

Your individual report is called the **Performance Analysis Report**; it is designed to serve as the primary report for evaluating your results for each test in the Fasteners & Metals Interlaboratory Program. These lab-specific Performance Analysis Reports display the wide array of measurement evaluation tools available to you, because the interlaboratory program is designed to evaluate much more than just your measurement performance on each individual sample. The design of the program allows laboratories to evaluate the consistency of their measurement system and to evaluate performance as part of continual quality assurance activity.

The Performance Analysis Report is a two-sided document. The front of the report is your **Historical Chart** or **Chart of CPV Results** for the current cycle. The back is the **Current Cycle** Section. In addition to the Performance Analysis Report, a **Summary of Chemical Analysis** is provided if your lab is enrolled in any Chemical Analysis. The Summary of Chemical Analysis can also be found on our web site. The following pages describe the features and interpretation of the Performance Analysis Report.

Figure 1a

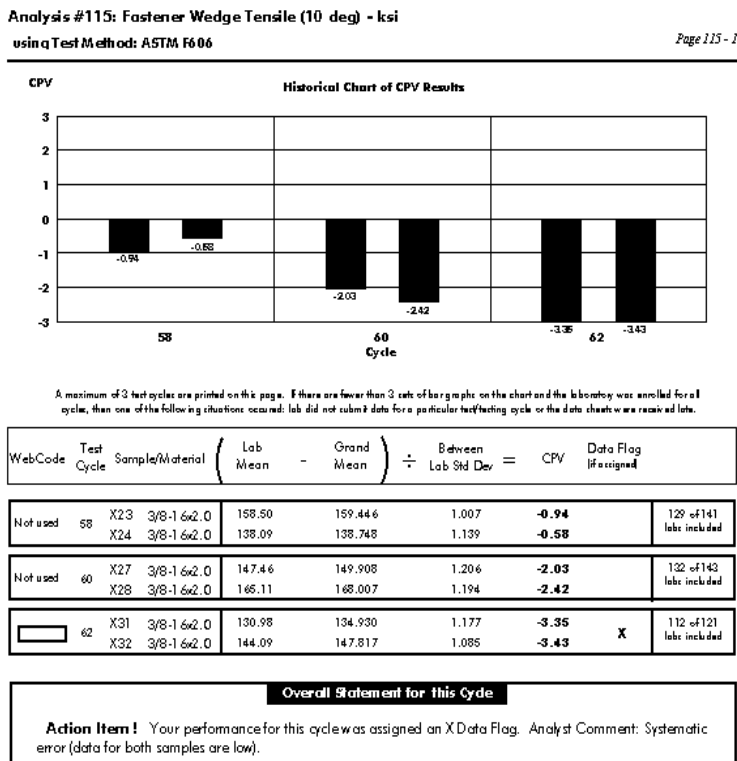
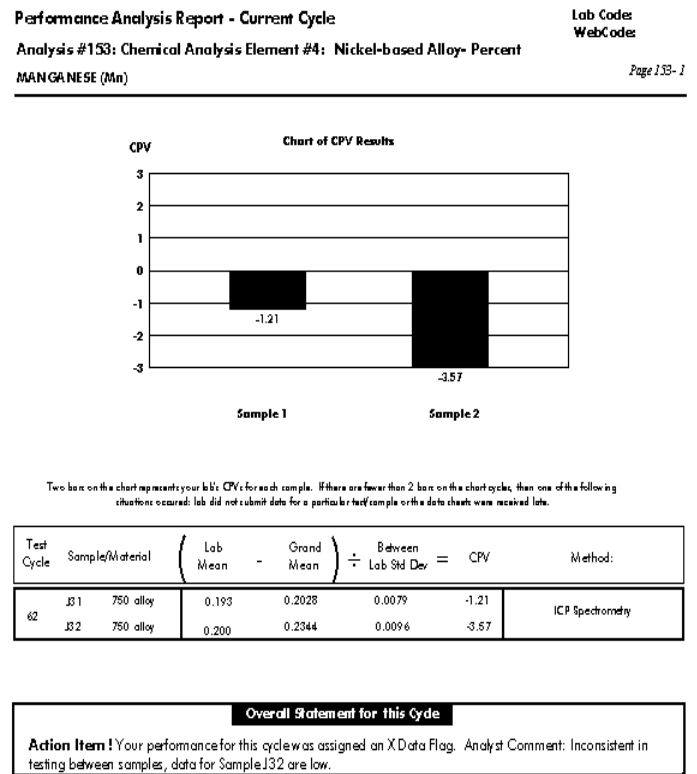


