

STOCKPILE MEASUREMENT SERVICES

MONITORING QUANTITY LEVELS OF YOUR STOCKPILES

SGS has the expertise, equipment and personnel to provide prompt, accurate inventory control services, regardless of requirements or commodity. The bulk material handling process includes stockpiles, a pile or storage location for bulk materials. A basic stockpile is formed by dumping bulk materials into a pile, either from dump trucks or pushed into piles with bulldozers. More controlled stockpiles are formed using conveyors to form piles. Stockpiles are used in many different areas including ports, refineries, manufacturing facilities and mine sites.

SGS offers trusted stockpile measurement services for the minerals sector worldwide. We use state-of-the-art technology to provide you with independent, accurate determinations of exactly how much your stockpiles contain. Our professional staff has decades of industry experience, and they will work closely with you to ensure that a complete and accurate measurement of mineral commodities is obtained. Our stockpile measurement system can accurately measure stockpiles for commodities including:

- Coal
- Fertilizers
- Iron ores

Stockpile measurement is a technique to measure the volume and weight of commodity stockpiles. It is a scientific/instrumental method, using Total Station



$$\text{Mass}_{\text{Stockpile}} = \text{Density}_{\text{Stockpile}} \times \text{Volume}_{\text{Stockpile}}$$

equipment to determine the volume of the stockpile quantity. Any shape of stockpile can be measured as long as the whole surface is visible. The measurements (data from site) are automatically stored in the data logger (data collector) of the Total Station instrument. The data is downloaded to a PC to calculate the volume and generating contour map by using Civil CAD software. Bulk density is determined from the average field test results of an individual stockpile. The mass of the stockpile is calculated by multiplying the volume by the density.

Time to complete measurement for each pile will vary according to the shape and profile. Generating the quantity from the software is very fast with the density available. Normally, we generate the provisional report of each day. Thus you can expect to have the quantity on a daily basis.

KEY BENEFITS

Conducting a stockpile evaluation management system provides several critical benefits to you which include:

- Providing proper evaluation of the inventory for:
 - Financial reports and excise duty
 - Loans for banks and financial institutions
- Following regulatory requirements (EU countries must do a mass balance to calculate CO2 emission)
- Assisting in planning and managing purchasing and stock administration
- Improving the stockyard management

SGS LASER TECHNIQUES

SGS has specific laser technologies to determine the accurate amount of your stockpiles. Below are two technical data examples for stockpile measurement:

Laser Technique Example 1

- **Velocity:** up to 50.000 points/sec
- **Accuracy:** mesh up to 5mm x 5mm pitch à 40.000 pts/m²
- **Precision:** each single point as a tolerance of 4mm @ 100m against 3mm @ 100m of a total station-gps
- **Range:** 360° of horizontal field of view and 270° of vertical field of view
- **Ease of use:** High Definition Surveying™ software
- **Versatility:** computer analysis of stockyards

Laser Technique Example 2

- **Velocity:** up to 11.000 points/sec
- **Accuracy:** mesh up to 5mm x 5mm pitch à 40.000 pts/m²
- **Precision:** each single point as a tolerance of 10mm @ 1000m
- **Range:** 360° of horizontal field of view and 80° of vertical field of view
- **Ease Of Use:** High Definition Surveying™ software
- **Versatility:** computer analysis of stockyards

In order to perform a proper stockpile measurement, there are several critical components that are required. Critical components for a proper stockpile measurement required which SGS' technical experts can bring include:

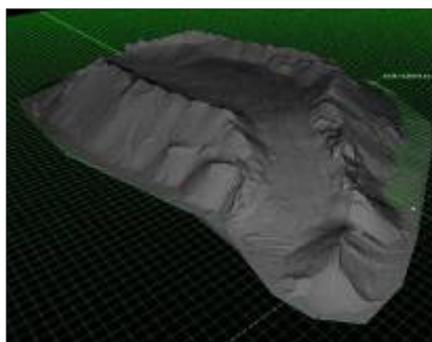
- Topographic tools (basement, targets)
- A skilled operator
- Lifting pantographic platform

