How Accurate is Steel Media Hardness Testing?

I was recently asked why there were variations among laboratory hardness reports for steel peening media. What I discovered in a brief investigation of the supplied reports was interesting and suggests that we need to pay attention to these findings. The hardness range of the sample is 45-52 HRc (Hardness Rockwell C scale). The accompanying illustrations indicate two areas of concern. First, there is a disparity among the laboratory results despite that all the labs were Nadcap accredited. Second, the sample had a higher hardness level than allowed in specifications.

An initial data analysis using only hardness averages indicated that there is, indeed, data scatter. A lab might accept the media if it looks only at the average values and claims that the results are within spec limits. I gained more insight into the data scatter with the histograms on page 41. The histograms made it easier to see that there is something drastically wrong. There should be a way for the labs to synchronize their readings since they are Nadcap accredited.

I'm not only concerned with the differences in the lab results as the sample had a much higher hardness than specifications allow. Figures 1-4 show the individual hardness readings in standard histogram display with the Lower Specification Limit (LSL) and the Upper Specification Limit (USL) set at 45 and 52 respectively. Each graph's readings are near the USL. Figure 5 combines all of the readings of the four graphs into one graphic and here we see that almost half of the data is above the USL. I used another graphical technique to further illustrate the data collection seen in Figure 6. This again shows the combination of all four tests but uses color bars to show how the four evaluations relate to each other.

It's interesting to note that Figure 1-Test 1 has two very high readings. If averaged, the media would meet the specification requirement. But this isn't an engineering college course where students get to "dismiss the data that doesn't fit." This is the real world and two high readings were reported and must be respected.

SAE document AMS 2431, Peening Media General Requirements, refers to ASTM E 18 "Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials." There is, however, a lot more that needs to be considered for a reliable hardness test of media. The following excerpts from SAE J 827 state:

Sample Mounting for Testing
Shot samples used for testing for hardness, microstructure, and objectionable defects shall be mounted one layer deep in Bakelite or other suitable strong metallurgical sample mounting media.

The mounted sample shall be ground to the center of the particles and polished by methods acceptable for microscopic examination. When grinding and polishing the sample, care must be taken not to overheat the sample and affect microstructure and/or hardness.

Hardness Testing
Hardness measurements shall be taken at the half radius on a minimum of 10 particles in the mounted samples.

The hardness shall be determined by using ASTM E 384 and using a 500 g load for sizes HCS S280 and finer, and 500 or 1000 g load for sizes HCS S330 and larger. Other microhardness test methods may be used as long as a reliable hardness conversion can be obtained by calibrating the test machine against known standards. Approximate conversion to Rockwell C Hardness Numbers can be obtained from ASTM 140 and from manufacturers of hardness testers.

If a laboratory doesn't adhere to these guidelines, then erroneous readings are likely to result. The requirement for "one layer deep" is predicated on the likelihood that a lower reading or an unstable reading will result if two shot particles are aligned vertically in the Bakelite. If severe grinding is used, then the shot particles might exhibit a lower hardness due to the tempering effect.

Another facet of this problem is the variables in hardness testing methods used around the world. Europe and Asia tend to use Vickers hardness while the U.S. uses Knoop hardness and converts the values to Rockwell C scale hardness equivalents. (Newbies can look this up on Wikipedia.)

This cursory review leads me to believe that more research is needed which might lead to a spec revision on data scatter. The issue with high-hardness media will have to be reviewed by the media producer. ●

