Differential Testing of Rotary Meters

Madeline Corb
Product Manager
Western Gas Measurement Short Course
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Differential Testing Is...

… done without removing customer from service

… a quick and effective way to compare a meter’s current performance with it’s original or “born-on” performance

… a good indicator of a change in meter condition.

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Rotary meter differential pressure…

Can be affected by:

- line pressure
- specific gravity of the line content
- flow rate
- internal friction

Differential Testing Is...

…an Inferential Test (e.g. Spin Testing for Turbine Meters but more reliable)

… recognized by NBS (NIST) since 1946

… recognized by AGA (*ANSI B109.3*)

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Differential Testing Is Not ...

... an accuracy test

… a lengthy, complicated process

… effective on

- Turbine Meters
- Diaphragm Meters
- Orifice Meters

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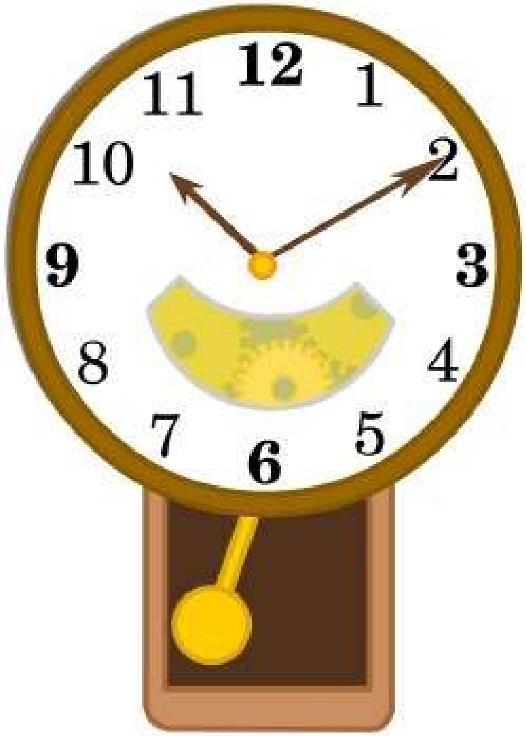
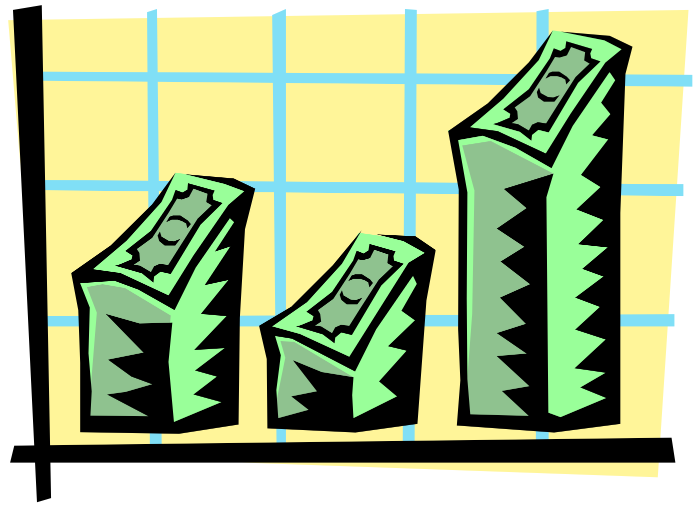
Why do utilities use Differential Testing?





It's a simple equation…

Time Savings = Increase in Revenue!

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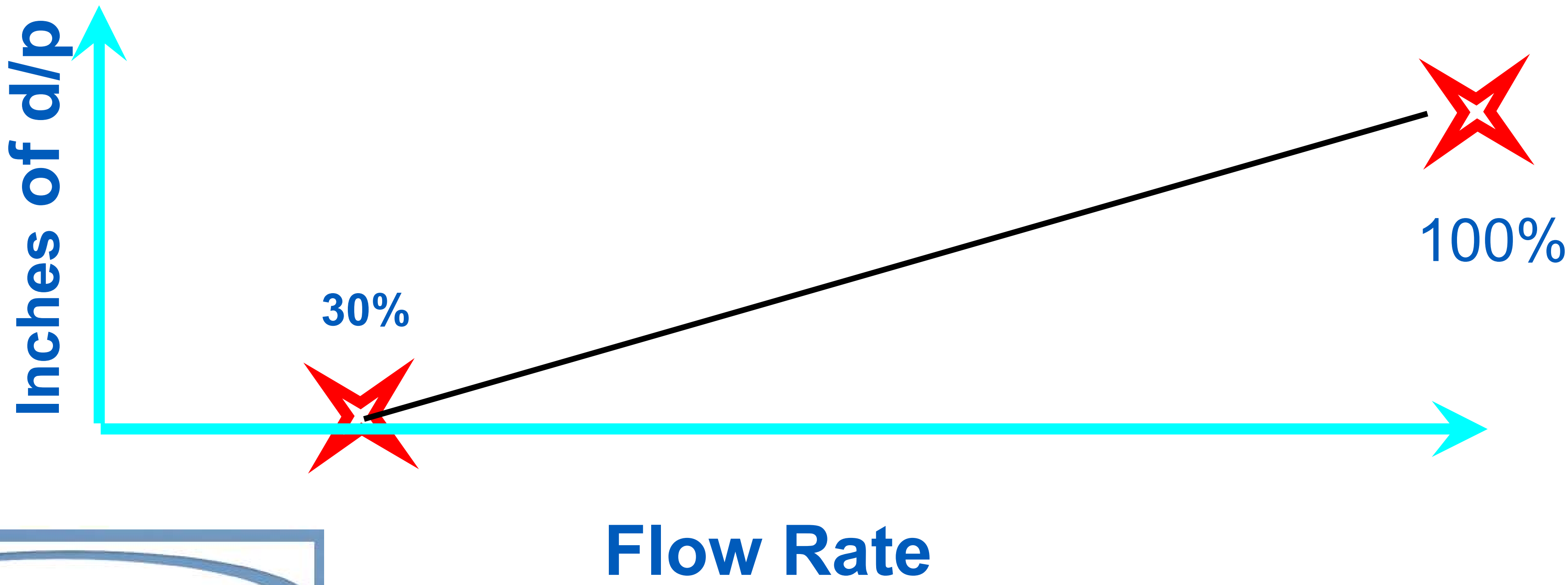
What is Differential Pressure Testing?

