Metallurgical Accounting in Practice: Performance Non-Negotiables

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ABSTRACT

Metallurgical accounting is a standard requirement in all mineral processing operations and recognisable at most levels of a mining organisation as an essential input into business reporting processes. The data produced by the metallurgical accounting system however has more fundamental value in defining the operational efficiency of the process plant and the economic value of the mineral resource. Sustained high performance in metallurgical accounting is an essential component of a well-run mining operation, facilitating timely and well directed action from the site management team. Metallurgical accounting is therefore a core business activity, providing a platform from which to improve the profitability of a mining venture and maximize stakeholder value.

Contrary to this broad value statement, too often the importance of good metallurgical accounting practices is not evident in plant design, nor in some cases plant management. This reality illustrates the prevailing attitudes towards metal accounting; while high levels of performance are expected, the value of this performance is evidently not sufficient to dictate capital investment or operational resourcing. The operational challenges are not helped by the limited guidance available to plant operators on how to enable consistently high performance within the constraints of their resourcing and numerous competing demands. The inevitable outcome is recurring performance issues, and the associated diversion of valuable resources into corrective investigations with uncertain outcomes.

Given the seemingly inevitable deficiencies in system design, and the guaranteed limitations of the processing department’s resources, plant operations need a lean, focussed approach to metallurgical accounting system management. Such an approach can deliver the robustness and credibility required by the corporate and financial spheres, while being manageable and sustainable at an operational level. This paper proposes the core requirements of such a system specifically for gold plant operators, based on examples of best practice observed at a number of operations.

BACKGROUND

Metallurgical accounting is a key foundation of any metallurgical operation and is critical to the effective management of that facility. Metallurgical accounting data provides both the basis for short interval performance assessments, and the reference to gauge long term performance trends. The ability of process plant management to reliably assess the impact of changes in ore properties and process conditions on plant performance efficiency, be they positive or negative, is directly proportional to the quality of metallurgical accounting data used to support that assessment. Quality decision making requires quality data, and therein lays the primary value proposition of metallurgical accounting.

It is the author’s broad conclusion that metallurgical accounting practices in plant operations often do not demonstrate comprehension of the significance of basing good decision-making on good data. Metallurgical accounting in practice is typically executed as a means to an end, with the primary objective of ‘punching out numbers’, generally at month end. Reporting on daily, month-end, quarter-end and year-end timelines dominate the focus of the metallurgical accounting process, and these are often given significantly higher priority than the regular internal accounting system health checks that are essential to maintain data quality. Often the first plant management knows of a problem with the metallurgical accounting system is at month end, when a significant discrepancy between forecast and physical metal production is observed. At this point the issue directly causing the discrepancy has likely been manifesting for several weeks, compromising the quality of both production reporting and management decisions during that time.
Examples have been observed where an embedded positive accounting bias has persisted for long periods of time, for several years in more than one case. The focus on not ‘coming up short’ during the month end reconciliation can be so ingrained that the magnitude of the accounting discrepancy becomes virtually irrelevant, and the concept of accuracy is all but abandoned. In these instances, site and corporate management must take significant accountability for the longevity of the bias, as the processing team is invariably rebuked for under-delivering on reconciled month end metal production. Conversely the penalties to plant management over-delivering at month end are non-existent. The unfortunate side effect of all this is that there is an invariable loss of production data quality in order to enable a bias to persist, and this can affect the quality of plant tonnage, grade and recovery values reported by the process plant. Unfortunately, this skewed attitude to metal accounting is not unique.

Metal accounting received a profile boost with the AMIRA P754 project and the production of the Metal Accounting Code of Practice and Guidelines (AMIRA, 2007) – “The Code”. The Code was also followed by the JKMRC (2008) textbook “An Introduction to Metal Balancing and Reconciliation”, designed to support the adoption of The Code by industry and to provide more specific guidance to that end. The Code’s primary objective was to improve auditability and transparency of metal accounting and, by extension, to enable good corporate governance (Gaylard et al, 2014), whilst recognising that the primary purpose of the metal accounting system is not to generate financial reporting inputs, but to inform operational management (Gaylard et al, 2006). In modern mineral processing facilities, where human resources are limited and the processing teams are becoming progressively less technically skilled (Munro and Tilyard, 2009, McCaffery et al, 2014, Munro 2016), it is essential that the metallurgical accounting system is lean and focussed.

All activities must contribute directly to achieving what is the most significant and material stipulation of The Code, addressed by the first sentence of its ten central principles:

The metal accounting system must be based on accurate measurements of mass and metal content.

