

CALENDAR

■ MineWest '06: Managing The Boom

November 8–9, 2006
Colorado Convention Center
Denver, Colorado
e-mail: cdorn@mining-media.com

■ Mines and Money 2006

November 20–22, 2006
Hilton London
London, England, United Kingdom
e-mail: eileen.smith@mining-journal.com

■ Argentina Gold 2006

November 29–30, 2006
Hotel Sheraton Libertador
Buenos Aires, Argentina
e-mail: informes@panoramaminero.com.ar

■ Northwest Mining Association – Sustaining the Boom

December 4–8, 2006
John Ascuaga's Nugget Casino Resort
Reno, Nevada
e-mail: mheywood@nwma.org

■ Mineral Exploration Roundup 2007

January 29 – February 1, 2007
The Westin Bayshore
Vancouver, B.C., Canada
e-mail: roundup@amebc.ca

■ 2007 SME Annual Meeting and Exhibit

February 25 – 28, 2007
Colorado Convention Center
Denver, Colorado
e-mail: meetings@smenet.org
Visit PAH/Runge at Booths 623 & 625

■ PDAC 2007 – Prospectors & Developers Association of Canada International Trade Show & Investor's Exchange

March 4 – 7, 2007
Metro Toronto Convention Centre
Toronto, ON, Canada
e-mail: info@pdac.ca
Visit PAH/Runge at Booths 310 & 312

Final Product to Ore Reserve Reconciliation

The reconciliation of final product back through the processing plants and mining operation (the "production process") to the ore reserves is often not given the attention it deserves until there are issues with stockpiles running out or significant write downs in stock value occur. The operation's final product may occur at any point along the production process stream, for example, FOR coal (Free on Rail), concentrate sales at port of discharge or refined metal sales, all of which represent the final involvement of the operation or company. The final measurements of product sold need reconciling back through the production process to reserves on a regular basis to assess the effectiveness and efficiency of the operation's processes and to provide information for future planning, scheduling and budgeting.

Product should be measured at appropriate stages of production in order to monitor the production process, to assist in the control and planning of the process, for contractor or award payment determinations and also for stock valuation. Most operations have a number of in-process stocks at various positions in the production process, and these too are measured and valued on a period basis.

The measuring processes involve the weighing of product through the process and the taking of representative samples. The

weighing process has a certain level of accuracy, often to a few percent, and the samples only provide an estimate of the product content. These inaccuracies result in imbalances within the reconciliation process causing discrepancies. The individual discrepancies may identify problems and inaccuracies in the measuring and sampling process of particular products, which may require assessing and fixing, but they may not necessarily require adjustment as the discrepancies may reverse the following month. Adjustments of figures will be necessary when there are accurate measurements, such as stockpile zeros, significant differences between survey and calculated stock figures or final agreed sales figures. Trends in discrepancy should be monitored for drift which may indicate a problem in the measuring process.

The data used in the reconciliation is often collected in a number of different ways, collated and stored in different formats and destinations, and transferred to the reconciliation model at the end of the reporting period (usually monthly) for processing to determine inventory levels, the production process efficiencies and adjustments to balance the data. The results provide data for the monthly management reports and provide stock data for monthly inventory valuation.

There are a number of problem areas which cause inaccuracies and discrepancies in the

balance, the most important of which can be summarized as follows:

- ◆ Inadequate weighing and sampling processes.
- ◆ Inadequate determination of moisture content.
- ◆ Inadequate testing and calibration of weighing equipment.
- ◆ Poor stockpile management and measurement.
- ◆ Inadequate control and measurement of in-process stocks.
- ◆ Numerous different data transfer processes.
- ◆ Inaccurate assumptions and fixed data.
- ◆ Lack of data checks for reasonableness in models.
- ◆ Production process not accurately reflected in the reconciliation model.
- ◆ Over-complication of reconciliation models.
- ◆ Errors in the model calculation formulae.
- ◆ Unnecessary adjustments and lack of trend monitoring.
- ◆ Too many personnel or unsuitable personnel involved in the reconciliation process.

Auditing the Process

The auditing of the reconciliation process can be divided into several components. The physical process of production needs to be mapped and the full process flow checked, focusing on key measurement points where data is collected for use in the reconciliation model. Stockpile management and measurement processes require evaluation. The process flow of data collection, storage, transfer and management requires mapping and assessing. The reconciliation model requires evaluating and the results, discrepancies and adjustments checked, including results from previous periods.

Mapping the Process Flow

Material Process Flow

The complete flow of materials is mapped incorporating all the weighing and sampling points which are relevant to the reconciliation process. See Figure 1 below.