A differential test consists of a d/p reading taken across the meter at a gas flow rate within the meter's range of capacity.

30% - 100% of meter rated capacity



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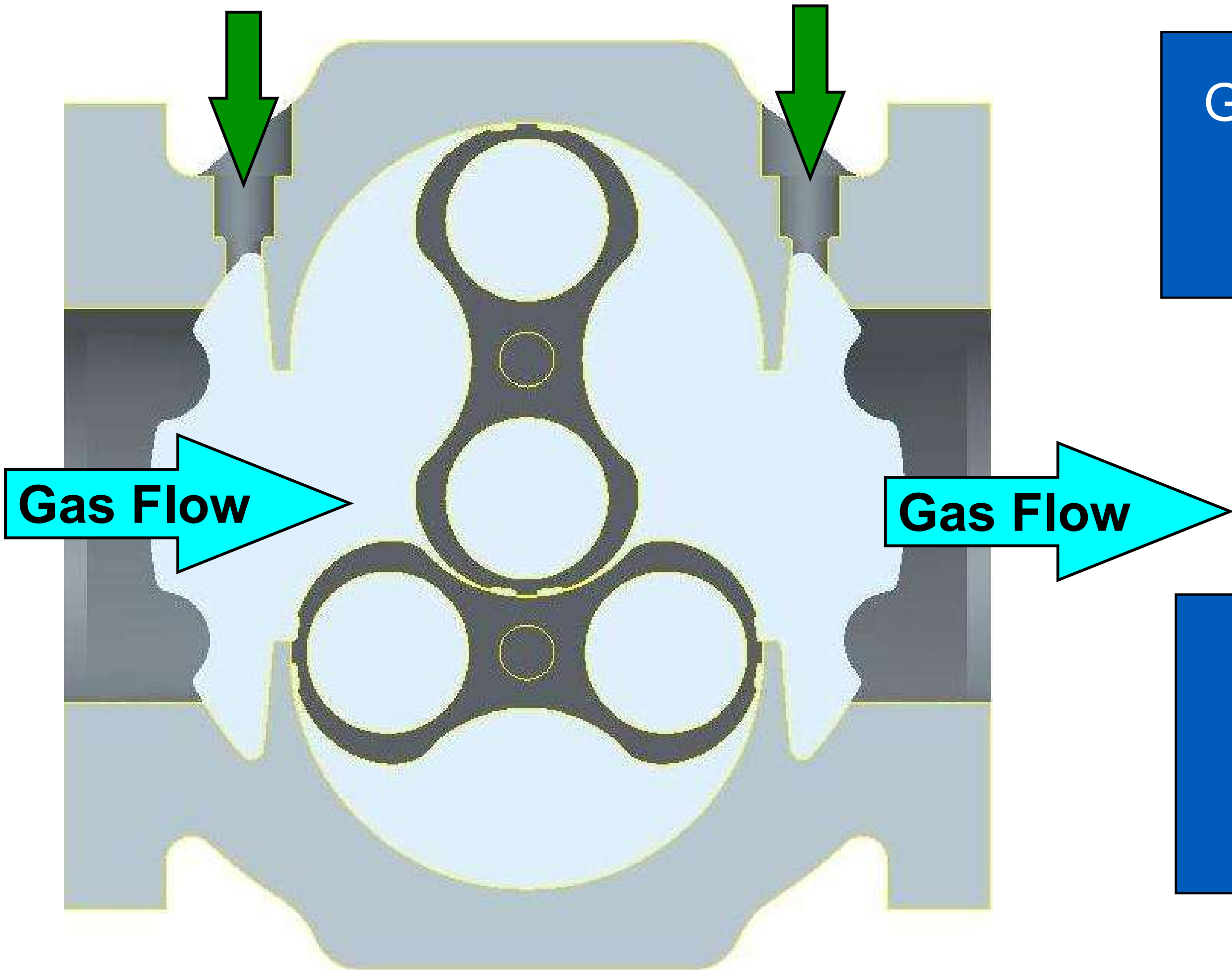
Principles of Differential Testing



Gas pressure is measured on either side of the measuring cylinder (see arrows)

Pressure Drop is typically expressed
in “inches of water column”.

