipped with pressure gauges. The twin purposes of the APGAS were: 1) to evaluate the accuracy --at specified pressure levels (25, 35, 45, 55 psi)-- of the station's pressure gauge; and, 2) to identify the type of gauge used. Thus,

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**Joseph Stevano** is a Statistician employed by Rainbow Technologies, Inc., a contractor working for the Mathematical Analysis Division of the National Center for Statistics and Analysis.

in this report the data regarding the measurement of gauge accuracy come from the APGAS, while all of the other data come from the TPSS.

## Survey Methodology

In the TPSS, the gas stations were sampled using a multi-stage selection process<sup>1</sup> whose goal was to obtain a sample of gas stations -from all regions of the country- that were as representative<sup>2</sup> as possible.

The APGAS was designed to ensure that the measurement and gauge identification data were as accurate as possible by controlling for:

- i. the equipment used;
- ii. time of day at which measurements were taken;
- iii. pressure levels at which the reference pressures were set; and
- iv. the procedure followed to take the pressure measurements.

At each gas station, an identical device (Air Works 7 gallon Portable Air Tank) was pressurized using the station's pump to reference pressure levels (measured using the station's gauge ) of 25, 35, 45 and 55 psi. For each of these levels, a corresponding measurement was recorded using the researcher's gauge (in every case, the same model

of gauge was used: a Longacre Model 50402 0-60 psi Tire Pressure Gauge). The uniform procedure consisted of:

- i. taking the measurements in the above order;
- ii. for each level, first bleeding the tank to at least 20 psi less than the reference level<sup>3</sup>;
- iii. refilling the tank to the reference level (as measured by the station's gauge); and, then,
- iv. measuring the actual pressure using the researcher's gauge.
- iv. The day's second set of measurements was then obtained by repeating this same process in the same order.

In addition to ensuring uniformity of procedure and equipment, a special effort was made to make recorded measurements as independent as possible by:

- i. taking 4 different readings at each reference pressure level;
- ii. having the readings taken on two different days (two each day) by
- iii. two different researchers who were instructed to
- iv. fax his/her readings to a NASS Zone Center immediately after taking them and to
- v. not show or discuss his/her measurements with the other researcher.

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<sup>1</sup> For details, see Research Note, *Tire Pressure Special Study: Methodology*, NHTSA, August 2001, DOT-HS-809-315.

<sup>2</sup> However, please note that, since the population from which these gas stations were drawn consisted of those having at least two islands, all of the estimates reported here refer to gas stations of at least this size.

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<sup>3</sup> For example, to obtain the 45 psi measurement, the tank would first be bled down to below 25 psi.

Finally, the type of gauge the station had was identified by taking a digital photograph of the gauge, which was then emailed to NHTSA where it's type could be unambiguously determined.

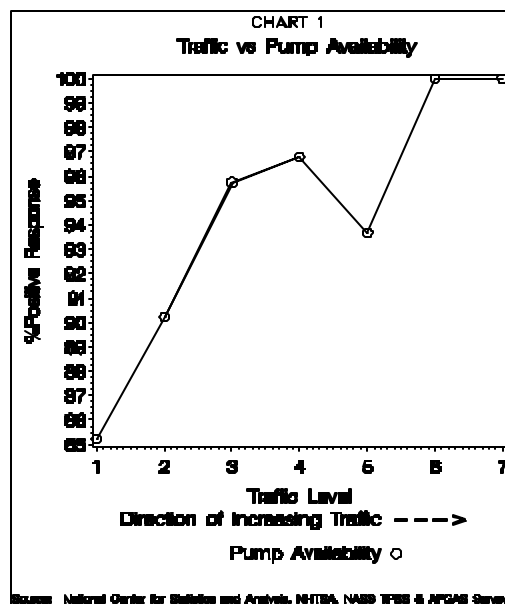
## Results: Pump Availability

The TPSS results show that it is quite common for gas stations to have air pumps: from these data NCSA estimates that 94 percent of the stations in the US have air pumps. Although this figure indicates that, in general, when a passenger vehicle pulls into a gas station the driver can feel fairly confident of encountering an air pump, it could be masking a possible problem in the sense that stations which have small amounts of traffic - specifically those in sparsely populated areas- may have a much lower probability of being equipped with an air pump.<sup>4</sup> Thus, it would be desirable to get some idea of to what extent pump availability varies with station traffic. As Chart 1 shows, there appears to be strong positive relationship between pump availability and station traffic. However, even at the lowest traffic level<sup>5</sup>

<sup>4</sup> Since urban areas tend to be well-endowed with gas stations, even if only 80 percent of the stations have air pumps, the consumer should have little difficulty in finding an air pump equipped station. On the other hand, a similar percentage in rural areas could point to exactly the opposite conclusion: since there are many fewer gas stations available, if only 80 percent of them have pumps, this may mean that some consumers will have a difficult problem finding air pumps.

