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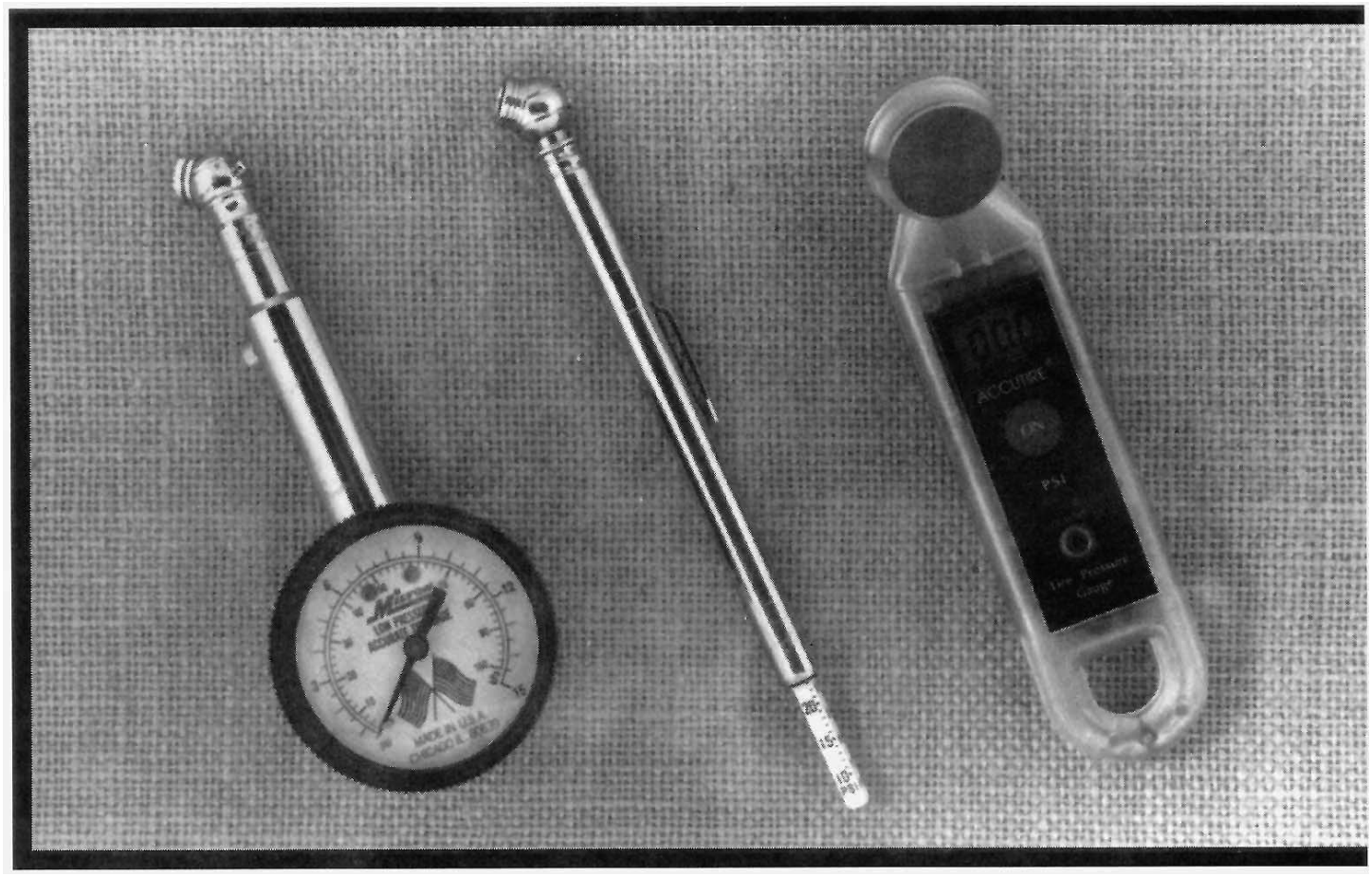

Comparison Tests on Tire Pressure Gauges

A Co-operative Program Between
Alberta Agriculture, Food and Rural Development
Alberta Farm Machinery Research Centre

COMPARISON TESTS ON TIRE PRESSURE GAUGES

INTRODUCTION

The growing use of radial tires on farm tractors along with the recently lowered allowable inflation pressures for radial tires increase the importance of accurate “on farm” tire inflation pressure measurements. Incorrect tractor tire inflation costs money. Overinflated tractor tires reduce traction performance, increase fuel costs and contribute to ride and power hop problems. Underinflated tires wear rapidly and are more susceptible to damage and flats.

Accurate tire inflation pressure measurement requires accurate tire pressure gauges. The Alberta Farm Machinery Research Centre (AFMRC) tested a range of tire pressure gauges to evaluate their performance. Readability, accuracy, durability, repeatability and resistance to damage from tractor tire ballast solutions were evaluated.

TYPES OF GAUGES

The tire gauges commonly used on farms are of three major types: pencil or “stick”, dial and digital readout. Individual gauge models cover a range of pressures and are usually purchased for a specific range of pressure measurement.

Pencil gauges consist of a metal or plastic casing, a pocket clip and a deep set chuck, usually with a pressure release bump on the opposite side. Pressure scales are marked on an indicator bar that extends when air pressure is applied to the gauge. To use the gauge, the chuck end is placed on a tire valve and the indicator bar slides out of the gauge a distance corresponding to the pressure in the tire.

Dial gauges consist of a protective casing around a dial indicator with a pressure scale on the dial background. An air chuck is attached to the dial either rigidly or with a section of flexible tubing.

To use the gauge, the chuck is placed on the tire valve and the indicator needle rotates over the scale corresponding to the pressure.

Digital readout gauges consist of a protective casing around some form of digital readout with the necessary electronics to drive the readout. An air chuck is attached to the casing either rigidly or with a section of flexible tubing. To use the gauge, the chuck is placed on the tire valve, the gauge is turned on, and the digital display indicates the pressure.

GAUGES TESTED

Representative samples from each of the three pressure gauge types were tested, including six different pencil gauges, three different dial gauges and one digital gauge. Three gauges were marked only in english units while the other seven had both english and metric units. The english unit scale was always pound per square inch (psi) while the metric unit scales varied between kilopascal (kPa), bar and kilogram per square centimetre (kg/cm^2). The pencil and dial gauges tested were in various pressure ranges and have been grouped as low pressure or higher pressure gauges. Low pressure gauges were defined as those from 0 to 20 psi (0 to 138 kPa) and higher pressure gauges as those from 5 to 60 psi (34 kPa to 413 kPa). The digital gauge tested had a pressure range of 0.5 to 150 psi (3.5 to 1034 kPa).

Gauge Names and Model Numbers:

Low Pressure	Higher Pressure
Pencil Pencil	
- Bridgeport 40-399	- Bridgeport 40-402
- Milton s917	- Milton s928
- Motomaster	- Superex
Dial	Dial
- Milton s901	- Power Fist
- Superex	
Digital	
- Accutire	

SUMMARY OF RESULTS

Three samples of each gauge were tested to evaluate accuracy, repeatability, readability, durability and resistance to damage from tractor tire ballast solutions. Test details and evaluation criteria are described in the Test Description section. TABLE 1 ranks the various gauges in order of overall performance and shows their performance in each of the evaluation categories.

Accuracy: Accuracy is a measure of the difference between the indicated gauge reading and the actual pressure reading.

Average pressure readings that were within 5 percent of the true pressure were considered acceptable. Three of the gauges, the Milton s928 pencil gauge, the Superex dial gauge and the Power Fist dial gauge showed unacceptable accuracy levels throughout their range and were rated as poor. The remainder of the gauges were acceptable. Two gauges, the Superex pencil gauge and the Milton s901 dial gauge showed average readings within 2 percent of the true readings and were rated excellent.

Repeatability: Repeatability is a measure of the ability of a gauge to show the same value when taking multiple readings of the same pressure. The repeatability of three of the gauges, the Milton s928 pencil gauge, the Superex dial gauge and the Power Fist dial gauge was poor. For these gauges, the differences in readings within the sample set varied as much as 4 psi (28 kPa). The repeatability of the other gauges was acceptable. For these gauges, the repeated measurements taken by individual gauges were within 0.3 psi (2 kPa) on average. The differences in readings within each set of these gauges was within 0.6 psi (4 kPa).