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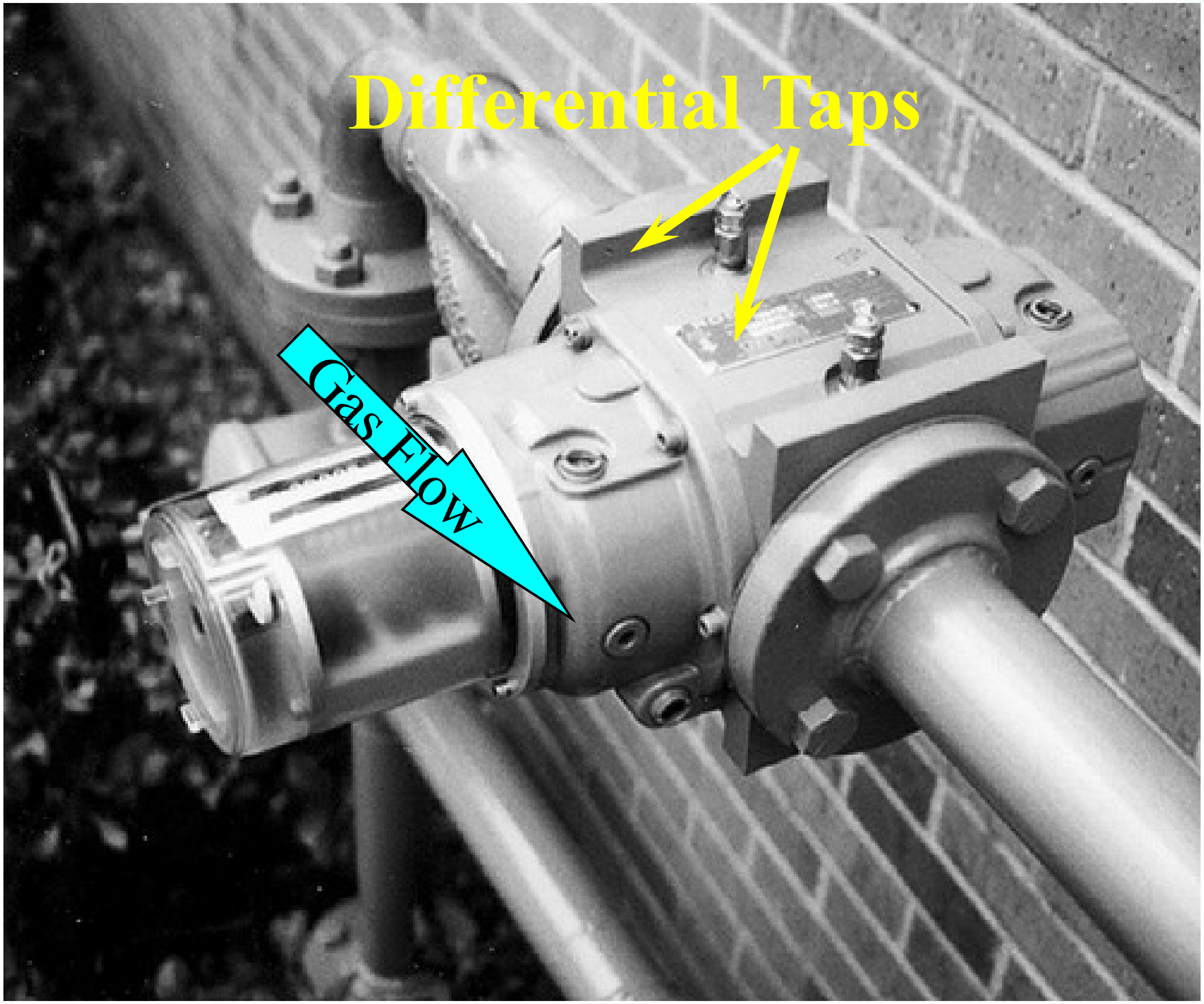
Principles of Differential Testing

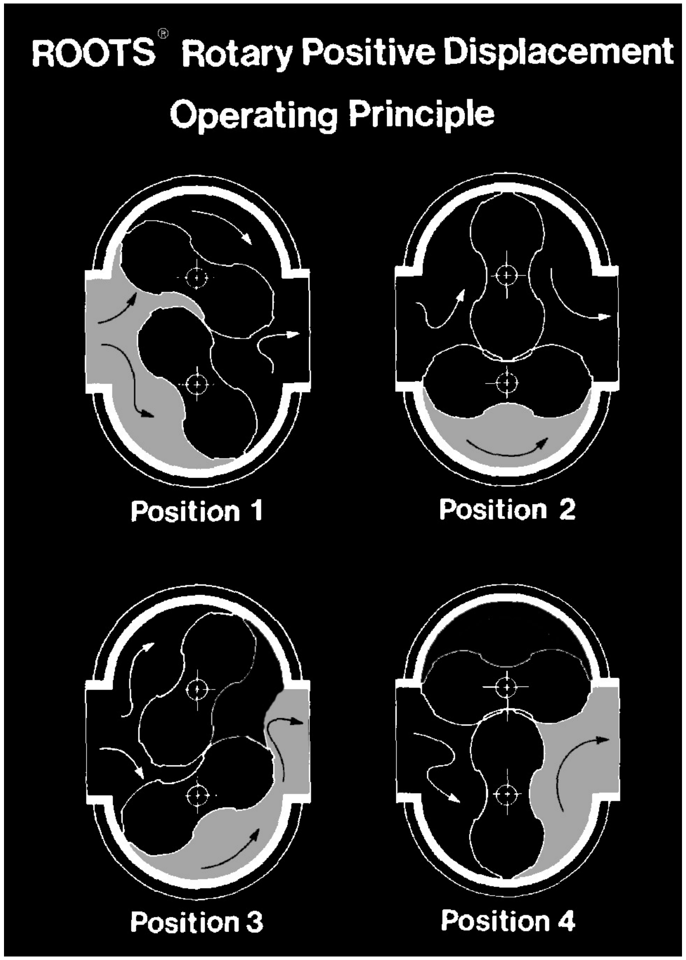


Why Differential Testing works

•The accuracy of a rotary meter is non-adjustable.

•There are no linkages, cams, valves or parts which can be used to adjust or change the meter accuracy.

•The meter has fixed, non-wearing and non-contacting internal parts in the measuring chamber.



Why Differential Testing works

•The static displacement of a rotary gas meter appears to be almost unaffected by deposits, even those resulting from unpurified gas.

•Once accuracy has been determined, it will seldom be necessary to redetermine. Rotary meters have "machined-in" accuracy!

•Only 3 possible conditions exist which will affect meter accuracy:

- Change in static displacement
- Enlarging meter clearances
- Increase in meter's internal resistance

Differential pressure testing is a way to measure the internal resistance of the rotary gas meter!

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Why Differential Testing works

Principal causes for increased internal resistance are:

- Impurities in the gas stream…
  - Dirt, valve grease, weld slag
- Binding of impellers…
  - Possibly due to surge at meter start up
- Worn bearings, improper lubrication
  - Too much or too little oil
  - Overfilling can cause meter oil to disappear down the pipeline
  - Using the wrong oil can affect meter performance

What does this mean?