<sup>5</sup> The TPSS survey provided the estimates for station traffic by counting the number of vehicles coming in to the gas pumps during five 15 minute periods starting at 8 am, 10 am, 12 pm, 2 pm and 4 pm. Thus, the station traffic was arrived at by taking the sum of the traffic during these five 15 minute periods. For this report, the data was used to partition the stations into 7 traffic levels as shown in Table 1.

(accounting for only 14 percent of the gas stations in the US), the number of stations equipped with pumps is estimated to be over 85 percent.



## Results: Pump Functionality

Pulling into a gas station and finding an air pump there is one thing, but what if it's not working? Are non-working pumps a problem, or can the consumer feel reasonably sure that if the station has a pump that it will be functioning? The data show that an estimated 9 percent of gas station air pumps will not be working. Thus, when the consumer pulls into a gas station the probability that a pump will be there and also that it will be functioning is about 86 percent.

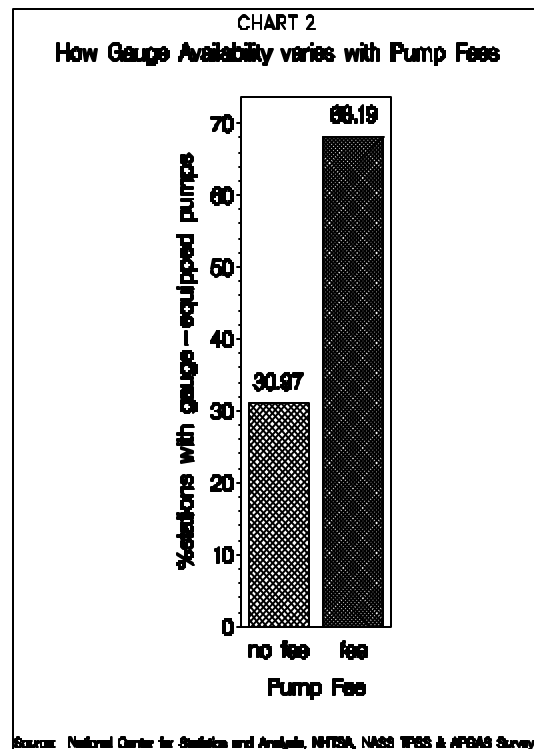
Table 1 Criteria Used to Partition Stations into Traffic Categories		
Traffic Level	Number of Vehicles in 75 mins	% of Stations in Traffic Level
1	0-15	14%
2	16-25	18%
3	26-35	23%
4	36-45	20%
5	46-60	11%
6	61-75	10%
7	76+	4%

The next step is to consider what factors play a role in determining whether a pump is working or not. Since many stations charge a fee for use of the air pump, it is reasonable to investigate the relationship between whether a fee is charged and the probability that that pump will actually be working. A priori, one would think that there should be a positive relationship between the presence of a pump fee and the probability - conditional on a pump being available - that it will actually be working: the reason being that if a fee is charged, then the owner of the pump has more of an incentive to keep it working. Although such a hypothesis seems reasonable, the actual results show the opposite: the presence of a fee actually **lowers** the probability that the pump will be working: from 95 percent if no fee is charged, to 86 percent in the presence of a fee.

### Results: Gauge Availability

Maintaining proper tire pressure requires not just using a pump, but also measuring tire pressure. Thus, it is significant that **less than half** (49 percent) of the pump-equipped gas stations also have a tire gauge.

The next thing to consider is whether this has something to do with the fact that most stations (57 percent) do not charge a fee for pump use. And, indeed, there is a strong relationship between gauge availability and pump fees. As Chart 2 illustrates, in the presence of pump fees, estimated gauge availability (conditional on a pump being available) more than doubles, going from only 31 percent to 68 percent.