- Final computer analysis
- High strength batteries
- High performance PC

DENSITY DETERMINATION

Determining the density is required to compute your overall tonnage. SGS offers density determination through measurement methods. SGS owned drilling and density sensing equipment is staffed by dedicated professionals whose primary function is to provide data that is used to accurately characterize storage pile density. Stockpile density is not a constant value because of:

- Stratification and compacting (mechanical or natural)
- Height and depth of sampling



The Process

The ASTM 6347 Standard states how to determine compacted stockpile density using a radioactive source. The method employed by SGS, representing the latest state-of-the-art technology, utilizes a nuclear depth density gauge. The probe source is a radioactive material that emits gamma radiation at a constant average rate. The gamma rays interact in various processes at the atomic level with the surrounding medium. The number of interactions, or scattering events, per unit time is a function of the density of the medium. The variation in chemical composition of the commodity in storage and the different sources represented in most stockpiles requires calibration of the nuclear depth gauge to a representative sample of the commodity in each stockpile.

Once the nuclear gauge has been calibrated to the commodity, the borings can proceed for the density determination task. After boring, the access tubing is inserted into the bore-hole. The nuclear probe is then lowered into the access tubing and readings are taken at pre-determined depth intervals. The nuclear counts are returned to the surface of the stockpile and are recorded for calculation of density.

Best practice is to use a stainless steel cylinder with a diameter 3 - 5 times nominal top size with a length of 1 to 1.5 meters. The cylinder is then insert in the stockpile by bulldozer and extracted with some chains linked to the bulldozer. Once the pipe is extracted using a cap the surface of your commodity is levelled.

With a meter the empty part of the tube is evaluated and by difference the volume of your commodity is obtained. Then the cylinder is emptied in a box and the box weighed. For hard bulk materials such as ferroalloys, where compacting is negligible, then a laser scanner technology can be used. The difference between the empty and full bucket determines the volume. The difference between the bulldozer weight with empty and full bucket determines the mass.

DETERMINING THE VOLUME OF THE STOCKPILE

Data acquisition at ground level or by photogrammetry is normally conducted in a fashion to satisfy the requirements of a TIN (Triangular Irregular Network) creating software package. Mass points and break lines are collected that describe the surface to be mapped. In order to insure that the volume result includes all the coal in storage and only the coal in storage, the elevation of the soil on which the coal is stored must be known. The information that describes the changing elevation of soil within the storage yard may be referred to as the "base" datum or the soil elevation datum. This datum provides the surface above which coal volume will be calculated. The prismoidal method uses a data point file to create a TIN of the coal surface within the storage



area. The volume of coal within the TIN is then computed by electronically filling the volume of the TIN above the soil elevation datum with prisms or polyhedrons of known volume. The software then totals the number of polyhedrons required to fill the volume of the TIN.

TONNAGE COMPUTATION

Once the density in pounds per cubic feet and the volume in cubic feet are known, total tons of the commodity in the stockpile are readily determined, using the following calculations: Wet tons = volume (ft³) x density (pcf) / 2,000.

STANDARD OPERATING PROCEDURES (SOP)

SGS has designed and implemented several vital standard operating procedures (SOP) to outline consistent stockpile management. Our SOPs allow us to offer you our stockpile management systems on a consistent basis no matter the commodity inventory you require. Our global network also allows us to offer our stockpile inventory services on a global platform.

IN CONCLUSION

For business planning, financial reporting, and regulatory reasons, one must accurately determine the quantity of your inventory. For all of your stockpile and inventory needs, SGS can help you by providing:

- The latest state-of-the-art technology for volume computation
- The best SOP for bulk density evaluation
- Knowledge and expertise for proper sampling of your dry bulk commodities
- A third party weight ascertainment for all management purposes

Our professional staff has decades of industry experience, and we will work closely with you to ensure that a complete and accurate measurement of mineral commodities is obtained.

CONTACT INFORMATION

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