Data Process Flow

The flow of data is mapped including collection, processing and storage, transfer to databases and to the reconciliation model, including verbal, written and electronic transfer of data. Some data is processed, e.g., averaged, prior to incorporation in the reconciliation model, and this should be checked, depending on time constraints. See Figure 2 below.

Physical Audit of the Process Flow

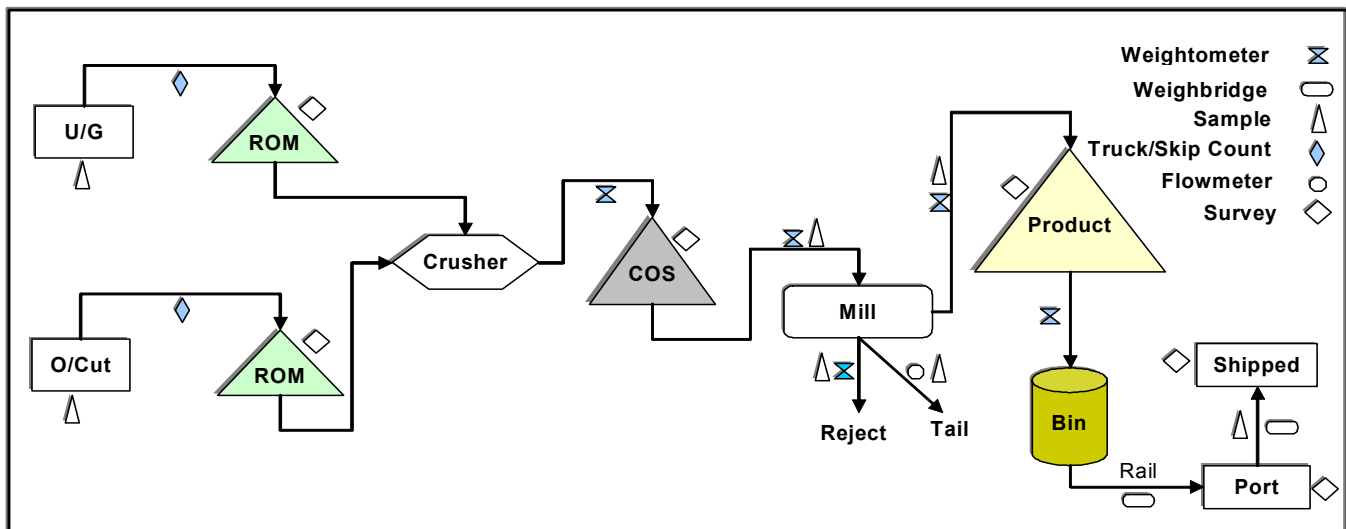
The key measuring points are audited.

Weights

The quantity of material is determined a number of ways:

- ◆ Skips, trucks and loaders may be fitted with onboard weighing systems such as "loadrites."
- ◆ Truck counts use volume and density factors to determine tonnages.
- ◆ Pit or stope surveys and density

Figure 1: Simplified Flow Diagram of a Physical Process



- factors produce tonnages mined.
- ◆ Conveyor weightometers, static weighers, weighbridges.
 - ◆ Rail cars may be weighed by static weighers at loading or discharge points, but may also pass over dynamic weighbridges in transit.
 - ◆ Volume measurement and estimation and density factors.
 - ◆ Determinations from balance equations.

The physical state of all weighing stations should be checked for cleanliness and suitability.

Calibration procedures and calibration records should be checked, including live-load tests.

Sampling

The sampling processes and procedures are evaluated. This includes:

- ◆ Belt sampling - primary and secondary cutters, grab samples etc.
- ◆ Material flow sampling.
- ◆ Truck and rail car sampling.
- ◆ Stockpile sampling etc.

Sample handling procedures should be assessed to ensure there is no moisture loss or contamination. Samplers should be clean and in working order and the sampling process and type should be representative and suitable for the type of product and commodity.

Assaying and Moisture Determination

Moisture determinations are normally carried out on site and some operations may also have on site assay laboratories. Internal and external laboratories may be audited.

Laboratory equipment such as ovens and thermometers, balances, crushers, grinders, splitters and assay equipment should be audited for:

- ◆ Process.
- ◆ Suitability.
- ◆ Cleanliness.
- ◆ Zeroing, calibration and certification.
- ◆ Record keeping.

Laboratory procedures should be assessed for monitoring and recording,

sample handling, reserve samples, use of standards and duplicates, and for written procedures.