Readability: Readability is a measure of the ease of determining a pressure with a gauge. Considering the readability of the gauges tested, the digital gauge was the easiest to read, followed by the dial gauges and finally the pencil gauges. No estimation or interpretation was required or possible when reading the digital gauge. Being able to see the entire scale on the dial gauges made it easier to estimate between two marked points with the dial gauges than with the pencil gauges.

Durability: The digital and pencil gauges were unaffected in the durability tests and were ranked as acceptable. All the dial gauges were damaged to varying degrees and were ranked as poor.

Ballast: Exposure to liquid chloride ballast solution affected all the gauges. In general, if the gauges were not cleaned well after being exposed to ballast, their accuracy and reliability suffered.

Assuming a vigorous water rinse after each use, three pencil gauges, the Superex. Motomaster and Bridgeport 40-402 were ranked as acceptable with chloride ballast. Even with careful cleaning the other gauges were significantly affected by the ballast and were ranked as poor. The Milton s928 pencil gauge was specifically designed to be used with ballasted tires but suffered

Table 1. Gauge Performance Summary (ranked from best to worst)

GAUGE	TYPE	PRICE (CDN $)	PRESSURE (psi)	ACCURACY	REPEATABILITY	READABILITY	DURABILITY	BALLAST
Superex	Pencil	6.00	10 to 50	Excellent	Excellent	Excellent	Excellent	Acceptable
Motomaster	Pencil	6.00	0 to 20	Acceptable	Acceptable	Excellent	Acceptable	Acceptable
Bridgeport 40-402	Pencil	9.00	5 to 45	Acceptable	Excellent	Acceptable	Acceptable	Acceptable
Bidgeport 40-399	Pencil	8.00	0 to 20	Acceptable	Acceptable	Excellent	Acceptable	Poor
Accutire	Digital	30.00	10 to 150	Acceptable	Acceptable	Acceptable	Acceptable	Poor
Milton s901	Dial	20.00	0 to 15	Excellent	Excellent	Acceptable	Poor	Poor
Milton s917	Pencil	8.00	0 to 20	Poor	Acceptable	Acceptable	Acceptable	Poor
Milton s928	Pencil	8.00	5 to 50	Poor	Poor	Acceptable	Acceptable	Poor
Superex Dial	Dial	8.00	8 to 60	Poor	Poor	Excellent	Poor	Poor
Power Fist	Dial	5.00	8 to 60	Poor	Poor	Excellent	Poor	Poor

a significant and continuing decrease in accuracy with continuing exposure to ballast.

CONCLUSIONS

In selecting and using tire pressure gauges for farm tractor tires, the following can be done to improve the accuracy of the resulting measurements:

1. Select gauges that are designed to measure in the desired pressure range. The best accuracy is obtained when using gauges to measure pressures that are not near the limits of the designed range of the gauge.
2. Select gauges with scale graduations that are easy to read in the desired pressure range.
3. Check that gauges are accurate within the desired pressure measurement range. Gauge accuracy should preferably be checked against a known reference or at least against another gauge.
4. Recognize that exposure to liquid ballast can affect the accuracy of any tire gauge whether designed to be used with ballast or not. After using a gauge on a ballasted tire, rinse out the gauge thoroughly with water and if appropriate for the gauge, oil the mechanism. Regularly recheck the calibration on gauges that have been exposed to ballast.
5. Store tire gauges in a clean, protected and moisture free environment.
6. Avoid dropping, jarring and exceeding the maximum pressure on tire gauges. If a gauge is dropped or over pressured, check the gauge against a reference to see if it still reads correctly.
7. Dispose of any gauges found to be damaged or inaccurate.

TEST DESCRIPTION

For each gauge model selected, three separate samples were tested. The results were averaged to produce a group value for the gauge type. The samples for each gauge were tested through a range of pressures that covered the designed range of operation.

The gauge readings for accuracy and repeatability were taken using a standard tire valve stem connected to an air supply. A pressure regulator and an air tank were used to regulate and vary the air pressure supplied to the valve stem. A Druck DPI 601 digital pressure indicator, accurate to within 0.05 psi (0.34 kPa), was connected in parallel with the valve stem and used as the reference. Since correct tractor tire inflation pressures can range from as low as 6 psi (40 kPa) to upwards of 30 psi (200 kPa), readings were taken at intervals across the 6 to 30 psi (40 to 200 kPa) range or as much of that range as a particular gauge covered. Once the regulator was adjusted to deliver a desired pressure, the gauge under test was placed on the valve stem and the pressures indicated by the gauge and the meter were recorded. At each test pressure three separate measurements were taken with each gauge, removing and replacing the gauge for each measurement. All pressure measurements were recorded in psi since this scale was common to all the gauges tested. After the readings were completed across the scale range, the recorded values were analyzed to determine the accuracy and the repeatability of each set of gauges.

Accuracy is a measure of the difference between the gauge reading and the actual pressure reading. An acceptable accuracy level was defined by considering that the pressure in a nominally 20 psi (138 kPa) tractor tire can vary as much as 1 psi (6.8 kPa) with temperature changes from morning to evening. This 5 percent variation is considered acceptable by tire manufacturers. Accordingly, a three gauge set was ranked acceptable if the maximum average error of the set in the operating range was less than 5 percent, and ranked poor if the maximum average error of the set was greater than 5 percent. Gauge sets with a maximum average error in their operating range of less than 2 percent were ranked as excellent. A 5 percent variation at 30 psi (207 kPa) would be 1.5 psi (10 kPa) and at 6 psi (41 kPa) would be 0.3 psi (2 kPa).

Repeatability is a measure of the ability of a gauge to show the same or similar value when repeatedly measuring the same pressure. Gauges were ranked for repeatability using the standard deviation of the measurements for the set. Standard deviation reflects the scatter of the reading values from the average or mean reading. Individual gauges or sets with a standard deviation of 0.2 or less were ranked as excellent, those with a standard deviation between 0.2 and 0.4 were ranked as acceptable and those with a standard deviation greater than 0.4 were ranked as poor. For each gauge set, sections of the pressure range were noted where the repeatability was low but where multiple readings could be taken and averaged together to obtain a reliable and repeatable average measurement.

The readability and the ease of use of the gauges were noted throughout testing and pertinent observations were recorded. During the measurements on the ballasted tractor tire, comments on the readability and ease of use of each gauge on a tire were also recorded. Based on these comments, overall gauge readability was then rated as either excellent, acceptable or poor.

Durability was tested by dropping one gauge sample from each set onto a concrete floor from a height of 3 ft (0.91 m), 5 ft (1.52 m) and 6 ft (1.83 m). At each height the gauge was dropped three times, each time aligned to impact at a different orientation. The orientations were: First, flat on one side for the pencil gauges and flat with the scale face up for the dial and digital gauges; second, chuck end first for all the gauges; and third, the end opposite the chuck first for all the gauges. Any damage that occurred was recorded. Each gauge was tested for changes in accuracy after being dropped from each height. The same accuracy standards were applied that were used for the original accuracy tests. Gauges that did not change in accuracy were ranked as excellent in durability. Gauges that changed in accuracy but did not move out of their previous accuracy ranking were ranked acceptable. Those that changed in accuracy and moved out of their previous accuracy ranking were ranked as poor. Gauges that experienced any damage that affected the usability of the gauge were also ranked as poor.

