INSTRUCTION MANUAL

2022

Split-Net℠ Service Instruction Manual

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I. Steps involved in the Split-Net Service

1. Subscribe to service.
2. Training of proper image acquisition and sampling techniques.
3. Acquire images.
4. Send digital images to Hexagon. Specify any special sizing request or data output preferences.
5. Hexagon processes your images, analyzes results and returns information in desired format, usually within five business days.

II. Service Subscription

Contact to establish an account. With your Split-Net subscription we will provide you with Scaling Equipment if necessary (two scaling balls) and this instruction manual. You can use our new free Split Camera smart device App for image acquisition of muckpiles without the need for scale objects.

III. Image Acquisition Training

To insure that we can provide the size information you desire, we will provide information for you and your staff on proper image acquisition and sampling techniques. The quality of the information we can supply is directly related to the quality of images sent to us for processing and analysis. Image acquisition training can be achieved via phone conversations, email and by the use of this manual. For long-term studies and for obtaining data with a higher degree of confidence, we suggest a more in-depth training session on image acquisition techniques (price upon request). You can collectively train all staff that will be participating in the Split-Net service at one time for the same rate.

IV. Image Acquisition Techniques

Safety First:

Please practice common sense if working around heavy machinery that is in operation and/or if working close to muckpiles or an active face. Please obey all current safety rules and regulations! Not only the safety rules and regulations of your company, but also of the prevailing governmental agency or authority responsible for regulating safety and health in your industry.

Methodology:

It is important to capture your images in a *systematic* manner so that the calculated results truly represent the size distribution of the material of interest. Consistent methods should be applied to all samples that you collect so that you can make valid comparisons between sites of interest. Try to develop (and we will assist you) a fixed scheme for acquiring images at various scales and various locations and stick to it as to avoid introducing artificial bias or scatter in the size information.

You should make an attempt to capture images over the entire exposed surface of the pile or one continuous section of the pile with minimal overlap so that the results are not biased by omission or by repetition. Remember that only what is visible can be sized, and that the surface may hide variations of the material beneath. The outside surface of a muck pile before digging should not be used to represent the material within the pile but may be important by itself. The surface of an un-excavated muck pile may be quite different from the material within the pile that is exposed while digging. It is recommended for muck piles to let the shovel advance to about the middle of the shot before acquiring images that can be deemed representative of the blasted material. If you are only able to obtain images from the exposed surface before digging, make sure you only compare those to similar sets of data. It is probably not good practice to compare the distribution of the outside of an un-excavated pile to the inside of a partially excavated pile.

The amount of fines is determined by the images at the largest scale. The distribution of fines is calculated from the zoomed in images of fines. Make sure that the largest scale images include the patches of fines that are actually visible and not just the largest boulders or your results may be in error. You should be careful of changes in geology within the area of interest, since most investigators are interested in the size distribution within a specific geology.

Technique:

To eliminate side-to-side distortion, all pictures should be taken **perpendicular** to the line of the toe of the slope. To eliminate vertical scaling error, the scaling balls need to be placed in a manner that the balls **intersect the plane** of the materials slope. Or use the Split Camera app that estimates the slope of the muckpile.

For muck piles, take **3 scales of images**: 1) large scale (20 X 20 feet) including boulders and areas of fines, this scale range is to get resolution on material above 8-inches; 2) medium scale

(10 X 10 feet) of typical regions of 2 to 8-inch material and; 3) small scale (1.5 X 1.5 feet) are zoomed in images of representative samples of the finer material, typically 2-inch minus.

With the Split Camera app, there is no zooming capability so all images will be acquired at medium scale. Small scale images can be acquired with the app as well, if necessary.

If you are not interested in the size distribution of the smallest scale of material and are happy to accept a Schuhmann or Rosin-Rammler curve in this range, you may omit taking the small-scale images. If you are interested in taking the small scale, it is important to use an object level to the plane of the material and not raised above the ground; this would result in the scale being closer to the camera lens than the material, yielding a misrepresentation of the true size distribution. A good scale for the small-scale image is a ruler.

