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P. Keleher

D. Cameron

M. Knijnikov

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Improving Fundamental Stockpile Management Procedures

P Keleher¹, D Cameron¹ and M Knijnikov¹

INTRODUCTION

Coal Quality management and the control of the flow of coal through complex mining preparation and transport phases of standard mining operations has assumed greater importance over recent years.

Considering the history of the Australian industry from 1970, it is significant to note the increase in production levels and the inferred increase in focus on quality control - both of which drive the management of product quality into a position of greater importance. Quality management is one fundamental of the industry coming under increased pressure.

HISTORY

The Australian coal industry has grown from a saleable coal production level of 45 mt per annum in 1970 to 192 mt per annum in 1996.

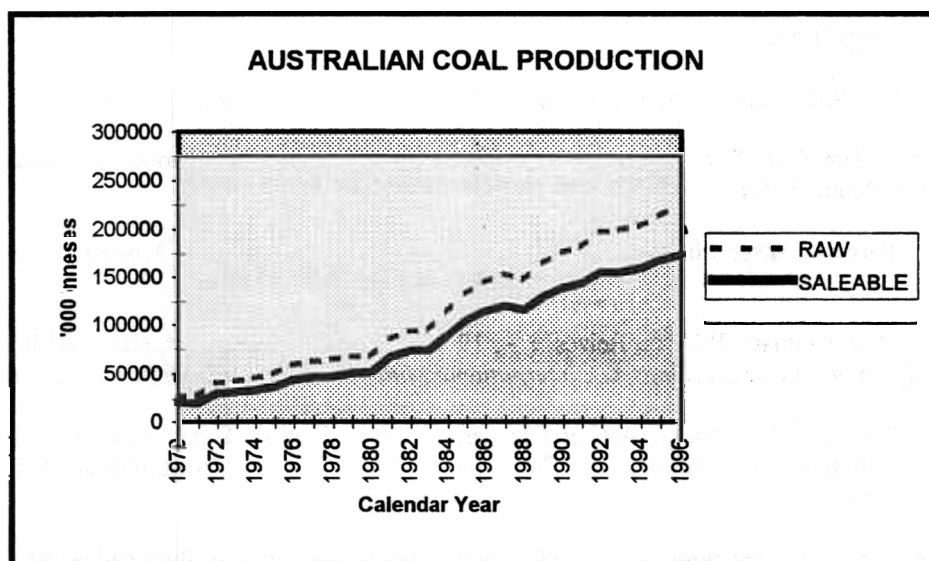


Fig. 1 - Source Australian Black Coal Statistics

Emerging from that increase is the need for greater focus on stock control. Issues such as optimum stockpile size, stockpile turnover period, stock level fluctuation and timely stock management have all assumed greater significance

The practices of the past are no longer sufficient to cope with the needs of today's industry where a changing environment of higher quality standards, more sophisticated quality control and total quality management is driving the quality issue to being one of the more pressing aspects of the coal mining industry. An aspect requiring a review.

Further evidence for the increased pressure on quality management is the gradual reduction in saleable coal as a proportion of total coal production. Saleable coal production comprised 87% and 80% of raw coal production in 1970

¹ Carbon Consulting International Pty Ltd, Queensland

and 1996 respectively. One of the contributors to this change has been the increased pressure from customers for a cleaner, more consistent and better presented product.

Compounding the situation, quality specifications are now required on more parameters and to a greater level of precision.

As a result, the perceived importance of quality in the coal industry has increased dramatically over the past 27 years. In 1970, ash, energy and other basic parameters were almost alone in consideration of quality indications. (Fig. 2)

Gradually the concentration of parameters has increased not only for the metallurgical coal market but also for the thermal market. As coal utilisation technologies evolve so too is the need for greater precision in the management and tracking of coal evolving and with the imminent introduction of gasification and new steel making technologies this trend is set to increase.