Figure 1b

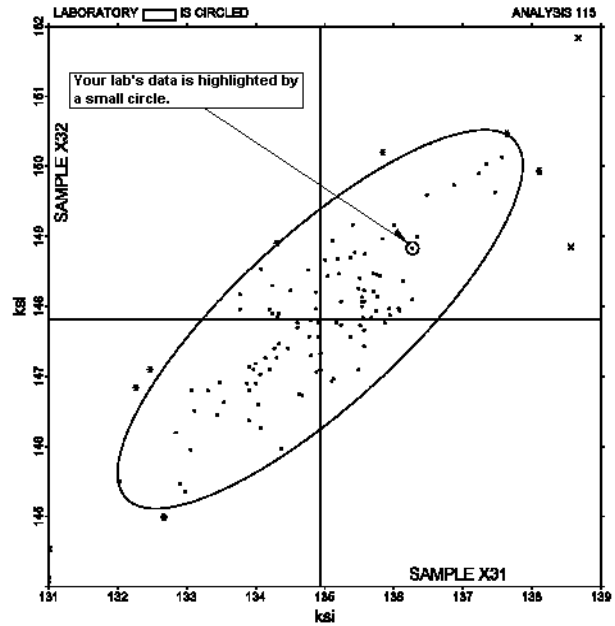


Historical Chart [Figure 1a] includes data for up to 4 cycles of interlaboratory testing. The data table below the bar chart lists the CPVs shown in the bar chart and also provides supporting information. Below the data table an Overall Statement of Performance for this cycle is shown.

For all analysis when Historical Charts are not appropriate the first page shows the **Chart of CPV Results [Figure 1b]** where your lab's CPV for each sample is shown as a bar. Immediately below the chart your data for this cycle and an Overall Statement of performance is shown.

For all **Performance Analysis Reports**, if your measurement performance has been flagged in the two-sample analysis, an **Action Item** will be posted along with analyst comments. The **Action Item** should serve as notice of a problem that requires immediate attention. **Action Items** appear in the Overall Statement of Performance box only for the most current cycle. Other types of data flags are discussed in the Key to Individual Reports.

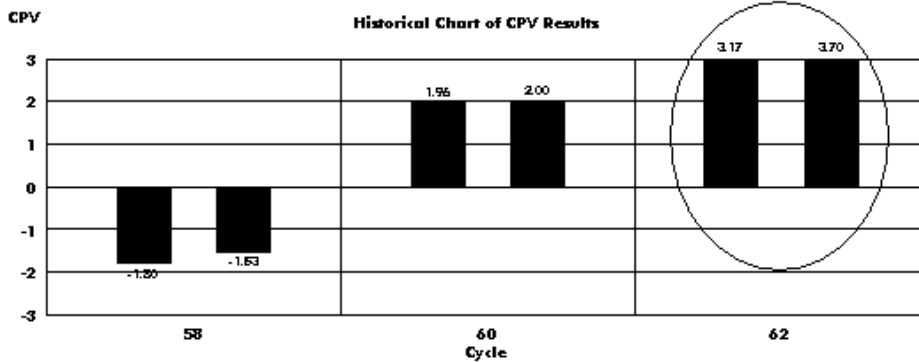
The **Current Cycle** Section of the Performance Analysis Report contains all of the information about your laboratory that was formerly supplied in the printed group report, including the two-sample plot showing the control ellipse. Your laboratory's data point is located at the intersection of the Lab Means for each sample. Provided both Lab Means are within the boundaries of the plot, your laboratory's results will be indicated by a small circle. The cross hairs in the plot represent the Grand Means for each sample and the control ellipse is a graphical representation of our bi-variate control chart analysis.



Because similar materials are chosen for both samples, there should be a correlation of measurement performance between the two samples. CTS uses a bi-variate analysis technique (represented by the ellipse) to judge measurement performance on both samples simultaneously. Quite often measurement performance that differs from the group can be classified as either a systematic difference (means for both samples are similarly offset from the group means) or a consistency difference (measurements for both samples were not as correlated as other laboratories). If your results received a Data Flag, the Action Item may include our characterization of the error as a systematic or consistency variation.

Analysis #115: Fastener Wedge Tensile (10 deg) - ksi

using Test Method: ASTM F606



A maximum of 3 test cycles are printed on this page. If there are fewer than 3 sets of bargraphs on the chart and the laboratory was enrolled for a full cycle, then one of the following situations occurred: lab did not submit data for a particular test/testing cycle or the data charts were received late.

