The Los Angeles Silhouette Club

Testing The Consistency Of The Commonly Available
Cast Bullet BHN Test Equipment

Cast Bullet BHN Tester Experiment

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Introduction

Casting Method:

All bullets in this test were cast on a Ballisti-cast Mark II machine, which eliminated many variables that may occur during the hand casting process. Bullets came from the same batch of wheel weight alloy, and lead was dropped into the molds at a temperature of between 683 and 688 degrees Fahrenheit. At least two thousand bullets were cast prior to collection of the sample to insure a constant mold temperature during the collection process. Approximately 5.1 seconds passed between the filling of each mold and the quench into water that was within a degree or two of 36 Fahrenheit.

Testing Method:

Bullets were cast at the same time on March 23, 2008, and testers were asked to measure on May 10, 2008. This extended time frame was designed to allow for age hardening changes to subside. The scope of this test included 42 different testers using a total of 47 different testing tools. Ten bullets were supplied for each testing tool, and participants were instructed to test the nose of the bullet in a manner consistent with their normal testing procedures. Of the four major types of tester used, 13 were Cabine Tree, eight were LBT, 12 were Lee, and nine were SAECO'S. In addition, four other brands of tester were included, and one batch of bullets was tested on regularly calibrated laboratory equipment. More information about the lab testing can be found on the "lab" excel worksheet.

Initial Analysis of Results:

- At initial glance, LBT and SAECO tools seem to have the highest standard deviation. Throwing out the high LBT tool reading and eliminating the early test that was redone with a different batch of bullets closer to the testing date moves the standard deviation more into line with the Cabine Tree and Lee testers.
- Cabine Tree, LBT, and Lee tools appear to have been equally consistent within their groups for this particular batch of bullets. SAECO seemed to have more variance, due in part to conversion factors.
- SAECO and Cabine Tree BHN estimates were more dependent on user conversion from the raw data reading into a BHN number than the LBT and Lee tools.
- The Cabine Tree numbers could be more accurate with more "mapping" of the correlation between indent depth and actual lead hardness.
- LBT numbers were closest to the actual lab results, with all other tools measuring the samples as harder than reported by the laboratory. This is especially true if the "high tester" set and the early duplicate test are eliminated from the data. SAECO and Cabine Tree testers measured the farthest from the actual lead hardness.
- Cabine Tree tools produced the smallest extreme spread, while the LBT tools produced the largest. If the LBT high test is removed, then the SAECO would appear to have the highest extreme spread.
- The Lee tester appeared to produce the most readings that were both consistent and closest to the actual laboratory results. Although individually other testers came in with slightly smaller standard deviations and

numbers that came in closer to calibrated equipment, the Lee appeared to have the best combination between the two areas.

- The differences in the SAECO numbers raised the question of if there was any correlation between the age of the tester and the BHN that was reported. A query was sent out to the SAECO users to determine if their tools were the older, metallic colored ones, or the newer, yellow anodized aluminum ones. Testers 5, 9, 12, 16, and 17 were reported to be the newer yellow testers. Testers 15, 26, and 44 were older, metal colored units. This information seems to indicate there is not a correlation between the jump in numbers on the SAECO'S and age of the tools. There has been no response from tester 37 yet, but at this point it is doubted the age of the tester (equipment) will shed much more light on any age to measurement connection than the initial responses already have.
- An experience that may be relevant to this experiment was reported by user Dye (with SAECO testers 16 and 17). He sent his testers back to the company when the measurements of one of his alloys did not come back the same between the two testers. When they were returned to him they still provided different readings. Although the deviance did not appear to be present for this particular alloy (in this test), Dye's experience may or may not shed light on other differences that have appeared between SAECO'S in this test. There simply isn't currently enough information collected to determine the cause of the differences beyond the shadow of a doubt. It could be simply that this alloy was harder than the "sweet spot" that this particular brand of tester measures accurately.

NOTE: S.D. = Standard Deviation - E.S. = Extreme Spread.