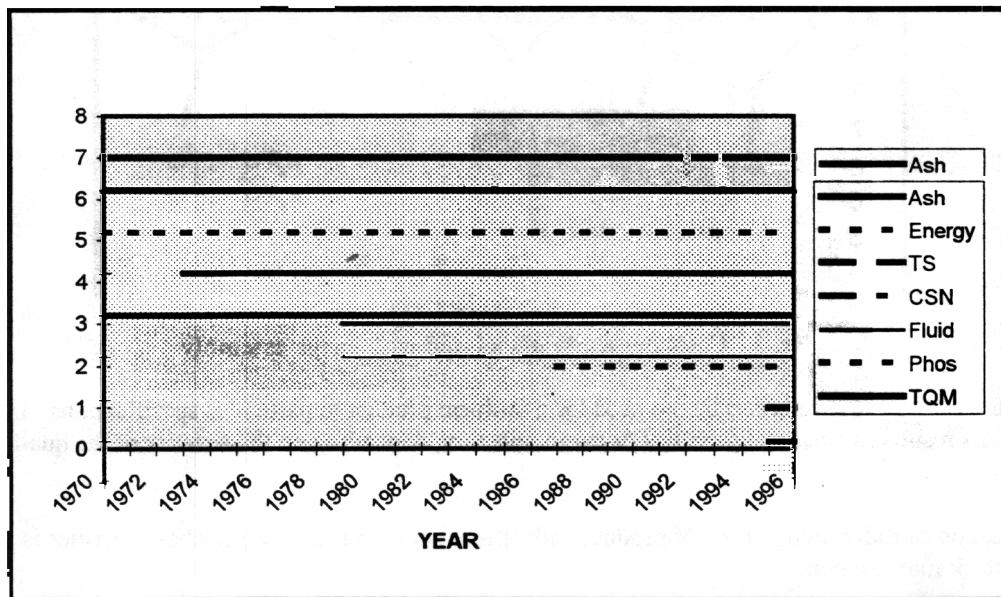


Fig. 2 – General Observations On Quality Requirements

THE COSTS

Historically, quality issues have been addressed using standard visual and recording techniques. The Quality officer has routinely visited key stockpile and production points and recorded relevant data. These techniques have been improved and adapted to accommodate change but in general the same tools are applied today for the same purpose. Meanwhile the requirement for a precise tracking tool has become more acute.

Obviously there are shortcomings to the existing methods, and these shortcomings emanate from sources including the heterogeneous nature of coal, increased production levels and more stringent specifications

The obvious costs are;

- Loss of quality definition on stockpiles;
- Lack of precise quality control; and
- Continuous sampling to track parcels of discreet quality.

Each of the above causes either direct or indirect costs to an operation.

A less obvious but very significant cost is the adoption of a cautious and reactive approach to cargo preparation. The Quality Control Officer, in the absence of reliable timely data, ensures the cargo is well within specification. The loss of yield, inefficient machinery use and loss of valuable management time sacrificed to short term reactive measures are rarely quantified, but are recognised by industry as being substantial.

Even with the abundant downstream analysis, the final result can still be mediocre as depicted on Fig. 3.