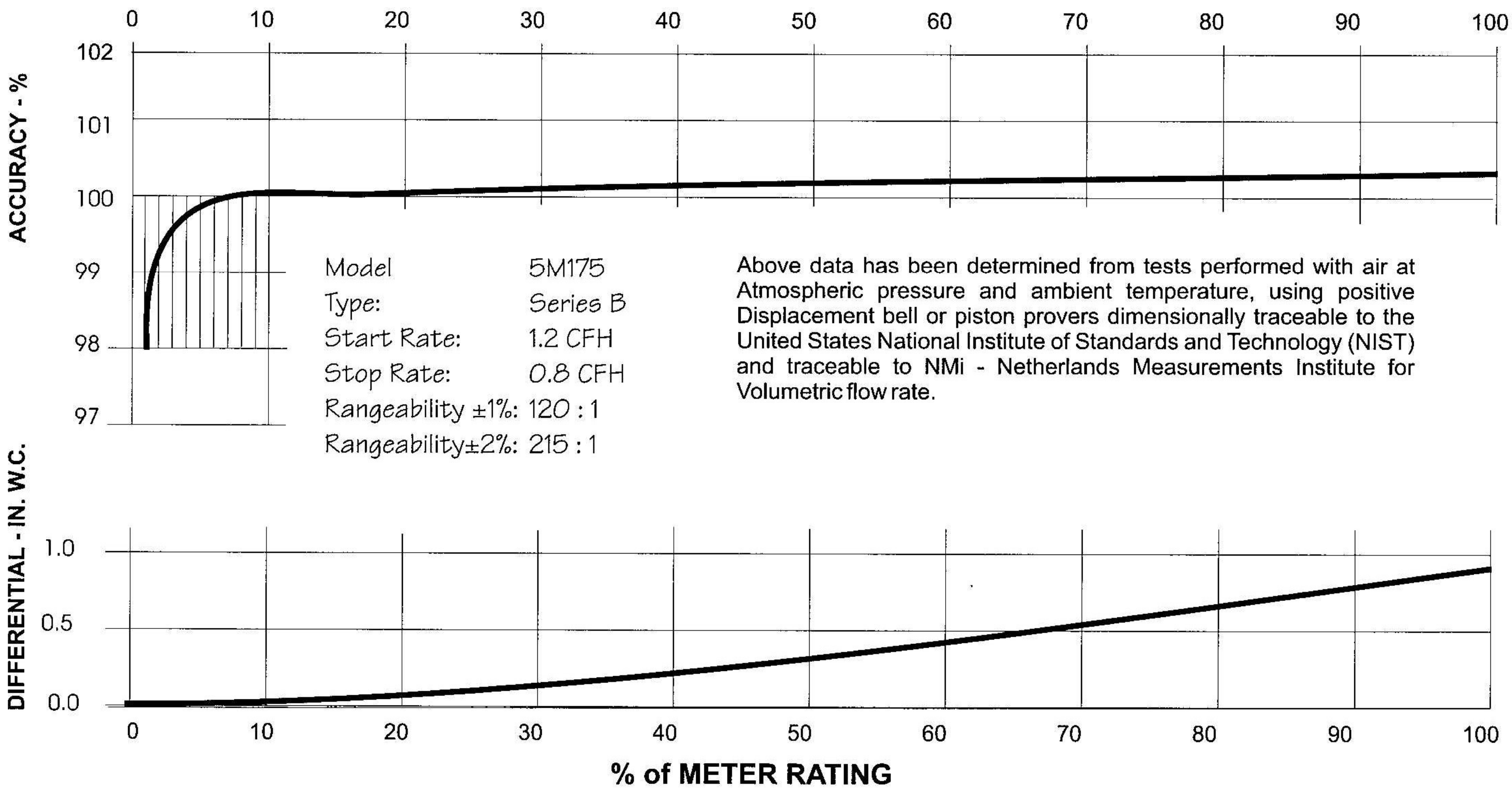
- Any significant increase in the rotary meter's internal resistance to flow will increase the pressure drop across the meter. When this happens, it may be inferred that the result is a less accurate meter.

- Differential testing is not a direct replacement for a prover accuracy test.

- However, if the differential across the inlet and outlet differential taps of the rotary meter rises by more than 50% of the original dp value, a prover test is suggested to determine if meter accuracy is off.

Typical Rotary Meter

Typical Performance Curve of a 5M Dresser ROOTS® Meter



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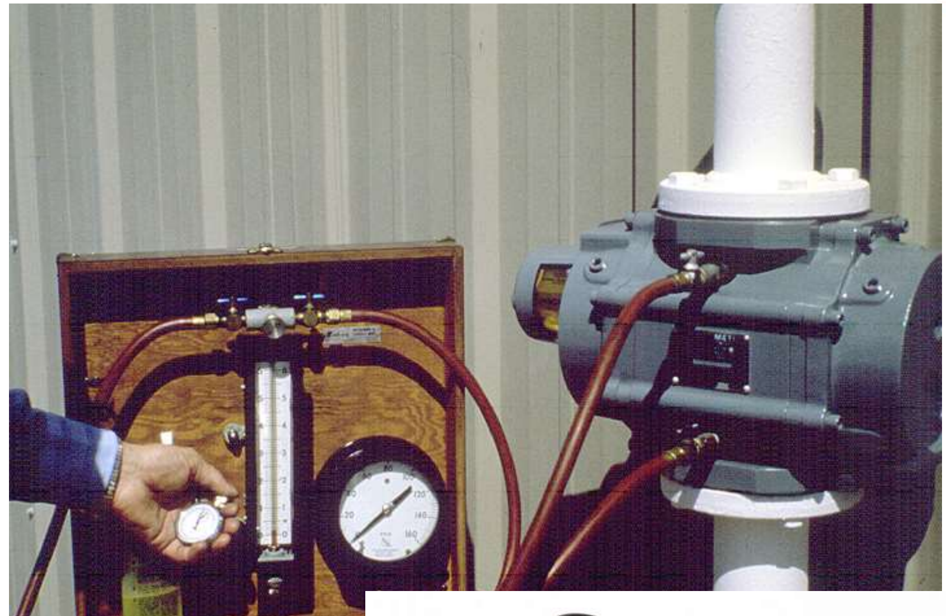
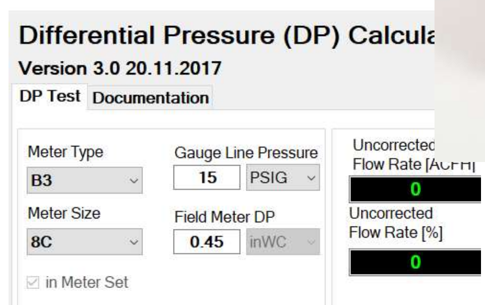
Equipment Typically Needed to Perform a Differential Test