The effect of chloride tire ballast solutions on the accuracy and repeatability of the gauges was determined by exposing one gauge sample from each set to ballast. The pressure of a tire filled with standard calcium chloride liquid ballast was taken three times with the sample gauges. Each gauge was then cleaned by rinsing in warm water. Gauges were oiled if appropriate. The gauges were left to sit for 24 hours (one day) and then tested for changes in accuracy. Next, the same pressure measurements on the ballast filled tire were then repeated but the gauges were left uncleaned for 48 hours (two days) and then tested for accuracy changes. Finally the same pressure measurements on the ballast filled tire were repeated and the gauges were left uncleaned for one week. The gauges were then tested again for changes in accuracy. The same accuracy standards were applied that had been used for the original accuracy tests. If the gauge accuracy was not significantly affected, whether the gauge had been cleaned or not, the gauge was ranked as excellent. If the accuracy was not significantly affected when the gauge had been cleaned well, the gauge was ranked as acceptable. If the accuracy was affected even with cleaning, the gauge was ranked as poor. Gauges showing any damage or changes in physical appearance from the ballast that affected the use the gauge were also ranked as poor. The tests did not address any longer, term effects that chloride ballast may have had on the gauges.

INDIVIDUAL GAUGE RESULTS

Performance summaries follow for each gauge, arranged in alphabetic order. The gauge performance summary describes the gauge and gives the test results. Each summary has two photos, the first an overall view of the gauge and the second a close-up of the reading area of the gauge. Each summary also contains two graphs, the first showing the average accuracy of the gauge and the second showing the pressure error range.

On the average accuracy graph, the solid line is the average of the gauge readings plotted against true pressure values. The dashed line is the true pressure line (zero gauge error). Deviations from this line indicate gauge errors. The start and stop points of the solid line are marked and indicate the range of pressures where the gauge will function. At each of the test pressure points a vertical bar shows the range of the individual measurements recorded at that pressure. Longer bars indicate greater scatter in the measurements.

On the pressure error graph, the vertical spread of the points shows the repeatability of the readings in the gauge set. The larger the spread, the lower the repeatability of the gauge set. Additionally, the point locations show the direction of the errors and how the errors varied across the pressure test range.

Manager: R, P. Atkins **Project Engineer: Reed Turner**

ACCUTIRE DIGITAL GAUGE

Made in USA:
Measurement Specialists, Inc.
41 Plymouth Street
Fairfield, New Jersey 07004

DESCRIPTION

This is a single scale digital pressure gauge, reading from 0 to 150 psi with a resolution of 0.5 psi. The gauge has a light weight plastic casing with a liquid crystal display and is powered by a “life of the gauge” non replaceable battery. Below the display is an ON button and below that a SET ZERO button.

ACCURACY

Acceptable. The maximum individual gauge error was 1 psi (6.8 kPa) and the maximum average percent error of the set was 3.3 percent. This is shown by the deviations the gauge readings take from the line of absolute accuracy in the graph.

REPEATABILITY

Acceptable. Individual gauges all showed excellent repeatability. The repeatability of the set was not as good but still acceptable. The standard deviation of the readings for the set was 0.37.

READABILITY

Acceptable. Before using the gauge, it must be calibrated to set a zero value. This is done by pressing and holding the SET ZERO button until 188.8 appears on the display, releasing the button and waiting until 0 appears on the display. To use the gauge, it must be placed securely on the valve stem. Once the gauge is seated in place, the ON button is depressed and the gauge held securely on the valve stem until it ‘beeps’, usually about 5 seconds. The liquid crystal digital read out then shows the pressure. The reading remains for about 5 seconds and then the gauge automatically shuts off. This gauge can be difficult to operate in hard to reach areas. Holding the gauge seated on the valve as the ON button is depressed typically requires two hands. The digital display is clear and easily read in bright or dim light. Because of the finite values shown on the display, it is impossible to interpolate between two readings.

DURABILITY

Acceptable. No significant changes in gauge accuracy occurred during the drop tests.

BALLAST

Poor. After the third exposure to ballast the gauge read 1 to 2 psi lower than previous readings. Some ballast remained in the gauge following the tests and ballast which leaked out of the gauge crystallized around the inside of the chuck. There was no way to take the gauge apart and clean or remove the ballast.

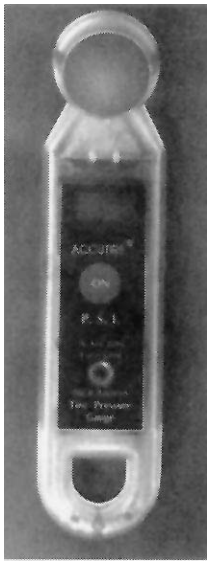

Figure 1. Overall view of gauge.

Figure 2. Gauge pressure indicator.

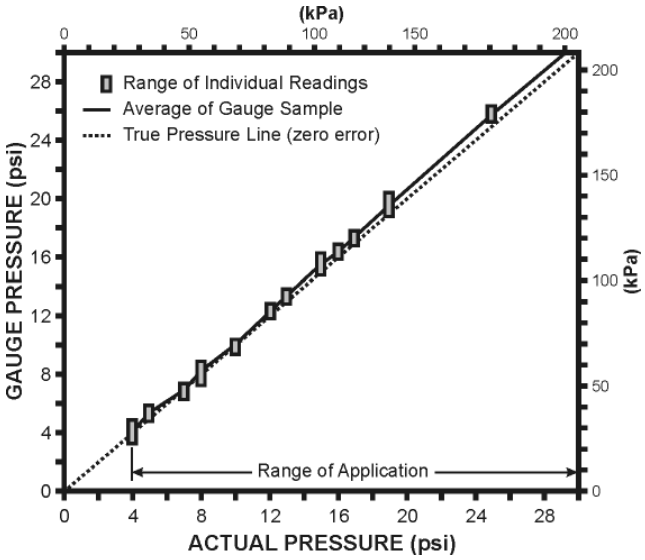

Figure 3. Gauge accuracy.

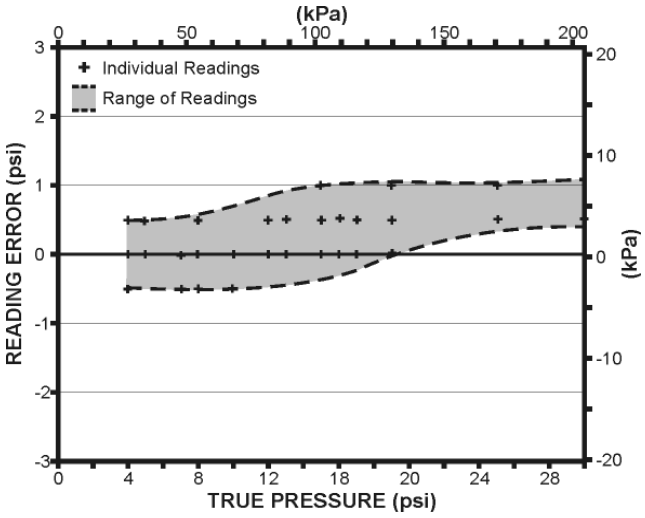

Figure 4. Pressure error.

BRIDGEPORT 40-399 PENCILGAUGE

Made in USA, distributed by:
Docap Corporation Limited
Rexdale, Ontario
M9W 5M2

DESCRIPTION

This is a low pressure single scale pencil gauge designed for use on air shocks and low pressure tires on recreational vehicles. The scale is marked from 1 to 20 psi with a 0.5 psi resolution. One gauge sample had a black indicator band to mark the reading and the other two had red indicator bands. The metal body and the chuck of the gauge is made of red coloured aluminum. The gauge is approximately 1/3 the weight of a steel pencil gauge.

ACCURACY

Acceptable. The maximum individual gauge error was 0.5 psi (3.4 kPa) and the maximum average percent error of the set was 4.4 percent. The maximum average percent error occurred at the low end of the range. Above 9 psi (62 kPa) the error was always less than 2 percent.

REPEATABILITY

Acceptable. Throughout the range of the gauge, the repeatability was acceptable. The standard deviation of the readings for the set was 0.311. Throughout the range of the gauge one reading was sufficient to obtain a reliable average measurement.

READABILITY

Excellent. Measurements could be read to 0.5 psi. The gauge retained the reading until the indicator bar was reset. No difference in ease of reading was found between the red and black indicator bands. During the ballast test the gauge was easy to read and operate.

DURABILITY

Acceptable. No significant changes in gauge accuracy occurred during the drop tests. The only visible damage was a slight dent on the chuck.

BALLAST

Poor. The accuracy of the gauge was affected by the ballast. The sample gauge read up to 2 psi low after the tests. Most of the ballast was expelled from the gauge when the gauge was removed from the tire valve and reset.