A simple statement in a literal sense, but one that requires considerable, sustained effort to achieve due to the many possible sources of bias. However, if a mineral processing operation can sustainably comply with that simple sentence, then system governance in turn becomes more readily achieved. To get there requires establishing some simple non-negotiables of accounting system design and management, and avoiding indiscriminately overwhelming the limited site resources with complicated processes.

THE NON-NEGOTIABLES OF GOOD METALLURGICAL ACCOUNTING SYSTEM DESIGN AND PERFORMANCE

Performance Targets

Where sites are observed to operate with sustained accounting bias, they are invariably also operating without any defined expectations of system accuracy. Again, the principal objective of the accounting system is to not to ‘come up short’ at month end, and therefore avoid the consequences of under delivering on expected metal production and the associated perception of underperformance. This approach can in turn facilitate the persistence of one or more unrecognised causes of accounting system bias. Should the accounting system performance be governed by well-defined discrepancy targets, it is unlikely that low data quality will become an embedded component of the system. By extension the data supporting the accounting system will be of higher quality, as would the day to day metallurgical performance of the plant and the decision making of management.

Such targets are a very effective means to communicate system performance to management, to ensure that remedial action is initiated in a timely fashion, and the corrective action is appropriately focussed. The nature of these targets can be generalised as the ratio of reconciled (shipped) metal production to indicated metal production derived from daily sampling and measurement, for a defined accounting period,
such as a calendar month. The use of long-term targets in addition to short-term targets ensures that any deterioration in accounting system health is more readily identified and high standards of system performance are sustained. Unfortunately, most of the guidance available on metallurgical accounting does not address this important topic in any material sense.

A previous publication by Newmont Goldcorp (Giblett et al, 2012) provided guidance on gold plant accounting discrepancy targets based on assessment of a range of gold operations. Ongoing evaluation of accounting system performance in the ensuing years since that publication has demonstrated that these ranges remain practical. The further comparison of those recommended discrepancy targets for gold operations against an example of Newmont Goldcorp best practice maximum and minimum values, for a single operation over 4 years of operation, is shown in Table 1 for reference.

Table 1: Example Gold Plant Metal Accounting Discrepancies, Newmont Goldcorp Operations

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Target</th>
<th>Best Practice Site (2015 - 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month End Discrepancy</td>
<td>± 10%</td>
<td>+3.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-4.4%</td>
</tr>
<tr>
<td>Three Month Rolling</td>
<td>± 5%</td>
<td>+2.6%</td>
</tr>
<tr>
<td>Discrepancy</td>
<td></td>
<td>-3.2%</td>
</tr>
<tr>
<td>Twelve Month Rolling</td>
<td>± 3%</td>
<td>+2.5%</td>
</tr>
<tr>
<td>Discrepancy</td>
<td></td>
<td>-1.5%</td>
</tr>
</tbody>
</table>

Applying similar, clearly defined performance expectations and enacting effective systems to drive compliance are the first non-negotiable requirement of good metal accounting practice. Adopting formal system performance targets has materially improved metal accountability at several Newmont Goldcorp operations in recent years, reflected by recent monthly performance statistics for gold operations shown in Figure 1. This figure essentially reflects the difference between month end physical and daily calculated indicated metal production as described earlier.

Figure 1: Newmont Gold Operations Monthly Metallurgical Accounting Performance
Understanding the Limitations of System Accuracy

There are many parties with vested interests in good metal accounting system performance. The metal balance is a key product of the site metallurgy department and its quality reflects on them directly. The Process Plant Manager and site General Manager are further held to account for system performance by company management and are dependent on the system performing well. Company management are dependent on the system to reliably define metal shipments and inventories for financial statements and are in turn accountable to investors and shareholders for those outcomes.

All parties should therefore share the same expectations of system performance and have a clear appreciation of the resourcing required to deliver on those expectations. Referring specifically to the best performance ranges shown in Table 1 and considering that this performance has been actually achieved at a gold operation, (and in the case of Figure 1 at many operations simultaneously), it is hard to argue that a monthly discrepancy target of ± 5% is not achievable when it clearly is. The issue is more regarding how easy it is to sustain this target. If the accounting system is poorly designed or lightly resourced, this level of performance is simply not sustainable. The most likely outcome of more aggressive targets in this instance is a significant increase in dissatisfaction with the accounting system and those who manage it. A better approach is to ensure production and financial guidance recognises the realistic accuracy range of the system and specifically reflects the exposure to a production shortfall. This is likely to be infinitely less time consuming and more constructive than expecting the system to conform to unsubstantiated expectations of accuracy, or best case assumptions of measurement accuracy that do not reflect the likely disconnect between best in class performance and the effort required to achieve and sustain it.