Figures 1 - 4

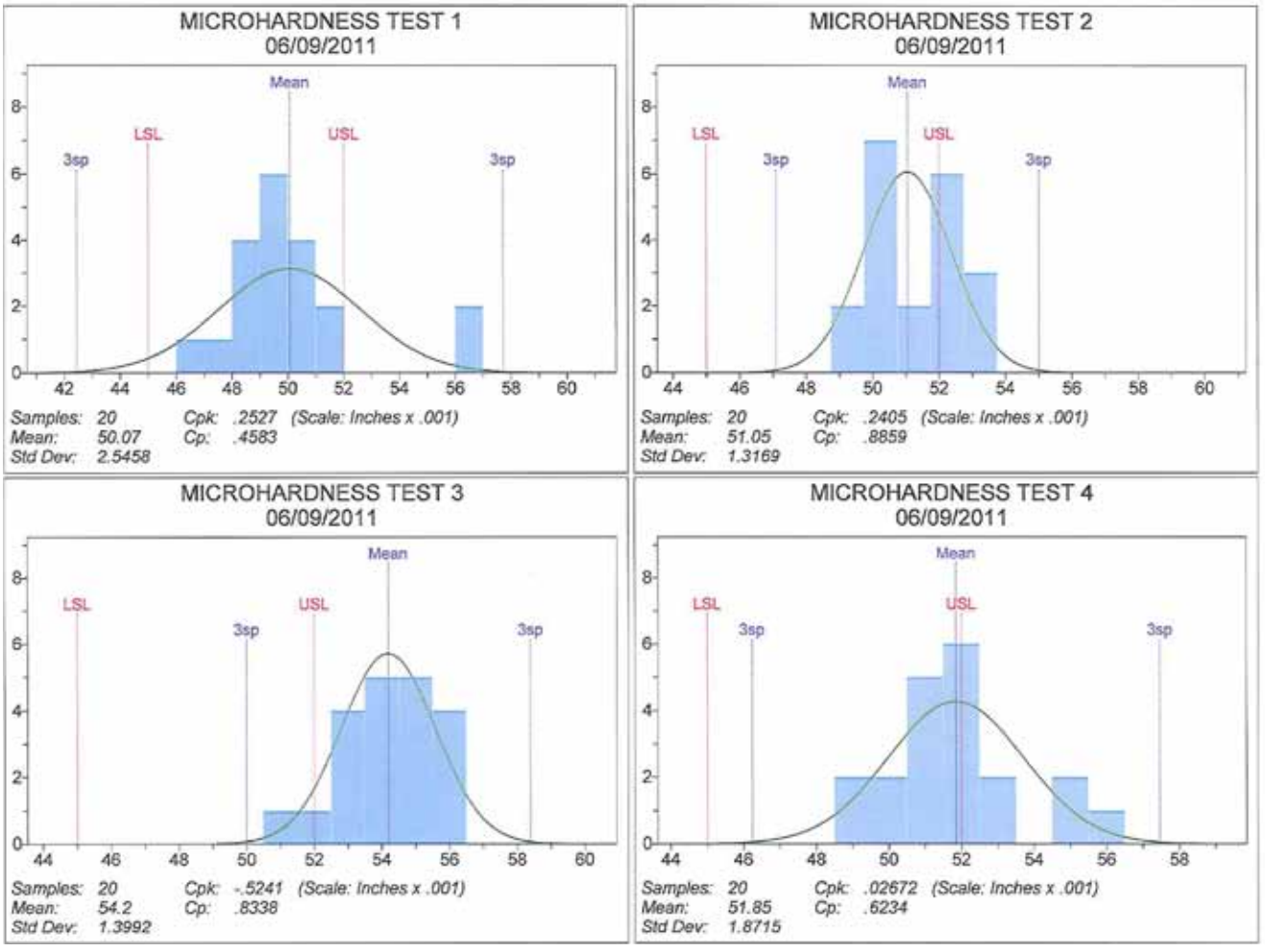

Figure 5

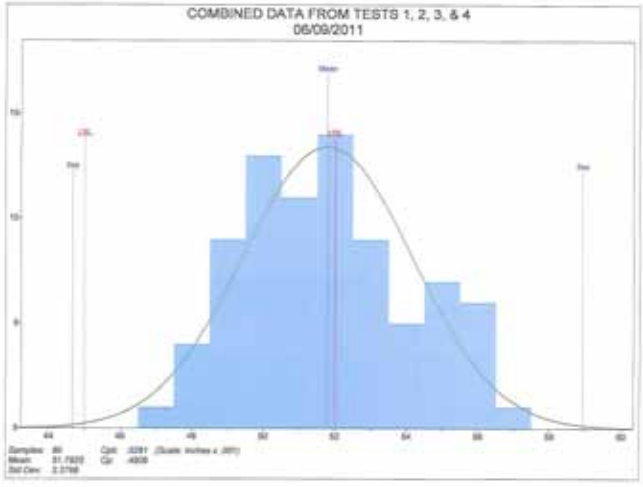

Figure 6