Stockpiles

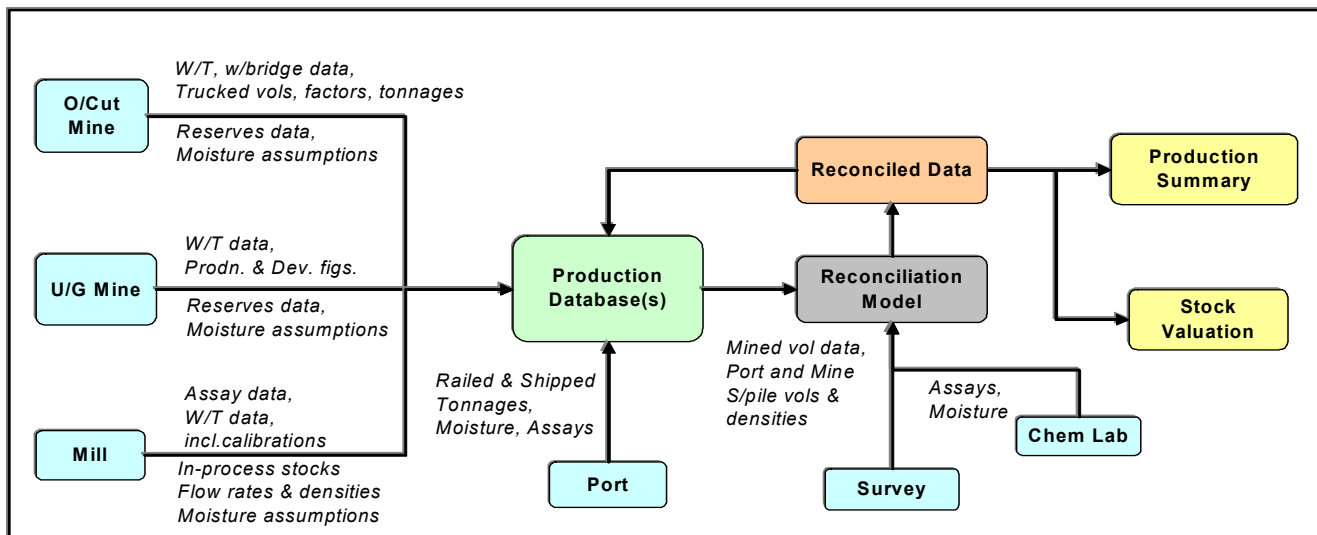
Stockpile management procedures should be checked, including surveying, density measurements, whether "first in first out" (FIFO) is employed, sampling, and any data assumptions. Stockpile data is often used as the accepted figures in the metal balance process.

Model Evaluation

Models

In most mining operations the reconciliation is undertaken using one or more spreadsheets, where data is referenced or added manually by copy and paste or direct entry. Data should be validated prior to incorporation in the reconciliation process. The reconciliation process is often interactive, with the more accurate data, such as stockpile zeros and accurate metal weights and sales,

Figure 2: Simplified Flow Diagram of Data in the Process



usually accepted and other data modified to achieve a balance in the reconciliation process.

Spreadsheets are powerful tools and properly used give reliable results, but they are fraught with error due to the ease in which they can be accessed, modified and copied. Some larger operations may have web-based tools which allow real time web-based data entry, collation of data, monitoring of adequate data collection and input, reconciliation and reporting, which have been customized to the operation. This may utilize existing databases, such as spreadsheets, and also reporting formats.

Model Auditing

Data Checking

The source of input data is checked. Assumptions and historical data such as moistures, densities, recoveries, fixed assays etc., should be evaluated for validity and representativeness.

The calibration data for weightometers may identify errors which may require spreading across the last month's daily weightometer figures.

Model Process Checking

The nature of the data entry, such as manual, copy and paste, import, referencing should be evaluated. Checks on input data for normality should be assessed and whether the model will warn of data issues with error messages.

The model structure should be evaluated for the separation of input data, output data and calculated data sections.

The model should be evaluated to determine if it matches the actual production process.

The detailed workings of the model, including formulae and calculations, checks and balances, should be evaluated.

Protection and Access Controls

Access to files, folders, drives etc, should be assessed to ensure access is limited to appropriate personnel. Model protection should be assessed along with data and models from previous reporting periods.

Reconciliation

The reconciliation process should be followed through and evaluated for its

suitability and accuracy, focusing on the following:

- ◆ Reconciliation process is appropriate.
- ◆ Calculations and formulae.
- ◆ Data referencing.
- ◆ Adjustments.
- ◆ Trends in results.

Summary

The end product produced by an operation is that which it is finally paid for, as this figure will not change. If these figures are not reconciled back through the production process, errors in measurement from reserves and resources through in-process products and stockpiles to final products will not be recognized. The operation misses an opportunity to optimize its process to improve efficiency, reduce costs, and have accurate stockpile figures and valuations.

This month's article was provided by Steve Hinde, Senior Consulting Geologist, Pincock, Allen & Holt - Australia steve.hinde@pincock.com



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