Figure 1. Overall view of gauge.

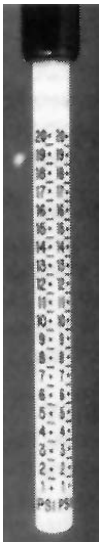

Figure 2. Gauge pressure indicator.

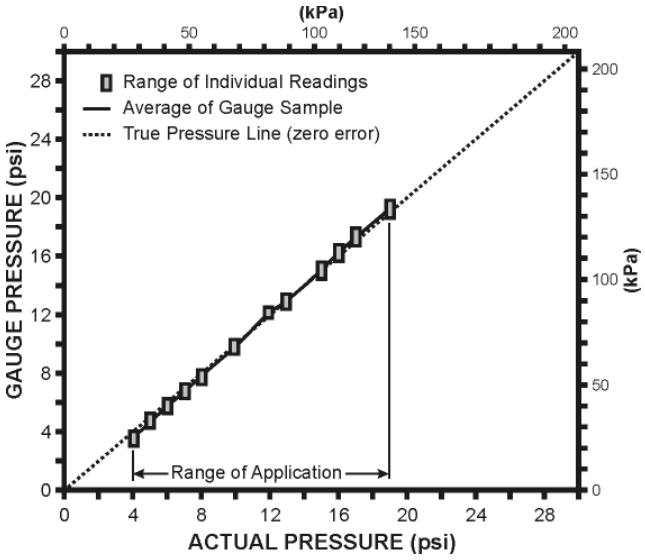

Figure 3. Gauge accuracy.

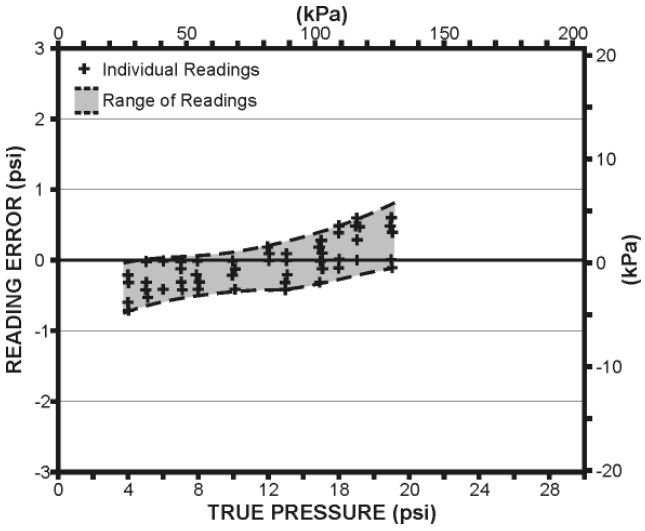

Figure 4. Pressure error.

BRIDGEPORT 40-402 PENCIL GAUGE

Made in USA, distributed by:
Docap Corporation Ltd.
Rexdale, Ontario
M9W 5M2

DESCRIPTION

This is a single scale pencil gauge designed for use on air and liquid ballast filled tires. The scale is marked from 5 to 45 psi with a resolution of 1 psi. A red indicator band marks the reading. The indicator bar is designed to retract and expel ballast from the gauge when the gauge is removed from the tire valve stem. The metal body and the chuck of the gauge is made of polished steel. While the packaging indicates that this gauge can be used from 10 to 50 psi, the actual gauge is marked from 5 to 45 psi.

ACCURACY

Acceptable. The maximum individual gauge error was 0.8 psi (5.5 kpa) and the maximum average percent error of the set was 6.1 percent. This occurred at the low end of the gauge range and the percent error decreased as the pressure increased. This is shown in by the gauge pressure approaching the true pressure line as the pressure increases (FIGURE 3).

REPEATABILITY

Excellent. The repeatability of the individual gauges was acceptable. The standard deviation of the readings for the set was 0.20. As shown in FIGURE 4, the repeatability was lower at pressures below 16 psi. Pressure readings taken below 16 psi should be repeated three times and averaged to obtain a reliable measurement.

READABILITY

Acceptable. Measurements could be read to 0.5 psi. Since the indicator bar was designed to retract when the pressure was removed, readings had to be taken while the gauge was on the tire valve. This made obtaining a measurement difficult if the tire valve stem was in an awkward place.

DURABILITY

Acceptable. No significant changes in gauge accuracy occurred during the drop tests.

BALLAST

Acceptable. No significant change in accuracy occurred after the first two exposures to ballast. Most of the ballast was expelled from the gauge as the indicator reset when the gauge was removed from the tire valve. The accuracy of the gauge was slightly affected after the ballast was left in the gauge for one week. Cleaning the gauge after use should limit the effects of ballast on the gauge.

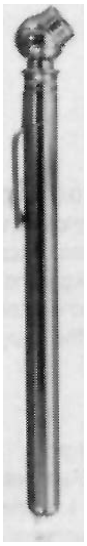

Figure 1. Overall view of gauge.

Figure 2. Gauge pressure indicator.

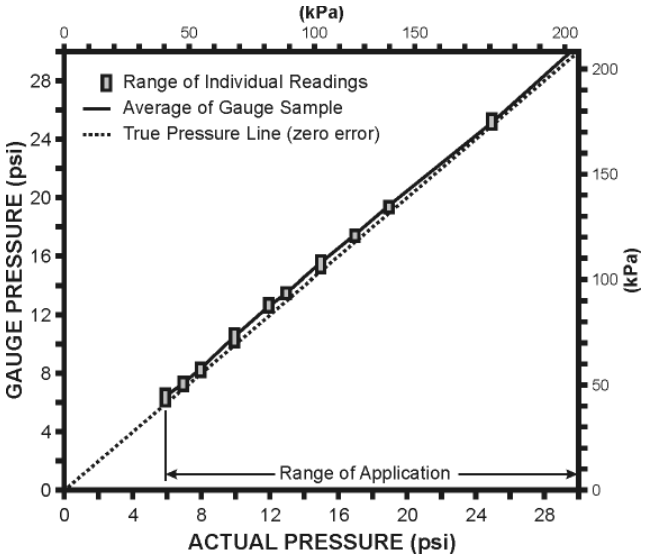

Figure 3. Gauge accuracy.

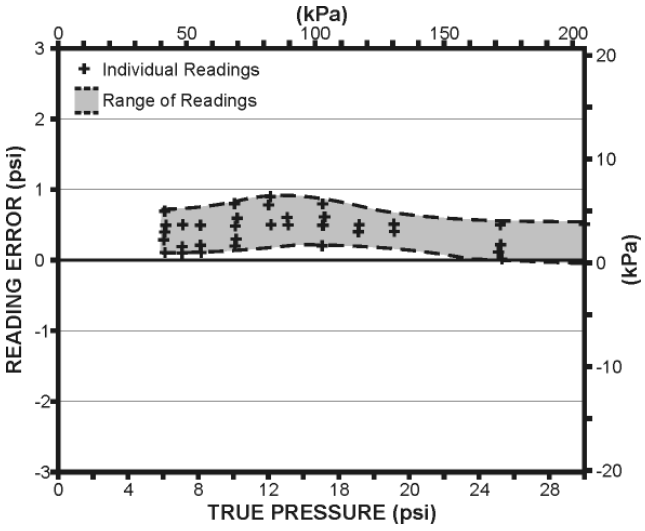

Figure 4. Pressure error.

MILTON s901 DIAL GAUGE

Made in USA:
Milton Industries Inc.
Chicago, Illinois

DESCRIPTION

This is a dual scale low pressure dial gauge marked from 0.5 to 15 psi with a resolution of 0.5 psi and from 4 to 100 kPa with a resolution of 2 kPa. The gauge has a silver metal stem attached to a black plastic casing around the dial face. The dial face has a white background with the psi scale in blue and the kPa scale in red. A black hand indicates the reading. The gauge has an air release button to reset the gauge after a reading.

ACCURACY

Excellent. The maximum individual gauge error was 0.5 psi (3.4 kPa) and the maximum average percent error of the set was 2.8 percent. This low percent error is shown in FIGURE 1 by the gauge readings being very close to the line of absolute accuracy.