WebCode	Test Cycle	Sample/Material	Lab Mean	Grand Mean	Between Lab Std Dev	CPV	Data Flag (if assigned)
Not used	58	X23 3/8-1 6x2.0	157.63	159.446	1.007	-1.80	129 of 141 labs included
		X24 3/8-1 6x2.0	137.00	138.748	1.139	-1.53	
Not used	60	X27 3/8-1 6x2.0	152.27	149.908	1.206	1.96	132 of 143 labs included
		X28 3/8-1 6x2.0	170.40	168.007	1.194	2.00	
[]	62	X31 3/8-1 6x2.0	138.67	134.930	1.177	3.17	112 of 121 labs included
		X32 3/8-1 6x2.0	151.83	147.817	1.085	3.70	

Overall Statement for this Cycle

Action Item! Your performance for this cycle was assigned an X Data Flag. Analyst Comment: Systematic error (data for both samples are high).

Systematic variations

Bias is an unavoidable fact of life in laboratory testing. The best illustration of bias is the control ellipse on the two sample plot. If a particular analysis/sample combination did not show bias, the control ellipse would become a circle. Differences in procedures, conditions, instrumentation and sample preparation all contribute to the bias of a laboratory. When these differences become too large, a laboratory may receive a Data Flag for a Systematic Error. When the test results for both samples are both high or low compared to the group, a laboratory has a fixed set of factors on which to focus to identify a cause. Furthermore, since additional testing on similar samples should produce similar high or low results, it is possible to determine that a systematic error has been successfully corrected.

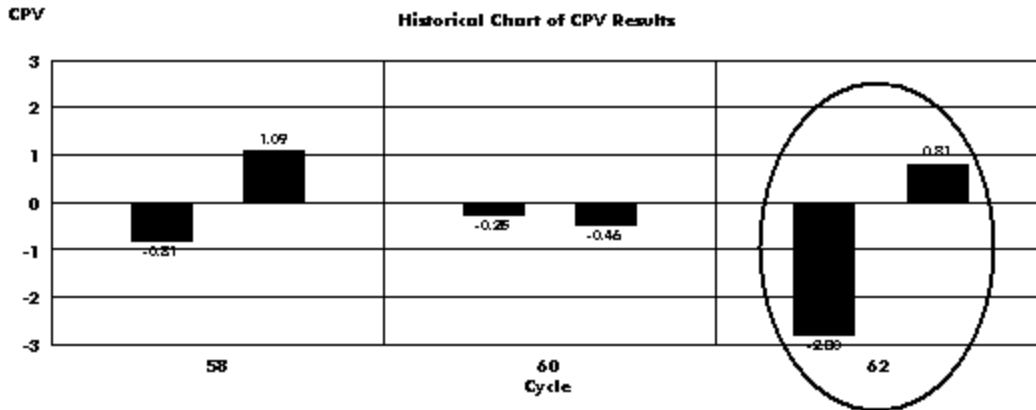
Inconsistency in testing

Inconsistencies that do not involve extreme data may be the most difficult error for labs to understand and to identify a cause. Often, a lab's first instinct is to conclude that each lab mean does not exceed a reasonable limit, so there is no cause for concern. But because the samples provided are similar to each other, it is expected that there will be a correlation between the measurement results for the two samples. This correlation is clearly shown by the control ellipse. The test results for all labs are compared against each other, thereby computing an "acceptable" level of inconsistency and illustrated in part by the width of the control ellipse. A lab flagged for Inconsistency in testing has exceeded what the other labs have determined is a reasonable correlation between the means for the samples.

Analysis #180: Chemical Analysis Element #1 - Corrosion Resistant Steel - Percent

CARBON (C)

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A maximum of 3 test cycles are printed on this page. If there are fewer than 3 sets of bar graphs on the chart and the laboratory was enrolled for all cycles, then one of the following situations occurred: lab did not submit data for a particular test/factoring cycle or the data charts were received late.

WebCode	Test Cycle	Sample/Material	Lab Mean	Grand Mean	Between Lab Std Dev	CPV	Data Flag (if assigned)
Not used	58	M23 AISI 309	0.054	0.0568	0.0035	-0.81	65 of 70 labs included
		M24 AISI 310	0.063	0.0584	0.0042	1.09	
Not used	60	M27 AISI 321	0.0473	0.04809	0.00297	-0.25	64 of 66 labs included
		M28 AISI 321	0.0433	0.0468	0.00290	-0.46	
X	62	M31 AISI 304	0.0313	0.03961	0.00296	-2.80	57 of 62 labs included
		M32 AISI 304	0.0177	0.01482	0.00354	0.81	

Overall Statement for this Cycle

Action Item! Your performance for this cycle was assigned an X Data Flag. Analyst Comment: Inconsistent in testing between samples, data for Sample M31 are low.