### Results: Gauge Accuracy

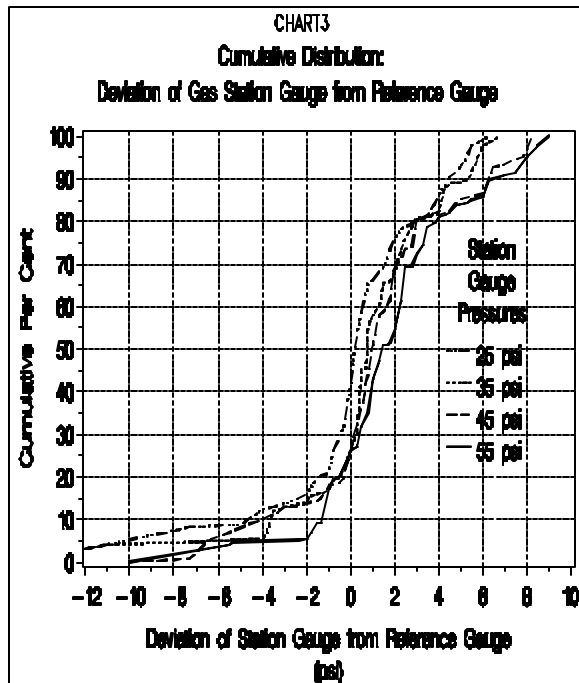
One of the most critical items this study set out to discover was exactly how much faith the consumer could place on the pressure readings given by the station's gauge.

Since the rulemaking goal specified by the TREAD Act concerned coming up with a system to report under-inflation, clearly Congress felt that under-inflation was a more dangerous problem than over-inflation. The APGAS found that, in general, gas station gauges tend to over-report, rather than under-report, the true tire pressure (thus encouraging the more dangerous under- rather than the less dangerous over-inflation). Table 2 and Chart 3, which show the distribution of the deviations between the station gauge and the reference gauge for the four reference levels, illustrate this tendency to over-report.

**Table 2**  
**Amount of Deviation (psi) of Station Gauge from Reference Gauge**  
**By Percentiles\***

Station Gauge Pressure (psi)	Percentiles										
	5th	10th	20th	25th	40th	50th	60th	75th	80th	90th	95th
25	-7.3	-4.5	-1.3	-0.7	0	0.3	0.7	2	3.1	4.6	5.3
35	-5	-3.5	-0.4	0	0.5	0.8	1.4	2.5	3	5.4	6
45	-5.9	-3.3	0	0	0.8	1	1.7	3	3.1	6.3	8
55	-2.7	-1	-0.2	0	1	1.5	2.3	3.4	3.9	6.8	8.1

Note: Negative values indicate under-reporting: measurement of the station gauge is less than the researcher's gauge. Positive values indicate over-reporting: measurement of the station gauge is greater than the researcher's gauge.  
Source: National Center for Statistics and Analysis, NHTSA, APGAS Survey, Aug. 2001



Source: National Center for Statistics and Analysis, NHTSA, NACS TPSS & APGAS Surveys

The APGAS also found that the higher the recommended tire pressure, the greater the probability of encountering a station whose gauge will over-report the actual pressure (leading motorists to under-inflate their tires). For example, at a pressure level of 25 psi, 25 percent of station gauges over-report pressure by at least 2 psi; at pressure levels of 35 and

45 psi, about 32 percent of station gauges over-report by this amount; while at 55 psi, about 45 percent of station gauges over-report pressure by at least 2 psi.

While over-reporting of 2 psi may not be significant, many station gauges did over report by a substantial amount. Table 3 shows the percentage of station gauges over-reporting by 4 psi or more.

**Table 3**  
**Over-Reporting by Station Gauges**  
**By Pressure Levels and Level of Over-reporting**  
**(Percent Over-reporting)**

Station Gauge Pressure (psi)	Percent over-reporting		
	by 4 psi or more	by 6 psi or more	by 8 psi or more
25	16	2	0
35	19	9	0
45	19	14	5
55	20	15	9

Source: National Center for Statistics and Analysis, NHTSA, APGAS Survey, Aug. 2001

As Table 3 shows, at a pressure level of 45 psi, 5 percent of station gauges over-

report tire pressure by 8 psi or more; while at a pressure level of 55 psi, over-reporting of this magnitude occurs at nearly one station in ten.