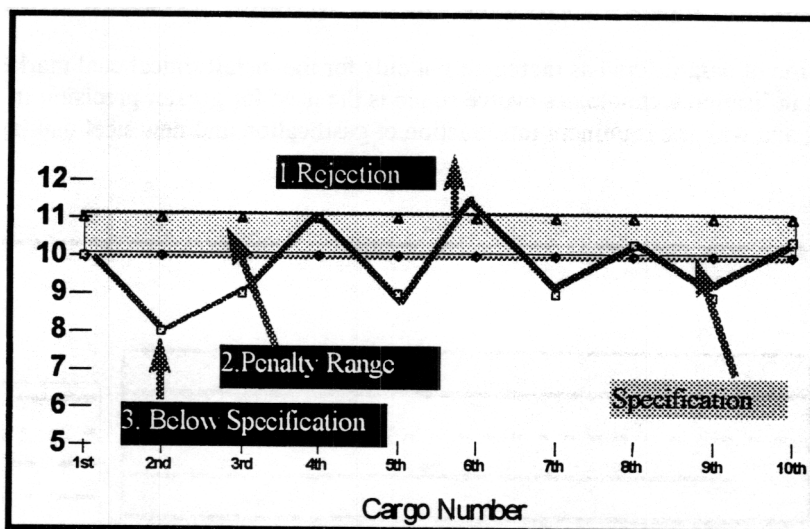


Fig. 3 - Costs presently associated with cargo assembly

Coal markets however, are characterised by the need for a uniform product to particular specifications. Inability to meet these specifications results in financial penalties or cargo rejection, depending on the severity of the quality non-conformance.

Knowing the location of individual parcels of product with their own individual quality characteristics is a fundamental requirement of stock management.

A SOLUTION

In response to this fundamental need, industry has employed a variety of tools and technologies for particular applications.

These include:-

- High speed computers;
- Increased sophistication in database software;
- Improved radio communications;
- On line analysers and weightometers; and
- Reliable real time surveying techniques.

Individually, each of these benefit the quality recording methods in specific applications. However, individually they do not provide a real time quality management tool to meet the tracking needs for complex stockpiling situations.

By combining the above tools and techniques the tracking of quality through a coal flow system in real time becomes a reality.

QMASTOR© is such a system.

SYSTEM OVERVIEW

Essentially QMASTOR© has three elements:

a) A Remote Positioning System

Differential GPS technology is used to monitor the movement of coal through all 'active' stockpiles using satellite receivers placed directly on the working plant (loaders, trucks, dozer). The receivers automatically transmit the position of the machinery, and consequently the coal parcel, to a central computer via a radio telemetry link. This 3-dimensional positional data is transmitted many times per minute to facilitate the location of coal with precision appropriate to the task.

b) A Central Computer

The central computing system emulates a customised 3-dimensional stockpile model and is comprised of several individual elements including a relational database, machine tracking software, stockpile mapping, 3D visualisation routines and production reconciliation tools.

It has the capacity to receive a variety of data types including both planning and production information. This data is received either as static files or real time data strings.

For example, quality data from an on stream analyser can be fed to the system, matched with the GPS data and compared with the master production schedule thus providing a continuous real-time quality profile of the required stockpiles.

The status of stockpiles can be reported either on screen or on a report format by:

- sub zone;
- longitudinal or lateral section;
- individual stockpile composites.

c) An Optimisation Model for Coal Reclamation

Coal being reclaimed from stockpile must meet pre-defined quality specifications. The optimisation model automatically determines a reclamation schedule to meet these specifications in the most economic fashion based on the value and quality of available coals. As coal is reclaimed to the blend, monitoring via DGPS continues, maintaining an up to date status of the various stockpiles. A schematic of the Total System Configuration is shown in Fig. 4

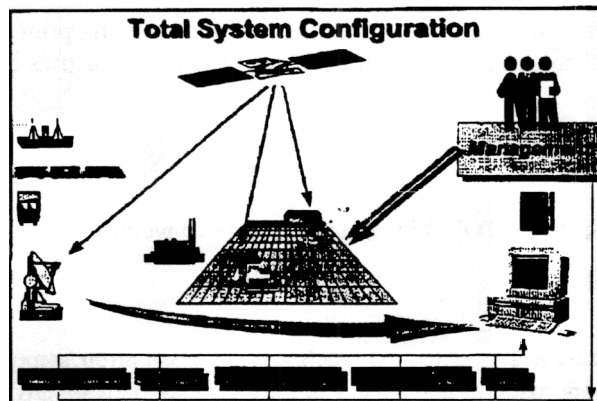


Fig. 4 – Total system configuration

Whilst QMASTOR© is a product in its own right, it can also be integrated with other quality management tools, providing a real-time update facility for the planning of coal flow systems.