Cabine Tree

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
1. Cabine Tree	8	23.0	23.0	23.0	23.0	23.0	24.0	24.0	24.0	24.0	24.0	23.5	0.5	1.0
2. Cabine Tree	4	23.0	23.0	23.0	23.0	23.0	24.0	24.0	24.0	24.0	24.0	23.5	0.5	1.0
3. Cabine Tree	21	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	0.0	0.0
4. Cabine Tree	22	23.0	24.0	24.5	25.0	25.5	26.0	27.0	27.5	28.0	28.0	25.9	1.7	5.0
5. Cabine Tree	25	27.0	27.0	27.0	27.0	27.0	28.0	28.0	28.0	28.0	28.0	27.5	0.5	1.0
6. Cabine Tree	28	18.0	18.0	18.0	19.0	19.0	19.0	19.0	20.0	20.0	20.0	19.0	0.8	2.0
7. Cabine Tree	30	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	0.0	0.0
8. Cabine Tree	32	27.0	27.0	27.0	27.0	27.0	28.0	28.0	28.0	28.0	28.0	27.5	0.5	1.0
9. Cabine Tree	33	23.5	23.5	23.5	23.5	23.7	23.7	23.7	23.7	23.7	25.0	23.8	0.5	1.5
10. Cabine Tree	34	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	0.0	0.0	0.0
11. Cabine Tree*	38	25.0	25.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	28.0	26.7	0.9	3.0
12. Cabine Tree	40	24.5	25.0	25.0	25.3	25.5	25.5	25.6	26.4	26.4	26.8	25.6	0.7	2.3
13. Cabine Tree	47	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	0.0	0.0

Low value 18.0 High value 28.0

Average of All Cabine Tree Testers Combined	BHN	S.D.	E.S.
	24.1	2.5	10.0

Tester:	LBT Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
1. LBT**	1	20.0	20.0	20.0	20.0	21.0	21.0	21.0	21.0	23.0	23.0	21.0	1.2	3.0
2. LBT**	2	18.0	18.0	19.0	19.0	20.0	20.0	20.0	21.0	21.0	21.0	19.7	1.2	3.0
3. LBT	10	30.0	30.0	35.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	37.5	4.2	10.0
4. LBT	19	15.0	16.0	16.0	17.0	17.0	17.0	18.0	18.0	18.0	18.0	17.0	1.1	3.0
5. LBT	20	18.0	18.0	18.0	18.0	18.0	19.0	19.0	19.0	19.0	19.0	18.5	0.5	1.0
6. LBT	23	19.0	20.0	20.0	20.0	20.0	20.0	20.0	21.0	21.0	21.0	20.2	0.6	2.0
7. LBT	24	16.0	16.0	16.5	17.0	17.0	17.0	17.5	17.5	17.5	17.5	17.0	0.6	1.5
8. LBT	36	22.7	24.0	25.0	25.3	25.3	25.7	25.7	26.3	26.3	26.3	25.3	1.1	3.6
9. LBT	48	17.0	17.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0	20.0	17.9	0.9	3.0
Low value 15.0		**High value 40.0**							**Average of All LBT Testers Combined**			**BHN**	**S.D.**	**E.S.**
												21.6	**6.4**	**25.0**

** Test 1 and 2 for LBT tool were done on the same tool on two separate dates.

Lee

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
1. Lee	3	20.9	23.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	27.2	24.6	1.5	6.3
2. Lee	6	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	0.0	0.0
3. Lee	7	22.7	22.7	22.7	22.8	23.8	23.8	23.8	23.8	24.8	24.8	23.6	0.8	2.1
4. Lee	11	19.3	20.9	22.7	22.7	22.7	22.7	22.7	22.7	24.8	24.8	22.6	1.6	5.5
5. Lee	14	20.9	20.9	20.9	20.9	20.9	21.8	22.7	22.7	22.7	22.7	21.7	0.9	1.8
6. Lee	18	20.9	21.8	21.8	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.3	0.6	1.8
7. Lee	27	24.8	26.0	26.0	26.0	26.0	26.0	26.0	27.2	27.2	27.2	26.2	0.8	2.4
8. Lee	29	16.0	16.0	16.0	16.0	16.0	16.6	16.6	20.1	20.1	20.1	17.6	1.9	4.1
9. Lee	31	22.7	22.7	22.7	22.7	22.7	22.7	22.7	24.8	24.8	24.8	23.3	1.0	2.1
10. Lee	35	21.8	21.8	21.8	21.8	22.7	22.7	22.7	22.7	22.7	22.7	22.3	0.5	0.9
11. Lee	39	20.9	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.8	22.7	0.9	3.9
12. Lee	41	28.5	28.5	28.5	28.5	28.5	28.5	28.5	29.9	29.9	29.9	28.9	0.7	1.4
Low value	16.0	High value	29.9				Average of All Lee Testers Combined					BHN	S.D.	E.S.
												23.4	2.8	13.9

