

ChloroSense, *Accuracy and Reproducibility*

The launch of the ChloroSense fundamentally changes the way in which chlorine testing is performed. For the first time since Dr Palin developed the DPD methodology at Palintest, a new technology that is technique independent can perform to the same accuracy and reproducibility as DPD.

DPD is the standard method for testing chlorine residuals across the world. There are some differences between countries and standards as to how DPD performs in detecting chlorine accurately.

At Palintest, we tested the accuracy and reproducibility of both methods and included technique as a variable.



How is accuracy and reproducibility defined?

In statistics, "accuracy is the degree of closeness of a measured or calculated quantity to its actual (true) value. Accuracy is closely related to precision, also called reproducibility or repeatability, the degree to which further measurements or calculations show the same or similar results."

John Robert Taylor (1999). An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements. University Science Books. pp. 128-129. ISBN 093570275X.

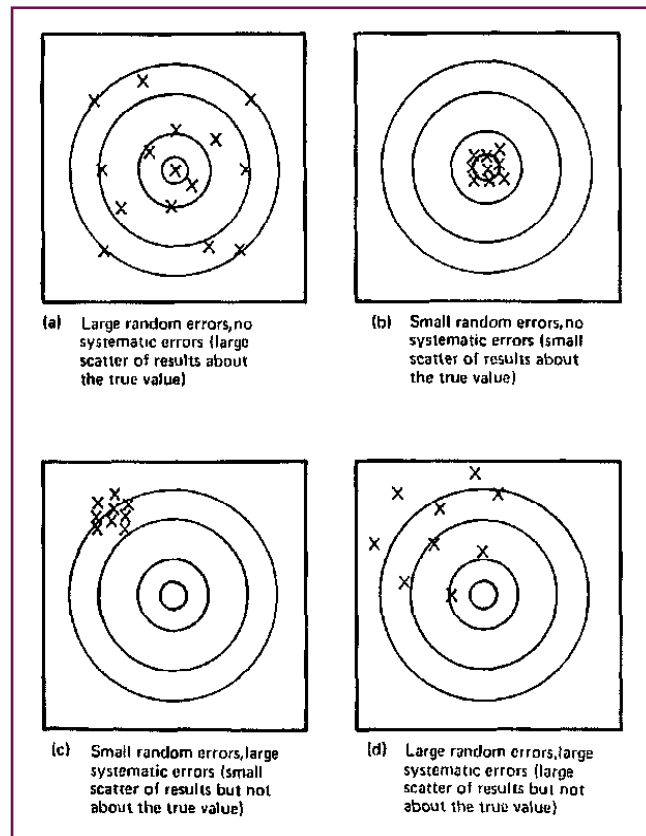
The diagram below demonstrates the difference between accuracy and reproducibility,

Picture a) demonstrates the concept of accuracy with no reproducibility

Picture b) demonstrates an accurate and reproducible set of results

Picture c) demonstrates an inaccurate but reproducible set of results

Picture d) demonstrates an inaccurate and irreproducible set of results



How did we compare the performance?

To test both methods, we took a known standard solution and confirmed its chlorine concentration via titration.

