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SURFACE VEHICLE INFORMATION REPORT

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Metallic Shot and Grit Mechanical Testing

Foreword—Shot testing machines differ in detail, but are alike in the fundamental principle that a sample of shot is subjected to repeated impacts on a target. The percentage of breakdown is readily determined by means of a screen analysis. These data can be used to check the uniformity of shipments or to determine the relative fatigue life. The results obtained from testing machines are not intended to be used in establishing consumption or cost in production machines because of other considerations not duplicated in the laboratory. However, the machines can be used to test incoming shot for consistency and comparative life with previous shipments of the same type of shot from the same manufacturer under laboratory conditions. Some machines can be fitted with standard test strips[1] to measure energy transfer.

NOTE—Shot particles may be subject to multiple impacts in a test machine. The target material of test machines are made of hard steel to resist wear during testing. Hard shot is more elastic than soft shot. Due to these considerations and their influence on shot failure, care must be exercised when analyzing results from this accelerated, laboratory testing.

1. Scope—This SAE Information Report is intended to provide users and producers of metallic shot and grit[2] with general information on methods of mechanically testing metal shot in the laboratory.

1.1 Rationale—This document has been reaffirmed to comply with the SAE 5-Year Review policy.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J442—Test Strip, Holder, and Gage for Shot Peening
SAE J443—Procedures for Using Standard Shot Peening Test Strip

1. See SAE J442 and SAE J443.
2. Shot and grit will be hereafter referred to as shot.

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2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 215—Methods of Sampling Finished Lots of Metal Powders

3. Sampling—Samples for testing shall be representative of each shipment or production lot. The method of sampling shall be ASTM B 215, Method B.

4. Calibration—Because results can be influenced by the condition of a test machine, the machine must be recalibrated according to the machine manufacturer's recommendation. This may be accomplished by reserving an adequate amount of shot of known life, and comparing the results obtained on tests with that of the "standard shot." The machine must be repaired or adjusted as necessary when off-standard conditions are observed.

5. Examples of Test Procedures

5.1 Average Life by Measurement of the Area Under the Breakdown Curve—If a representative sample of shot is observed as it is broken down in a testing machine, and the percent of the sample retained on a control sieve is plotted against the number of cycles, on rectangular coordinate paper, a breakdown curve typical of the shot is obtained. The control sieve aperture should be approximately equal to the removal size in the blast operation. The area under this curve is a measure of the average number of cycles required to reduce the size of the shot particles which pass through the control sieve. This average number of cycles, commonly referred to as the average life of the shot, is a complete evaluation of the life of the shot under the conditions of the test.

5.1.1 EXAMPLE PROCEDURE

a. Place 50 to 100 g of the sample to be tested into the test machine.
b. Run until about 20% passes through the control sieve.
c. Screen, weigh, and plot the percent retained on the control sieve against the number of cycles, using rectangular coordinate paper.
d. Return the sample retained on the control sieve to the machine and continue running.
e. Repeat steps (c) and (d) at intervals dictated by the rapidity of breakdown of the sample, until less than 5% of the sample is retained on the control sieve.
f. Draw the breakdown curve, extrapolating to 0% at the end of the next test interval. The breakdown curve, using the data from the following example, with trapezoids inscribed, is shown in Figure 1.
g. Measure the area under the breakdown curve. For example, use a planimeter or sum the areas of the individual trapezoids inscribed under the breakdown curve. Record the value as average life, in cycles.

5.1.1.1 Example

a. Initial Charge—100 g of S660
b. Control Sieve Opening—600 μm
c. Test Intervals—500 cycles

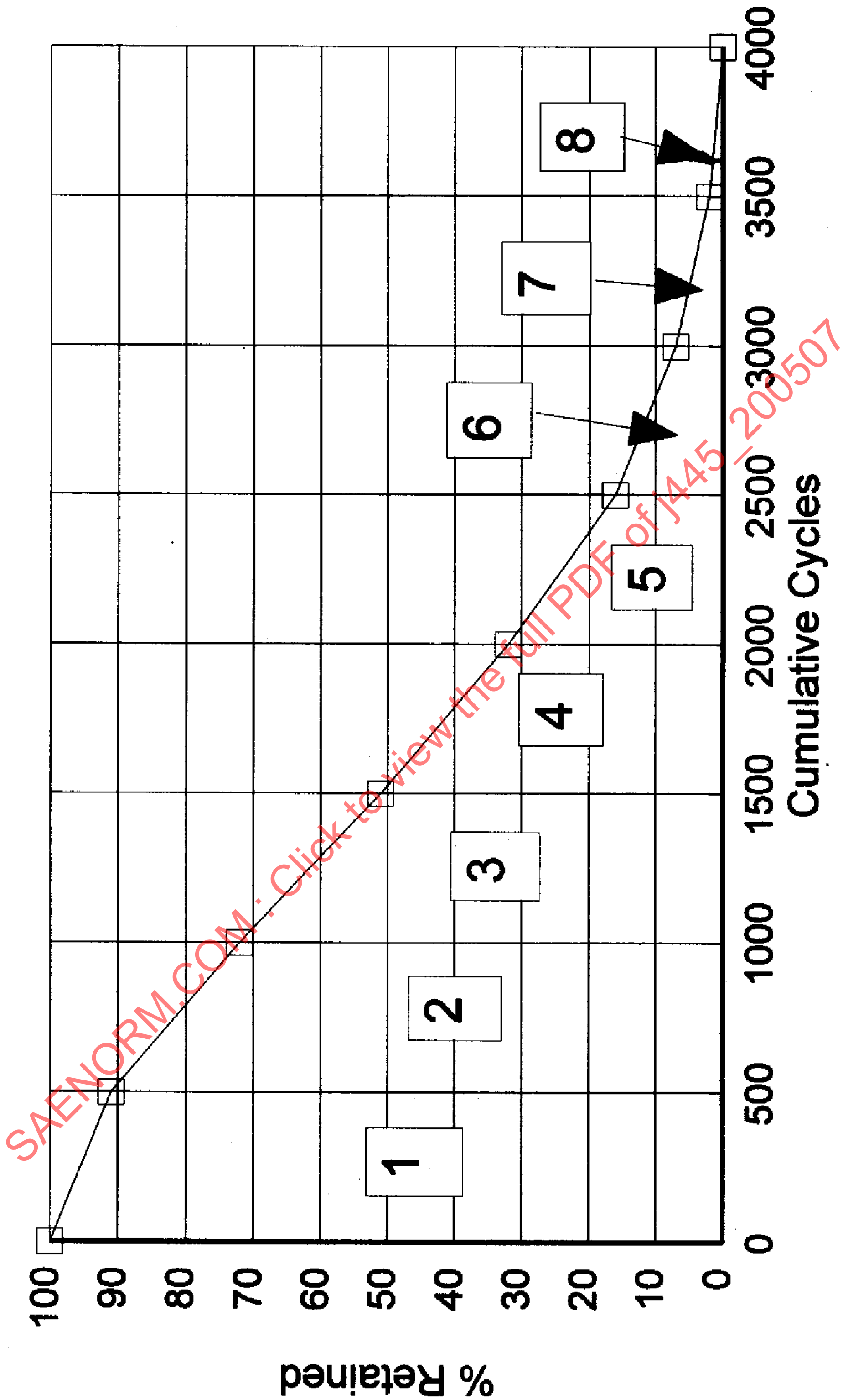

FIGURE 1—BREAKDOWN CURVE S660 SHOT TRAPEZOIDS INSCRIBED AND NUMBERED

5.1.1.2 Breakdown Data—(See Table 1.)

TABLE 1—BREAKDOWN DATA FOR EXAMPLE

Cumulative Cycles	% Retained on Control Sieve
0	100
500	91
1000	72
1500	51
2000	32
2500	16
3000	7
3500	2
4000	0

The area of a trapezoid is determined by multiplying the average height by the base. The area of trapezoid 1 is calculated as follows:

$$\text{Average height} = (100\% + 91\%) \text{ divided by } 2 = 95\% \quad \text{(Eq. 1)}$$

where:

the base = 500 cycles
Area = 95.5% x 500 cycles = 47 750% cycles

The calculations of areas of all the trapezoids are shown in Table 2.

TABLE 2—CALCULATION OF THE AREA UNDER THE BREAKDOWN CURVE AS THE SUM OF THE AREAS OF TRAPEZOIDS INSCRIBED UNDER THE BREAKDOWN CURVE

Trapezoid No.	1	2	3	4	5	6	7	8
Height 1, %	100	91	72	51	32	16	7	2
Height 2, %	91	72	51	32	16	7	2	0
Avg. Height, %	95.5	81.5	61.5	41.5	24	11.5	4.5	1
Base, cycles	500	500	500	500	500	500	500	500
Area, % cycles	47 750	40 750	30 750	20 750	12 000	5750	2250	500

NOTES

Sum of areas 160 500 % cycles

The average life = 160 500 % impacts divided by 100% =1605 cycles.

5.2 Stabilized Loss Method—A sample of shot is run in a test machine for a given number of cycles. The sample is then screened to remove particles which pass through a control sieve. The control sieve aperture should approximately equal the removal size in the blast operation. New shot is added to replace the amount removed. Repeat the procedure, always running the same number of cycles until the amount discarded (the loss) achieves stabilization. The stabilized loss data can be used to compute the average life of the sample.

NOTE—The loss pattern, when each loss is plotted against test cycles, may go through several peaks and valleys before true stabilization occurs. Initial samples should be tested through sufficient test cycles to insure that the sample loss rate has truly stabilized. Stabilization occurs when three consecutive losses vary by less than 0.50% of the initial charge weight.

5.2.1 EXAMPLE PROCEDURE

a. Place 50 to 100 g of the shot to be tested into the testing machine.
b. Run for a given interval, preferably a number of cycles sufficient to break down about 20% of the sample.
c. Screen the shot from the machine, discarding the portion which passes through the control sieve, weigh the sample, and calculate and record the loss.
d. Add new shot to restore the sample retained on the control sieve to the initial charge weight.
e. Repeat the procedure, always running the same interval until the amount discarded (the loss) achieves stabilization.
f. The stabilized loss rate equals the average of the last three values obtained, divided by the cycles intervals used.

5.2.1.1 Example

a. Initial Charge—100 g of S660 shot
b. Control Sieve Opening—600 µm
c. Test Intervals—500 cycles

5.2.1.2 Breakdown Cycles—(See Table 3.)

TABLE 3—BREAKDOWN CYCLES

Cumulative Cycles	Grams Lost
500	9.0
1000	19.8
1500	24.5
2000	26.9
2500	28.9
3000	27.1
3500	27.2
4000	26.9

$$\text{Stabilized loss} = (27.1\text{ g} + 27.2 + 26.9\text{ g})/3 = 27.06\text{ g} \quad \text{(Eq. 2)}$$

where:

Stabilized loss rate = 27.06 g/500 cycles = 0.0541 g/cycle
Final weight equals initial weight minus stabilized loss = 100 g – 27.06 g = 72.94 g