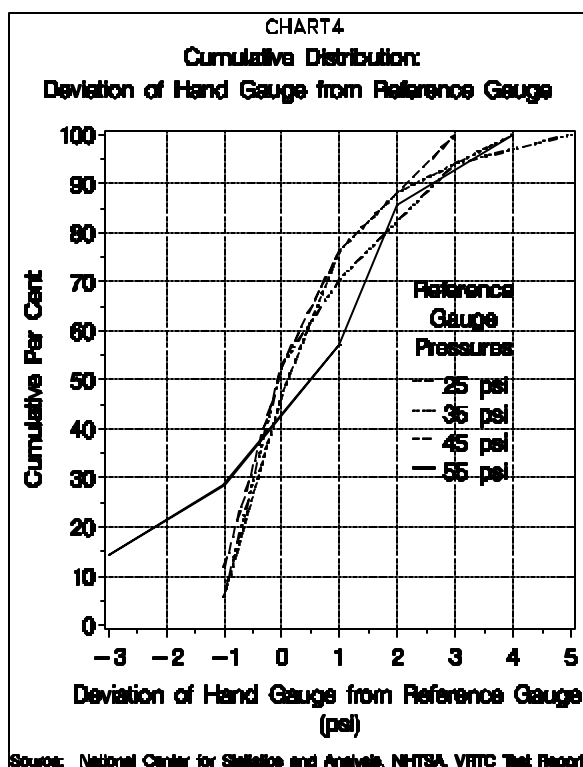
Between (depending on the pressure level) 16 and 20 per cent of gas station gauges over-report pressures by at least 4 psi (Table 3). Thus, for about one gas station in five, it will be the case that a motorist filling his tires to the recommended pressure will, in fact, have unknowingly under-inflated them by at least 4 psi.

At 35 psi, which is at or close to the recommended tire pressure for most passenger cars and SUVs, 9 percent of station gauges over-report by 6 psi or more. That is, at nearly one station in ten, the motorist relying on the station gauge to fill the tires of his car or SUV to their recommended pressure will, in fact, be unknowingly under-inflating them by 6 psi or more.

Given these findings, the question arises as to whether a motorist would be better off bringing his own gauge. NHTSA's Vehicle Research and Test Center (VRTC) tested 17 new<sup>6</sup> commercial gauges and found that, as was the case with gas station gauges, hand held gauges tend to over- rather than under-report pressures (thus encouraging under-, rather than over-, inflation). Mean deviation from the reference gauge ranged from 0.6 psi (at a pressure level of 55 psi) to 1.6 psi (at a pressure level of 25 psi). Five percent (Chart 4) of the hand held gauges over-reported pressures by at least 4 psi (pressure level, 25 psi) while, at the other pressure levels, between 2.5 percent and 0

percent of the hand held gauges over-reported by at least 4 psi.

Finally, the 17 gauges were partitioned<sup>7</sup> into digital and non-digital (i.e., dial and pencil) gauges. The mean deviations for non-digital gauges ranged from 1.3 psi (pressure levels, 35-45 psi) to 1.8 psi (pressure level, 55 psi); in contrast, digital gauges showed a mean deviation of 0.1 to 0 psi at all pressure levels.



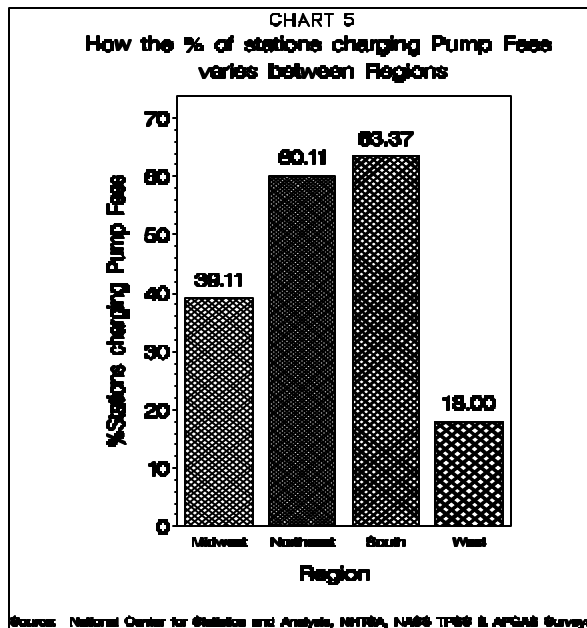
## Results: Pump Fees

Overall, an estimated 43 percent of the pump-equipped gas stations in the US charge a fee for use of their air pump. However, this study found that whether or not a fee is charged varies greatly (Chart 5) from region to region.