The accuracy of the accounting system is determined by the sum of errors and uncertainties associated with a large number of data sources. However, in the context of final reconciled monthly production, this can be simplified to the uncertainty associated with the opening inventory ($\sigma_O$), closing inventory ($\sigma_C$) and product shipments ($\sigma_S$). Following guidance on the propagation of error provided by Napier-Munn (2014), we can define the uncertainty in our month end production estimate as:

$$\sigma \text{ (production)} = \sqrt{\sigma_O^2 + \sigma_C^2 + \sigma_S^2}$$  \hspace{1cm} (Eq. 1)

As reported by Blanchette et al, 2011, the uncertainty in the gold inventory of a CIL circuit can be as much as ± 10%, although if a more conservative estimate of 5% is applied to Equation 1, the outcome is a standard deviation of the order of ± 5% on the monthly reconciled production estimate. If 95% confidence limits are then applied to the reconciled production this becomes ± 9.8% and aligns well with the targets proposed in the previous section.

Data Foundations

The first of the ten principles of metallurgical accounting proposed within the Code documentation states the need for the system to ‘be based on accurate measurements of mass and metal content’ which concisely and correctly identifies the principal foundation of any metal accounting system. To achieve this requires a series of accurate measurements on the primary accounting streams defining the metal flow into and out of the process facility as represented in Figure 2.
The specific measurements required for the short-term metal balance are the determination of mass flow (tonnage), sampling and analytical determinations to calculate metal contents in solid and solution phases. This provides key data required for daily production reporting as well as the development of a cumulative metal balance that can be used to estimate longer term metal production. It is essential that the streams are physically measured rather than calculated by difference wherever possible. However, it is not uncommon for physical tonnage measurements on plant tailings streams to be excluded from the primary measurements as a slurry stream is not always conducive to accurate mass measurement.

On at least a monthly basis, and often more frequently, in-circuit inventory measurements will be performed to allow a second assessment of metal production by defining any accumulation or depletion in metal locked up in the circuit. This requires different sampling and mass measurement procedures by comparison to the daily production balance, as the inventory exists in process vessels (tanks, thickeners), stockpiles or intermediate storage (bags, drums). As a result, a different set of accounting procedures will be in place for in-process inventory. These inventory values are also significant from a financial reporting perspective as, along with leach pad and ore stockpile contents, they represent a material financial asset and are reported as such.

These measurements of mass and metal contents for plant feed, products and process inventories represent the foundations of the accounting system and not surprisingly are the areas that if not well managed will invariably result in material accounting performance issues. Any failure to continuously and critically assess the accuracy of this information will result in performance issues and an ongoing performance trend that will cycle in and out of the target range. This illustrates the most common failure of site metal accounting systems – a lack of sustained focus on system performance. The impact is more pronounced when there is inadequate focus on long term performance trends as an indicator of system bias.

**Check in Check Out System Structure**

The principle of the “check in check out” accounting system structure is covered extensively in the Code and its supporting publications. It is not uncommon to find accounting systems in violation of this key principle of good metal accounting practice, which unfailingly results in a compromised accounting system. Common examples include a failure to reconcile the daily balance data against measured changes in inventory at month-end to determine the accounting discrepancy, or the failure to measure or use measurements of primary accounting streams in the metallurgical balance. Examples of the latter include the calculation of the mass of flotation concentrate produced using the two-product formula in preference to direct mass measurement, or the back calculation of the flotation feed grade from flotation concentrate and tailings measurements, in the absence of any flotation feed analysis. Such calculations can provide useful internal system health checks on primary accounting data, but are unsuitable for use in substitution for direct measurements of mass and grade.
It is essential that the metal balance includes both the accurate measurement of all primary streams and inventory for mass and metal content, and the structure of the balance is “check in check out” compliant, facilitating the calculation of the metal accounting discrepancy at defined intervals and the assessment of system health against defined targets such as those in Table 1. The further application of “check in check out” principles within core process modules, such as gold rooms, concentrate handling circuits and metal recovery staged (CIP, Merrill Crowe) can also be an important tool to identify metal accumulation or loss that might otherwise be unrecognised.