SAECO

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
1. SAECO	5	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	0.0	0.0
2. SAECO	9	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	18.0	17.1	0.3	1.0
3. SAECO	12	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	0.0	0.0
4. SAECO	15	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	0.0	0.0
5. SAECO	16	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	0.0	0.0
6. SAECO	17	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	0.0	0.0
7. SAECO	26	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	0.0	0.0
8. SAECO	37	18.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	21.6	1.3	4.0
9. SAECO***	44	18.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	21.6	1.3	4.0
Low value	17.0	High value	35.0				Average of All SAECO Testers Combined					BHN	S.D.	E.S.
												27.9	7.0	18.0

*** In this test BHN numbers were not provided, but estimated using similar numbers converted by other testers.

Shore Scleroscope

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
Shore Scleroscope	42	18.3	18.3	18.3	18.5	18.8	18.8	18.8	18.8	19.0	19.8	18.7	0.5	1.5

TEC

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
TEC	43	21.4	21.9	21.9	21.9	21.9	21.9	21.9	21.9	24.5		22.1	0.9	3.1

Rockwell "R" scale

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
	13	105.0	106.0	106.0	107.0	107.0	107.5	108.0	108.0	108.0	108.5	107.1	1.1	3.5

Rockwell "B" scale

Tester:	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
	45	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	0.0	0.0

Results of Lab BHN Test

Lab Tested Hardness - BHN	Person	Bullet 1	Bullet 2	Bullet 3	Bullet 4	Bullet 5	Bullet 6	Bullet 7	Bullet 8	Bullet 9	Bullet 10	Average	S.D.	E.S.
	46	18.8	19.1	19.1	19.8	19.8	19.9	19.9	20.3	20.5	20.6	19.8	0.6	1.8
Indent size (mm)	46	0.918	0.920	0.924	0.932	0.933	0.934	0.934	0.950	0.950	0.956	0.935	0.0	0.038

Lab Information:

Here is the data on the hardness of the 10 bullets you sent to me. The indentations were made last Friday night which is as close to the Saturday date you requested as I could get. Last night I measured the diameters of each indentation three times as shown in the attached photograph. This is an extremely accurate measurement technique as it is done at 100X magnification. The indentations were made with a 15 kilogram force and using an indentation ball of 1/16 inches (1.587 mm) in diameter. Each bullet was mounted in a cold setting epoxy mounting medium. Then the surface of the mount using appropriate metallographic technique was gently shaved by about 0.010 inches to provide a flat surface to the indenter of the bullet nose.

Shore Scleroscope Information:

Nose 1	Nose 2	Nose 3	Nose 4	Total	Average
15	15	14	15	59	14.75
15	15	15	15	60	15
16	16	16	15	63	15.75
15	16	15	16	62	15.5
16	16	16	16	64	16
15	15	15	16	61	15.25
15	16	15	16	62	15.5
16	15	16	15	62	15.5
15	15	16	15	61	15.25
17	17	16	16	66	16.5

Base 1	Base 2	Base 3	Base 4	Total	Average
18	18	19	20	75	18.75
18	18	18	19	73	18.25
18	17	19	19	73	18.25
20	19	18	18	75	18.75
19	19	19	17	74	18.5
19	20	17	19	75	18.75
20	20	18	18	76	19
19	19	18	19	75	18.75
18	19	17	19	73	18.25
19	20	20	20	79	18.75

Nose + Base	Average	Band	Copper ref.
33.5	16.75	14	13
33.25	16.625	14	12
34	17	14	12
34.25	17.125	12	12
34.5	17.25	12	13
34	17	13	12
34.5	17.25		12
34.25	17.125		13
33.5	16.75		12
36.25	18.125		12

The Scleroscope process depends on an average of multiple tests for improved accuracy. Shore had in mind testing anything from bearing metal to tool steel with a single tester.