REPEATABILITY

Excellent. Individual gauges all showed excellent repeatability. The standard deviation of the readings for the set was 0.19. Throughout the range of the gauge one reading was sufficient to obtain a reliable average measurement.

READABILITY

Acceptable. Measurements could be read to 0.25 psi or 1 kPa. Only one of the sample gauges retained the reading until the gauge was reset. The gauges that did not retain the reading were harder to read since readings had to be taken while the gauge was on the tire valve stem. The orientation of the chuck and the scale were different for each sample gauge. On some gauges the orientation was such that the scale was difficult to see when the chuck was on the valve stem.

DURABILITY

Poor. The accuracy of the gauge decreased after the gauge was dropped from 3 ft (0.91 m) and decreased again after the 5 ft (1.52 m) drop. No testing could be completed after the gauge was dropped from 6 ft (1.83 m) because the chuck could no longer be placed over the valve stem. The face of the gauge was also damaged.

BALLAST

Poor. The accuracy of the gauge decreased as the exposure time to ballast increased. Ballast material remained in the gauge after the ballast tests. When the gauge was retested, the air forced ballast out of the gauge. The ballast expelled from the gauge was an orange/rust colour indicating that a chemical reaction was occurring inside the gauge. On disassembly, the gauge had parts that were beginning to corrode. After exposure to ballast the gauge should be disassembled and cleaned to maintain the accuracy of the gauge. Gauge disassembly was difficult and time consuming.

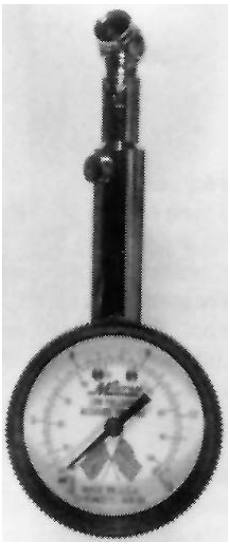

Figure 1. Overall view of gauge.

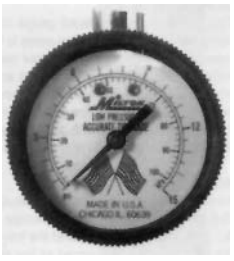

Figure 2. Gauge pressure indicator.

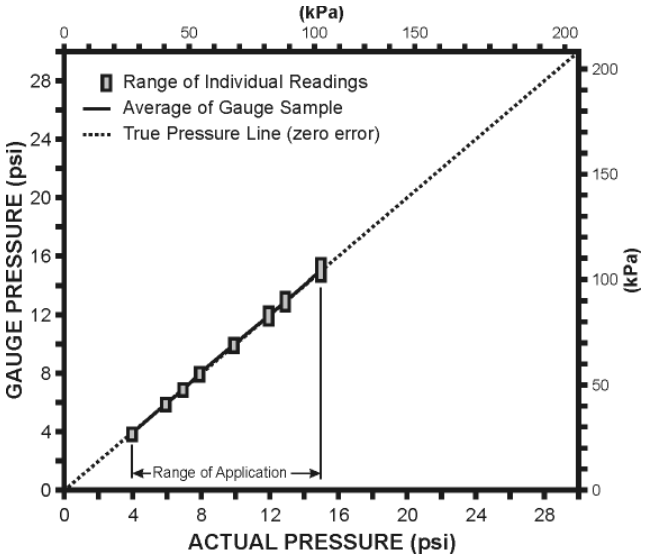

Figure 3. Gauge accuracy.

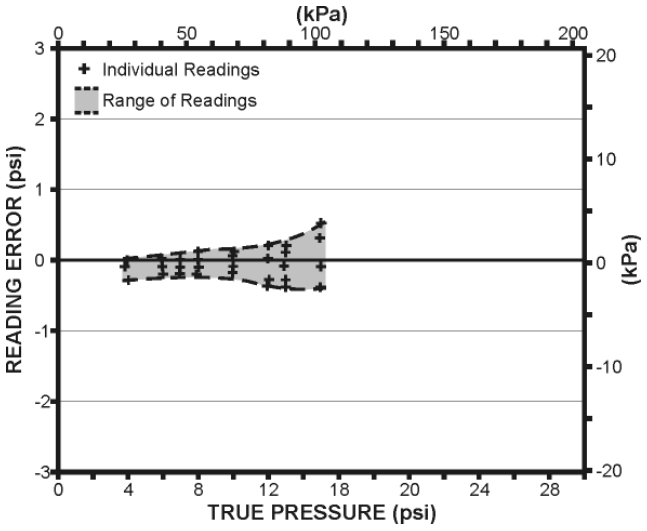

Figure 4. Pressure error.

MILTON s917 PENCIL GAUGE

Made in USA:
Milton Industries Inc.
Chicago, Illinois

DESCRIPTION

This is a low pressure dual scale pencil gauge designed for use on all terrain vehicles, golf carts and air lift springs. The scales are marked from 2 to 21 psi with a resolution of 1 psi and from 20 to 150 kPa with a resolution of 10 kPa. The pressure scales appear on alternating sides of the indicator bar. A red indicator band marks the readings. The metal body and the chuck of the gauge is made of polished steel.

ACCURACY

Poor. The maximum individual gauge error was 1.5 psi (10.3 kPa) and the maximum average percent error of the set was 16.7 percent. The percent error was highest at pressures less than 10 psi (69 kPa). FIGURE 3 shows that the gauge was consistently off from 0.6 to 1.1 psi throughout its range.

REPEATABILITY

Acceptable. Throughout the range of the gauge, the repeatability was acceptable. The standard deviation of the readings for the set was 0.22. Throughout the range of the gauge one reading was sufficient to obtain a reliable average measurement.

READABILITY

Acceptable. Measurements could be read to 0.5 psi (2.5 kPa). The scale marking numbers were large and easy to read. More precise readings were difficult to make because large spaces between scale marks resulted in part of the scale marks being hidden. The gauge retained the reading until the indicator bar was reset. During the ballast test this gauge took longer to read than the other pencil gauges because of the limited scale markings.

DURABILITY

Acceptable. No significant changes in the accuracy of the gauge occurred during the drop tests.

BALLAST

Poor. The accuracy and the repeatability of the gauge decreased after each exposure to ballast. This happened even though most of the ballast was expelled from the gauge when the gauge was removed from the tire valve and reset.

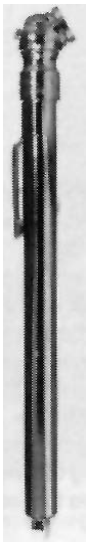

Figure 1. Overall view of gauge.

Figure 2. Gauge pressure indicator.

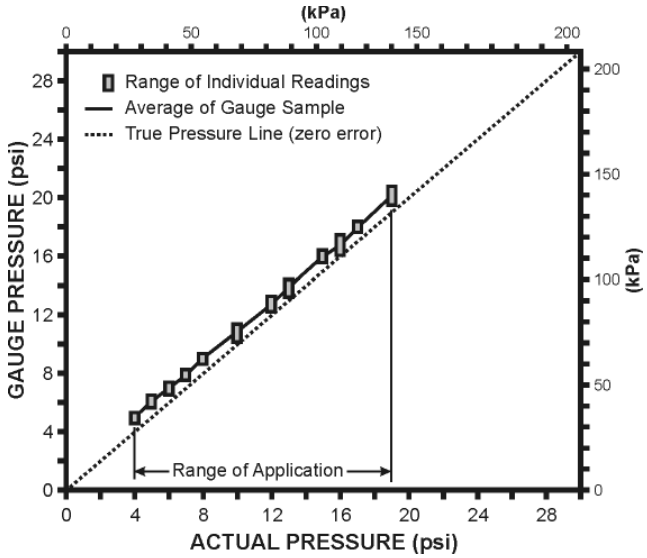

Figure 3. Gauge accuracy.