The Performance Analysis Report - Current Cycle presents the two-sample plot and control ellipse for each analysis. The Lab Means for the first sample form the x-axis and the Lab Means for the second sample form the y-axis, so you can easily find the circled point that represents your lab. However, if one or both of your lab means is extremely high or low, you may "fall off the plot".

You will notice a correlation between your bar graphs for the cycle and your position on the plot. For example, if both bars are above or below the zero-line, you will find your lab in the upper right or lower left quadrant, respectively. If your lab falls in the lower right or upper left quadrant of the plot, your bars go in opposite directions.

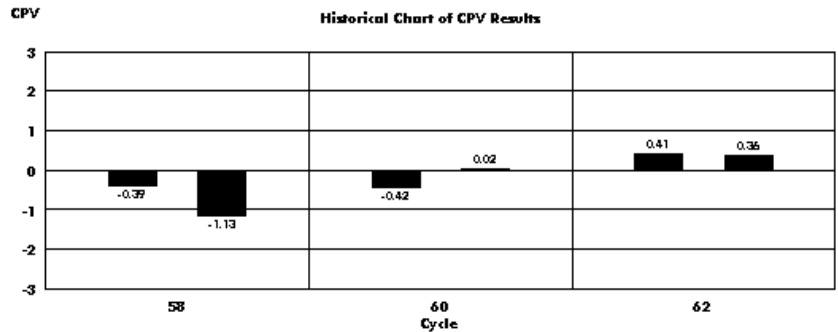
When considering your lab's position on the plot relative to the control ellipse, remember that, generally speaking, if a lab's plotted point falls on the major axis of the ellipse, the lab is consistent in its measurements between the two samples but exhibits an offset from the grand mean (systematic error). If a plotted point falls to the side of the ellipse, it indicates possible differences in the way that the lab tested the two samples or differences in sample behavior (inconsistency in testing). The two-sample plot enables you to see which sample, if either, is out of control and to ascertain the nature of the out-of-control situation.

CTS uses the CPV ratio to allow for evaluation of measurement performance over time. Small differences in sample means and variation are not of critical importance when using the CPV to evaluate performance, so laboratory results can be compared from cycle to cycle, even though the samples used may be different. When comparing data among test cycles, remember that such comparisons may be limited if there have been changes to equipment, test procedures, or technicians. Despite these limitations and the long time span between the tests, labs that choose to maintain a constant approach to the interlaboratory program may find that the Historical Charts provide more than just additional data; the Historical Charts may have diagnostic and/or predictive value. The following examples illustrate how the information presented in the Performance Analysis Report could be interpreted.

Consistency

The Tensile Strength results are consistent from round to round showing only normal and acceptable flutter about the Grand Means, with all CPVs between -1.50 and +1.50. This should give the lab greater confidence in its Tensile Strength measurements.

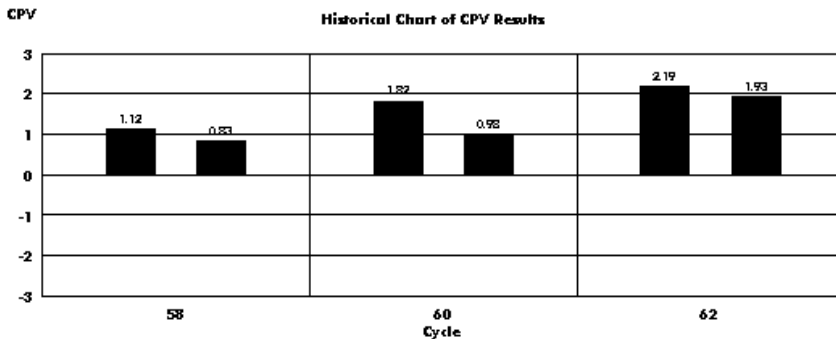
Analysis #130: Tensile Strength (Flat Steel) - ksi
using Test Method: ASTM E8



Analysis #125: Rockwell Hardness of Externally Threaded Fasteners - Rockwell Hardness Number
using Test Method: ASTM F606/F606M AND ASTM E18

More Consistency

These results show a different type of consistency. The Rockwell Hardness results from this laboratory are consistently higher than the Grand Mean, but have not been assigned a Data Flag. Depending on the laboratory's interpretation of the results, action may be taken to bring the testing in closer agreement with the consensus.



Sudden blip

The historical chart can reveal a one-time deviation from usual performance. These deviations happen, even to the best of labs, and cannot be predicted. Was there a change in instrument? Improper calibration? A departure from procedures? New technician?

Analysis #187: Chemical Analysis Element #8 - Corrosion Resistant Steel - Percent
CHROMIUM (Cr)