Design Standards

Many operations are simply “shot in the foot” before they start by a lack of emphasis on high standards of metallurgical accountability in plant design and construction. Capital cost pressures often result in the purchase of inferior equipment, the exclusion of key equipment, a lack of consideration to manual sampling access and inadequate plant footprint to allow the correct installation of the purchased equipment. There is too frequently inadequate priority placed on metallurgical accountability during project development and this can have longstanding performance impacts as invariably system accuracy is compromised. It would be far too easy to compile an entire publication on poor design standards in metallurgical accounting based on current installations, and accountability for improvement in this area rests squarely with the executive management of mining companies. The oft quoted definition of insanity applies here: “if we expect to measurably move the needle on accounting system performance, we need to start doing things differently in plant design”.

Minimum standard requirements for plant design should include:

- adequate plant footprint to install OIML Class 0.5 weightometers on mill feed and filtered product conveyors in complete compliance with manufacturer recommendations
- provision for the installation and deployment of certified calibration chains should be minimum standard for primary accounting weightometers
- an allowance for secondary mass measurement systems on primary accounting streams, via weightometer/belt scale or volume and slurry density instrumentation
- adequate head height to install multistage cross stream sampling stations on primary accounting streams, as a minimum on concentrate and tailings streams
- adequate allowance for access to all equipment for inspection and maintenance
- particular consideration to ventilation when designing sampling systems for cyanide slurries
- provision for manual sampling access for secondary sampling of all primary accounting streams
- design of sampling systems to appropriately address the impacts of coarse gold on the accuracy of grade determinations for tailings and concentrates (Giblett et al., 2012)
- consideration of the use of gravity concentration to improve metallurgical accountability where required based on the coarse gold content criteria (Giblett et al., 2017).

Operational readiness and staffing plans should observe the requirement for frequent inspection, cleaning and maintenance of measurement and sampling systems. Failure to keep up with these requirements in operation will ensure metallurgical accounting performance will be comparable, or even worse, than if inferior systems were installed in the first place. This is one area frequently identified as needing improvement in site accounting systems, most notably for field instrumentation such as weightometers, and automatic sampling stations. Both are prone to accumulation of dust, mud or rock, wear, damage and alignment issues which can only be effectively detected by physical inspection.

Redundant or Secondary Data

The best performing site studied in recent years, referenced in Table 1, is notable in that it extensively utilises redundant data, or more accurately secondary measurements, to allow ongoing assessment of system accuracy. Feed tonnage rate measurements generated on mill feed, leach feed and leach tails are trended side by side and reviewed at least weekly. Manual shift composite samples are taken from cyclone
overflow, leach feed and leach tailings and trended against the primary accounting composites collected by the automatic samplers. As such any sampling, sample handling or instrument bias can be readily identified and addressed. An example is shown in Figure 3. Any sampling or measurement error that might be associated with the secondary measurement techniques is mitigated by the use of rolling trends and cumulative sum charts to simply detect a drift in alignment between the two measurements over time, highlighting the likely deterioration in accuracy of one of the measurements.

![Figure 3: Example of Redundant Data Tracking, CIL Feed Grades](image)

This simple process of generating and assessing secondary data is one of the most important components of a well-run metallurgical accounting system. Rather than waiting until month end, or the next weightometer calibration or sampler inspection to identify an issue, continuously assessing the system for the development of bias is more likely to allow the system to be corrected in a timely fashion. The use of cumulative trends is also a useful technique to monitor the agreement between duplicate measurements of mass and volume, as shown in Figure 4 allowing a drift in one of the key instruments to be readily identified.

![Figure 4: Cumulative pregnant liquor volumes using duplicate flowmeters](image)

**Shipment Accounting**

Off-site processing of high value metal and mineral products such as bullion, cathode and concentrates is common in precious and base metals processing. The final metal valuation, which is usually provided after product receipt by the buyer, is definitive and dictates the ultimate financial settlement. This leads to the generalisation in some cases that all prior estimates of product value are somewhat inconsequential, and this custody transfer is often seen as a natural end point of the metal accounting process. However this represents an essential validation step of the metal accounting process, and a check on both the accuracy of the on-site accounting systems and those at the custody transfer point to the buyer. Where a close watch on shipment accountability is not maintained it can result in misrepresentation of resource grades by failing to account for true metal values, inaccurate metal recoveries being reported or potential lost revenue due to metal values not being accurately recognised at sale. Consequently, best practice in metal accounting requires close tracking of the off-site metal reconciliation, facilitating timely corrective action.
Change Logs and Approvals

Invariably there will be some concerns about data quality during the metallurgical accounting process. A common example regarding inaccurate inventory measurements due to pulp viscosity changes is discussed further in this paper. Other examples will include abnormal assays due to contaminated samples, mislabelled samples, ‘spurious’ assays or missing assays. Whatever the basis for the concerns about data quality, the operation needs to have a well-considered system for identifying and recording any adjustments to raw data and demonstrating that these adjustments have been communicated to, and approved by, management. The same applies to any adjustments to calculations used in the metallurgical balance. Failure to do so demonstrates a lack of quality control over the metallurgical accounting process and reflects poorly on the site metallurgical team.