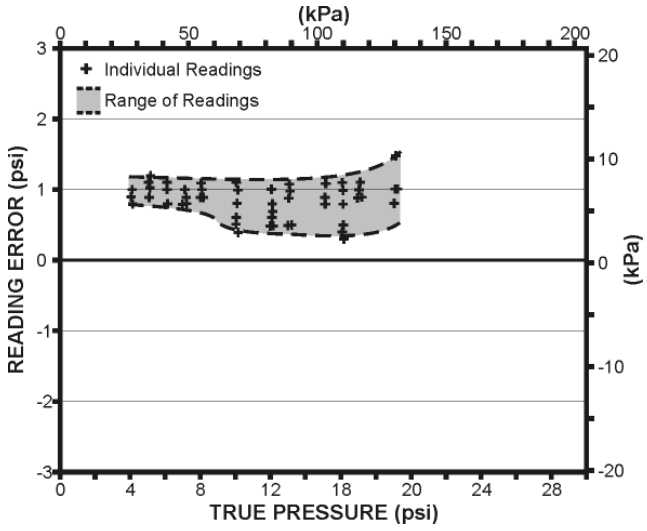

Figure 4. Pressure error.

MILTON s928 PENCIL GAUGE

Made in USA:
Milton Industries Inc.
Chicago, Illinois

DESCRIPTION

This is a dual scale pencil gauge designed for air and liquid ballast filled tires. The scale is marked from 5 to 50 psi with a resolution of 1 psi and from 40 to 310 kPa with a resolution of 10 kPa. The different scales appear on alternating sides of the indicator bar. A red indicator band marks the reading. The indicator bar is designed to retract and expel ballast from the gauge when the gauge is removed from the tire valve stem. The metal body and the chuck of the gauge is made of polished steel. Cleaning instructions to be followed after the gauge has been exposed to ballast are included with the gauge. These instructions suggest rinsing by placing the chuck end in warm water and pulling and releasing the indicator bar several times. After cleaning the gauge is to be lubricated by placing light oil in a hole in the side of the gauge.

ACCURACY

Poor. The maximum individual gauge error was 2.5 psi (17.2 kPa) and the maximum average percent error of the set was 19.1 percent. The percent error decreased as the pressure increased but never went below 5 percent.

REPEATABILITY

Poor. Individual gauges all showed acceptable repeatability but the variations within the set of gauges was relatively high. The standard deviation of the readings for the set was 0.40. Pressure readings taken below 16 psi (kPa) should be repeated three times and averaged to obtain a reliable average measurement.

READABILITY

Acceptable. Measurements could be read to 0.5 psi or 5 kPa. Since the indicator bar was designed to retract when the pressure was removed, readings had to be taken while the gauge was on the tire valve. This made obtaining a reading difficult when the tire valve stem was in an awkward place.

DURABILITY

Acceptable. No significant change in accuracy occurred during the drop tests. The only visible damage was a slight dent to the chuck.

BALLAST

Poor. The accuracy of the gauge decreased with each successive exposure to ballast. Most of the ballast was expelled from the gauge when the indicator reset itself as the gauge was removed from the tire valve. Instructions that came with the gauge suggested that to reduce ballast entering the gauge, measurements should be taken with the tire valve at top of the tire, and that before the gauge was placed on the tire valve stem, the stem should be cleaned by releasing air from the tire.

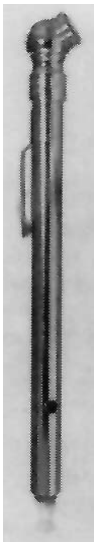

Figure 1. Overall view of gauge.

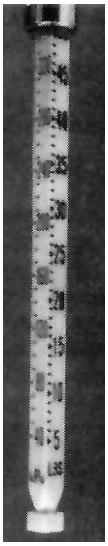

Figure 2. Gauge pressure indicator.

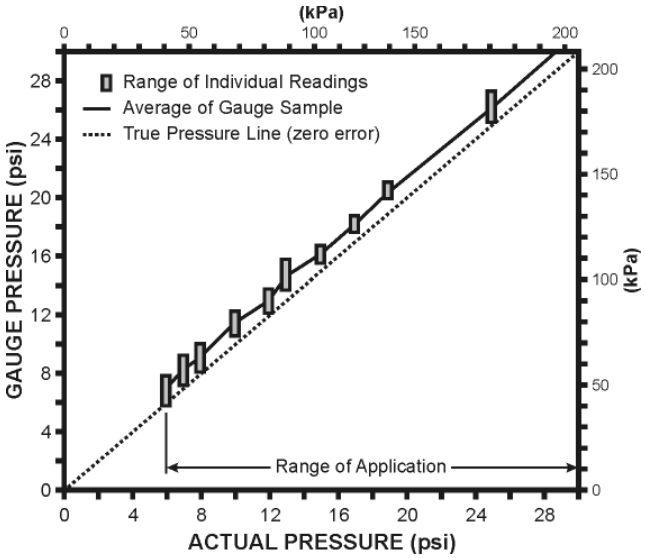

Figure 3. Gauge accuracy.

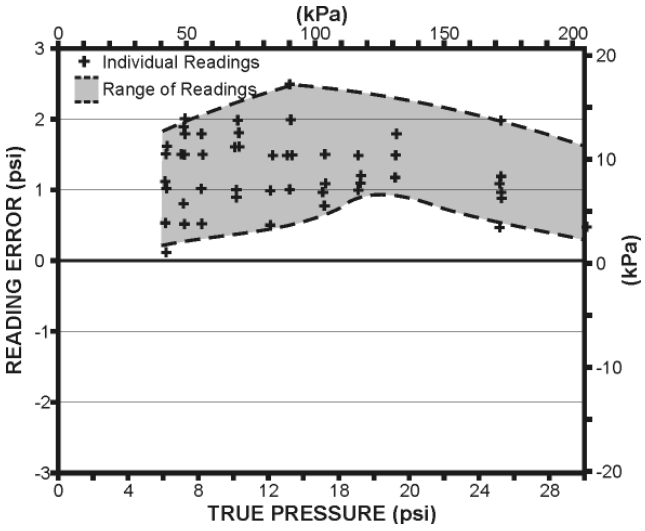

Figure 4. Pressure error.

MOTOMASTER PENCIL GAUGE

Part No. 09-5503-6

Made in USA, imported by:
Canadian Tire Corporation Ltd.
Toronto, Ontario
M4P 2V8

DESCRIPTION

This is a low pressure dual scale pencil gauge designed for use on home and garden tractors, dune buggies and ATV's. The scale is marked from 1 to 20 psi with a resolution of 0.5 psi and from 10 to 135 kPa with a resolution of 5 kPa. The psi and kPa scales appear on alternating sides of the indicator bar. A black indicator band marks the reading. The metal body and the chuck of the gauge is made of polished steel.

ACCURACY

Acceptable. The maximum individual gauge error within the range was 1.1 psi (7.6 kPa) and the maximum average percent error of the set was 4.5 percent. All samples of this gauge showed a constant percent error of around 4 percent. This is shown in FIGURE 3 by the gauge readings deviating slightly from the true pressure line as the pressure increases.

READABILITY

Excellent. Measurements could be read to 0.5 psi or 5 kPa. During the ballast test the prominent scale markings made this gauge particularly easy to read. The gauge retained the reading until the indicator bar was reset.

REPEATABILITY

Acceptable. Individual gauges all showed excellent repeatability but small variations existed between different gauges. The standard deviation of the readings for the set was 0.30. Within the range of the gauge one reading was sufficient to obtain a reliable average measurement.

DURABILITY

Acceptable. No significant change in the accuracy occurred during the drop tests. The only visible damage was a slight dent on the chuck.

BALLAST

Acceptable. No significant changes in gauge accuracy occurred after the gauge was exposed to ballast. Most of the ballast was expelled from the gauge when the gauge was removed from the tire valve and reset.

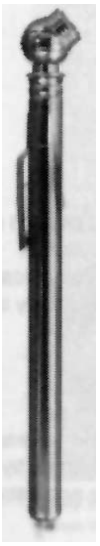

Figure 1. Overall view of gauge.

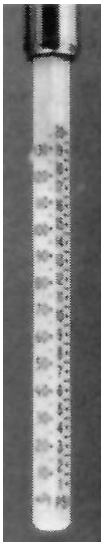

Figure 2. Gauge pressure indicator.