- Stopwatch
  - Note that on certain integral electronic correctors, flow rate is present on the LCD.
    - No need for a stopwatch
- Line Pressure Gauge
- Manometer
- Reference Data including:
  - The original Meter test data sheet
    - *The meter's "birth certificate"*
  - The manufacturer's "typical" curves
  - Previous differential test data for this particular meter (records)





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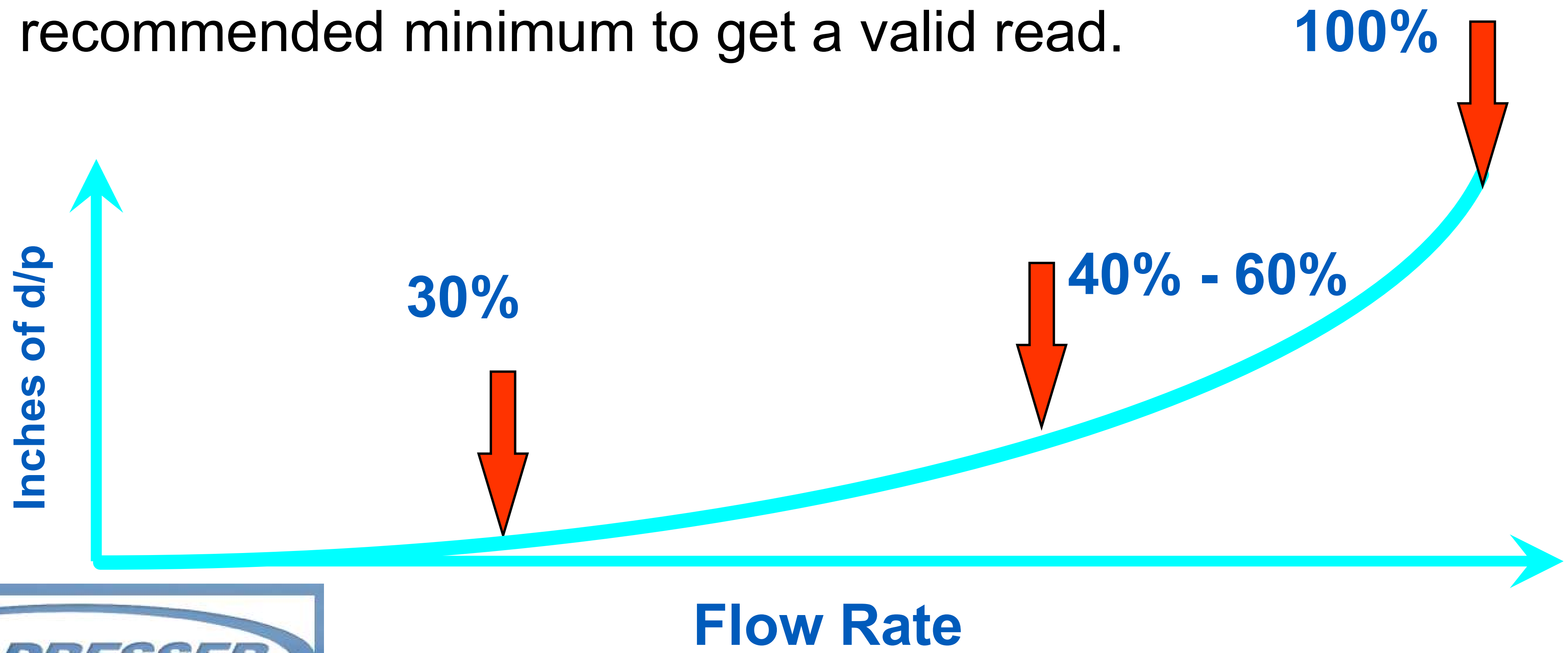
To establish a differential test curve

•Plot a point for the differential at each point of flow capacity during the differential test

•A minimum of 3 points within the range is required to establish an accurate curve with 30% being the recommended minimum to get a valid read.



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Test Method

- Connect a Manometer to the meter inlet and outlet differential taps - typically using Pete's Plugs or tubing & valves.

- If the meter's accessory unit is mechanical, use a stopwatch to clock the meter. If the meter is fitted with integral electronics, the flow rate may be visible on the LCD.

- Install a Gauge to monitor Line Pressure

- For new installations, use a chart to plot meter differential at three test points between 30% - 100% of the rated capacity of the meter. This is the baseline differential for the meter. Save this chart to be used to compare future differential tests to this baseline differential.

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Typical Differential Testing Options:

New technology allows differential to be sensed automatically and DP test reports provided via download - either locally or remotely!

Historically performed using a manometer kit and stopwatch

Calculating Flow Rate

Example:

Time to measure 10 cubic feet: 37 seconds
- refer to stopwatch for elapsed time

10 cf / 37 sec. = 0.2702 cubic feet per second

0.2702 x 3600 (seconds in an hour) = 973 cubic feet per hour

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Interpreting the Numbers!

	Pressure	10% Flow	973 cfh 32% Qmax	100% Flow
Typical Differential (per mfrs data)	Atmosph.	0.01" wc		0.6
	45 psi	0.03" wc	0.27" wc	2.59" wc
	60 psi	0.034" wc	0.36"	3.25" wc
Field Test #1	50 psi		.33" wc	

Interpreting the Numbers!

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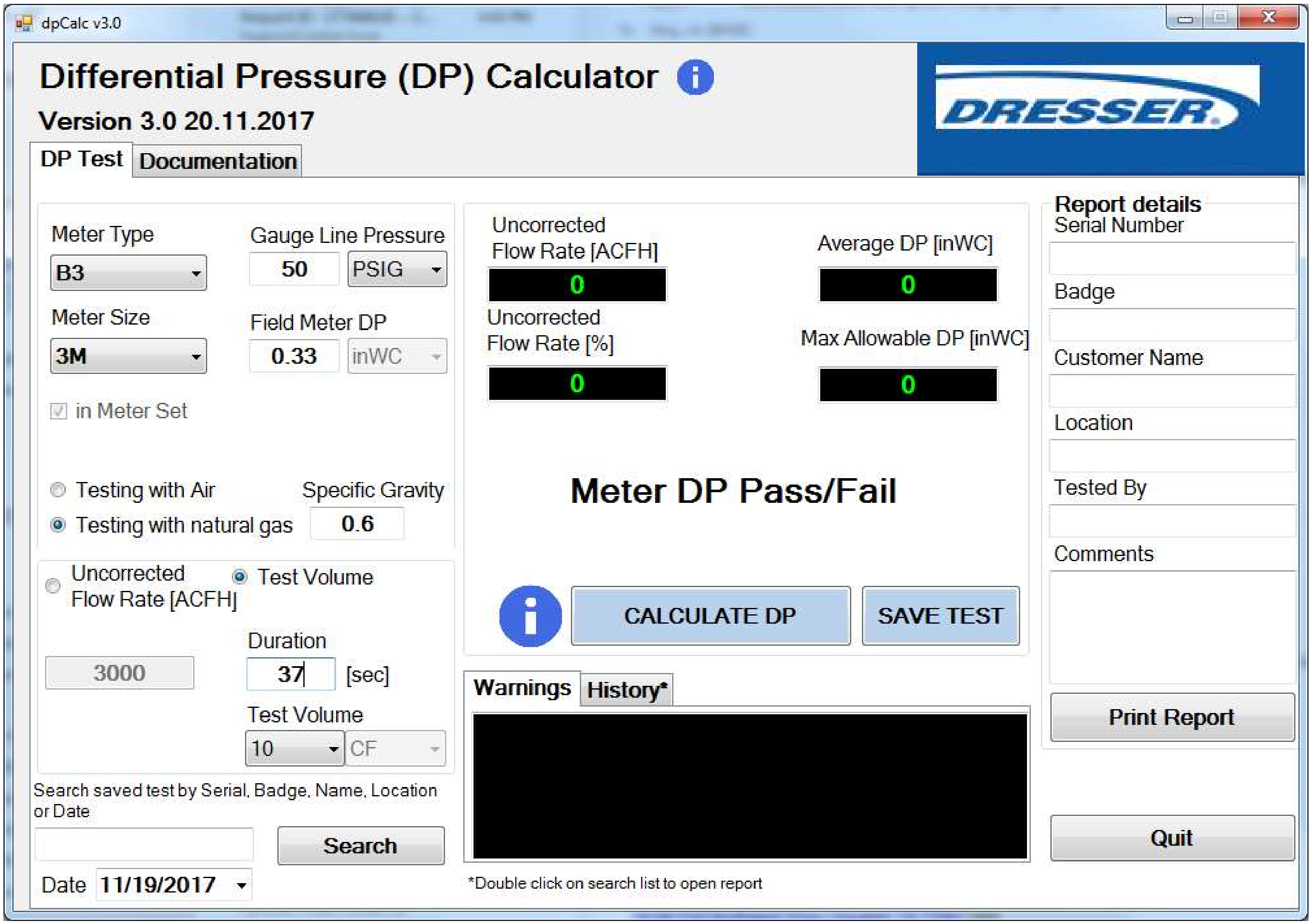
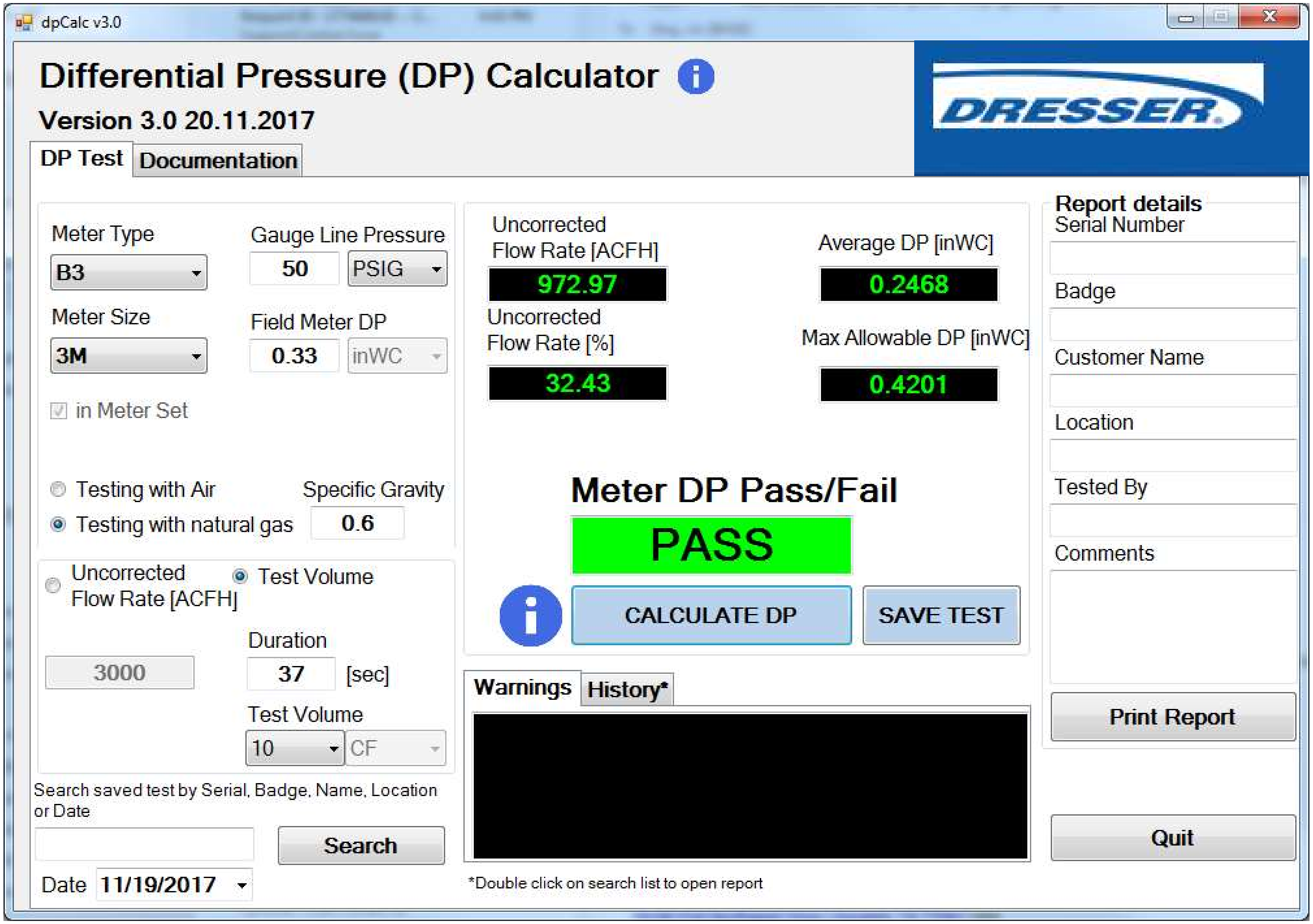
Field Test #1		50 psi				.33" wc		
Field Test #2		42 psi				.36" wc		