ADVANTAGES

The provision of accurate stockpile information allows management to make well informed timely decisions. Specific advantages include

- Confidence that a cargo is not only in specification but also optimised for quality and cost parameters;
- Reduced operating costs associated with survey and traditional quality control methods;
- Stockpile tracking on a real time basis;
- Facility to analyse and backtrack machine usage;
- Immediate survey control; and
- Reduction/elimination of downstream sampling and analysis.

The need for volumetric surveys (either ground based or aerial) is eliminated by the continual GPS record of the stockpile surface. QMASTOR© techniques achieve a level of control unmatched by industry alternatives.

The need for double handling of product due to quality uncertainty is eliminated and the need to sample is reduced. In addition, the user can clearly demonstrate to their customers a dedication to total quality management and state of the art quality control; parameters which may soon be standard in sales contracts.

APPLICATIONS

QMASTOR© can be applied in any material flow system where there is a need for accurate and timely stockpile control. For the coal industry this could be:

1. at the port - to ensure optimum use of coal whilst consistently meeting specification
2. at the washplant - where clean coal stocks require careful maintenance to ensure client needs are met
3. prior to the washplant - for raw coal blending into the plant to maximise yield.

Other applications in the coal industry may include raw coal haulage and blending prior to the washplant. Outside the coal industry potential clients in the transport and bulk materials industries are investigating the suitability of the system to their particular needs.

RESULTS

Fig. 5 demonstrates the advantage of QMASTOR© in comparison to a conventional method of tracking stock.

1. Background

To compare QMASTOR© with a conventional technique, a population sample of 30 vessels is selected. The method relies on a simple approach of comparing quality characteristics analysed by either the conventional or the QMASTOR© method and comparing those results with the superintending results through automatic sampling of the vessel. The superintending results are taken as correct.

The Conventional method is based on pre-shipment analysis. During the transportation and stockpiling from the clean coal area to pre-shipment area regular samples are taken from the mobile equipment.

Interpretation of the results is based on standard statistical techniques.

2. *Analyses of conventional result.*

In the diagram, the curve with large dots represents the differential on ash basis between the conventional technique and the automatic sampler. As can be seen from the diagram, approximately 23% of vessels had a differential more or equal to -0.35. Similarly, 3% of vessels have -0.2 differential result, going up to 18% for -0.1, and so on. For this case the distribution is almost random, and the curve is roughly approximated by a simple line at 0.10.

3. *Analyses of QMASTOR® results* The QMASTOR® results are represented by the curve with asterisks. The curve approximates the Normal distribution of probabilities. For example, differential zero results between QMASTOR® and automatic sampling are achieved for 24% of vessels. In contrast, the theoretical probability equals 26%.

Shown as background to the QMASTOR® curve is the theoretical histogram for the precision of <-0.35 and >0.35. For this normal distribution, the rule of 3 sigmas (standard deviation) is applied. For example, comparison of QMASTOR® and conventional method probabilistic results for 1 sigma gives ~68.27% of vessels and ~33.3% respectively.

4. *Comparison of results reached by QMASTOR® and conventional methods.* The Australian standard on methods of analysis and testing of coal and coke gives figures on repeatability and reproducibility of 0.15 and 0.25 respectively. In probabilistic terms, QMASTOR® improves this result 2 times (~68.27% and ~33.3%). Similarly, QMASTOR® gives considerably improved results across the whole spectrum

CONCLUSION

Fig. 5 clearly demonstrates, QMASTOR® has the following advantages over conventional methods of stock management:

- It reduces the variance of shipped product;
- It provides confidence in the planning of cargoes quality; and
- It is a controlled management tool (as demonstrated by the Normal probabilistic distribution) which gives the operator control over quality.

QMASTOR® provides companies with a system to consistently strike quality targets with accuracy and confidence. It also forms a basis for continual improvement of not only the quality of the product, but also the efficiency of the total operation. This is a versatile product and its application will assist in resolving one of the coal industries fundamental challenges.