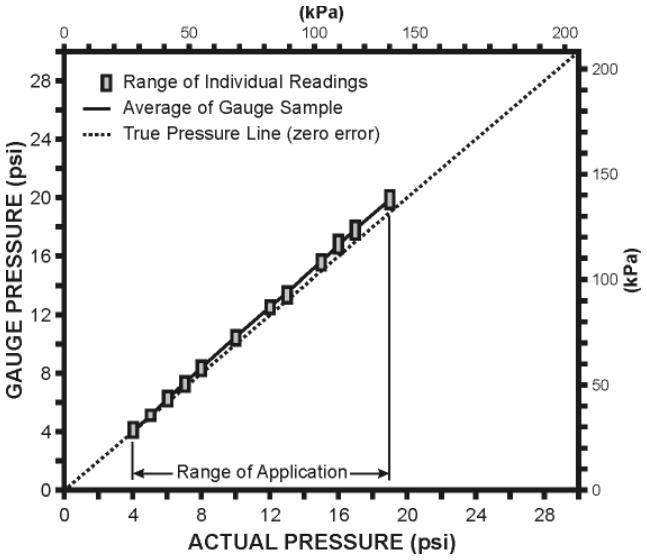

Figure 3. Gauge accuracy.

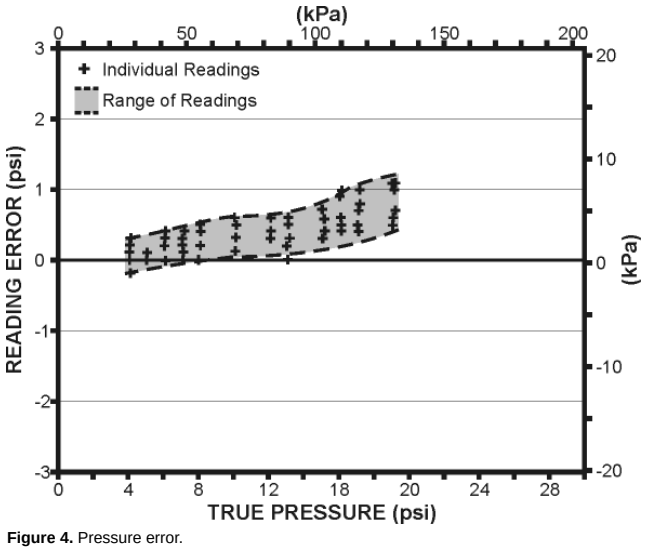

Figure 4. Pressure error.

POWER FIST DIAL GAUGE
Item 4271656

Made in Taiwan, imported by:
Princess Auto Ltd.
P.O. Box 1005
Winnipeg, Manitoba
R3C 2W7

DESCRIPTION
This is a dual scale dial gauge marked from 8 to 60 psi with a resolution of 2 psi and from 0.5 to 4.3 bar with a resolution of 0.1 bar. The gauge has a black plastic casing with a black face and white scale markings. A red hand indicates the reading. The gauge has an air release button to reset the gauge after a reading.

ACCURACY
Poor. The maximum individual gauge error was 4.5 psi (31 kPa) and the maximum average percent error for the set was 24.3 percent. The percent error decreased as the pressure increased, although as shown in FIGURE 4 the average error of the gauge was usually above 1 psi (6.9 kPa).

REPEATABILITY
Poor. Two sample gauges showed acceptable individual repeatability but unacceptable variations occurred with the third sample and with the set of gauges. The standard deviation of the readings for the set was 1.04. Pressure readings within the range of the gauge should be repeated five times and averaged to obtain a reliable average measurement.

READABILITY
Excellent. Measurements could be read to 0.5 psi or 0.05 bar. The gauge retained the reading until it was reset. The white lettering stood out well on the black background and was easy to read.

DURABILITY
Poor. The accuracy of the gauge decreased during the drop tests. Although no permanent physical damage occurred, the gauge came apart when it was dropped from 6 feet (1.82 m) onto concrete. The gauge was subsequently put back together and tested.

BALLAST
Poor. Exposure to ballast decreased both the accuracy of the gauge and the repeatability of the gauge. Gauge disassembly to remove the ballast was difficult and time consuming.

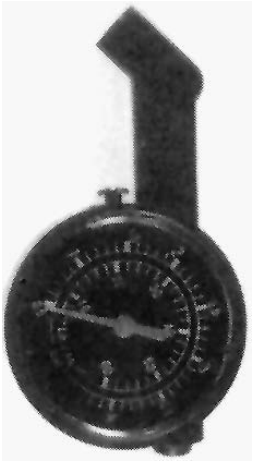

Figure 1. Overall view of gauge.

Figure 2. Gauge pressure indicator.

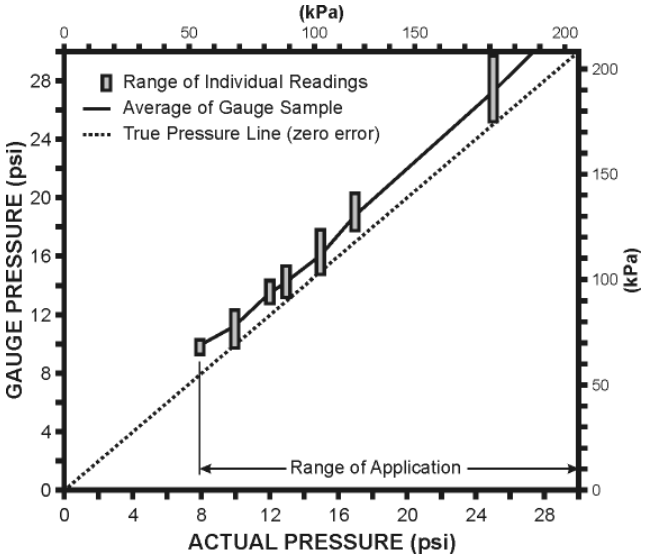

Figure 3. Gauge accuracy.

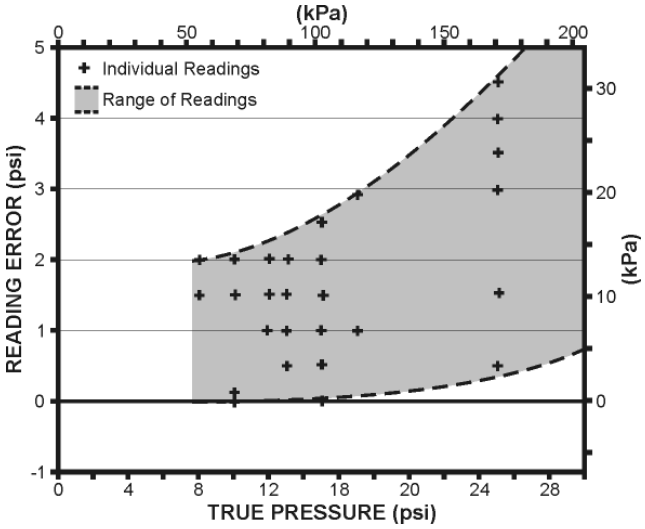

Figure 4. Pressure error.

SUPEREX DIAL GAUGE
Code No. 50-128

Made in USA, imported by:
Superex Canada Ltd.
Toronto, Ontario
M2H 3B8

DESCRIPTION
This is a dual scale dial gauge marked from 8 to 64 psi with a resolution of 2 psi and from 0.4 to 4.5 kg/cm² with a resolution of 0.1 kg/cm². The gauge has a metal stem and scale casing. The scale has a white face with black lettering and a red indicator hand. The gauge has an air release button to reset the gauge after a reading.

ACCURACY
Poor. The maximum individual gauge error was 4.5 psi (31 kPa) and the maximum average percent error for the set was 25.6 percent. The percent error decreased as the pressure increased, although as shown in FIGURE 4 the error of the gauge was usually above 2 psi (13.8 kPa).

REPEATABILITY
Poor. Individual gauges all showed poor repeatability. The standard deviation of the readings for the set was 1.02. All pressure readings should be repeated five times and averaged to obtain a reliable average measurement.