How can the typical manometer kit process be less manual?



Software is available to assist the operator…



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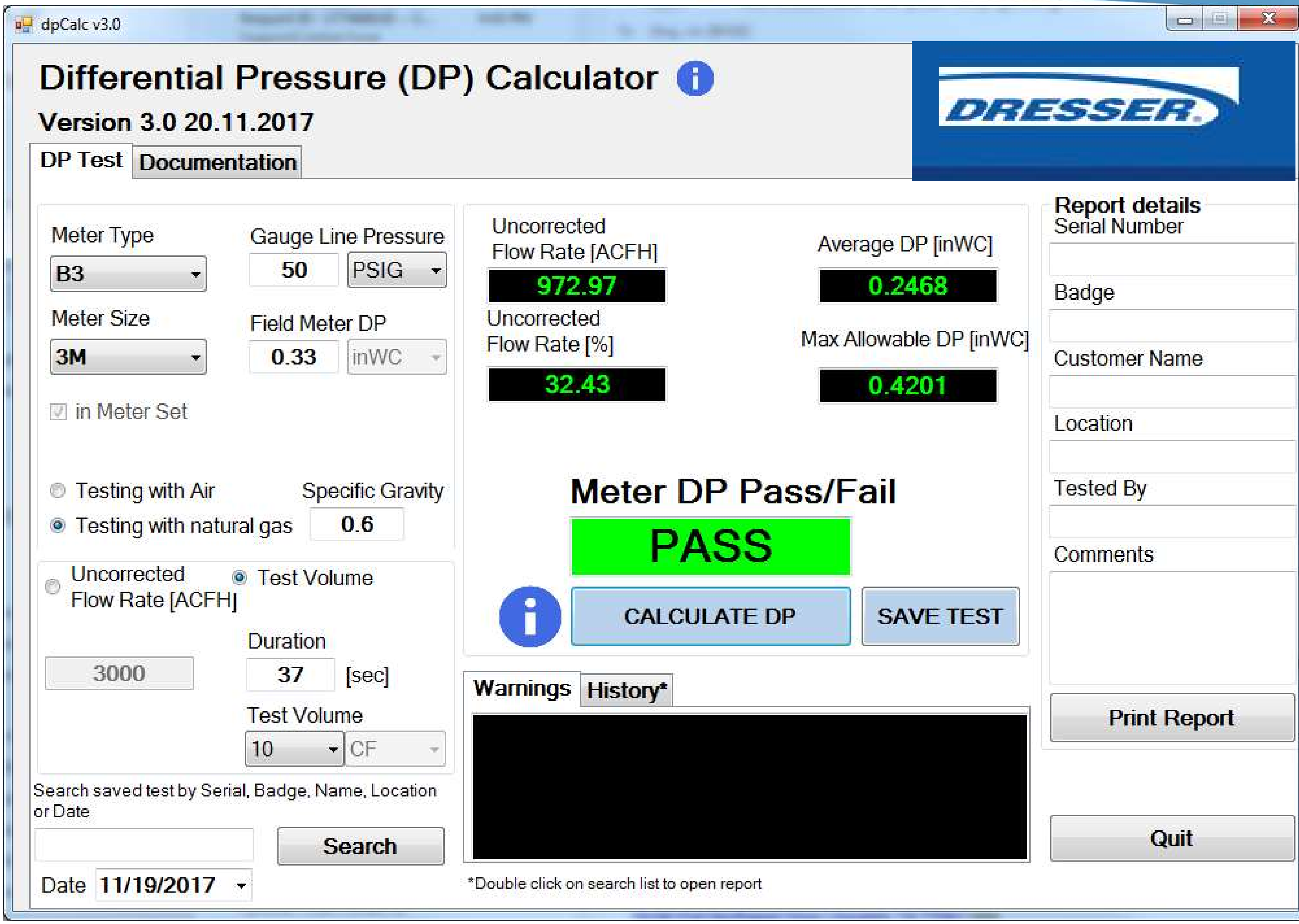
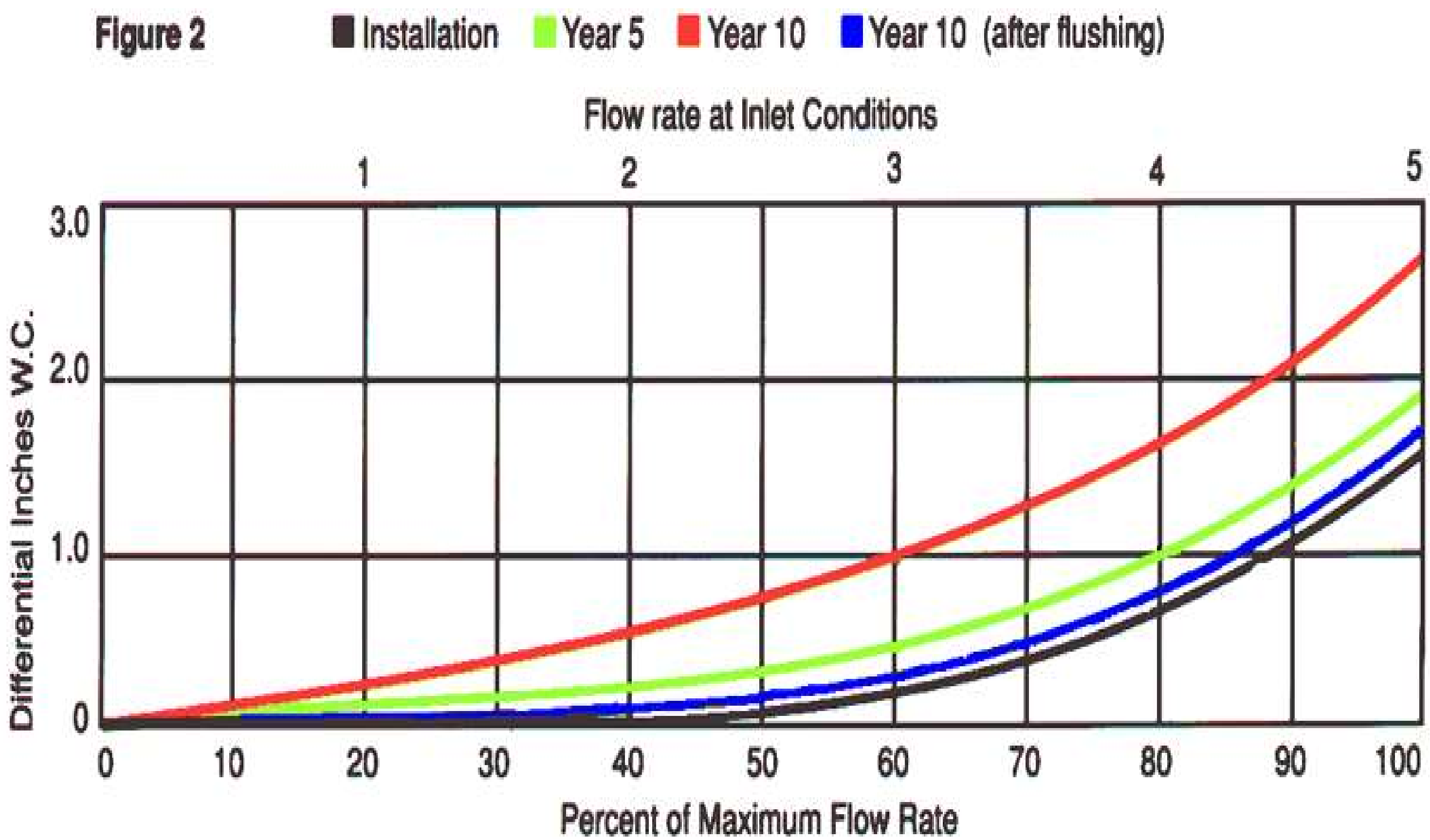
You simply plug in the numbers and you get the verdict!



Differential-Rate Test Data



You can see the unacceptable rise in dp in Year 10

What caused the differential in year 10 to be high?

ANSWER: Increase in internal friction!

CORRECTIVE ACTION: Remove the meter from the line and using a company approved safety solvent, flush the meter.

FOLLOW UP: Return the meter to the line and perform another differential test. There is a very good chance that the differential will once again be within acceptable limits!

DIFFERENTIAL TESTING is a convenient, widely accepted, efficient and cost effective test that can be performed at the meter site!

Established Standards – NBS Paper RP 1741

- The U.S. Department of Commerce National Bureau of Standards Research Paper *RP1741,* Volume 37, September 1946
- Part of the Journal of Research of the National Bureau of Standards - Testing Large-Capacity Rotary Gas Meters. This paper has been and remains the basis for differential testing programs and standards around the world.
- In summary, *RP1741* states that a differential test under actual operating conditions will provide the most reliable data for future checks of a meter's operating condition.

Although accuracy cannot be directly determined by a differential test, results have shown that an increase of up to 50% in differential pressure can be tolerated without affecting meter accuracy at the higher flow rates (30% and above), by more than 1%.

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Established Standards – ANSI B109.3

- The Standard now followed in the United States for ROTARY-TYPE GAS DISPLACEMENT METERS, PART IV IN-SERVICE PERFORMANCE, 4.3.2 Differential Pressure Testing. ANSI B109.3 states the following:

"As a general rule, when the differential pressure of a rotary meter increases over 50% under the same operating conditions, corrective action should be taken to return the meter to the normal differential pressure or it should be removed from service."

"Should the differential in a later test indicate less than a 50% increase, the meter proof is not affected and the meter has remained in satisfactory mechanical condition. Should the differential increase by **more than 50%** for the same RPM and pressure, some source of increase in the internal friction is present and a more detailed inspection and testing of the meter should be undertaken to determine and rectify the cause of the friction."

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Questions?