When replacing shift assays due to spurious or missing data, ideally the site should apply a standard protocol, preferably one that is automated and wherever possible, statistically valid. An example of automation would be using a lookup reference formula that substitutes a missing value for the average of the last 2 shift assays. This readily eliminates the use of arbitrary practices to come up with a value, which can occasionally be interpreted as selective. It is commonly observed that procedures to qualify and particularly document the assessment of an assay value as spurious are limited to say the least, and this is one area where statistical or geostatistical analysis of assay data could be more effectively and consistently employed.

Analytical Laboratory

The analytical laboratory is arguably the most rigorously scrutinised component of the site metallurgical accounting system. Daily performance is assessed for accuracy using certified references and precision using duplicate analysis, resubmissions are often performed to confirm original results and formal monthly reports are distributed detailing laboratory performance. If the other components of the accounting system were consistently subject to the comparable levels of review the performance of the overall system would be undoubtedly improved.

Some variability has been observed in the robustness of the quality management systems employed in analytical laboratories with the most significant differences observed in site managed vs commercial laboratories. The latter are observed to generally operate under a more robust quality management system. All operations should ensure the laboratory’s quality management program is aligned with best practices, including routine calibration of all equipment used in analytical procedures, the use of well selected reference standards, routine sample resubmissions and assessments of analytical precision. Laboratory performance should be reviewed monthly and in detail, rather than the reports being generated simply for posterity.

Inventory Measurement and Production Reconciliation

The majority of gold mining operations utilise some variation of carbon-in-pulp (CIP) technology for the recovery of gold from cyanide leach liquors. This process results in the accumulation of a significant amount of metal, approximately equivalent to two weeks’ worth of production, on the carbon held within the adsorption circuit. The accurate measurement of this inventory is challenging using conventional sampling techniques, which attempt to define the concentration of carbon in slurry by sampling a small section of the tank volume. Bruington (1991) gave an account of these challenges, as well as listing some alternative sampling techniques that are rarely seen in practice.

The carbon inventory measurement can be subject to significant bias, particularly when slurry viscosity is variable. An extreme example of this effect is shown in Figure 5, where the measured carbon inventory in tonnes is clearly subject to substantial inaccuracy. In many such instances, the metallurgical accountant feels little choice but to report the carbon inventory as measured and suffer substantial swings in gold in circuit inventory levels, and reconciled metal production as a result. However, this information is clearly
Neither accurate nor credible, and should not be considered an acceptable basis for a financially material data point. In these instances, repeating the same flawed measurement process will generally not produce a materially different outcome, and an alternative inventory estimation method must be considered.

Figure 5: Variable CIL/CIP Carbon Inventory

Figure 6 shows the alignment between measured carbon inventory at one operation and the closing inventory value calculated from the opening inventory, plus new carbon additions, less typical carbon consumption on a unit consumption basis, over an 18 month period. This data clearly comes from a different operation to the example in Figure 5, namely one that is not subject to large changes in pulp viscosity. Nonetheless the example demonstrates that estimating the carbon inventory can be as reliable as measuring it directly and, for this data set, statistically the measured values are the same as the calculated values. This can be demonstrated using the methods described by Napier-Munn (2014), to demonstrate that the gradient of the regression line is not significantly different to a value of one (parity), nor is the intercept significantly different to a value of zero.

Provided the operation has suitable controls in place to detect screen failures and subsequent loss of carbon inventory, this process of estimating the carbon inventory can be used to indicate if there is an issue with the accuracy of the closing inventory measurement. When there are clear issues with that measurement, as indicated in Figure 6, the calculated values can be used as an alternative basis for month end inventory calculation.