<sup>6</sup> Thus, unlike the gas station data, the hand gauge data does not reflect the impact of wear and tear on gauge accuracy.

<sup>7</sup> The measurement mechanism of dial/pencil gauges is fundamentally different from that of digital gauges: the latter is mechanical while the former is electronic (Chip Chidester/Art Carter, NHTSA).





In the West only 18 percent of the gas stations charge a fee for pump use, while in the South, fees are charged 63 percent of the time.

## Conclusions

1) Overall, the probability that a randomly selected gas station will have an air pump is 94 percent.

2) Pump availability does vary positively with the volume of traffic through a gas station: the higher the traffic, the more likely it is to have an air pump (there appears to be a high floor for this percentage: even among those stations in the lowest quintile of volume, the probability that they would have a pump available is still in excess of 85 percent).

3) Overall, the probability that a randomly selected gas station will have a functioning air pump is 86 percent.

4) Surprisingly, if a fee is charged for use of a pump, the probability is greater that the pump will **not** be working.

5) Given that a station has an air pump,

the estimated probability that that air pump will also have a gauge<sup>8</sup> is only around 50 percent.

6) The presence of a pump fee substantially increases the probability that a station will have an air pump equipped with a tire pressure gauge.

7) Station gauges tend to over-, rather than under-, report the true tire pressure (thus encouraging the more dangerous under- rather than the less dangerous over-inflation).

8) The magnitude by which station gauges over-report tire pressure is significant: between 16 percent and 20 percent of station gauges over-report by at least 4 psi (all pressure levels); for pressures of 35-55 psi, between 9 percent and 15 percent over-report by at least 6 psi while for pressure levels of 45-55 psi, between 5 percent and 9 percent of station gauges will over-report by 8 psi or more.

9) Like station gauges, hand held gauges tend to over- rather than under-report tire pressures (thus leading motorists to under-, rather than over-, inflate their tires). Nevertheless, hand held gauges were not only much less likely to over-report tire pressures by 4 psi or more but, unlike station gauges, none of the hand holds over-reported by more than 8 psi.

10) Overall, about 43 percent of U.S. gas stations charge a fee for pump use.

11) The probability that a fee will be charged for pump use **is** regionally dependent (varying from a low of 18 percent in the West to a high of 63 percent in the South).

<sup>8</sup> I.e., the probability that a gas station will have a tire gauge conditional on it having an air pump.

## Concluding Note

With respect to tire gauges, two things must be emphasized. First, only about 50 percent of station pumps are equipped with a gauge. Secondly, gas station gauges tend to over-report tire pressures (i.e., give readings which exceed the actual pressure). Consequently, motorists who rely solely on a station gauge to evaluate their pressure face a high probability of unknowingly under-inflating their tires. For both these reasons it is advisable that motorists bring and use their own gauge.

How seriously could they be under-inflating their tires? It depends on the pressure to which they inflate their tires. In the 25-35 psi range (the recommended tire pressure range for virtually all passenger cars and SUVs) nearly one station gauge in five will over-report tire

pressure by at least 4 psi. At 35 psi, nearly one station in ten will give a reading which exceeds the actual pressure by at least 6 psi (thus, a motorist inflating his tires to a recommended pressure of 35 psi will, in fact, pull out of such stations with an actual pressure of 29 psi or less).

Finally, most drivers do not randomly select the gas station at which they check their tire pressures -instead, they probably have a particular gas station which they frequent and at which they check their tire pressure. Thus, without even realizing it, at about one station in five it is the case that drivers who rely on the station's gauge to check their tire pressure are using a gauge that over-reports the pressure by 4 psi or more, thus causing them to under-inflate their tires by this amount.

For additional copies of this research note, please call (202)366-4198 or fax your request to (202)366-3189. For questions regarding the data reported in this research, contact Joseph Stevano [202-366-2219] of the National Center for Statistics and Analysis. This research note and other general information on highway traffic safety may be accessed by internet users at <http://www.nhtsa.dot.gov/people/ncsa>.

U.S. Department  
of Transportation  
**National Highway  
Traffic Safety  
Administration**

400 Seventh Street, S.W., NRD-31  
Washington, D.C. 20590