For soft stuff I use the "magnifying hammer" marked .226. It seems to correlate well with known samples. Since the Shore scale goes from 0 to 140, with 60 Shore being equal to 45 Rockwell "C" scale with the standard hammer, conversion can be complex.

A practice session with known material is done first. I then calibrate the hammer to a piece of annealed copper. I usually run a control hit on the copper after each part as well.

I tested each bullet four times on the nose, and four times on the base. I also tested a few right on the driving band out of curiosity. The clamping of the bullet leaves a bigger mark than the test.

There were some surprises. The base is definitely harder than the nose. Test after test. All of the samples were harder than the pure annealed copper rod. Pure lead tests much softer than pure copper in this tester, so I know this is good data. A piece of 60/40 solder was tested at a reference of 10 with that hammer as well. Your stuff is plenty hard.

For bullet work I usually use the Shore numbers as is. Converting to BHN at the lower ranges can be deceiving. I have poured a lot of bearings, and have used the comparative method for bearing alloys with 100% success.

By yammerschooner on castboolits.com May 2008

Comments on the tests by The Webmaster:

These are not laboratory grade pieces of equipment; no one should think they are, no one could afford them if they were. What is important with these testers is consistency. It doesn't really matter if a lab tested piece of lead is 20 BHN and your tester says it's 18 BHN and someone else’s says 22. What is important for your handloads is that your tester ALWAYS says 18 BHN plus or minus about 1 BHN and the other guys always says 22 plus/minus 1. That's close enough for you to keep accurate notes and use it to assemble very consistent ammo from batch to batch.

In these experiments there were nine different LBT testers. Of the 9 two were very clearly out of calibration, the remaining 7 testers where easily consistent enough for consistent BHN readings for cast bullets. The other two testers can be calibrated and should be. With the LBT testers if the two erroneous tests are removed the seven remaining average 19.0 BHN (the lab average was 19.8 BHN). With each of the brands tested if you throw out the various obvious erroneous readings (chalk these readings up to machine and/or operator error) they are easily close enough (accurate enough) for consistent cast bullets.

I did an extensive long range BHN test with my 9" FA 357, many hundreds of rounds in 5 shot groups that took a year and a half shooting scoped from the bench at 150 meters. All loads where as identical as I could make them using only virgin brass, powder, primers and alloy from the same lot numbers. BHN changes ranged from air cooled WW @ 11 BHN to convection oven HT 30 BHN and many BHN ranges in between. My revolver shot the best groups with the lowest S.D. and E.S. at 17-18 BHN. A BHN range of 1 or 2 within the same group seemed to make no difference in grouping. Shooting a group with a wide variation in BHN (say 15 BHN to 22 BHN within the same 5 shot group) destroyed groups and opened up both S.D. and E.S.. Repeating the same tests over and over proved this out. Without a consistent method of determining BHN "ranges" this testing would not have been possible.

So yes, these testers are a valuable asset to the bullet caster. Does my tester say an alloy is 18 BHN and the lab says no . . . its 20 BHN . . . Well, so what? It doesn’t matter as long as mine always says 17-18. Consistency matters, an exact match to lab results does not. If your casting technique is consistent enough to keep your bullets within 1 BHN and your BHN testing tool is consistent enough to measure within 1 BHN even the most demanding caster should be good to go. Alloy consistency is important for long range top end loads grouping and these tools are an important "aid" in assembling consistent cast bullet loads.

So what do these experiment prove? The differences between the various testers, the simplicity of using the tester making consistent readings possible, the users ability to use the tester consistently and interpret the results. This test also has shown how close to the lab tested sample (most of) the various testers really are.

Warning: All technical data mentioned, especially bullet casting and handloading, reflect the limited experience of individuals using specific tools, products, equipment and components under specific conditions and circumstances not necessarily reported in the article or on this web site and over which The Los Angeles Silhouette Club (LASC), this web site or the author has no control. The above has no control over the condition of your firearms or your methods, components, tools, techniques or circumstances and disclaims all and any responsibility for any person using any data mentioned. **Always consult recognized reloading manuals.**