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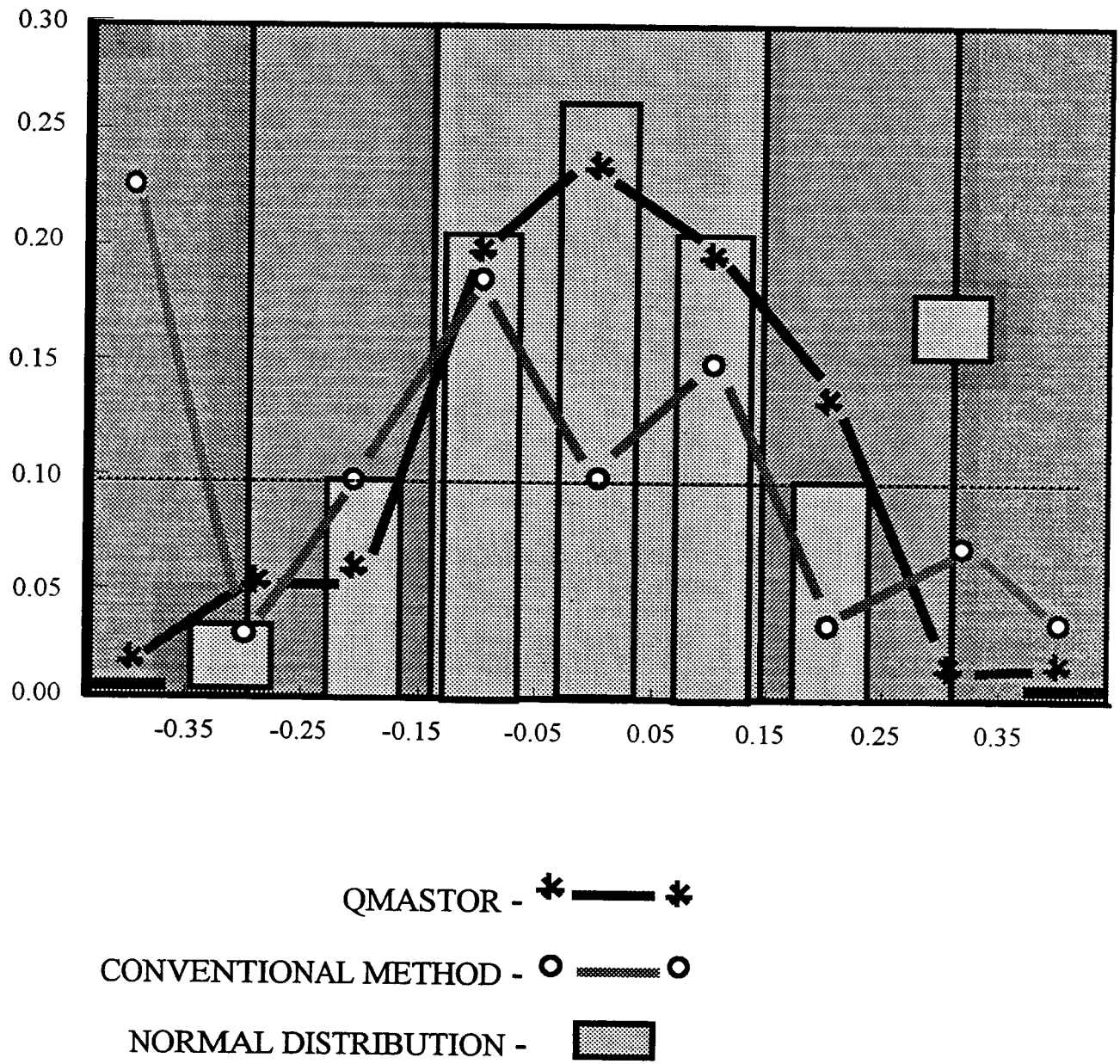


Fig. 5 – Comparison of Results