Large Scale – Far Range Image

Medium Scale – Medium Range Image

Small Scale – Zoom-in Image

Parameters:

Size Range: Make sure the largest scale images really show the overall size range present. Include the patches of fines that are actually visible and not just the largest boulders or the results from the analysis may be biased toward the coarse end.

Lighting: Be conscious that shadows and light do not interfere with the overall image appearance. Overcast days actually provide the best lighting due to even lighting and fewer shadows. Make sure the images are in focus.

You must get close enough so that the rock fragments are distinguishable in the image: The image below was taken too far away to define the particles well. Much "wasted" space in the image, i.e. space that is not going to be analyzed such as sky and foreground in front of the pile. Size characterization is done on the material that is in the talus slope below the high wall bench face (no characterization can be done on material in the vertical bench face itself).

Images should contain more than a few number of particles:

Good image….
Scaling tools set scale in the slope of the pile
Few shadows in rocks.
Nice range in size.

Poor image…
There is only one large rock in the picture, thus an extremely biased sampled of the pile.

Zooming: You should zoom in or get closer to patches of fine material to help determine the size distribution of the finer material. With the Split Camera app, there is no zooming capability, so all images will be acquired at medium scale and small scale.

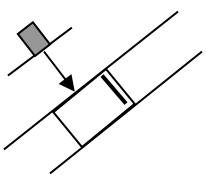
Scaling:

With the Split Camera app, images of muckpiles can be acquired without the need for scale objects in the scene. By configuring the App settings and following the image acquisition procedure for the App, quality images can be acquired. Please reference the separate tutorial document for configuration and use of the Split Camera app.

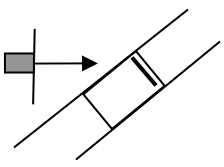
Without the App or in cases where the sample is not a muckpile, an object or objects of known size must be in the picture in order to set the scale for the entire image that is to be analyzed. The change in apparent size of objects due to the top of a pile being further away from the observer than the bottom is also corrected by using the scaling information. The best scaling tools for this method are rubber balls with handles on them so that a rope can be used to retrieve the balls.

One-Known Object Method: For zoomed-in images it may be necessary to use a ruler or scale as the known size in the image. In the case where only one known object is used and the distance and angle are not measured, it is important to take the image in the same plane as the slope of the material imaged. By imaging in the same plane, scaling differences and slope distortions are greatly reduced. The image must also be taken as perpendicular as possible to the scaling object, especially if the scale object is not spherical.

Correct Zooming:

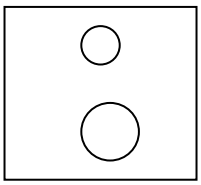


Incorrect Zooming:

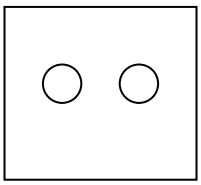


Two-Known Object Method: Use two known objects to scale the image, preferably spheres of known diameter. Place the two scaling objects on the pile so that both are in the field of the view of the image that is to be taken. The objects should be at different **vertical** heights within the image to correct the effect of slope on the scale. Place the scale balls fairly centered in the image in the plane of the slope of the material that is imaged. The bottom scale ball should be about ¼ up from the bottom of the image and the top scale ball should be ¼ down from the top of the image. The scale balls are creating two known scales at those two points in the image and the scales will be linearly calculated from the top to bottom of the image. If the scale balls are placed too close together at the top, bottom or even in the middle of the image, the scale calculation will be inaccurate.

Correct Scaling:



Incorrect Scaling:



Acquiring Multiple Images:

A recurring and important question is: how many images do I need to acquire?

The number of images required to calculate the size distribution of a given sample of material is not fixed and varies from situation to situation. The number of images to acquire depends on 1) the physical size of population of material in question and 2) the rock size fraction that is of interest (i.e. do you need images at all three scales to calculate a complete distribution curve? Or, are you most interested in oversize and will accept an estimation of finer material?).

Taking these two key issues into consideration should lead you to the correct number of images to acquire for your sample. For more information, or if you wish to discuss this issue, please contact. Also, you can contact to discuss methods for determining a significant sample for conveyor belt material.