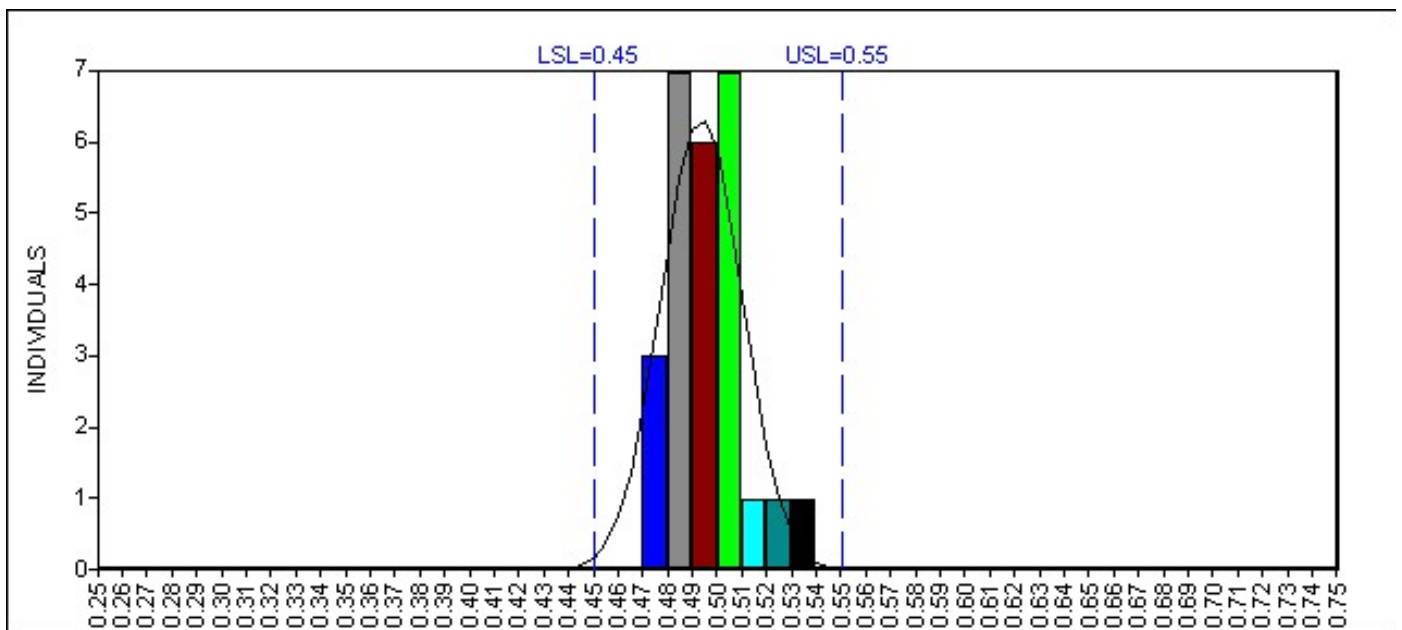
The following results were obtained:

Stock solution = 104.6mg/l, working solution = 0.50mg/l free chlorine

	No of Tests	Free Chlorine mean response (mg/l)	Standard Deviation	%CV
ChloroSense	25	0.49	0.015	3.0
DPD <i>Very Experienced User</i>	25	0.53	0.015	2.9
DPD <i>Less Experienced User</i>	25	0.61	0.031	5.0

The distribution of results is shown diagrammatically below:

ChloroSense:



Smallest Value = 0.47

Largest Value = 0.53

Average = 0.49

Skewness = 0.75

Kurtosis = 0.70

Standard Error of Mean = 0.00

K-S Test: 0.41

Curve Fit: Normal

Process Sigma = 0.02

Population Sigma = 0.01

Sample Sigma = 0.01

High Spec: 0.55

Low Spec: 0.45

% Above High Spec: 0.02%

% Below Low Spec: 0.58%

% Out of Spec: 0.60%

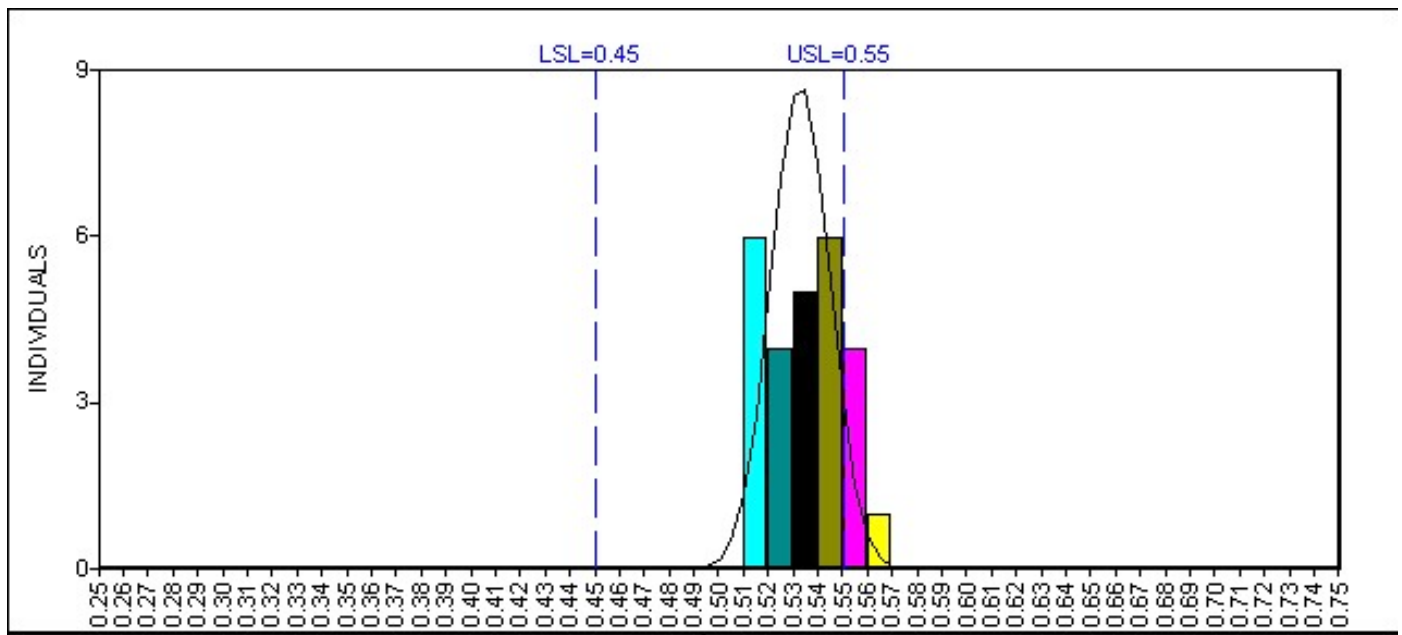
Sigma Level: 2.52

Cpk: 0.841 Cp: 1.022

Ppk: 0.928 Pp: 1.127



DPD - Very Experienced User:



Smallest Value = 0.51

Largest Value = 0.56

Average = 0.53

Skewness = 0.07

Kurtosis = -1.11

Standard Error of Mean = 0.00

K-S Test: 0.28

Curve Fit: Normal

Process Sigma = 0.01

Population Sigma = 0.02

Sample Sigma = 0.02

High Spec: 0.55

Low Spec: 0.45

% Above High Spec: 4.68%

% Below Low Spec: 0.00%

% Out of Spec: 4.68%

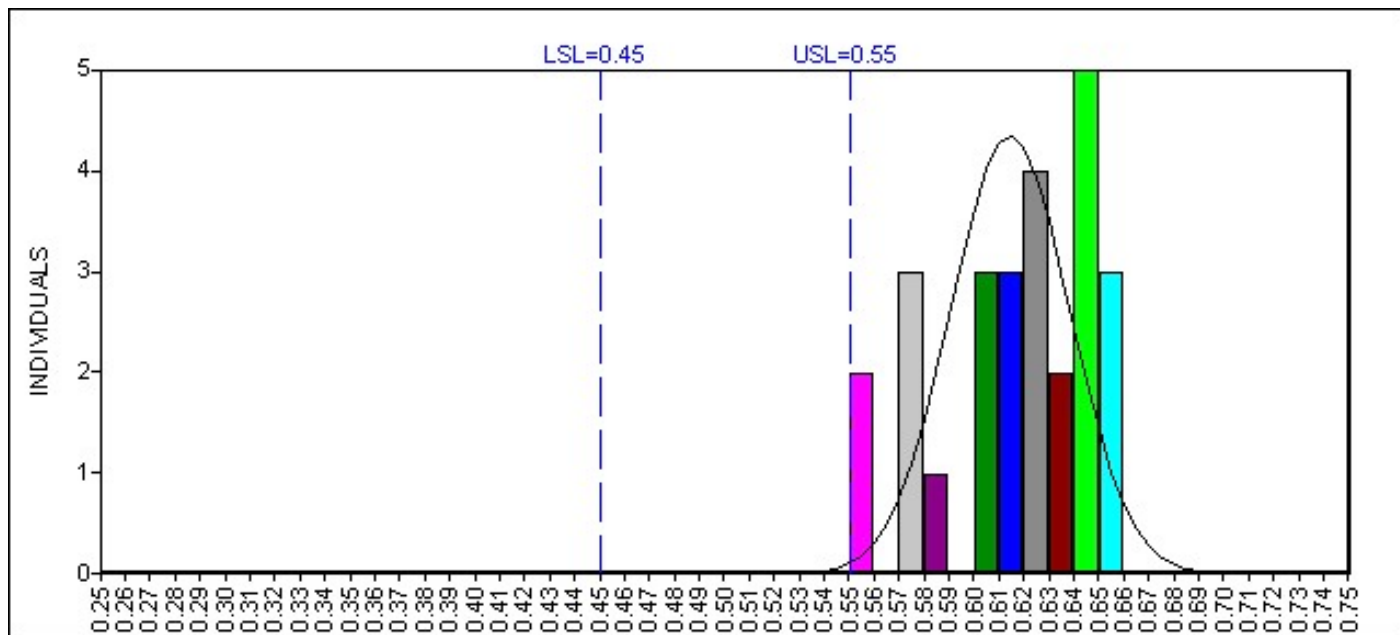
Sigma Level: 1.68

Cpk: 0.559 Cp: 1.425

Ppk: 0.426 Pp: 1.085



Less Experienced User:



Smallest Value = 0.55

Largest Value = 0.65

Average = 0.61

Skewness = -0.66

Kurtosis = -0.58

Standard Error of Mean = 0.01

K-S Test: 0.51

Curve Fit: Normal

Process Sigma = 0.02

Population Sigma = 0.03

Sample Sigma = 0.03

High Spec: 0.55

Low Spec: 0.45

% Above High Spec: 99.54%

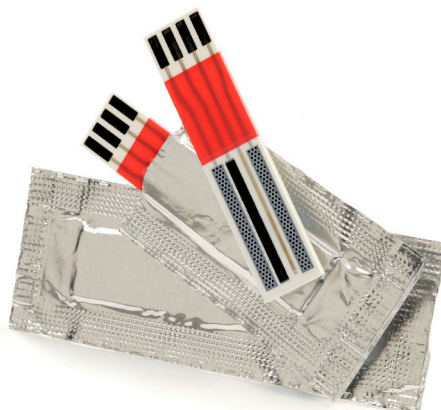
% Below Low Spec: 0.00%

% Out of Spec: 99.54%

Sigma Level: -2.61

Cpk: -0.869 Cp: 0.702

Ppk: -0.672 Pp: 0.542



What do the results tell us?

- When discussing accuracy and reproducibility (or precision) its important to understand what these terms actually mean. People sometimes use them incorrectly.
- The nominal value of chlorine in these tests was 0.5mg/l. From the table you can see that the mean ChloroSense value is closest to this nominal value and the DPD method is slightly above this nominal value. The DPD value is not exactly the same as the true chlorine value because DPD methods use surrogate standards.
- The distribution of results is equivalent between the ChloroSense and a very experienced DPD user. The relative standard deviation (%CV) is the same in both methods.
- The advantage of the ChloroSense is seen in the results of the less experienced user. These users get a much larger distribution of results and the accuracy of those results is affected, shown by the higher mean result of 0.61mg/l.

What does this mean?

- The ChloroSense reduces the risk of user error when conducting the test
- The ChloroSense reduces variability between results for typical users
- The ChloroSense prevents systematic errors arising from calibration

The greatest advantage of the ChloroSense is seen in the results of the less experienced user. These users get a much larger distribution of results and the accuracy of those results is affected, as shown by the higher mean value.

ChloroSense®
Unique Sensor Technology