READABILITY
Excellent. Measurements could be read to 0.5 psi or 0.05 kg/cm². The gauge retained the reading until it was reset.

DURABILITY
Poor. After completion of the drop tests there was a slight change in the accuracy of the gauge. The protective cover broke off the face of the gauge and left the needle unprotected.

BALLAST
Poor. The accuracy of the gauge decreased after the second exposure to ballast and decreased further after the third exposure. Ballast material remained in the gauge after the ballast tests. Gauge disassembly to remove the ballast was difficult and time consuming.

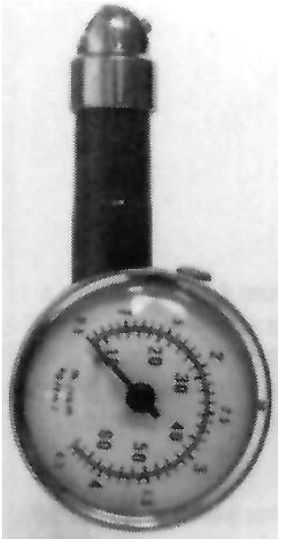

Figure 1. Overall view of gauge.

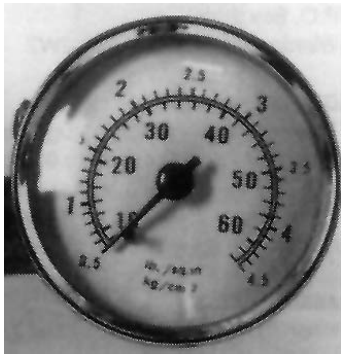

Figure 2. Gauge pressure indicator.

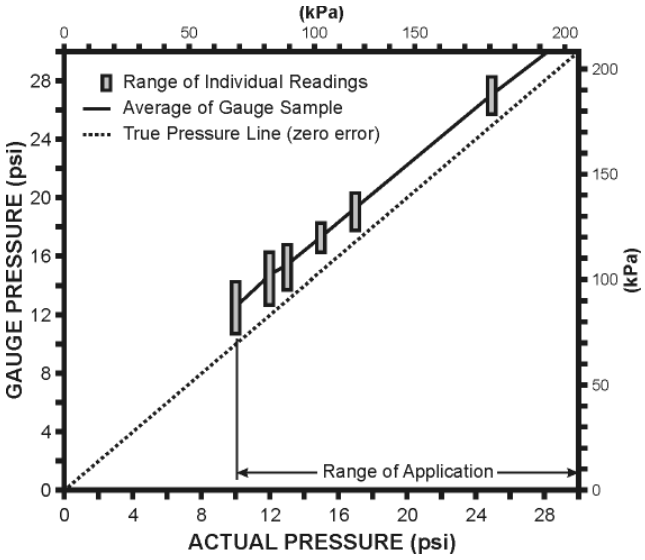

Figure 3. Gauge accuracy.

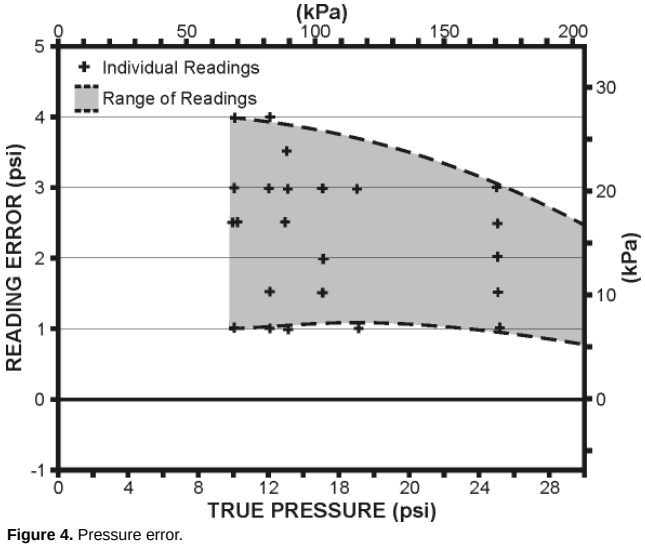

Figure 4. Pressure error.

SUPEREX PENCIL GAUGE

Code No. 50-100

Made in USA, imported by:
Superex Canada Ltd.
Toronto, Ontario
M2H 3B8

DESCRIPTION

This is a dual scale pencil gauge marked from 10 to 50 psi with a resolution of 1 psi, and from 75 to 340 kPa with a resolution of 5 kPa. Pressure scales appear on alternating sides of the indicator bar. A black indicator band marks the reading. The metal body and the chuck of the gauge is made of polished steel.

ACCURACY

Excellent. The maximum individual gauge error was 0.5 psi (3.4 kPa) and the maximum average percent error of the set was 1.3 percent. This low percent error is shown in the first graph by the gauge readings being very close to the line of absolute accuracy.

REPEATABILITY

Excellent. Throughout the range of the gauge, repeatability was excellent. The standard deviation of readings for the set was 0.20. Throughout the range of the gauge one reading was sufficient to obtain a reliable average measurement.

READABILITY

Excellent. Measurements could be read to 0.5 psi or 2.5 kPa. The gauge retained the reading until the indicator bar was reset.

DURABILITY

Excellent. No significant changes in gauge accuracy occurred during the drop tests. The only visible damage was a slight dent to the chuck.

BALLAST

Acceptable. No significant changes in gauge accuracy occurred after the gauge was exposed to ballast. Most of the ballast was expelled from the gauge when the gauge was removed from the tire valve and reset.

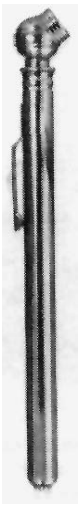

Figure 1. Overall view of gauge.

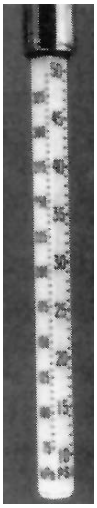

Figure 2. Gauge pressure indicator.

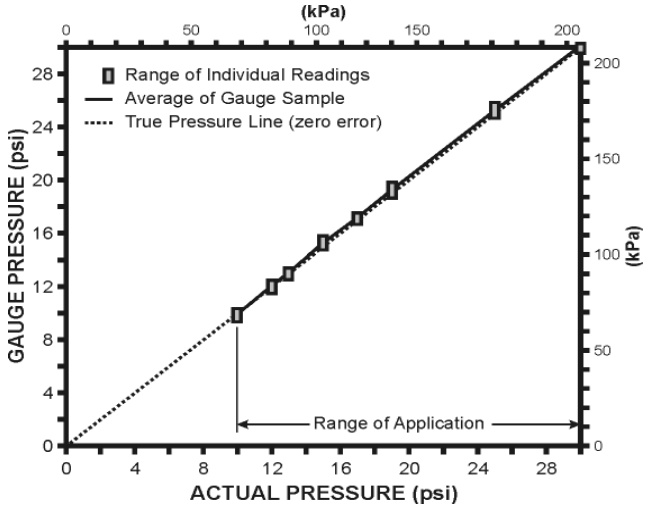

Figure 3. Gauge accuracy.

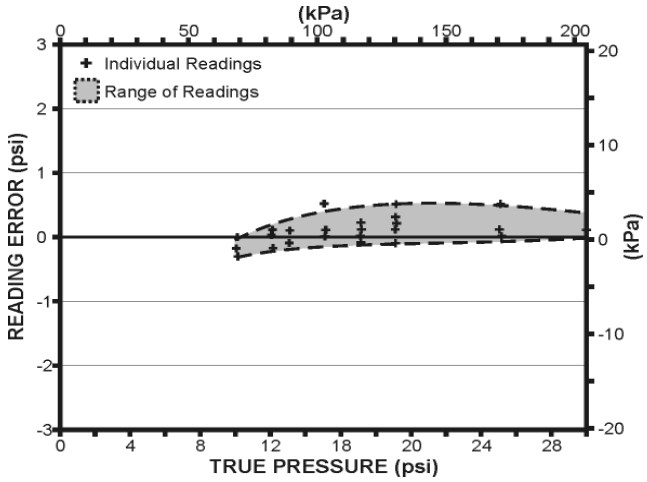

Figure 4. Pressure error.

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