Physical Size of Material to be Measured: If what is on the surface of the material in question is deemed to be representative of the entire population of material, then images covering the entire *surface area* of the material should be taken. A key consideration in assessing the surface area is the homogeneity of the material on the surface. If the entire pile looks similar in size on each exposed face, then extra images of the "same" material will probably not result in better size information. If the surface area does expose varying size fractions, then images of the entire surface should be acquired.

Again, when imaging muckpiles, it is recommended to acquire images after the shovel has advanced towards the middle of the pile as the surface of the blast is rarely representative of the contents inside the pile.

Size Fraction of Interest: As previously recommended, images should be acquired of the surface at varying scales (large scale - far range, medium scale - medium range and small scale – zoom-in). This allows the software to focus and analyze particles at different scales that will eventually be merged together in one cumulative size distribution as a complete size sample.

For example, if you are only interested in oversize material, you can stand back and take large scale - far range images of the entire surface that will capture those large particles (12" + or higher). The Split software will not be able to detect mid-size particles (5" – 8" or so) or smaller with only the far range image and will estimate for what it cannot detect. For every scale image, there is a cut-off point where the Split imaging software cannot detect (delineate) any smaller particles. Below that point is the "fines estimation." Depending on the scale of the image, the fines estimation may be for fairly large particles, not only the actual fines in the sample. The fines estimation is based on the a Schuhmann or Rosin-Rammler distribution and is a function of the slope of the curve up to the cutoff point.

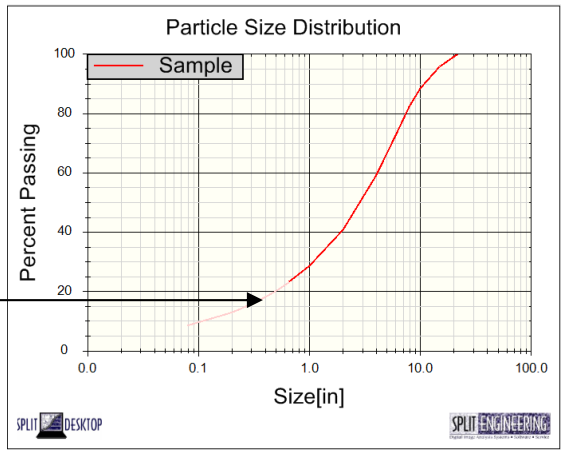
Very large particles in this medium range image. There is no need to zoom further in and acquire another image as the particles are clear and distinguishable in the image.

If this surface area represents the entire population of the material that you wish to measure, you will have to accept an estimation for the particles that you cannot see since there are no smaller particles to measure on the surface.

Far range picture captures largest particles, but loses resolution on the finer particles, particularly between the scaling balls. A medium scale image can be acquired without moving the scaling balls to obtain better resolution on the smaller particles. Zoom even further in to achieve resolution on the smaller particles to the bottom left of the top scaling ball. If you are happy to accept an estimation of those particles based on the slope of the curve using the large scale and medium scale images, then omit acquiring the small scale zoom-in image

Basically, if estimation is not acceptable for smaller size fractions, acquire the medium and small-scale images. The Split software will merge the entire sample together as one size distribution curve and the size cutoff and fines estimation will be lower.

Where the line changes color signifies that below this point the Split software did not delineate any particles, therefore, the remainder of the curve is an estimation (using either the Schuhmann or Rosin-Rammler distribution.



Size[in]	Sample % Passing
25.00	100.00
15.00	95.78
10.00	88.52
8.00	82.18
6.00	72.59
4.00	58.72
2.00	40.69
1.00	28.62
0.75	24.79
0.50	20.32
0.38	17.67
0.25	14.55
0.19	12.69
0.08	8.57

% Passing	Sample Size[in]
F10	0.11
F20	0.48
F30	1.10
F40	1.93
F50	3.00
F60	4.16
F70	5.56
F80	7.46
F90	10.64
Topsize (99.95%)	21.70

	Sample
Fines Cutoff[in]	0.65
Fines Factor	50.00

Imaging Form:

To keep a record of each test, the Split-Net Digital Imaging Form (See Appendix A) should be completed for each test analyzed. Information such as the test sample #, photographer, sample date, sample location, sample geology, blasting conditions, picture number, time of photo, picture resolution, picture location, scaling method, download file name, comments and test notes are necessary for proper image processing and analysis. A digital imaging form should be complete for every test imaged. An electronic copy of this form should be included with each test sample. The more information we have about the images, the better the results that we can provide. This also allows us to keep records of prior analysis and gain a better understanding of fragmentation at each site and ultimately serve our clients better.