Assuming that the operation is able to generate an unbiased measurement of the gold in circuit inventory, there remains the issue that this measurement remains the least accurate measurement in the entire metal accounting process. As demonstrated by Blanchette et al, 2011, the precision of the measurement of carbon concentration alone can be ± 10%, heavily influencing the precision of the entire estimate of gold in circuit inventory. Recognising that this precision applies to both the opening and closing inventory values used to determine the reconciled metal production, the impact on final reconciled metal recovered is significant. Considering such particular examples, the practice of using the reconciled month-end production as the most accurate estimate of metal recovered could be argued as questionable. As could any associated adjustment of the measured plant feed grade and mine production to consider the magnitude of the observed accounting discrepancy. This is one reason why the monitoring of accounting system accuracy based on longer term rolling averages can be more practical than focussing on more heavily on month by month performance trends.
COMMON PROBLEM AREAS IN METALLURGICAL ACCOUNTING

It is interesting to consider the comparison of applying error (or more accurately uncertainty) propagation techniques to daily production data, against the balance of opening and closing inventory measurements for a given accounting period for gold operations. The typical conclusion from this exercise is that there are substantially higher levels of confidence in the daily production numbers by comparison to the month-end production reconciliation based on metal shipments and changes in inventory. That generalisation can be highly misleading in the author’s experience, as issues with mass measurement accuracy and grade determinations in the daily production balance can be the cause of poor accounting performance in as many cases as inaccurate inventory estimations.

In order to avoid the most common metallurgical accounting issues in gold plants, the metallurgy team should focus on achieving the highest possible accuracy in mass measurement, stream sampling, inventory measurement and analytical determinations. Where mineral concentrates are generated for off-site sales or toll treatment, such as flotation concentrates, metal precipitates or loaded carbon, considerable effort to align measurements of metal produced, shipped and received (sold) is required.

As discussed in this paper, diligent shipment accounting, the generation of secondary data, and the use of “check in check out” accounting methods around internal unit processes can be applied to reduce metal accounting system exposures in these areas.

Of course, plant operations are infinitely more complex and the origins of the trappings of metallurgical accounting are many and varied. Conveyor, idler and weigh frame alignment; weigh frame condition; calibration weight condition; sampler condition (parking position, cut speed, cutter design and condition); sample contamination; flowmeter scaling/fouling; specific gravity variations (solids and liquids); pulp viscosity variations; metal precipitation (loaded eluate tanks and pipes); metal accumulation (sumps, hoppers); metal hold up (electrowinning cathodes); manual sampling protocols for high grade precipitates and procedural variations (sampling, sample preparation, analytical methods and instrument calibration) are some examples of more specific causes of poor accounting performance.

Given the variety of potential problem areas in metallurgical accounting, the role of the metallurgist is essential to embed good system design and practices, and to ensure system health is maintained. While accounting systems can come undone due to gaps in system design or poor fundamental practices, the issue is more often deterioration in practices over time. If systems are not in place to constantly audit the quality of system output data, as well as the adherence to the supporting procedures to generate that data, sub-par metal accounting performance is inevitable. It is therefore critical that the role of the metallurgist is clearly defined, and focussed on continuously assessing system performance and health. Conversely, should the metallurgy team become overly burdened by more administrative tasks associated with data entry, reporting and forecasting; it will be harder to achieve the necessary level of pro-activeness to sustain metal accounting system health.
CONCLUSIONS

The greatest value of the metallurgical accounting process lies in facilitating timely and effective decision making at the production level. This is reliant on achieving the first and most significant stipulation of the metal accounting code and guidelines - that the measurements be accurate. This is something of a variation on the 80:20 rule; such that 80% of the value comes from it, but unfortunately it also requires at least 80% of the effort to deliver and sustain. This reality should not be lost in any quest to achieve higher standards of corporate governance, and the site team must be allowed to remain focussed first and foremost on producing quality information. To that end having a simple but disciplined approach to metallurgical accounting offers the best chance of success. As has been proposed in this paper, key components of this approach are:

- clear performance targets and performance management processes, that are understood at all levels of the organisation and reflected in production guidance
- a system that prioritises foundational measurements on principal and secondary accounting streams, and conforms to a “check in check out” structure
- improved standards of plant design that address common deficiencies
- extensive use of redundant data and secondary measurement systems to allow high frequency monitoring of system accuracy
- appropriate system management practices, specifically field inspections, cleaning, maintenance and instrument calibration
- effective mechanisms to deal with missing or corrupted data, and record management for any system or data changes
- mature analytical quality management procedures
- fit for purpose inventory determination and reporting protocols.

In order to bring this all together, it is essential that the site metallurgy team is empowered and clear in its purpose to continuously monitor and maintain system health.

REFERENCES