V. Sending Images

Digital Image Download Instructions:

JPEG images are smaller in size and will transfer faster via file share or via e-mail. Most cameras and phones take images of sufficient resolution. Any image above 2 megapixel in size should be acceptable resolution for processing.

When using the Split Camera app, do not resize or rotate the images after acquisition. The native images acquired by the device need to be sent to for processing.

Transferring Digital Images:

Use whatever file transfer service is utilized by your company and approved by your IT department. Send links or information to splitnet@spliteng.com.

1. Transfer images via your file transfer service.

2. Email to inform us that you have completed your image transfer. This enables us to begin processing and analyzing your images in a timely fashion.

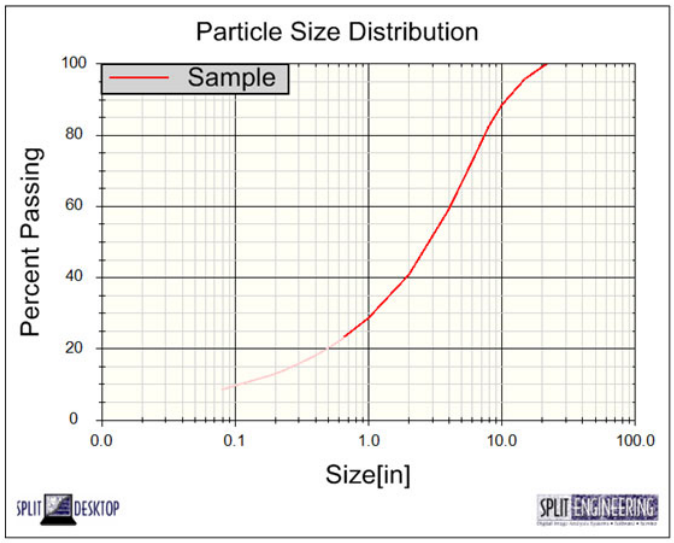
Using E-mail:

Send images attached to e-mail messages to splitnet@spliteng.com

VI. Format of Results Information

Software Graphical Output:

Our typical graphical output for the Split-Net service looks similar to the following examples: Linear/Linear or Log/Linear. Let us know the particular specifications you are interested in and we will tailor the results differently.



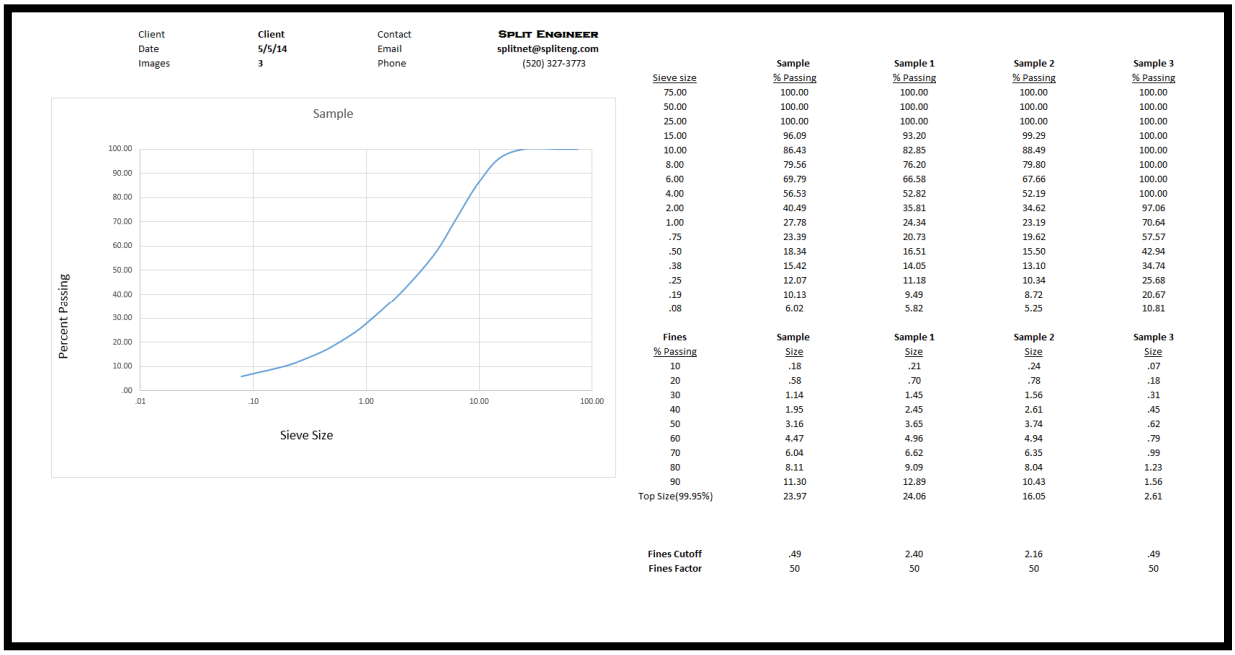
	Sample
Size[in]	% Passing
25.00	100.00
15.00	95.78
10.00	88.52
8.00	82.18
6.00	72.59
4.00	58.72
2.00	40.69
1.00	28.62
0.75	24.79
0.50	20.32
0.38	17.67
0.25	14.55
0.19	12.69
0.08	8.57

	Sample
% Passing	Size[in]
F10	0.11
F20	0.48
F30	1.10
F40	1.93
F50	3.00
F60	4.16
F70	5.56
F80	7.46
F90	10.64
Topsize (99.95%)	21.70

	Sample
Fines Cutoff[in]	0.65
Fines Factor	50.00

Provided Graphical Output:

Standard provided results are in Excel format unless requested otherwise.



Client	Client	Contact	SPLIT ENGINEER
Date	5/5/14	Email	splitnet@spliteng.com
Images	3	Phone	(520) 327-3773

Sieve size	Sample % Passing	Sample 1 % Passing	Sample 2 % Passing	Sample 3 % Passing
75.00	100.00	100.00	100.00	100.00
50.00	100.00	100.00	100.00	100.00
25.00	100.00	100.00	100.00	100.00
15.00	96.09	93.20	99.29	100.00
10.00	86.43	82.85	88.49	100.00
8.00	79.56	76.20	79.80	100.00
6.00	69.79	66.58	67.66	100.00
4.00	56.53	52.82	52.19	100.00
2.00	40.49	35.81	34.62	97.06
1.00	27.78	24.34	23.19	70.64
.75	23.39	20.73	19.62	57.57
.50	18.34	16.51	15.50	42.94
.38	15.42	14.05	13.10	34.74
.25	12.07	11.18	10.34	25.68
.19	10.13	9.49	8.72	20.67
.08	6.02	5.82	5.25	10.81

Fines % Passing	Sample Size	Sample 1 Size	Sample 2 Size	Sample 3 Size
10	.18	.21	.24	.07
20	.58	.70	.78	.18
30	1.14	1.45	1.56	.31
40	1.95	2.45	2.61	.45
50	3.16	3.65	3.74	.62
60	4.47	4.96	4.94	.79
70	6.04	6.62	6.35	.99
80	8.11	9.09	8.04	1.23
90	11.30	12.89	10.43	1.56
Top Size(99.95%)	23.97	24.06	16.05	2.61
Fines Cutoff	.49	2.40	2.16	.49
Fines Factor	50	50	50	50

APPENDIX A

Split-Net Digital Imaging Form

Test Sample #	
Photographer	
Test Sample Date	
Test Sample Location	
Test Sample Geology	
Test Blasting Conditions	

Test Sample Information

Key: *Picture Location*: M-Muck Pile, T-Truck, P-Pile for Test
Scaling Method: B-Balls, S-Scale, B/S-Balls & Scale, T-Truck
* BALLS = 6" or 10", SCALE = 12" X 1"

Pic #	Time	Picture Resolution	Picture Location (M,T,P)	Scaling Method (B,S,B/S,T)	Comments	Download Information (FILE NAME)

* TEST NOTES: