AUSTRALIAN GUIDELINES FOR THE ESTIMATION AND CLASSIFICATION OF COAL RESOURCES

2014 EDITION

Prepared by the Guidelines Review Committee
on behalf of
the Coalfields Geology Council of New South Wales
and
the Queensland Resources Council

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1 PREFACE

1.1 Prior to September 1999 the estimation and reporting of Coal Resources and Coal Reserves in Australia were prescribed by the "Australian Code for Reporting Identified Coal Resources and Reserves (February 1986)". This code was ratified by the Government Geologists' Conference in April 1986 and appended to the "Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves" (The JORC Code), prepared by the Joint Ore Reserve Committee (JORC) in February 1989. The JORC Code was subsequently revised in 1992 and 1996. In 1999, a significant revision occurred which resulted in the inclusion of the reporting of Coal Resources and Coal Reserves into the "Australasian Code for Reporting of Mineral Resources and Ore Reserves". This 1999 edition of the JORC Code referenced the 1999 edition of the "Guidelines for the Estimation and Reporting of Australian Black Coal Resources and Reserves". The guidelines were updated in 2003 as the "Australian Guidelines for Estimating and Reporting of Inventory Coal, Coal Resources and Coal Reserves" (the 2003 Guidelines), and were referenced in the 2004 and 2012 editions of the JORC Code.

1.2 "The JORC Code 2012 Edition", herein referred to as "the Code", provides minimum standards for public reporting of Exploration Results, Mineral Resources and Ore Reserves. The Code states in guidance notes for Clause 42 that for guidance on the estimation of Coal Resources and Reserves and on statutory reporting not primarily intended for providing information to the investing public, readers are referred to the "Australian Guidelines for Estimating and Reporting of Inventory Coal, Coal Resources and Coal Reserves" or its successor document as published from time to time by the Coalfield Geology Council of New South Wales and the Queensland Resources Council.

1.3 This successor document, the "Australian Guidelines for the Estimation and Classification of Coal Resources", herein referred to as "the Coal Guidelines", represents a substantial update of that work. It will continue to be reviewed periodically and re-issued as required.

1.4 This document is not part of the Code, however adherence to the processes and procedures outlined in the Coal Guidelines is recommended by the Code. This document must be read in conjunction with the Code, and if any conflict is perceived between this document and the Code, the Code takes precedence. Guidance notes to Clause 42 of the Code states these guidelines do not override the provisions and intentions of the JORC Code. Competent Persons should as always exercise their judgement in the application of these guidelines to ensure they are relevant to the circumstances being reported. They may not be applicable for use in all situations in Australia or overseas.

1.5 Some of the wording in the Coal Guidelines has been copied from the Code and the reader should note that requirements of the Code are mandatory if reporting of an estimate is said to meet the standard of the Code.

1.6 References to Coal Reserves in the previous version of this document were a partial replication of Ore Reserves documented in the Code. Since Coal Reserves are adequately covered by the Code they are now not replicated in the Coal Guidelines.

2 SCOPE

2.1 The scope of this document is to:

- Provide guidance reflecting good practice, which is recommended to be followed when classifying and estimating Coal Resources;
- Provide guidance for the determination of reasonable prospects for eventual economic extraction ("reasonable prospects") as this pertains to coal deposits;
- Include a variety of assessment tools that can be used for the estimation and classification of Coal Resources, to replace the application of suggested maximum distances between Points of Observation that were included for guidance in previous versions of this document; and

- Provide a definition of Inventory Coal (as included in this document) for the purposes of Government and non-public reporting.

2.2 The Coal Guidelines are broad in nature to accommodate the wide variation of coal deposits in terms of rank, quality and geological environment. This document is intended for use in Australian coalfields but may also provide guidance internationally.

2.3 In this document important terms have a definition provided in the Glossary.

3 GLOSSARY

3.1 The following terms and their intent are used in this document.

Table 1: Glossary of terms

Term	Definition and usage
Australian Standards	Australian Standards are published by Standards Australia and govern, amongst many other things, the manner in which coal and coke are sampled, analysed, tested and the results reported. There are Australian Standards to cover virtually all tests relevant to coal resource evaluation (refer Appendix A) and it is anticipated that coal analysis work carried out in Australia will be conducted according to these standards. AS1038 is the prefix used to identify the principal Australian Standards that detail the methods for analysis, testing and reporting of quality in higher-rank coal and coke. AS2434 is the prefix used for a similar series of Australian Standards for analysing and testing lower rank coals. There are other relevant standards, including AS4264 (sampling) and AS2519 (Guide to technical evaluation of higher rank coal deposits).
Basis (Reporting)	Basis refers to the state of the sample on which the quality assessment is based, and considers the moisture and ash values within the sample. The basis of any quality parameter should be stated in all forms of data storage and in all reports. Raw data may include data at a range of bases and it is important that the basis is known. The most common are: as received, air dry, dry and dry ash free and these are described in Appendix B. Other bases used include ash-free moist, dry mineral matter free and dry minerals and inorganics free. These are not described here. In terms of coal quality parameters that are relevant to reporting of Coal Resources, most that are moisture dependent are reported at air dry basis (the value of which should be stated). In terms of reporting of coal quantities, *in situ* moisture is the correct reporting basis and this should also be stated. *In situ* moisture is the moisture content of the coal, undisturbed in the ground.
Coal Reserve	Coal Reserve has the same meaning as “Ore Reserve” as defined in the Code.
Coal Resource	Coal Resource has the same meaning as “Mineral Resource” as defined in the Code.
Composition	Composition of coal refers to the chemical characteristics of a coal sample. These in turn depend on the combination of rank, type and grade of the coal, and also the extent to which the coal may have been modified by beneficiation.

Term	Definition and usage
Confidence	Confidence in Resource classification refers to the assessment of the critical data for a coal deposit and likely variation in the resource estimate following additional exploration.
Critical Variables	Critical variables are those physical and chemical properties of coal that may potentially limit reasonable prospects for eventual economic extraction. Understanding the distribution of critical variables within the deposit is of importance in defining the confidence of classification for the Coal Resource.
Density	The density of a coal sample is dependent on the rank, type, mineral matter and moisture contents of the coal. The moisture content of a sample will be affected by the manner in which it has been handled, broken, dried, or analysed. The determination (best estimate) of the density of coal *in situ* requires the conversion of those densities and moistures determined in a laboratory. The industry standard method follows the Preston and Sanders formula (Preston and Sanders, 1993) which utilises the best estimate of the *in situ* moisture (from a Moisture Holding Capacity test or an Equilibrium Moisture test on a higher rank coal) in conjunction with the laboratory-determined air dry density and air dry moisture content of the sample. For further information refer to Q4 (Appendix C) and Preston (2005).
Exploration Target	Exploration Target has the same meaning as “Exploration Target” as defined in the Code.
In situ	*In situ* refers to the condition of the coal as being undisturbed in the ground. An estimate of Coal Resources should state the condition of the coal in the ground and the values for moisture and density.
Inventory Coal	Inventory Coal refers to an estimate of *in situ* coal that does not consider or does not pass the reasonable prospects test. It may include coal that currently has low prospectivity due to natural or cultural features that preclude mining. For further information refer to section 6.1 and Appendix C (Q1 to 3).
Quality (Coal)	Quality is a term that encompasses all aspects of rank, type and grade that contribute to giving a coal its properties, as indicated by a standard suite of tests. Quality is normally considered in the context of coal’s potential utilisation and how it might favourably or unfavourably affect the utilisation process.
Rank (Coal)	Rank is a concept that describes the degree of coalification (physical and chemical transformation from vegetable material to coal) that has been achieved by plant materials, as a consequence of elevated temperature maintained over time and to a much lesser degree, pressure. The causal factor is principally deep burial of plant materials within the earth’s crust. Rank is indicated by a range of properties, including moisture and calorific value for low rank coals and mean maximum reflectance of vitrinite for higher rank coals.
Type (Coal)	Coal type refers to the composition of a coal in terms of its organic components, recognised as its macerals. The macerals are recognised according to a standard classification system, which refers to the original plant material from which they were formed and the degree of subsequent decomposition and degradation.
Grade (Coal)	Coal Grade refers to the inorganic constituents of a coal (the mineral matter) in terms of their total proportion (% mineral matter or its residue on combustion, ash) and in terms of their individual constituents (e.g. % Na, S, P etc.).

4 DATA FORMS

4.1 Points of Observation

4.1.1 Points of Observation are sections of coal-bearing strata, at known locations, which provide information about the coal by observation, measurement and/or testing. They allow the presence of coal to be unambiguously determined.

4.1.2 Points of Observation have varying degrees of reliability and can include surface or underground exposures, bore cores, calibrated downhole geophysical logs and representative drill cuttings in non-cored boreholes. Points of Observation may be classed by Quantity or Coal Quality. Each class should be clearly tabulated and presented in plans on a seam by seam basis.

4.1.3 Resource confidence outlines should be determined by the merging of Quantity confidence limits (tonnes) with Coal Quality confidence limits. The final confidence limits should be the more constrained of the two. Deposits without Coal Quality data cannot qualify as a Resource as there is no data to establish the relative value required for the reasonable prospects test.

4.1.4 In most coal deposits the density of Quantity Points of Observation is greater than the density of Coal Quality Points of Observation. As a result, Coal Quality Points of Observation are generally viewed as the principal delimiter of Resource categories. There are however deposits in which the quantity variability is greater than the quality variability. This would include highly faulted or structurally complex deposits. In these cases Resource confidence and outlines may be delimited by the Quantity Points of Observation.

Coal Quality Points of Observation

4.1.5 A Point of Observation for coal quality evaluation is normally obtained by testing samples obtained from surface or underground exposures, or from bore core samples having an acceptable level of core and sample recovery to be considered representative.

4.1.6 Relevant coal analysis data should be acquired to determine the nature of the coal and the potential products for Coal Quality Points of Observation. If beneficiation is required to achieve a desired product mix and/or additional quality parameters are required to confirm the suitability of the coal, then yield and relevant product quality data should be included in the criteria for Coal Quality Points of Observation. If this is not the case, then the absence of such data should be justified.

Quantity Points of Observation

4.1.7 A Point of Observation for quantity evaluation is normally obtained by measurements of surface or underground exposures and bore intersections. The seam thickness and location must be unambiguous. Seams covered by downhole geophysical logs in non-cored boreholes can provide Quantity Points of Observation.

4.1.8 Points of Observation for quantity estimation may not necessarily be used for coal quality evaluation and the relevant spacing and location of each should be reported separately.

4.2 Supportive Data

4.2.1 Supportive Data are observations supporting the existence of coal, gathered by interpretive or indirect methods. Supportive Data may include results from geological mapping, 2D and 3D seismic, magnetic, gravity and other geophysical and geological surveys.

4.2.2 Supportive Data can be used with Points of Observation to improve confidence in seam continuity. An example is depth adjusted 3D seismic data which may be used to define seam structure location between boreholes.

4.2.3 Detailed calibration of downhole geophysical logs with seam core sample analyses may allow the estimation of the *in situ* density and raw coal ash in non-cored boreholes. In this case, the interpreted raw ash estimates could be used to improve the confidence level in continuity between Coal Quality Points of Observation.

4.2.4 Supportive Data should not be used quantitatively in any seam thickness estimate unless there is clear technical justification to do so. When reporting Supportive Data, the technical basis of the interpretation should be stated.

5 ESTIMATING RESOURCES AND ASSESSING CONFIDENCE

5.1 Overview

5.1.1 Resources are classified based on the confidence in the geological data and the estimate. The Resource categories as defined by the Code are Inferred, Indicated and Measured, which, in order, reflect increasing levels of confidence in the Resource estimate.

5.1.2 In order to classify Coal Resources, an assessment of the confidence in the estimate of all significant variables should be undertaken. Classification categories (Inferred, Indicated and Measured) are also likely to cover a range of confidence levels. The criteria used to determine this confidence should be clearly documented.

5.1.3 For example, reporting a Coal Resource of coking quality requires that coking coal test work has been undertaken. It should be established that there is sufficient confidence that the stated product can be produced, as it would be misleading to report such a product type without suitable evidence. In the same way it is necessary to establish sufficient confidence in the physical parameters (e.g. thickness, dip, faulting) of the coal seam which may be subject to greater sensitivity than the quality.

5.1.4 The accuracy and precision of an estimate can also impact on confidence when the variable of interest is of a critical nature. Where variables of interest have a range that is likely to produce a negative impact in the reasonable prospects test, it is important to define the confidence in the measurement and estimation of those variables.

5.1.5 Confidence in classification categories of an estimate can be determined by a variety of methods and criteria. The combination of the most applicable methods and criteria to demonstrate confidence in the estimate should be used to support the classification assigned. Such methods and criteria include but are not limited to:

- Critical assessment of relevant local, geographical and geological settings
- Identifying critical data
- Data analysis, error and verification
- Domaining
- Statistical analysis
- Geostatistical analysis
- Geological modelling

5.1.6 Any Resource estimate should be accompanied by an assessment of the most influential risks to that estimation. Risks associated with Resource estimation include (but are not limited to) regulatory compliance and governance issues, drill and sampling management, and geological modelling risk, as well as computational uncertainty due to structure, stratigraphy, and coal quality variability.

5.2 Critical assessment of relevant local, geographical and geological settings

5.2.1 A comprehensive understanding of the relevant geology and geography of the deposit will inform the data resolution required to define Resource confidence. Understanding the geology of the deposit should be the most important factor and the starting point in Resource classification and estimation.

5.2.2 Assessment of the geology of the coal deposit should include, but not be limited to, consideration of the following:

- Regional geological setting;
- Comparison to neighbouring projects, including an understanding of geological similarities and differences; and potential hazards previously encountered in the region;
- The nature of the coal seam, including whether the seam is thick and continuous, or is made up of multiple thin seams and whether there is abundant splitting etc.;
- Structure of the deposit, including seam dip, faulting, folding etc.;
- Post-depositional influences, including depth of weathering, unconformities and wash-outs;
- Intrusions, including the impact on seam persistence or structure and on coal quality;
- Geotechnical properties of the coal and the non-coal strata and their influence on the proposed mining method;
- Coal composition and rank and the impact upon coal quality parameters and potential coal product(s);
- Geographical features and the relationship between structural and depositional features, particularly with respect to topographical variability, river systems, weathering and oxidation.

5.3 Identifying critical data

5.3.1 Coal deposits have key attributes critical to economic viability. These attributes are paramount to the determination of tonnage, quality, confidence and reasonable prospects.

5.3.2 Seam thickness, areal extent (including structural influences), moisture and density are the attributes determining tonnage estimates. The estimate of tonnages should be on an *in situ* moisture and *in situ* density basis. An outline of the methodology employed to determine both *in situ* moisture and *in situ* density should be provided.

5.3.3 The Resource estimation process must consider quality parameters that may be critical to the mineability and marketability of the product(s). This is crucial if the value of the marketable products has an impact on both cut-off limits and reasonable prospects. It may be useful to compare the quality of the resource with that of normally utilised and traded coals. Such an assessment may result in the identification of a critical parameter that needs to be further tested during ongoing exploration and/or incorporated into resource cut-off limits and categorisations.

5.3.4 It is necessary to analyse variability and confidence for individual seams in relation to critical parameters and assign confidence and cut-off limits on a seam basis. In a multi-seam deposit it may be practical to consider groups of seams, although this should be clearly justified.

5.3.5 If washed coal is to be marketed, then washed product yield is a critical parameter in the estimate. If limited product yield data are available then downgrading the confidence category of the Resource should be considered. Satisfactory relationships between yield and other product parameters (including ash percentage) can be used to support retention of the confidence categories determined for the *in situ* coal.

5.3.6 If metallurgical coal products are proposed to be marketed from the deposit, additional parameters need to be analysed, including coal rank (such as vitrinite reflectance and ultimate analysis), coal petrography, coking properties, phosphorous and critical trace elements. If hard coking coal is considered to be part of the product mix, the results of coke strength tests must support such a conclusion.

5.4 Data analysis, error and verification

5.4.1 Coal exploration data are dominantly obtained from exploration boreholes, in the form of cuttings and/or cores supplemented with downhole geophysical logs. Data may also be obtained from aerial topographic surveys, surface, underground and highwall mapping, trenching, and aerial and ground geophysical surveys.

5.4.2 The importance of understanding the history of the data, including the processes of collection, transfer, validation, conversion and storage, and the time taken to thoroughly understand the data, identify errors and cleanse the data, cannot be underestimated.

5.4.3 All data should be analysed statistically to understand the properties and relationships within the data-set and to identify any anomalous results. Attention is drawn to the requirement to consider the criteria in the Code (Table 1, Section 1 - Sampling Techniques and Data) on an “if not, why not” basis.

5.4.4 Some considerations pertinent to analysis of coal exploration data are highlighted in the following sections:

Validation of topographic and survey data

5.4.5 Borehole collar, topographic survey and other geographic data need to be validated to confirm that the correct survey datum and grid system has been used. The accuracy of survey methods used needs to be considered in addition to checking collar information against topographic data to identify anomalous locations.

5.4.6 Boreholes are not always vertical as assumed in many coal exploration programmes. Borehole deviations need to be checked and the lack of adequate downhole survey information should be taken into account during estimation and reporting.

Sample representivity

5.4.7 It is important to consider that potential loss of material from within a sample may be critical, irrespective of the relative percentage lost. The analysed sample should be representative of the *in situ* material within the interval of interest. Downhole geophysical data should be used to confirm the location and nature of any core loss in coal seams.

5.4.8 Good sample recovery is required for representative samples and it is important to identify and document what is considered acceptable for sample recovery. Unacceptable losses must be identified and where appropriate the sample rejected as a Point of Observation. Calculated mass recovery (from raw sample mass, relative density, core diameter) can be used to identify field measurement errors. Sample integrity and its impact on particle size distribution should be considered.

5.4.9 In the design of coal sampling and testing programmes consideration needs to be given to the sample top size and available mass to conduct the required tests.

5.4.10 Ideally, sampling should be carried out using data collected at the ply level for the full coal seam. This will provide a better understanding of the geological controls on coal quality characteristics. Sampling should not be controlled by mining criteria, as the parameters may change in the future, depending on factors such as economics or client product specifications.

Sample history and impact on coal quality and geomechanical properties

5.4.11 Sampling methods, sample preparation and analysis protocols need to be carefully reviewed to identify potential sources of error that may result in problems with data precision and accuracy.

5.4.12 Careful consideration should be given to evaluate the history of the sample storage as well as the handling from the field to the final analysis. Oxidation is of great importance in the early loss of coking properties; drying has impacts on geomechanical properties, coal moisture and density; and freezing and sample handling has impacts on particle size distribution.

5.4.13 Checks should be carried out on the various types of data, tracing the results back to the original source(s) and validating the relevant quality assurance / quality control (“QAQC”) systems.

Validation of coal quality data

5.4.14 An initial check of coal quality data should be carried out to confirm agreement between sampling intervals and lithological intervals.

5.4.15 Data can then be filtered, sorted, statistically analysed, cross-plotted (e.g. relative density vs. ash, calorific value vs. ash), and visualised (e.g. histograms of value ranges) to understand the data and to check for errors.

5.4.16 It should be confirmed that all samples taken have been analysed to relevant testing standards.

5.4.17 The basis of analysis of all parameters needs to be confirmed, and used consistently when data are combined.

5.4.18 Coal quality data may require normalisation where exploration has been in progress for a number of years and different approaches to sampling and test-work have been undertaken over time.

5.4.19 Quality data gathered from individual plies will usually require compositing into working sections; however attention is drawn to the fact that data from many analyses, by their nature, cannot be validly composited (e.g. caking properties).

Spatial analysis

5.4.20 Coal seam correlations and geological structure should be confirmed using down-dip and along-strike sections.

5.4.21 Careful evaluation of data posting and contour plots for the various parameters (e.g. thickness, coal quality), on a seam by seam and/or ply by ply basis, is required to validate the data (e.g. by checking for bulls-eyes in contour plots), to understand the lateral and vertical variations in the coal deposit, and to identify any separate geological domains (which can be confirmed using variography).

Accuracy, precision and error

5.4.22 Data measurements must be considered in terms of both precision and accuracy. The differences between precision and accuracy are demonstrated graphically in Figure 1.

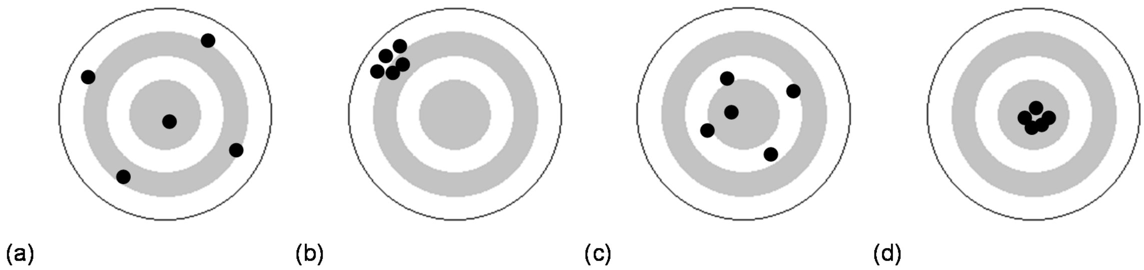


Figure 1: Relationship between precision and accuracy
(a) low accuracy & precision, (b) low accuracy, high precision, (c) high accuracy, low precision, (d) high accuracy & precision

5.4.23 All measurements taken contain some statistical error (observational error). Error does not refer to a mistake, but rather is the deviation between the measured value and its true value. Error occurs throughout the process of data collection. It is important that these various forms of error and how they may occur and be dealt with in reporting is understood (refer Appendix D).

5.4.24 Error may occur in:

- Sampling;
- Data measurement;
- Data management;
- Interpretation;
- Estimation; and
- Reporting.

5.4.25 Consideration of the error(s) that may occur in each form of measurement and the accumulation of those errors must be made to provide an indication as to the precision and accuracy of the estimate being made. Data should be stored, used and reported in a method that reflects this precision.

5.4.26 A variety of techniques can be applied to assess error in all forms of data capture. This requires implementation of rigorous and documented QAQC systems to assess the measurement, undertake evaluation and determine the significance of any error. The following techniques should be considered in developing QAQC protocols:

- Documented work practices
- Training and accreditation of personnel taking measurements
- Repetitive testing of known standards throughout normal data capture cycles
- Evaluation of standard and blank measurements over time
- Duplication testing by independent parties
- Independent audits

5.5 Domaining

5.5.1 Coal deposits are typically heterogeneous and include variations in seam characteristics. There may be both lateral and vertical variation in the structural complexity, quality characteristics, or other attributes. A key aspect of any estimate is to define the areas of a deposit that have similar features. These areas are known as geological domains.

5.5.2 Key features for domain definition may include: seam splitting and coalescing, intensity of structural deformation (such as folding or faulting), seam dip, igneous intrusions (and their impact on coal characteristics), washouts, seam subcrop (and weathering effects) and coal quality trends. Different domains may need to be identified for each of these features for each seam.

5.5.3 Domains may encompass features that impact on the mineability, marketability, or reasonable prospects of that part of the deposit. Analysis and modelling of data should be undertaken on a domain basis.

5.5.4 A deposit may have several geological domains, each of which may require a different data density to provide similar levels of confidence in the estimation of tonnage and/or quality.

5.6 Statistical analysis

5.6.1 A reasonable estimate of the population distribution for the key parameters should be obtained provided the method of sampling of the coal deposit has allowed the variability in geological and coal quality characteristics to be demonstrated.

5.6.2 It is important that the sampling techniques undertaken should represent both the spatial distribution and the variability of those parameters considered critical to the deposit.

5.6.3 An analysis can be undertaken to develop an understanding of population sample statistics for key parameters, such as:

- Number of samples
- Minimum and maximum variable values
- Mean and median
- Standard deviation
- Variance
- Coefficient of variation
- Standard error of mean
- Confidence limits of the mean

5.6.4 The use of such tools as histograms (normal and/or log), scatter plots, box and whisker plots, the coefficient of variation and cumulative distribution frequencies should be used to illustrate the distribution of data in the sampled population. These should support the understanding and confidence in the geological domains defined throughout the geological terrain.

5.6.5 Examination of the extreme ends of a sampled population distribution may indicate the presence of outliers (anomalous results or errors). Good practice is to check such results and determine a likely cause for the anomaly, and hence the data adequacy, before inferring anything about the sample value. Data analysis should be undertaken prior to excluding (with supporting justification) such samples from the population.

5.6.6 Not all variables sampled will follow a normal (Gaussian) distribution and consideration should be given to the impacts of this when reporting certain statistical results.

5.7 Geostatistical analysis

5.7.1 Geostatistical analysis provides a mechanism to understand and quantify a variable's continuity and the degree to which it is spatially correlated. The process can also provide an evaluation of the sample data geometry, and considers the volume ('support') of the data and the volume or area being estimated. Geostatistics provides a useful measure of the uncertainty of an estimate. Careful consideration of data selection, data validation, domain definition and identification of critical data are required for reliable geostatistical analysis.

5.7.2 Because coal represents a heterogeneous mixture of constituents, there is a range of coal quality parameters that should be considered for geostatistical analysis. With multiple variables, consideration of the primary defining drivers in the choice of critical variables is necessary. Continuity for different variables should be considered when determining the maximum influence of any data applied in any estimate. When numerous variables are assessed, the critical variable with the highest variability should take precedence in determining this maximum influence. This could be a deleterious component with a material negative economic impact. In all circumstances, the geostatistical result should be rationalised with respect to the geological interpretation.

5.7.3 If a specialist geostatistician undertakes this work, it should be done in consultation with a coal geologist who has familiarity and understanding of the geological interpretation and the features of the deposit and the dataset. The results of geostatistical analysis should never be applied in isolation from other factors in the resource estimation, such as the mining method, the geological interpretation, and the data reliability.

5.7.4 The project area may need to be divided into domains of geological and statistical consistency for variography and geostatistical analysis. Estimates can often be more easily executed if the same domains are selected for all variables, but the geological and geostatistical validity of this should be considered. If the spatial controls on one variable are clearly different to those of the others, then recognition of different domains may be warranted. There must to be sufficient data points available within each domain for the analysis to be representative.

5.7.5 Variography for coal variables is challenging when there are no closely spaced boreholes, because the short range variance (nugget) becomes difficult to define and there is a risk that the continuity of the variable may be overestimated. Variograms modelled using few data points also risk underestimating or overestimating the continuity of a variable, especially if those data points are broadly spaced.

5.7.6 Clear documentation of the data selected for use in variogram modelling, any manipulations of the data, and the domains used are required in reports. If a variogram is applied to more than one seam, cross-validation should also be conducted on those seams.

5.7.7 The variogram may assist in defining distances of continuity between Points of Observation. In isolation, this is not considered appropriate as it fails to consider all the other necessary factors contributing to the confidence in the estimate, such as sample geometry, mining methodology, local geological features and reliability of sample data. Sole use of the variogram is risky, in particular for variables with high nugget variance and/or short ranges.

5.7.8 Variability when estimated through geostatistical techniques is a function of the dimensions in which variance is reported. Larger volumes will be less variable than smaller ones. When quoting variances, the scale of the estimated blocks should be stated. For example Resource classification may be considered in terms of the expected mine production over a given time period.

5.7.9 Further description of variograms and geostatistical methods is provided in Q16 and 17 (Appendix C).

5.8 Geological modelling

5.8.1. A geological model is a mathematical depiction that reflects the geological interpretation of the deposit. A good understanding of the geology should be established before constructing the model, as this will guide selection of the most appropriate modelling technique for the deposit.

5.8.2 It is important to understand the principles underlying the software package being used. This includes understanding the steps required in the modelling process, and the order in which they must be completed to ensure the finished geological model represents the geological interpretation.

5.8.3 For the purposes of ensuring consistency in the modelling process a workflow (i.e. the defined sequence or steps to generate the model) should be established. This workflow should be documented for the purposes of materiality, transparency, and auditing. An explanation of what should be included is included in Q18 (Appendix C).

5.8.4 The geological model may be divided into several domains based upon the geology and data distribution. Care should be taken in extrapolating trends across domain boundaries. Refer to section 5.5 for description of domains.

5.8.5 Inputs into the geological model should be verified as reliable and representative of the geology prior to its construction. Any data excluded from the geological model should be documented, along with justification for its exclusion. Care should be taken to ensure the selection of data does not introduce bias to the geological model.

5.8.6 The impact of combining data from different sources and/or of different resolution into one geological model should be understood, such as the combination of ply and working section data. The impact of different generational sources of data may also be manifest as modelling discontinuities, such as boundaries between different mines or regional data sets.

5.8.7 If it is necessary to include artificial data to create a geological model that is consistent with the geological interpretation, these should be clearly identified both in the model and recorded in the supporting documentation. Such data should be reviewed and reassessed as new data are obtained.

5.8.8 Appropriate modelling parameters should be selected based on the density and distribution of the data, the data trends and the local geological interpretation. The suitability of these parameters should be confirmed using quantitative methods.

5.8.9 Consideration of modelling parameters may include:

- Selection of modelling algorithm
- Selection of model type
- Resolution of the grid mesh/block size
- Search neighbourhood
- Interpolation between data
- Reasonable extrapolation of trends in thickness and coal quality,

5.8.10 The selection of modelling parameters may differ by variable (e.g. thickness, ash, fluidity). The geological model should be constructed to provide maximum flexibility for subsequent mine planning options; however, this may be limited by the available data. The version of the geological model used for the estimation of Resources should be archived.

5.8.11 Validation should occur at all stages of the modelling process, and should identify and quantify the strengths and limitations of the geological model. The intended use of the geological model should be clear in the documentation, and the geological model should be confirmed as fit for purpose through peer review. A review of the geological model should be carried out in the event of a material change.

5.8.12 A geological model should represent the geological interpretation. Typical validation checks may include:

- Visual checks of the data such as by contour plots and sections
- Data honouring
- Statistical checks between the borehole and model data
- Reconciliation with previous models
- Validation of the model in relation to local geological understanding and trends
- An assessment of the sensitivity of the model to changes in geological interpretation, modelling assumptions or additional data

5.8.13 Common issues in geological models that can effect or compromise Resource estimations include:

- Not checking computer calculations
- Over-smoothing or overcomplicating the model
- Phantom coal being generated through automated modelling processes, a poor geological interpretation, or not understanding mined-out areas
- How the model caters for missing seams in boreholes
- Coal losses being generated through incorrect pinching out of seams
- Unreasonable extrapolation of trend surfaces
- The manner of dealing with unconformities and other limiting surfaces such as weathering and topography
- Dealing with different data densities in the same model
- Not confirming digital data against original data
- How the model deals with composited data, and whether correct weighting is applied to composite calculations
- Assumptions about the reliability and accuracy of the data
- Edge effects (including flattening of seam dips away from real data)

6 REASONABLE PROSPECTS

6.1 Inventory Coal

6.1.1 Inventory Coal is any occurrence of coal in the ground that can be estimated and reported without being constrained by economic potential or other modifying factors. That is to say estimates of Inventory Coal tonnages are not subject to or constrained by the reasonable prospects test. By definition Inventory Coal includes all known Coal Resources.

6.1.2 The location, quantity, quality, geological characteristics and continuity of Inventory Coal are known, estimated or interpreted from specific geological evidence and knowledge. In a similar fashion to Coal Resources, Inventory Coal is sub-divided in order of increasing geological confidence into Inferred, Indicated and Measured categories (refer Figure 2).

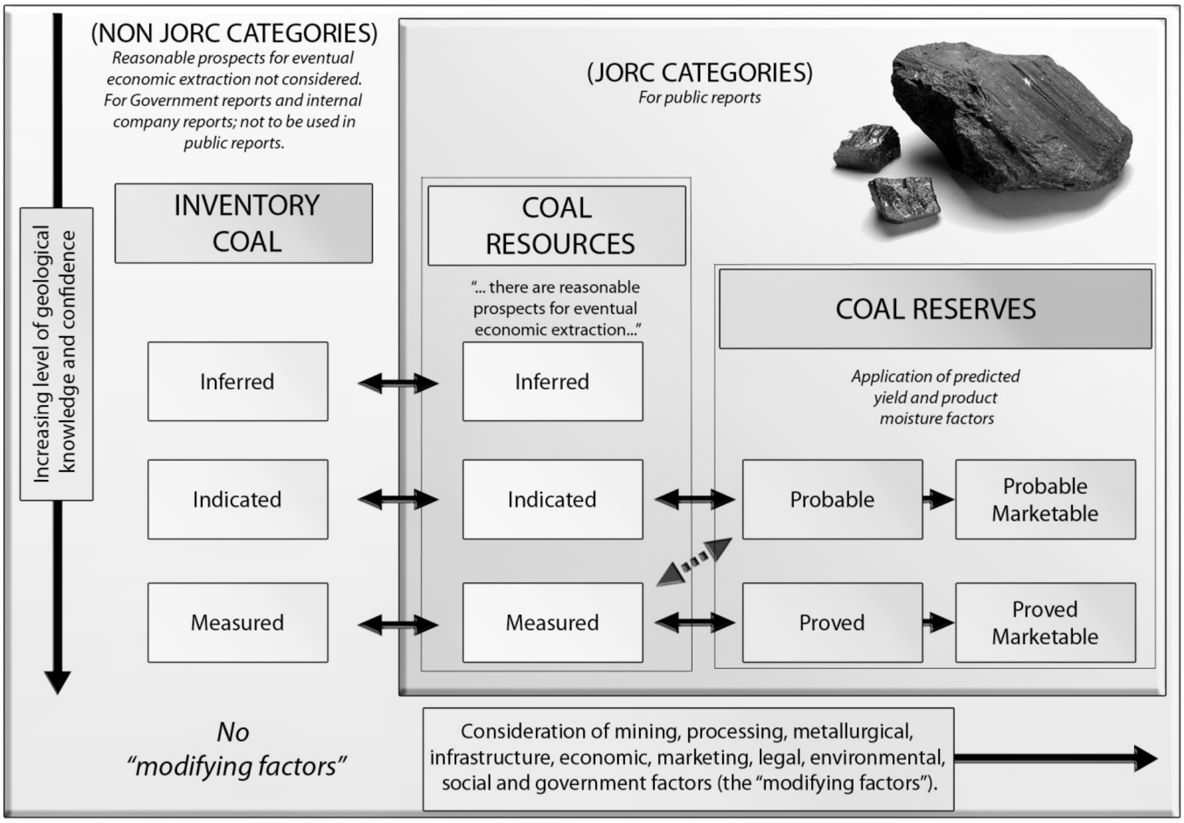


Figure 2: Relationships between Inventory Coal, Resource and Reserve Classifications

6.1.3 Inventory Coal is a term that enables a more complete estimate of unconstrained coal tonnages *in situ* to be reported to Government for the State's purposes or for purposes of strategic planning internally within companies that hold or manage mineral tenements.

6.1.4 Estimates of Inventory Coal must not be publicly reported.

6.1.5 Where estimates of Inventory Coal and Coal Resources are presented together in a non-public report, a statement must be included in the report which clearly indicates whether the Inventory Coal, as reported, is inclusive of, or additional to the Coal Resource.

6.1.6 An estimate of Inventory Coal is fundamentally different from an Exploration Target as defined in the Code, in that the latter is generally restricted to either one of two situations being:

- an aspirational or hypothetical (coal exploration) target based on little or no direct data but perhaps at best, supported by regional trends or a conceptual geological model or
- an estimate of potential coal *in situ*, which is at best an 'order of magnitude' estimate and which is based on extremely limited data (insufficient coverage, density or integrity) to properly allow the classification of Inventory Coal or Coal Resources estimates in accordance with the provisions of the Code or the Coal Guidelines.

6.1.7 Where some exploration has been conducted on an area, but is insufficient to enable the estimation and reporting of either Inventory Coal or Coal Resources with at least an Inferred level of confidence, it may be appropriate to report an Exploration Target based on those exploration results.

6.1.8 The reader is referred to clauses 17-19 of the Code for the strict public reporting conditions, including cautionary statement and the required information to be disclosed to enable investors to assess the significance of the Exploration Target. The statement cautions that it is uncertain if further exploration will result in the estimation of a Coal Resource.

6.2 Coal Resources

6.2.1 A Coal Resource as defined in the Code is not simply a summation of all coal drilled or sampled, regardless of coal quality, mining dimensions, location or continuity. It is a realistic estimate of the coal that, under assumed and justifiable technical, economic and development conditions, is more likely than not to become economically extractable.

6.2.2 These Coal Guidelines do not prescribe a specific approach to arriving at the key assumptions, or the level of detail required. Neither do they set out the economic indicators that need to be satisfied or the level of satisfaction that needs to be achieved for the coal to be said to have reasonable prospects and hence be classified as a Resource. The Coal Guidelines simply provide prompts as to the factors that need to be considered and documented, including but not limited to mining, processing, metallurgical, infrastructure, economic, marketing, legal, environmental, social, governmental and regulatory factors.

6.2.3 Guidance to Clause 38 of the Code states that in discussing 'reasonable prospects for eventual economic extraction' there is a requirement for an assessment (albeit preliminary) in respect of all matters likely to influence the prospect of economic extraction including the approximate mining parameters. While a Scoping Study may provide the basis for that assessment, the Code does not require a Scoping Study to have been completed to report a Coal Resource.

6.2.4 Clause 20 of the Code states that the basis for the reasonable prospects assumption is always a material matter, and must be explicitly disclosed within the Public Report using the criteria listed in Table 1 for guidance.

6.2.5 Guidance to Clause 20 of the Code discusses what may be considered as reasonable time frames for extraction of bulk commodities such as coal, and notes that in all cases, the considered time frame should be disclosed and discussed by the Competent Person.

6.2.6 An assessment must be made that considers those factors which will affect costs and revenues, as well as those factors which might affect the "licence to operate". The physical attributes of the deposit, together with the beneficiation characteristics, are those which heavily influence costs. Critical product coal quality attributes that determine the potential utilisation of the coal and the mix of product types will be the major influences on revenue. Licence to operate includes the regulatory, social, cultural, political and environmental factors that may inhibit or limit mine development, or add to the cost of development. It may be necessary to seek expert comment on these factors.

6.2.7 Clearly the reasonable prospects test is sensitive to the geological, geotechnical and coal quality parameters that will have been investigated as a precursor to the estimation process. In some cases the prospectivity of a coal deposit can be assessed by comparing the known parameters with analogues in nearby areas. However, rarely is it easy to properly assess the economic worth of a coal deposit without at least a basic appreciation of costs of extraction and likely revenues to be received. These matters are normally considered during the Resource study and in concert with engineers and other specialists.

6.2.8 Realistic cut-off parameters should be determined and applied to the deposit that take into account the likely mining scenario and the potential utilisation of the coal with reference to experience regarding similar operations. In deposits where both open cut and underground Coal Resources are considered to exist, the limits for each mining method, as well as thickness and coal quality constraints relevant to each mining method should be disclosed.

6.2.9 In a potential open cut mining scenario, emphasis on strip ratio, minimum mineable seam thickness, maximum non-separable parting thickness, pit wall stability and depth of weathering are important considerations. If beneficiation of the raw coal is envisaged, the clean coal yields should be factored into cut-off considerations, including strip ratios. It may be desirable to consider optimisation techniques to examine various options to support an assessment of cut-offs.

6.2.10 In an underground mining scenario, aspects such as depth, faulting, igneous intrusions, working section thickness, seam dip, physical properties of roof and floor lithologies, hydrogeology, stress regime, gas content, composition and permeability should be considered. In multi-seam underground deposits, the nature and thickness of the interburden material may be a critical consideration, as this might preclude extraction of some of the target coal seams.

6.2.11 The results of any relevant technical and economic studies should be considered. Reference to existing operations in a similar region and geological setting should also be referred to where possible and relevant. Caution should be exercised if limits on coal quality, including ash percentage and deleterious elements (e.g. sulphur and phosphorus) are strictly applied. Such quality aspects should be noted, but may not be of sufficient significance to declare that such a coal is not considered a Resource. Incorporation of mining limits, including depth, strip ratio, minimum (and maximum, if appropriate) mineable thickness, seam dips or intra-seam parting thickness are similarly to be treated with caution.

6.2.12 Consideration should be given to whether the tonnage and coal quality are sufficient to ensure satisfactory returns over a reasonable life of mine. If the estimated coal tonnage is not sufficient to support a mining operation this may preclude the coal's potential for future development unless sufficient upside can be identified (e.g., potential to increase the tonnage, or potential synergies with adjacent Coal Resources).

6.2.13 A coal deposit may be alienated from current markets if it is located in an extremely remote area devoid of relevant infrastructure, and where potential development in a reasonable timeframe may be difficult to justify.

6.2.14 Consideration should be given to whether all the coal is accessible for exploration and/or development. Coal Resources may only be estimated within the boundaries of valid exploration, development or mining tenures held by the reporting company, its subsidiary companies or its Joint Venture partners.

6.2.15 Areas with surface land access restrictions, such as a gazetted or proposed national park, would normally be excluded and the coal within these areas excised from a Coal Resource estimate. There may also be instances where coal adjacent to or underlying major rivers, bodies of stored water, urban developments or major infrastructure, such as railway lines, major bridges and highways, requires careful consideration and documentation in terms of potential future development of all or parts of the deposit. In these instances (and always assuming that the coal is sufficiently attractive and technically possible to mine) there may be additional costs and social or legal impediments to mining. Consideration needs to be made regarding a determination as to whether there are reasonable prospects for mining to take place within the time frame stated. Any such coal excluded from a Coal Resource may be included in Inventory Coal in a non-public report.

7 REPORTING AND DOCUMENTATION OF RESOURCES

7.1 Complete relevant sections of Table 1 of the Code, ensuring that all relevant sections are filled out on an "if-not why-not" basis. For Exploration Results this requires sections 1 and 2, for Coal Resources sections 1, 2 and 3. Suggestions of aspects to be considered are also provided in Appendix F.

7.2 It is the responsibility of the Competent Person to determine and justify the confidence categories for any given deposit. Documentation should be prepared that fully describes the estimation process and assumptions used. The documentation should address all items in Table 1 of the Code (refer Appendix E) and may include:

- The criteria used to differentiate between Inventory Coal and Coal Resources, i.e. define what is used to determine the reasonable prospects test.
- Tables of the estimates displaying: tenures, confidence categories, areal extents, thickness ranges, *in situ* densities, depth ranges and coal quality ranges relevant to the estimate for each seam or seam grouping.
- Reference to the probable mining method.
- The moisture basis of the estimate(s) and the moisture adjustment factor (if applied).
- A description of all factors used to limit the estimate(s).

- A declaration as to whether or not the Resource report complies with the requirements of the Code.
- The name, qualifications and experience of the Competent Person and the relationship with the tenure holder(s) and/or operators.
- The date of the report publication.

8 AUDITS

8.1 It is good practice to undertake an audit or peer review of the Resource estimate particularly where it is a maiden estimate or where a material change has occurred from previous Resource estimates.

9 FUTURE REVIEWS

9.1 These Coal Guidelines will be reviewed by a committee of industry and government representatives authorised by the Coalfield Geology Council of NSW, the Queensland Resources Council and representatives from other coal producing states.

9.2 The aim of subsequent revisions will be to provide clarification if required and to extend the level of commentary within the Coal Guidelines.

9.3 Submissions in writing for suggested amendments or changes should be directed to:

The Secretary
Coalfield Geology Council of NSW
C/o New South Wales Department of Trade and Investment
P.O. Box 344,
Hunter Regional Mail Centre NSW 2310

Or

The Director of Operations
Queensland Resources Council
133 Mary Street,
Brisbane, Qld, 4000.

Appendix A - List of relevant Australian Standards (as at 2014)

Standard	Description
AS-1038.10.0-2002 (R2013)	Determination of trace elements - Guide to the determination of trace elements
AS 1038.10.1-2003 (R2013)	Determination of trace elements - Coal, coke and fly-ash - Determination of eleven trace elements - Flame atomic absorption spectrometric method
AS 1038.10.2-1998 (R2013)	Determination of trace elements - Coal and coke - Determination of arsenic, antimony and selenium - Hydride generation method
AS 1038.10.3-1998 (R2013)	Determination of trace elements - Coal and coke - Determination of boron content - ICP-AES method
AS 1038.10.4-2001 (R2013)	Determination of trace elements - Coal, coke and fly-ash - Determination of fluorine content - Pyrohydrolysis method
AS 1038.10.5.1-2003 (R2013)	Coal, coke and fly-ash - Trace elements - Determination of mercury content - Tube combustion method
AS 1038.10.5.2-2007	Coal and fly-ash - Trace elements - Determination of mercury content - Acid extraction method
AS 1038.11-2002 (R2013)	Coal - Forms of sulfur
AS 1038.12.1-2002	Higher rank coal - Caking and coking properties - Crucible swelling number
AS 1038.12.2-1999 (R2013)	Higher rank coal - Caking and coking properties - Determination of Gray-King coke type
AS 1038.12.3-2002	Higher rank coal - Caking and coking properties - Dilatation
AS 1038.13-1990 (R2013)	Tests specific to coke
AS 1038.14.1-2003 (R2013)	Higher rank coal ash and coke ash - Major and minor elements - Borate fusion/flame atomic absorption spectrometric method
AS 1038.14.2-2003 (R2013)	Higher rank coal ash and coke ash - Major and minor elements - Acid digestion/flame atomic absorption spectrometric method
AS 1038.14.3-1999 (R2013)	Higher rank coal ash and coke ash - Major and minor elements - Wavelength dispersive X-ray fluorescence spectrometric method
AS 1038.16-2005	Assessment and reporting of results
AS 1038.17-2000 (R2013)	Higher rank coal - Moisture-holding capacity (equilibrium moisture)
AS 1038.18-2006	Coke - Size analysis
AS 1038.19-2000 (R2013)	Higher rank coal - Abrasion Index
AS 1038.2-2006	Coke - Total moisture
AS 1038.20-2002 (R2013)	Higher rank coal - Hardgrove grindability index
AS 1038.21.1.1-2008	Higher rank coal and coke - Relative density - Analysis sample/density bottle method
AS 1038.21.1.2-2002 (R2013)	Higher rank coal and coke - Relative density - Analysis sample/volumetric method
AS 1038.22-2000 (R2013)	Higher rank coal - Mineral matter and water of constitution
AS 1038.23-2002 (R2013)	Higher rank coal and coke - Carbonate carbon
AS 1038.24-1998 (R2013)	Guide to the evaluation of measurements made by on-line coal analysers
AS 1038.25-2002 (R2013)	Coal - Durham cone handleability
AS 1038.26-2005	Higher rank coal and coke - Guide for the determination of apparent relative density
AS 1038.4-2006	Coke - Proximate analysis
AS 1038.5-1998	Gross calorific value
AS 1038.6.1-1997 (R2013)	Higher rank coal and coke - Ultimate analysis - Carbon and hydrogen
AS 1038.6.2-2007	Higher rank coal and coke - Ultimate analysis - Nitrogen
AS 1038.6.3.1-1997 (R2013)	Higher rank coal and coke - Ultimate analysis - Total sulfur - Eschka method
AS 1038.6.3.2-2003 (R2013)	Higher rank coal and coke - Ultimate analysis - Total sulfur - High-temperature combustion method
AS 1038.6.3.3-1997 (R2013)	Higher rank coal - Ultimate analysis - Total sulfur - Infrared method
AS 1038.6.4-2005	Higher rank coal and coke - Ultimate analysis - Carbon, hydrogen and nitrogen - Instrumental method
AS 1038.8.1-1999 (R2013)	Coal and coke - Chlorine - Eschka method
AS 1038.8.2-2003 (R2013)	Coal and coke - Chlorine - High-temperature combustion method
AS 1038.9.1-2000 (R2013)	Higher rank coal and coke - Phosphorus - Ash digestion/ molybdenum blue method

Standard	Description
AS 1038.9.2-2000 (R2013)	Higher rank coal - Phosphorus - Coal extraction/ phosphomolybdovanadate method
AS 1038.9.3-2000 (R2013)	Coal and coke - Phosphorus - Ash digestion/ phosphomolybdovanadate method
AS 1038.9.4-2006	Higher rank coal - Phosphorus - Borate fusion/molybdenum blue method

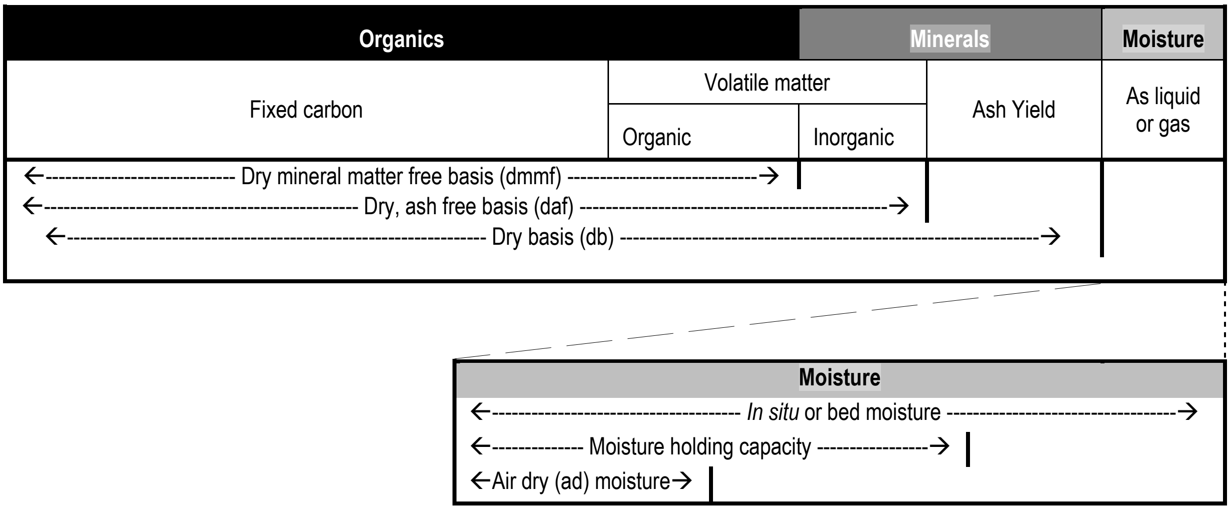
Other Australian Standards that may require consideration for analysis and testing in lower rank coals include:

Standard	Description
AS 2434.1-1999 (R2013)	Determination of the total moisture content of lower rank coal
AS 2434.2-2002 (R2013)	Lower rank coal - Determination of volatile matter
AS 2434.3-2002 (R2013)	Lower rank coal - Determination of the moisture holding capacity
AS 2434.4-2002 (R2013)	Dried lower rank coal and its chars - Determination of apparent density - Mercury displacement method
AS 2434.5-2002 (R2013)	Lower rank coal and its chars - Determination of moisture in bulk samples of lower rank coal and in analysis samples of char
AS 2434.6-2002 (R2013)	Lower rank coal - Ultimate analysis - Classical methods
AS 2434.7-2002 (R2013)	Lower rank coal - Determination of moisture in the analysis sample
AS 2434.8-2002 (R2013)	Lower rank coal - Determination of ash
AS 2434.9-2000 (R2013)	Method for the analysis and testing of lower rank coal and its chars - Determination of four acid-extractable ions in lower rank coal

Additional standards that may also require consideration include:

Standard	Description
AS 2096-1987	Classification and coding systems for Australian coals
AS 2418-1995	Coal and coke - Glossary of terms
AS 2916-2007	Symbols for graphic representation of coal seams and associated strata
AS 2519-1993	Guide to the technical evaluation of higher rank coal deposits
AS 2617-1996	Sampling from coal seams
AS 2856.1-2000 (R2013)	Coal petrography - Preparation of coal samples for incident light microscopy
AS 2856.2-1998 (R2013)	Coal petrography - Maceral analysis
AS 2856.3-2000 (R2013)	Coal petrography - Method for microscopical determination of the reflectance of coal macerals
AS 3899-2002 (R2013)	Higher rank coal and coke - Bulk density
AS 3980-1999 (R2013)	Guide to the determination of gas content of coal - Direct desorption method
AS 4156.1-1994 (R2013)	Coal preparation - Higher rank coal - Float and sink testing
AS 4156.2.1-2004	Coal preparation - Higher rank coal - Froth flotation - Basic test
AS 4156.2.2-1998 (R2013)	Coal preparation - Higher rank coal - Froth flotation - Sequential procedure
AS 4156.3-2008	Coal preparation - Magnetite for coal preparation plant use - Test methods
AS 4156.3-2008/Amdt 1-2009	Coal preparation - Magnetite for coal preparation plant use - Test methods
AS 4156.4-1999 (R2013)	Coal preparation - Flowsheets and symbols
AS 4156.6-2000 (R2013)	Coal preparation - Determination of dust/moisture relationship for coal
AS 4156.7-1999 (R2013)	Coal preparation - Coal size classifying equipment - Performance evaluation
AS 4156.8-2007	Coal preparation - Sample pre-treatment - Drop-shatter
AS 4264.1-2009	Coal and coke - Sampling - Coal - Sampling procedures
AS 4264.1-2009/Amdt 1-2011	Coal and coke - Sampling - Coal - Sampling procedures
AS 4264.2-1996	Coal and coke - Sampling - Coke - Sampling procedures
AS 4264.4-1996	Coal and coke - Sampling - Determination of precision and bias
AS 4264.5-1999	Coal and coke - Sampling - Guide to the inspection of mechanical sampling systems

Appendix B - Coal composition, moisture states and reporting bases



Note:

1) water of hydration of minerals, and organically bound water form part of the volatile matter

2) as received (ar) moisture may be greater or less than *in situ* moisture depending upon the condition of the sample and the presence of surface moisture

Given Basis	Desired Basis: As Received value *multiplied by*	Air Dry value *multiplied by*	Dry value *multiplied by*	Dry Ash Free value *multiplied by*
As Received		$\frac{100-M_{ad}}{100-M_{ar}}$	$\frac{100}{100-M_{ar}}$	$\frac{100}{100-(M_{ar}+A_{ar})}$
Air Dry	$\frac{100-M_{ar}}{100-M_{ad}}$		$\frac{100}{100-M_{ad}}$	$\frac{100}{100-(M_{ad}+A_{ad})}$
Dry	$\frac{100-M_{ar}}{100}$	$\frac{100-M_{ad}}{100}$		$\frac{100}{100-A_{d}}$
Dry Ash Free	$\frac{100-(M_{ar}+A_{ar})}{100}$	$\frac{100-(M_{ad}+A_{ad})}{100}$	$\frac{100-A_{d}}{100}$	

Appendix C – Questions and Answers

Q.1 The JORC Code makes no mention of the term "Inventory Coal". Why do the Coal Guidelines allow the term to be used, and what does it include?

Inventory Coal is the term that applies to all coal in the ground that can be estimated and classified according to geological confidence, and does not require a Competent Person to account for either potential commercial considerations or land use constraints. All coal that can be estimated on the basis of relative confidence levels and has passed the "reasonable prospects for eventual economic extraction" test can become a Coal Resource as defined by the JORC Code

Coal companies very often have a category, similar in concept to Inventory Coal that is used for internal company purposes – terms such as "global coal estimate", "*in situ* coal" have been widely used for many years.

Coal Resource estimates may tend to increase or decrease over time, depending on the views and perceptions of what passes or fails the reasonable prospects test between different Competent Persons and also the economic considerations and limitations adopted by different coal mining and exploration companies. However, within a coal deposit, defined by the extent (lateral and vertical) of geological data (Points of Observation), the Inventory Coal estimate will tend to remain relatively constant until the geological data limits change, e.g. new holes are drilled or old holes deepened.

The concept of Inventory Coal, within the Coal Guidelines, but outside the scope of the JORC Code, fulfils this need and provides a platform for estimates of Coal Resources to be updated and reviewed over time as and when conditions which impact the reasonable prospects test change. When first introduced into the 2003 edition of the Coal Guidelines the term was defined as "…any occurrence of coal in the ground that can be estimated and reported without necessarily being constrained by economic potential, geological or other modifying factors."

Estimates of Inventory Coal (like those of Coal Resources) are based primarily on Points of Observation and may be supplemented by Supportive Data. As data density and distribution allows, estimates of Inventory Coal are to be reported as Measured, Indicated and Inferred confidence categories and rounded to a relevant level of accuracy (in a similar manner to Coal Resources, refer to Clause 25 of the JORC Code). Estimates of Inventory Coal are to be expressed as raw coal on an *in situ* basis.

If not otherwise reported as Coal Resources, the Competent Person may estimate as Inventory Coal, coal that is not currently accessible for mining because of statutory restrictions on access to land (gazetted or proposed national parks or environmental conservation areas). These may include features such as rivers or watercourses, reservoirs or lakes (particularly those of major regional significance), major public infrastructure (e.g. rail, bridges) or areas of urbanisation. The Competent Person may, in many cases, choose to exclude coal underlying such features from a Coal Resource estimate, but may report such coal in the Inventory Coal category in non-public reports wherever sufficient data is available.

The JORC Code does not contemplate use of the term Inventory Coal, nor does it provide for the estimation of coal which might fall into this category or allow for it be publicly reported (as defined in the Code). The main application of the Inventory Coal report is likely to be for submission to relevant government agencies and internally by coal exploration companies for priority setting.

Q.2 Why estimate Inventory Coal?

Estimates of Coal Resources and/or Coal Reserves alone, do not present a complete picture of the coal that is in the ground. In considering only these types of estimates, decision makers, either regulatory (e.g. the Crown/State) or within exploration or mining companies may be completely unaware of what other coal is present in an area. Inventory Coal estimates can be used by various agencies representing the States' interest, to make fully informed, 'arms-length' decisions regarding a mining or development proposal. One of the considerations required is whether or not a proposed coal mining project will maximise recovery and minimise the potential for the project to impact on, or potentially sterilise, other identified mineral (broad 'common usage' context to include coal) occurrences.

Another use of Inventory Coal estimates is in the estimation of fugitive gas.

Examples where Inventory Coal can be significantly greater than the resource include the following:

- coal which doesn't meet the reasonable prospects test
- selective mining of a single coal seam or coal seams within multiple seam sequences;
- partial recovery (mining) of a thick coal seam using underground mining methods;
- coal rendered uneconomic by overlaying spoil or diverting watercourses.
- ground restricted or constrained for other uses

Q.3 I am preparing a report containing an estimate of Coal Resources. Can I include any estimates of Inventory Coal in the report?

That depends upon the type of report being prepared and its intended purpose.

Reports intended for the investment market ('Public Reports')

The Code defines what it means by a 'Public Report' as those "…prepared for the purpose of informing investors or potential investors and their advisors on Exploration Results, Mineral Resources or Ore Reserves …". The Code provides examples that include but are not limited to "…annual and quarterly company reports, press releases, information memoranda, technical papers, website postings and public presentations."

If a report is being prepared for the purpose of informing investors, potential investors or their advisors, as set out in the Code, the report must not include estimates of Inventory Coal.

For example, if the report was being prepared for inclusion in a company prospectus for a proposed listing on the Australian Securities Exchange, it is not acceptable to include or make reference to estimates of Inventory Coal in the report.

Other ('Non-public') Reports

The Code however recognises that at times, a report which contains certain 'documentation' that does not comply with the Code may be required.

Reporting on, and documentation of, coal either internally within a company or to government agencies may be required from time to time. Reports of this nature could generally be referred to as 'non-public reports' in that their primary purpose is not to inform the investing public or their advisors.

It could for example be to allow for a more complete record of all coal occurrences to be presented, to assist with an internal company decision or in making a recommendation to management. At this stage in the internal decision-making process within a company, it may be important to know, but not necessarily make a determination on, the technological, economic, land use or other constraints that might apply to a particular area under consideration.

In these cases, some of the coal occurrences documented in these types of reports may fall within the definition of 'Inventory Coal' as defined in the Coal Guidelines.

If a report is being prepared for internal company purposes only, then the Coal Guidelines could be used to assist in the preparation and reporting of Inventory Coal estimates.

If a report is primarily prepared as a technical geological report documenting the results of exploration activity undertaken by a company on an exploration tenement and is being submitted to a government department or other regulatory agency for compliance purposes, then estimates of Inventory Coal may, and indeed should be included in the report. When Coal

Resources are included in such 'non-public' reports, the Coal Guidelines may help preparing the estimates. Inventory Coal is classified in terms of confidence in the estimate, as Measured, Indicated or Inferred.

The report must include a clear and unambiguous statement as to whether or not the estimates of Inventory Coal are inclusive or exclusive of the Coal Resources.

When reporting estimates of Inventory Coal, any factors or physical features used to 'limit' the estimates should be clearly stated. Where these limits relate to the areal extent of the estimates, it should be clearly represented graphically on maps, plans or sections that accompany the report.

In doing so, in accordance with the recommendation of the Code, all reports of this type should include a statement to the effect that …"In so far as the report includes estimates of Inventory Coal (a term not recognised by the JORC Code) the report does not comply with the Code." (refer Guidelines to Section 6 of the JORC Code, page 5, 4th paragraph).

Q.4 How is coal density applied to the Coal Resource estimate?

The expression to determine *in situ* coal tonnes is simply:

$$Coal\ Tonnes = seam\ area\ (m^2)\ x\ seam\ thickness\ (m) x\ insitu\ coal\ density\ (t/m^3)$$

Seam area and thickness are simple, well known concepts, but coal density is less well understood. Nevertheless it needs to be considered just as carefully as the other two factors.

For Coal Resource estimates to be both numerically accurate with respect to the density factor and correct from a process logic perspective, all coal quantities should be estimated at *in situ* moisture and *in situ* density. The approach to estimating *in situ* moisture must be supportable and the resultant values realistic.

Whilst it is not strictly correct to equate density with relative density, for most practical purposes in resource estimation, density and relative density are numerically the same. In Australia density determinations are reported according to Australian Standards as relative density, in accordance with two testing methods, namely:

i. On air dry coal according to AS1038.21.1.1-2008 (the density bottle method). This is the most common and recommended method;

ii. On coal of unknown moisture according to AS1038.26-2005 (apparent relative density). Use of this method is not recommended.

Using as reported air dry relative density (RD) values to estimate coal tonnes (i.e. as determined by the density bottle method) will lead to an over estimate if not carefully dealt with during reserve estimation. However after correcting the air-dry relative density to the *in situ* moisture basis, it is this value that should be used for tonnage estimation purposes.

If apparent relative density (ARD) is determined according to method (ii) above, the moisture will not be known, thereby making it very difficult to properly correct this to *in situ* moisture and *in situ* relative density. Use of this standard, and of uncorrected apparent relative density values, is not recommended.

Methods for adjusting air dry relative densities to *in situ* relative densities and also for bringing apparent relative densities to an acceptable level of accuracy are outlined in Preston and Sanders, (1993) and Preston (2005).

Note that in most cases "*in situ* relative density" < "apparent relative density" < "air dry relative density". Bituminous coal *in situ* relative density generally has a range between 0.02 to 0.05 t/m^3 below the laboratory determined relative density (AS1038.21.1.1-2008).

Q.5 How is *in situ* moisture estimated?

It is currently not possible to measure *in situ* moisture empirically as the methods of sampling changes the moisture content. It can best be estimated by reference to other moisture indicators (e.g. air dry moisture, moisture holding capacity etc.) and to coal rank, type and grade. Generally as rank increases, *in situ* moisture decreases. Certain inertinite macerals have greater moisture carrying capacity than others and can give rise to high moisture relative to rank. Coals high in liptinite tend to display lower moisture relative to coals rich in other macerals of the same rank. High ash coals tend to carry less moisture, since there is a lower proportion of the more porous coal in the sample.

ACARP Report C10041 (Fletcher, IS and Sanders RH, 2003, Estimation of *in situ* moisture and product total moisture) details studies of *in situ* moisture and provides some mechanisms for its estimation, primarily by relating it to parameters such as Air Dry Moisture, Moisture Holding Capacity, Equilibrium Moisture and others. These methods are based upon statistical analysis and whilst they do provide indicative results for a range of coals, they may not necessarily provide correct results for specific coal deposits. Judgement must be applied to any results obtained from the application of equations published in the ACARP report.

Q.6 The revised Coal Guidelines no longer include suggestions regarding maximum distances between Points of Observation for the various confidence categories. Why were these removed?

The 2003 Guidelines made it clear that the distances between Points of Observation for the various confidence categories (Measured, Indicated and Inferred) are those which would not normally be exceeded unless there was sufficient technical justification to do so. These were suggested recommended maximum distances thought to be applicable in the main coalfields of eastern Australia. They were not prescribed distances or distances endorsed by the 2003 Coal Guidelines regardless of the geological characteristics of the coal being classified.

It was apparent that there was confusion on this topic within the coal industry as there were numerous examples of misinterpretation of the intent of this aspect of the 2003 Coal Guidelines, and using these recommended maximum distances in a manner that suggested a prescriptive intent. Classifications based solely on maximum distances were being made without due and deliberate consideration of the geology of the deposit.

By removing suggested maximum distances between Points of Observation for each confidence category in the Coal Guidelines, the responsibility is placed back with the Competent Person to determine the criteria for classification.

Q.7 When estimating Coal Resources, is it reasonable to extrapolate beyond the last Points of Observation?

Continuity is defined as being '…the state of being continuous or unbroken'. Continuity of a coal seam and its characteristics, both physical and quality, is demonstrated with greater confidence between Points of Observation than outside the last Point of Observation. Nevertheless it is considered that some level of extrapolation may be justifiable if a solid case can be made to support the continuity of the coal seam. This case would take into account the known characteristics of the coal seam both at a regional and local level and specifically where there is good data to support an understanding of its nature. In all cases it will be the confidence in the critical variables that will determine the extent of extrapolation.

Where the coal seam is known to show a high level of variability in either physical character or key quality variables, it is difficult to see how a case could be made for extrapolation of any significant distance, and there may also be a case for no extrapolation. Where a coal seam is known to be persistent and predictable in character, the case (again supported by evidence) may be made to extrapolate by some percentage of the allocated Point of Observation spacing. These

Guidelines do not support the view that there is an automatic licence to extrapolate a distance “half the nominal drill spacing”.

In all cases, transparency and materiality require that the basis on which the resource is extrapolated to these limits is explained clearly. Note also that for Inferred Coal Resources involving extrapolation beyond Points of Observation, the provisions described in Clause 21 of the Code apply.

Q.8 When reporting, how should the Coal Resource estimate be rounded to reflect the level of confidence in the estimate?

The JORC Code suggests the Competent Person consider the use of 2 significant figures (Clause 25) in most situations and one significant figure may be necessary on occasions to convey properly the uncertainties in resource estimation. Clause 25 should be considered the initial default for rounding for every resource estimate. The accuracy of coal quality parameters are defined by their relevant standards. Reporting of values for these parameters should not exceed the relevant significant figures or level of accuracy.

Q.9 How are downhole geophysical logs used in the classification of a Coal Resource?

Downhole geophysical logs can help to provide increased confidence in an understanding of the physical attributes (i.e. location, depth and thickness etc.) of coal seams in an area. They may also contribute, to a more limited extent, to an increased level of confidence regarding the variability in and continuity of certain basic chemical properties of those seams.

In coal exploration drilling, downhole geophysical logging (sometimes referred to as ‘wireline logging’) is undertaken on a routine basis to assist with identifying the lithologies intersected within a hole, particularly coal seams. Where borehole conditions allow, these logs (in particular the natural gamma, density and calliper combination) can be used to make reasonably accurate estimates of the top and bottom (roof and floor) boundaries of the coal seams intersected. This makes them of particular use in holes where no coring has been undertaken and also when the thickness cannot be reliably determined from core lengths

When sampling coal for analytical testing in holes where coal seams have been cored, geophysical logs (in particular density/calliper log combinations) can also be used to more reliably determine zones of significant core loss than would otherwise be the case.

Downhole geophysical logs are also an invaluable tool to assist with stratigraphic and coal seam correlations in coalfield studies, both on a regional scale and at a more localised ‘deposit’ or mine level.

The suite of logs run routinely in each hole should include at least long and short spaced density, (natural) gamma and calliper logs. Within an area of investigation/deposit, the responses of geophysical logs can be interpreted through comparison of the trace responses with the detailed core description from the core holes. This can then enable more reliable use to be made of the geophysical log responses (data) obtained from logs of other non-cored holes in the vicinity. Logs should be compared, or standardised, using the typical response from one, or more, reference holes within each deposit.

An intersection of the full coal seam in a non-cored hole that has been geophysically logged (with at least density and calliper logs) may be used as a Quantity Point of Observation that would allow for that point to be used for the purposes of volumetric estimation/calculation.

Visual ‘calibration’ of the geophysical responses against the lithologies logged within cored boreholes is recommended before geophysical logs from other non-cored boreholes elsewhere within the area of evaluation be considered for use in this way, to ensure that the interpretation of the geophysical responses is compatible with the lithologies observed in the cored boreholes.

When visually 'calibrated' in this way, geophysical logs of non-cored holes may be used for making approximate qualitative comparisons of certain basic coal quality and rock strength parameters with adjacent (or nearby) cored boreholes. In cases where the geophysical responses have been calibrated against laboratory derived coal quality analyses, and where the reproducibility of a particular geophysically derived parameter (for example ash value or density derived from the density/caliper log) is within acceptable tolerances, then that geophysically derived coal quality parameter could be used to support the raw coal quality continuity. However, geophysically derived coal quality attributes will not include any coking parameters as these can only be determined by the physical testing of coal samples.

Some borehole geophysical log responses, particularly density, gamma, neutron-neutron and sonic logs, may be correlated to the physical laboratory test results obtained from borehole core samples. From this, relationships may be established between, for example, laboratory-determined rock strength and sonic velocity. These geophysical tools respond to rock density, fracture spacing, rock strength and porosity. More specialized geophysical logs, such as dip-meter logs and optical or acoustic scanner logs may be used to measure the structural orientation of the bedding and the identification of structural features.

Q.10 What is a "spotted dog"?

The 'spotted dog' is a Resource estimate classification which displays the poor practice of estimating Measured, Indicated and Inferred Resources over disconnected circles of influence around individual Points of Observation or along a line of Points of Observation. An example is provided in Figure 3.

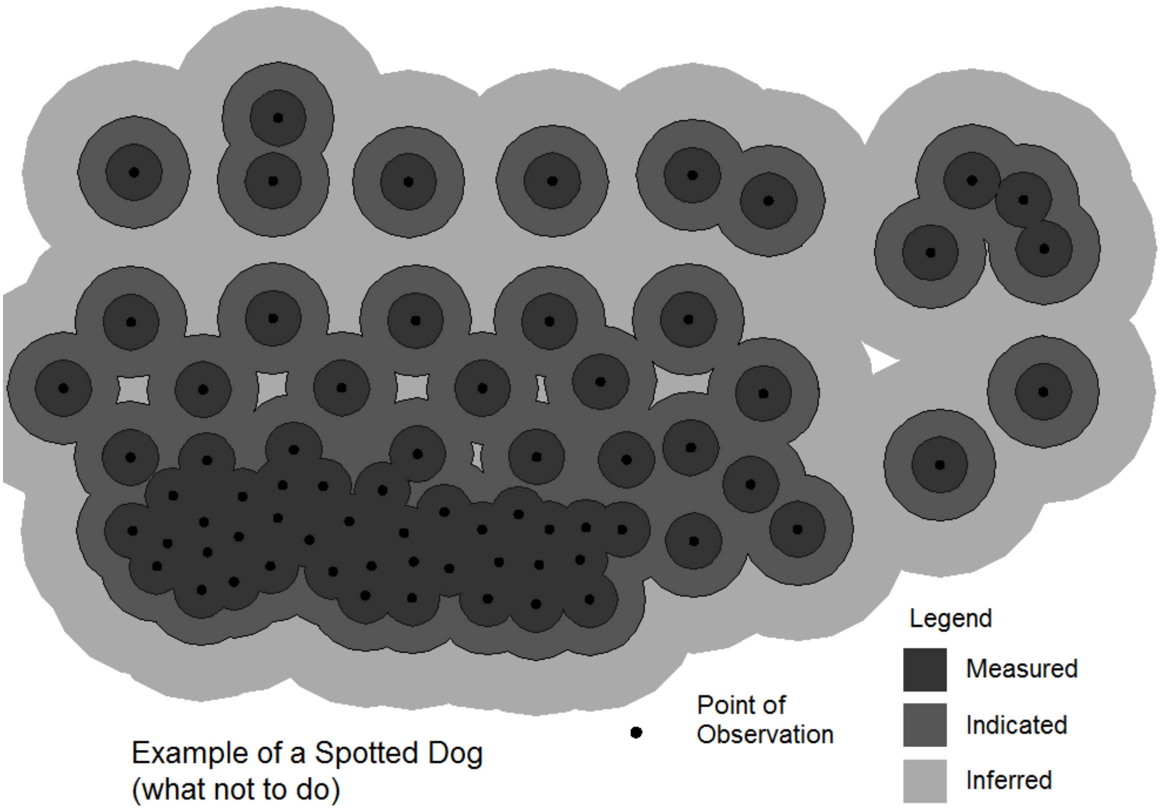


Figure 3: Example of a "spotted dog" – what not to do

Confidence regarding the extent of a zone of Measured, Indicated or Inferred Resources is always inadequate where there is a lack of support in both x and y dimensions from adjacent Points of Observation. An isolated point, two connected points, or a line of points do not demonstrate continuity in both directions (unless there is Supportive Data within the area of extrapolation).

The spacing of Points of Observation in the diagram above is considered sufficient by the Competent Person to demonstrate continuity to an Inferred status over the whole deposit and extrapolation in all directions. There is not always sufficient confidence in both x and y dimensions to support Measured and Indicated status between every Point of Observation. Consequently it is invalid to draw circles of Measured and Indicated status around every Point of Observation. This example has only considered spacing of Points of Observation and not any other matters discussed in the Coal Guidelines that should be considered by the Competent Person when classifying the estimate (refer Section 5).

For further discussion refer to the paper by Stephenson et al, 2006.

Q.11 What is a "JORC compliant" Resource estimate?

Resource estimates are not "JORC compliant". The JORC Code is a code for public reporting, not a Code that regulates the manner in which a Coal Resource is estimated. The term "JORC compliant" therefore refers to the manner of reporting not to the estimates. Use of the words "JORC compliant" to describe Resources or estimates is potentially misleading. The words "JORC compliant" should be replaced by: "Reported in accordance with the JORC Code". Additionally it could be stated that "Resources are estimated (or based on documentation prepared) by a Competent Person as defined by the JORC Code". Refer to Clause 6 of the JORC Code, 2012.

Q.12 Is tonnage of coal the only parameter required to be reported in public reports?

No, the quality of the reported coal tonnage should also be reported.

Q.13 Can material comprising more than 50% raw ash be estimated as coal?

The international standard for coal classification (ISO11760-2005) defines coal as being "carbonaceous sedimentary rock largely derived from plant remains with an associated mineral content corresponding to an ash yield less than or equal to 50% by mass (dry basis)". Material with a raw ash value (dry basis) of more than 50% is described as either "non-coal" or "shale".

It is recognised that coal seams are heterogeneous, consisting of plies less than or greater than 50% (db) raw ash. Multiple thin non-coal bands with an ash value > 50% (db) in a coal seam may be included in the defined working section, whilst thick separable non coal bands should not be included in the Coal Resource. The nominal industry minimum thickness for separable non coal bands varies between 0.1 to 0.5m depending on the mining method.

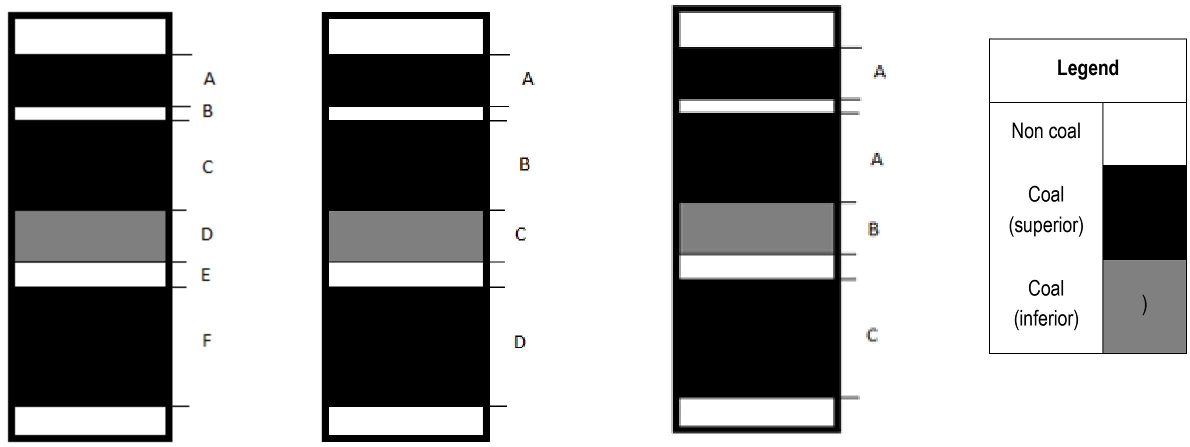
In cases where the bulk of the Resource has a raw ash >50% the rationale for reasonable prospects should be detailed, including yield.

Q.14 Can a single sample that covers several seams or plies be used as a Coal Quality Point of Observation?

Best sampling practice requires samples be taken in a way that represents the variability of the geological population. It is only by sampling in such a manner that the distribution is then understood. Often sample analysis does not adhere to this principle, but comprises samples or composited samples that have the internal variability over a short range masked by the sample being taken over wider intervals, or having intervals (sometimes discontinuous in nature) combined together (Figure 4).

The decision to allow such data to be used as a Coal Quality Point of Observation depends on whether or not the sample is representative of the way in which the analysis will be utilised. For example taking a composited sample value for a number of plies (in isolation of any other supportive data) and then stating each ply had a consistent value would be misleading. It may however be valid to state that the analysis values are representative of a combined unit.

When there is a lack of confidence that the analysis reported for a sampled interval represents the working section being reported then this must be taken into account during the assessment of confidence.



Sampling variability provides the greatest opportunity to understand multiple working section scenarios. Valid working sections could be A, AB, ABC, ABCD, ABCDE, ABCDEF, BC, BCD, BCDE, BCDEF, C, CD, CDE, CDEF, D, DE, DEF and F.

Non sampled intervals will result in composite bias if working section ABCD was created. Valid working sections would be A, B, BC, or D.

Larger sampling only allows for small set of working sections to be considered. Missing intervals may bias results. Valid working sections would be B and C.

Figure 4: Coal sampling and its implication for working section definition

Q.15 How is coal quality data composited?

The methodology of compositing coal quality data needs to be clearly understood. Be aware that some parameters are not additive (such as caking properties or ash fusion temperatures). Quality parameters should be composited as required. Some examples are given below:

- Relative Density (RD) is composited on a thickness basis
- Raw Quality parameters should be composited by mass multiplied by RD (thickness substitutes for mass to deal with core loss)
- Clean coal composites should be calculated on a mass multiplied by yield basis
- Clean coal composites yield should be calculated on a mass basis
- Clean coal composite ash analyses (dry basis) should be calculated on a mass multiplied by yield ash (db) basis.

Q.16 What is a variogram?

A variogram (Figure 5) provides an assessment of the spatial continuity of a given variable. The variogram consists of parameters quantifying very short range variability (the nugget), the total variability (the sill) and the distance at which there is no correlation (the range). The nugget incorporates a component of sampling and analytic error, as well as the difference expected from two nearly coincident Points of Observation.

The range can be isotropic (same in all directions) or anisotropic (different ranges in different directions). Coal deposits are by their very nature typically anisotropic.

Several types of mathematical functions ('variogram models') may be fitted to the experimental variogram calculated from the data (e.g. spherical, exponential). The type of model should be stated in reports. The shape of the variogram model close to the origin (especially the slope) is important and can have a significant impact on further applications.

An increasing or decreasing trend in the data as a function of the direction considered (or 'drift'") is a common feature of coal variables. When considering variables with drift, the domains, variography or geostatistical estimates can be adjusted in an effort to minimise the impact upon the variogram and the estimate.

Sensitivity analysis, which involves changing the parameters of the variogram or search, and back-estimation (or "cross-validation") are both useful validation tools.

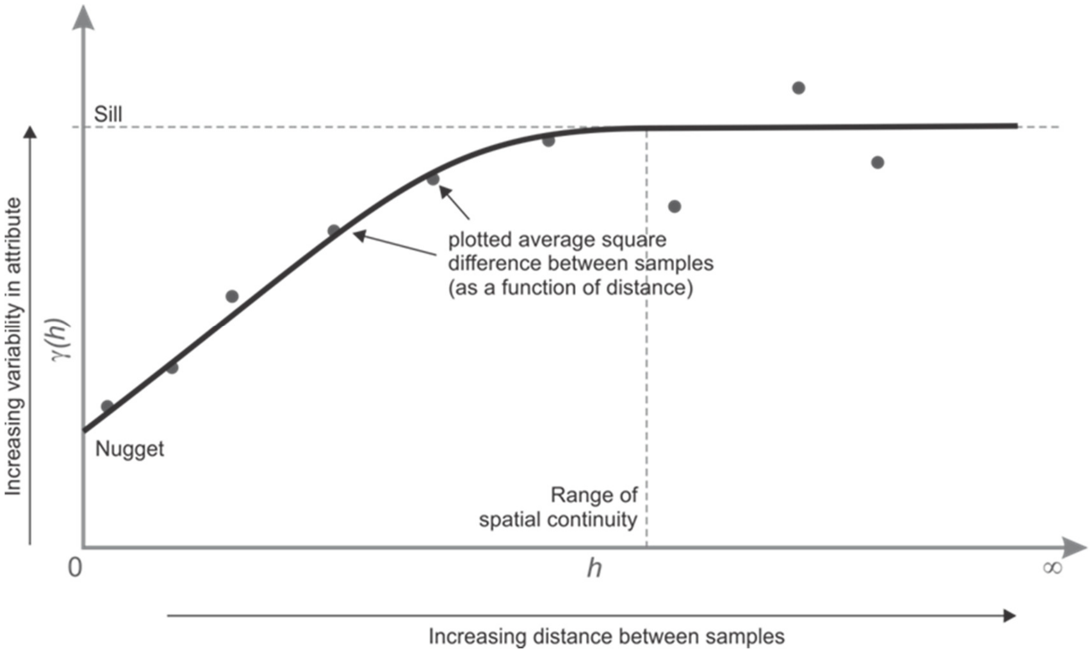


Figure 5: Representation of a variogram

The variogram may assist in defining distances of continuity between Points of Observation. In isolation this is not considered appropriate as it fails to consider all the other necessary factors contributing to the confidence in the estimate, such as sample geometry, mining methodology, local geological features and reliability of sample data. Sole use of the variogram is risky, in particular for variables with high nugget variance and/or short ranges.

Q.17 What geostatistical methods can be used to aid Resource Classification?

There are several methods for using geostatistical analysis as an aid to Coal Resource classification. Some of the more common methods are briefly described below, with the reader referred to the recommended reading list (Appendix E) for more detailed information.

Global estimation variance

A geostatistical approach to assessing global estimation variance (i.e. a measure of the variance of errors for a given volume or area, informed by a specific number and pattern of Points of Observation) can be used to calculate the theoretical optimum borehole spacing for a deposit at a given confidence interval and volume. This is sometimes termed Drill Hole Spacing Analysis. The optimum spacing may be used to recommend a distance of continuity between points of observation for use in resource assessment. The method is simple to implement, and correctly uses the variogram as a measure of the continuity of the variable.

Issues using this method can arise if variograms are based on sparse, broadly spaced data, where the continuity of the variable is consequently overestimated. As a consequence the results of this method should be applied with due consideration of the geological interpretation.

Kriging variance

Kriging is an estimation method that takes into account the variogram model, the sample geometry and the volume (or area) of the region being estimated. It is often described as a best linear unbiased estimate, meaning of all weighted averages, kriging will attain the lowest error variance for a given data geometry, variogram and search. An estimate of the error variance known as the "kriging variance" can be calculated for each block. The kriging variance is a measure of the confidence in an estimate. Several different methods of using kriging variance to aid Coal Resource classification are possible, including the use of relative kriging variances or kriging efficiencies (which are derived from the kriging variance).

The method is advantageous as it uses the geometry of the sample data, and allows a local assessment of the uncertainty of the estimate; however, kriging can have a smoothing effect on the estimate.

One of the key questions regarding Coal Resource classification is whether the addition of new data would materially change the estimate. Kriging variances can be useful in answering this question.

Conditional simulation

Conditional simulation is a process for assessing the uncertainty of a parameter within a geological context. A simulation model consists of a large number of 'realisations' or spatial images of the variable that are compatible with the variogram, histogram and data observations, each one having an equal probability of representing the unknown reality. Conditional simulation realisations agree with each other at points of observation, but differ away from these locations in a manner consistent with the variogram model.

The variation in a set of conditional simulation realisations can be used to assess the uncertainty associated with the Resource estimate and also to generate confidence intervals at global (domain) or local (block) scale.

A larger number of realisations in a set of conditional simulations will allow more reliable analysis. It is also important to check that the set of realisations is unbiased. To ensure this, the simulation characteristics (histogram, variogram etc.) should closely reproduce the original data. The average of a set of realisations for conditional simulation may also be compared to the kriged estimate, and should closely agree at global and local level. Conditional simulation requires more familiarity with geostatistics than kriging; it can be computationally intensive, and is more sensitive to the effects of drift than kriging.

An increasing or decreasing trend in the data as a function of the direction considered (or "drift") is a common feature of coal variables. When considering variables with drift, the domains, variography or geostatistical estimates can be adjusted in an effort to minimise the impact upon the variogram and the estimate.

Q.18 What should good geological modelling documentation include?

It is recommended that each model has documentation that details the following details:

- The model should be date stamped or have some date identification;
- Seam and variable codes need to be defined including moisture basis for quality variable;
- Those involved in the construction of the model should be identified;
- The intended purpose of the model ("Fitness for Purpose") and any limitations or risks associated with using the model should be noted;
- Reference the data used to construct the model, reasons for excluding any data, and the date of the last data used in the model;
- The survey datum;
- The source and accuracy of Digital Terrain Model (DTM) data and any manipulation of the data;
- Methods used to construct the model should be clearly described;
- Any manipulation of data (such as changes in moisture basis) should be documented;
- Notes on differences with previous models;
- Model validations and audits of the process should be referenced (and stored with the archived model).

Appendix D – Precision of test methods and schedule for reporting of results

Uncertainty of measurement

Users of the Australian Standards (AS 1038 and AS 2434) series of coal and coke test methods and those who use the results obtained by these methods should be aware of the variability of the results which may be obtained, which is commonly referred to as the uncertainty of measurement.

The best estimate of the variability of these test methods is the repeatability (within laboratory) and reproducibility (between laboratories) values quoted within each test method in the Standard and the meaning of these terms is summarised below. Reference should be made to Clauses 5 and 6 in AS 1038 for explanation of their use. In addition, reference should be made to the latest edition of the relevant Standard to verify the repeatability and reproducibility data.

Repeatability

The Repeatability of the determination of the volume percentage of a component is that difference between two single determinations each based on the same number of point counts carried out by the same operator on the same sample using the same apparatus, within which 95% of such differences would be expected to lie.

Reproducibility

The Reproducibility of the determination of the volume percentage of a component is that difference between two single determinations each based on the same number of point counts carried out by two different operators on two different sub samples taken from the same sample, using different equipment, within which 95% of such differences would be expected to lie.

Extracts are from AS 2856.3-2000 Table 2; AS 2856.2-1998 Table 1 and AS 1038.16-2005 Table C1. Reproduced with permission from SAI Global Ltd under Licence 1310 –c119. To be extracted, reproduced and distributed with the "Australian Guidelines for the estimation and classification of Coal Resources".

Australian Standard	ISO Standard	Material	Determination	r (Repeatability)	R (Reproducibility)	See Note 1	Report to nearest
AS 1038.1	589	Coal	Mas total moisture %	0.5	1.5	A	0.1
AS 1038.3	331562	Coal	Mad analysis moisture % <5	0.1	—	A	0.1
			Mad analysis moisture % ≥5	0.15	—	A	0.1
			Aad ash % <10	0.1	0.15	A	0.1
			Aad sh % ≥10 ≤30	0.15	0.25	A	0.1
			Aad ash % >30	0.2	0.6	A	0.1
			VMad volatile matter % <25	0.2	0.5	A	0.1
			VMad volatile matter % ≥25	0.2	1	A	0.1
AS 1038.5	1928	Coal, coke	qgr,v,ad (SE) gross calorific value MJ/kg (gross specific energy)	0.13	0.30	A	0.01
AS 1038.6.1	609	Coal	Cad carbon (total) %	0.3	0.6	A	0.1
			Had hydrogen %	0.1	0.2	A	0.01
AS 1038.6.2		Coal	Nad nitrogen %	0.03	0.08	A	0.01
AS 1038.6.3.1	334	Coal, coke	Sad sulfur (total) % (Eschka) ≤2	0.05	0.1	A	0.01
			Sad sulfur (total) % (Eschka) >2	0.1	0.2	A	0.01
AS 1038.6.3.2	351	Coal, coke	Sad sulfur (total) % (high temperature combustion) ≤1.5	0.03	0.08	A	0.01
			Sad sulfur (total) % (high temperature combustion) >1.5	2%	10%	A	0.01
AS 1038.6.3.3		Coal	Sad sulfur (total) % (Infrared) ≤1.5	0.03	0.05	A	0.01
			Sad sulfur (total) % (Infrared) >1.5 < 6	2%	8%	A	0.01
AS 1038.8.1	587	Coal, coke	Clad chlorine (Eschka) %	0.01	0.02	A	0.01
AS 1038.8.2	352	Coal, coke	Clad chlorine (high temperature combustion) %	0.01	0.02	A	0.01
AS 1038.9.1, 9.2, 9.3	622	Coal, coke	Pad phosphorus % <0.02	0.002	0.003	A	0.001
			Pad phosphorus % ≥0.02	10%	15%	A	0.001
AS 1038.11	157	Coal	Ss,ad sulfate sulfur %	0.02	0.03	A	0.01
			Sp,ad pyritic sulfur % <0.5	0.05	0.1	A	0.01
			Sp,ad pyritic sulfur % ≥0.5	0.07	0.15	A	0.01
AS 1038.12.1	501	Coal	CSN crucible swelling number 3 determinations	½	1	A	½
			CSN crucible swelling number 5 determinations	½	1	A	½
AS 1038.12.2	502	Coal	Gray-King coke type	one letter, or one unit in the subscript		A	N/A
AS 1038.12.3	8264	Coal	T1, T2, T3 dilatometer characteristics: temperature °C	7	15	A	5
			c dilatometer characteristics max. contraction %	5	8	A	See Standard
			d dilatometer characteristics max. Dilatation negative %	5	8	A	See Standard
			dilatometer characteristics: Dilatation positive %	5[1+(d/100)]	5[2+(d/100)]	A	See Standard
AS 1038.12.4.1		Coal	Gieseler plastometer properties (continuous torque) — max. fluidity dd/min < 20	0.3 log10	0.6 log10	A	See Standard
			Gieseler plastometer properties (continuous torque) — max. fluidity dd/min ≥ 20 to <10 000	0.1 log10	0.2 log10	A	See Standard
			Gieseler plastometer properties (continuous torque) — max. fluidity dd/min ≥ 10 000	0.2 log10	0.4 log10	A	See Standard
AS 1038.12.4.1		Coal	Gieseler plastometer properties (continuous torque)— characteristic temp °C	7	15	A	See Standard
AS 1038.12.4.2		Coal	Gieseler plastometer properties (discontinuous torque) — max. fluidity dd/min < 20	0.3 log10	0.6 log10	A	See Standard
			Gieseler plastometer properties (discontinuous torque) — max. fluidity dd/min ≥ 20 to <5 000	0.1 log10	0.2 log10	A	See Standard
			Gieseler plastometer properties (discontinuous torque) — characteristic temp °C	7	15	A	See Standard

Australian Standard	ISO Standard	Material	Determination	R (Repeatability)	R (Reproducibility)	See Note 1	Report to nearest
AS 1038.13		Coke	Tests specific to coke				
	616		Shatter index % 40 mm	6	—	B	1
			Shatter index % 10 mm	6	—	B	
	556		M40 Micum index %	3	—	B	0.1
			M10 Micum index %	1	—	B	
	556		I40 IRSID index	5		B	
			I20 IRSID index	2.5	—	B	0.1
			I10 IRSID index	2	—	B	
			ASTM tumbler test stability + 25 mm %	2	—	B	0.1
			ASTM tumbler test hardness + 6.3 mm %	2	—	B	
			JIS drum test 30 revs < 90% + 15 mm	4.0	—	B	0.1
			JIS drum test 30 revs ≥ 90% + 15 mm	1.5	—	B	
			JIS drum test 150 revs < 80% + 15 mm	2.5	—	B	0.1
			JIS drum test 150 revs ≥ 80% + 15 mm	1.5	—	B	
			CRI coke reactivity index % ≤30	2.5	—	B	
			CRI coke reactivity index % >30	5.0		B	
			CSR coke strength after reaction % >60	2.5	—	B	
		coke	CSR coke strength after reaction % ≤60	5.0	—	B	
AS 1038.14.3		Ash	Ash analysis (XRF) for other Ash Analyses Methods refer to the Standards.			A	
			SiO_2% 45 to 70	0.42	1.44	A	
			Al_2O_3% 20 to 35	0.25	1.01	A	
			Fe_2O_3% 1.5 to 13	0.007X + 0.035	0.027X + 0.063	A*	
			CaO% 0.5 to 3.5	0.035	0.089	A	
			MgO% 1.0 to 2.0	0.073	0.13	A	
			Na_2O% 0.1 to 1.0	0.063	0.11	A	
			K_2O% 0.5 to 2.0	0.012X + 0.009	0.062X + 0.016	A*	See Standard
			TiO_2% 1.0 to 2.5	0.037	0.10	A	
			Mn_3O_4% 0.02 to 0.25	0.010	0.017	A	
			P_2O_5% 0.05 to 1.0	0.022X + 0.01	0.078X + 0.014	A*	
			SO_3% 0.5 to 1.5	0.049X + 0.001	0.16	A*	
			BaO% 0.04 to 0.2	0.021	0.043	A	
			SrO% 0.01 to 0.1	0.004	0.195	A	
			ZnO% 0.01 to 0.03	0.006	0.011	A	
AS 1038.15	540	Ash	Ash fusion temperature °C deformation < 1300°C	30	80	A	10
			Ash fusion temperature °C deformation ≥ 1300°C	50	150	A	10
			Ash fusion temperature °C sphere	30	60	A	10
			Ash fusion temperature °C hemisphere	30	60	A	10
			Ash fusion temperature °C flow	40	80	A	10

Australian Standard	ISO Standard	Material	Determination	R (Repeatability)	R (Reproducibility)	See Note 1	Report to nearest
AS 1038.17	1018	Coal	MHC Moisture-holding capacity %	0.6	1.2	A	0.1
AS 1038.19	12900	Coal	AI Abrasion index ≤ 20	2	—	C	1
			AI Abrasion index > 20	10%	—	C	1
AS 1038.20	5074	Coal	HGI Hardgrove grindability	2	5	C	1
AS 1038.21.1.1		Coal, coke	RD Relative density—Analysis sample/density bottle < 1.6	0.03	0.08	A	0.01
			RD Relative density—Analysis sample/density bottle ≥ 1.6	0.04	0.08	A	0.01
AS 1038.21.1.2		Coal, coke	RD Relative density—Analysis sample/volumetric < 1.6	0.03	0.1	A	0.01
			RD Relative density—Analysis sample/volumetric ≥ 1.6	0.04	0.12	A	0.01
AS 1038.23	925	Coal	Cm,ad carbonate carbon %	0.01	0.02	A	0.01
AS 1038.25		Coal	Fs Handleability s /kg <1	5%	10%		0.1
			Fs Handleability s /kg ≥1	10%	20%		1
AS 2856.3—2000	7404-5	Coal	**Microscopical determination of the reflectance of coal macerals**	%	%		
			Maximum Reflectance Sample Size 30	0.026	0.076		0.01
			Maximum Reflectance Sample Size 50	0.019	0.073		0.01
			Maximum Reflectance Sample Size 100	0.014	0.071		0.01
			Random Reflectance Sample Size 30	0.027	0.092		0.01
			Random Reflectance Sample Size 50	0.02	0.088		0.01
			Random Reflectance Sample Size 100	0.015	0.087		0.01
AS 2856.2-1998		Coal	**Coal Petrography Maceral Analysis**				
			Theoretical Standard Deviation and repeatability of the percentage of a component based on 500 count points				
			Volume % of component 5 Standard deviation of the volume percentage 1	2.8	not specified		0.1
			Volume % of component 20 Standard deviation of the volume percentage 1.8	5.1	not specified		0.1
			Volume % of component 50 Standard deviation of the volume percentage 2.2	6.3	not specified		0.1
			Volume % of component 80 Standard deviation of the volume percentage 1.8	5.1	not specified		0.1
			Volume % of component 95 Standard deviation of the volume percentage 1	2.8	not specified		0.1

Appendix E – Recommended reading

ASX, 1 December **2013**, *ASX Listing Rules Chapter 5; Additional reporting on Mining, Oil and Gas Production and Exploration Activities* http://www.asx.com.au/documents/rules/Chapter05.pdf

ASX, 1 December **2013**, *ASX Listing Rules Guidance Note 31 Reporting on Mining Activities* http://www.asx.com.au/documents/rules/gn31_reporting_on_mining_activities.pdf

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AusIMM, **2014**, Monograph 30 *Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice (second edition)*, (The Australasian Institute of Mining and Metallurgy; Carlton, Victoria 3053, Australia).

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Coombes, J., **2008**, *The Art and Science of Resource Estimation: A practical guide for geologists and engineers*, Coombes Capability, Perth

Cornah, A., Vann, J., and Driver, I., **2013**, *Comparison of three geostatistical approaches to quantify the impact of drill spacing on resource confidence for a coal seam (with a case example from Moranbah North, Queensland, Australia)*, International Journal of coal Geology, Volume 112, 1 June 2013, Pages 114–124

Dohm, C., **2005**, *Quantifiable Mineral Resource Classification: A logical approach*, Quantitative Geology and Geostatistics Volume 14, 2005, pp 333-342

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Journel, A.G., and Huijbregts, C.J., **1978**, *Mining Geostatistics*, Academic Press, London

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Preston, K., **2005**, *Estimating the In situ Relative Density of Coal – Old Favourites and New Developments*, in JW Beeston (ed.), Bowen Basin Symposium 2005, The Future for Coal – Fuel for Thought, Geological Society of Australia Inc., Coal Geology Group and the Bowen Basin Geologists Group, Yeppoon, October 2005

Preston, KB, and Sanders, RH., **1993**, *Estimating the In situ Relative Density of Coal*, in Australian Coal Geology, Volume 9, Journal of the Coal Geology Group of the Geological Society of Australia Inc.

Sinclair, A.J. and Blackwell, G.H., **2002**, *Applied Mineral Inventory Estimation*. Cambridge University Press.

Standards Australia Subcommittee on Coal Mining and Geology, **1993**, *AS2519-1993(R2013), Guide to the technical evaluation of higher rank coal deposits*, Standards Australia.

Stephenson, PR, Allman, A, Carville, DP, Stoker, PT, Mokos, P, Tyrrell J and Burrows, T., **2006**, *Mineral Resource Classification – It's Time to Shoot the 'Spotted Dog'!*, in Proceedings Sixth International Mining Geology Conference, pp 91-95 (The Australasian Institute of Mining and Metallurgy; Carlton, Victoria 3053, Australia).

Ward, C.R. (ed.), **1984**, *Coal Geology and Coal Technology*. Blackwell Scientific Publications; Carlton, Victoria 3053, Australia

Yeates, G., and Hodson, D., **2006**, *Resource Classification – Keeping the end in sight*, in Proceedings Sixth International Mining Geology Conference, pp 97-104 (The Australasian Institute of Mining and Metallurgy: Carlton, Victoria 3053, Australia)

Zhou B. and Esterle J., **2007**, *Improving the Reliability of Density and Grade Estimation from Borehole Geophysical Log Suites.* ACARP Report C15036 (CSIRO Exploration Report P2007/62).

Appendix F – JORC Code, 2012 Edition Table 1 report template

Section 1 Sampling Techniques and Data - (Criteria in this section apply to all succeeding sections.)

Criteria	JORC Code explanation	Guidance - Coal
Sampling techniques	Nature and quality of sampling (eg cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as down hole gamma sondes, or handheld XRF instruments, etc). These examples should not be taken as limiting the broad meaning of sampling.	Discussion should be provided on the types of sampling techniques used and the reliability of the samples produced. The methods could include provision of physical samples from boreholes, surface outcrops, trenches, and mining faces (open cut and underground) or measurement from downhole geophysical logging. Description should be provided of the type of sample generated (e.g. chip or core samples, channel or strip samples, gas, water, geophysical log interpretation). Detail should be given of the scale of sample size (i.e. ply, parting, waste, seam, working section, etc.).
	Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.	Describe measures taken to maximise chip or core recovery, and to ensure each ply is adequately represented by length and mass. Core loss, core expansion, lost circulation, borehole caving, the drilling fluid or any other influence on sample representivity should be recorded. Discussion of geophysical logging should include tool descriptions, calibration procedures, filtering, borehole conditions, and if logging was undertaken in air, mud or water or through drill rods. Suitable metadata should be recorded for each geophysical log. Describe how geophysical logs have been used to determine ply or sample intervals where these boundaries are not evident in the core.
	Aspects of the determination of mineralisation that are Material to the Public Report.	Describe how coal intervals have been determined; from analysed core samples, visual determination from core, interpretation of geophysical log(s)etc. Describe how seam depths, thickness and quality (e.g. density) have been defined?
	In cases where 'industry standard' work has been done this would be relatively simple (eg 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (eg submarine nodules) may warrant disclosure of detailed information.	
Drilling techniques	Drill type (eg core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc) and details (eg core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc).	Describe fully the drilling method (e.g. diamond core, reverse circulation, blade, PCD, hammer, auger, blast hole, etc.), borehole size, core size (e.g. HQ, NQ, HMLC, 4C, etc.), core barrel size, and the sampling techniques (e.g. single, double or triple tube, cyclone, collar, etc.) utilised. If orientated cores were taken, provide details on how the orientation was established.
Drill sample recovery	Method of recording and assessing core and chip sample recoveries and results assessed.	Report how core loss was determined. Identify if sample loss was associated with any structural or stratigraphic influence (e.g. faulting, intrusion, heating, thin banding of coal and non-coal material, hard bands, etc.). If geophysical logs were used to determine seam thickness then describe how this was done and what adjustments were made to the logs and sample details.

Criteria	JORC Code explanation	Guidance - Coal
	Measures taken to maximise sample recovery and ensure representative nature of the samples.	Describe how sample recovery was assessed and what measures were utilised during drilling to maximise recovery.
	Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.	Record where circulation was lost, where drilling methods affected sample integrity, and where contamination of samples occurred. Document if sample loss could bias associated analytical results (e.g. the bright vitrinite component was lost resulting in a higher ash sample).
Logging	Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.	Clearly describe the manner in which core and non-core boreholes or other Points of Observation were logged (geologically, geotechnically and geophysically) and whether or not this was adequate to support the Coal Resource estimate.
	Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc.) photography.	Document when the borehole was drilled, when the sample was taken, the condition of the core, the procedures used to 'clean' the core, how the sample was taken, how it was stored, any methods used to minimise oxidation or deterioration of caking properties, and the time period between sampling and analysis. Report on the styles of logging, how any samples have been recorded, and whether or not suitable photographs were taken.
	The total length and percentage of the relevant intersections logged.	Confirm that the logging has provided adequate coverage of the full length of each sample and the coal seam.
Sub-sampling techniques and sample preparation	If core, whether cut or sawn and whether quarter, half or all core taken.	Coal core samples are largely fully sampled, yet the process of how samples are taken in the field and stored prior to analysis can have a marked impact on results. Confirm that core of coal seams has been fully sampled. Describe techniques used to ensure contamination was minimised, that drying out or inclusion of excess moisture was avoided, and that the full sample was taken. Any variations or sub-sampling in the field must be recorded (e.g. gas desorption samples, geotechnical samples).
	If non-core, whether riffled, tube sampled, rotary split, etc and whether sampled wet or dry.	
	For all sample types, the nature, quality and appropriateness of the sample preparation technique.	The process of how samples are taken in the field and stored prior to analysis can have a marked impact on results and should be recorded. Outline the procedure for bagging, identifying and sealing individual samples, and for compiling samples for storage and transportation (i.e. use of poly sacks, drums, refrigerated containers, etc.).
	Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.	Sub-sampling of coal bore core is normally undertaken at the coal laboratory. Describe laboratory sub-sampling and pre-treatment procedures.
	Measures taken to ensure that the sampling is representative of the *in situ* material collected, including for instance results for field duplicate/second-half sampling.	Define the QAQC measures that are undertaken to maximise sample representivity. Clearly document where such procedures are unknown in historical data
	Whether sample sizes are appropriate to the grain size of the material being sampled.	Describe any size treatment procedures (e.g. drop shatter, dry sizing, wet tumble), the size interval percentages, the top size analysed and the influence of top size and core size (i.e. diameter and mass) on the usefulness of the result. Clearly document where such procedures are unknown in historical data.
Quality of assay data and laboratory tests	The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.	Discuss whether the coal analyses are fit for purpose. Are the analyses sufficient to determine the potential coal products and support an assessment of the marketability of the coal products?
	For geophysical tools, spectrometers, handheld XRF instruments, etc., the parameters used in determining the analysis including instrument make and model, reading times,	

Criteria	JORC Code explanation	Guidance - Coal
	calibrations factors applied and their derivation, etc.	
	Nature of quality control procedures adopted (e.g. standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (i.e. lack of bias) and precision have been established	QAQC protocols by the laboratory in relation to verification of sampling results should be well understood and appropriate documentation provided that supports verification of analysis, either by duplicate testing or round robin analysis. A determination of accuracy between different laboratories and the precision in results should be established.
Verification of sampling and assaying	The verification of significant intersections by either independent or alternative company personnel.	Twinning borehole locations to verify the reliability of historical drilling results should be clearly reported and discussed fully. Adjustments made to laboratory results should be reported on a sample basis with calculations applied clearly documented. The process of data entry and storage should be well documented.
	The use of twinned holes.	Twinning borehole locations to verify the reliability of historical drilling results should be clearly reported and fully discussed.
	Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) protocols.	The process of data entry and storage should be well documented.
	Discuss any adjustment to assay data.	Adjustments made to laboratory results should be reported on a sample basis with calculations applied and justification clearly documented. Discuss any adjustments to sample thicknesses based on reconciliation with interpreted downhole geophysical log depths. Ensure the correct thickness and mass values were used by the laboratory, especially for any compositing of samples, and have been recorded in databases used for Coal Resource assessment.
Location of data points	Accuracy and quality of surveys used to locate drill holes (collar and downhole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.	Establish and report the accuracy of survey control both at surface (boreholes and other Points of Observation) and downhole.
	Specification of the grid system used.	Confirm the same grid system has been used across the data set or clearly describe where discrepancies occur and why.
	Quality and adequacy of topographic control.	
Data spacing and distribution	Data spacing for reporting of Exploration Results.	A discussion should be provided on the density and distribution of boreholes (both core and non-core). The discussion should include the average depth of boreholes in relation to the depth range of the target coal seams in the deposit. Reports should include appropriately scaled plans depicting borehole locations relative to other features with symbols reflecting the purpose of the borehole.
	Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.	
	Whether sample compositing has been applied.	
Orientation of data in relation to geological structure	Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit type.	Although most coal deposits in Australia are oriented sub-horizontally, with boreholes drilled vertically to shallow depths, an assessment of seam dip to the borehole orientation should still be made to determine that no bias has been introduced. Discuss what methods have been used to check borehole verticality (e.g. downhole verticality logs) and how they have been utilised in the geological model.
	If the relationship between the drilling orientation and the orientation of key mineralised	

Criteria	JORC Code explanation	Guidance - Coal
	structures is considered to have introduced a sampling bias, this should be assessed and reported if material.	
Sample security	The measures taken to ensure sample security.	Describe how samples are uniquely identified in the field and in the lab, and how sample receipt at each stage of transportation and transfer is recorded. The chain of custody should be reviewed to ensure that sample swapping has not occurred between the field, the lab and the final database input. Report how this has been carried out.
Audits or reviews	The results of any audits or reviews of sampling techniques and data.	

Section 2 Reporting of Exploration Results (Criteria listed in the preceding section also apply to this section.)

Criteria	JORC Code explanation	Guidance - Coal
Mineral tenement and land tenure status	Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.	Describe the tenement with reference to its type, name/number, size, location, ownership and expiry. Consider and report other agreements with Government Departments, local Councils, landholders, overlapping tenure holders, community groups, and other land users. Comment on any current or planned competing land use by Government, public or private interests or exclusion zones.
	The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.	
Exploration done by other parties	Acknowledgment and appraisal of exploration by other parties.	Clearly document any previous exploration by Government or companies. Describe the exploration history of the area to provide useful insights to its future potential. Indicate what information or data is used in the current interpretation of the coal deposit and its reasonable prospects.
Geology	Deposit type, geological setting and style of mineralisation.	The geological setting both on a regional and local setting should be described. Geological maps, stratigraphic profiles and seam stratigraphy should be provided to support this description.
Drill hole Information	A summary of all information material to the understanding of the exploration results including a tabulation of the following information for all Material drill holes: • easting and northing of the drill hole collar • elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar • dip and azimuth of the hole • down hole length and interception depth • hole length.	Tabulations of all Points of Observation (Quantity and Coal Quality) used in the estimate should be presented in the report or references to previous reports containing this data should be provided. Details of the Point of Observation that should be included to enable its orientation and sample length to be established are: borehole name; geographic location and grid; collar height and datum; spatial position (x, y, z); total depth; borehole verticality; sample value(s); and sample basis as required.
	If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent Person should clearly explain why this is the case.	
Data aggregation	In reporting Exploration Results, weighting averaging techniques, maximum and/or	The combination of samples prior to testing should be recorded by reference to original sample

methods	minimum grade truncations (eg cutting of high grades) and cut-off grades are usually Material and should be stated.	numbers and reported. It must be stated if compositing was on a length or mass basis. Exclusion of material from composited lengths should be defined and supportable. Inclusion of partings or waste material should be noted.
	Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.	Compositing of sample types should be clearly described for each coal quality variable. Exclusion of material from composited lengths should be defined and supportable. Many analyses by their nature cannot be validly composited (eg caking properties).
	The assumptions used for any reporting of metal equivalent values should be clearly stated.	
Relationship between mineralisation widths and intercept lengths	These relationships are particularly important in the reporting of Exploration Results.	An assessment should be made to determine whether any sample and analysis result is representative of the deposit and over what area it is valid. This will be recorded as the confidence category for that data point.
	If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.	
	If it is not known and only the down hole lengths are reported, there should be a clear statement to this effect (eg 'down hole length, true width not known').	
Diagrams	Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.	A selection of contour and isopach plans should be provided at legible scales with data posting for each seam or seam grouping, depicting structural orientation, thickness and critical coal quality variables. Strip ratio contour plans should be presented for open cut coal deposits. Plans should also include tenure boundaries, location and areal extent of each confidence category, any boundary between open cut and underground (if applicable), the factors used to limit the estimates, the Points of Observation (with the coal quality holes for that seam clearly differentiated) and any Supportive Data on which the Coal Resource estimates for that seam were based. Cross sectional diagrams at a scale that clearly demonstrates how geological continuity has been established across the deposit area should be included. Type borehole profiles providing greater detail combined with wireline logs should be considered in reporting to demonstrate the geology.
Balanced reporting	Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.	When reporting exploration data the report must be balanced providing detail on all material issues. The report should provide an unbiased view of the information collected and interpretations without being misleading. A Coal Resource report should contain a tabulation indicating the depth and thickness ranges for each seam or working section, and the range of values for key analytical results (e.g. proximate analysis results, energy, caking properties, yield).
Other substantive exploration data	Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances.	Documentation of other types of observations should include washability and clean coal test work, gas testing, geotechnical and spontaneous potential tests.
Further work	The nature and scale of planned further work (eg tests for lateral extensions or depth extensions or large-scale step-out drilling).	
	Diagrams clearly highlighting the areas of possible extensions, including the main	

	geological interpretations and future drilling areas, provided this information is not commercially sensitive.	

Section 3 Estimation and Reporting of Mineral Resources - (Criteria listed in section 1, and where relevant in section 2, also apply to this section.)

Criteria	JORC Code explanation	Guidance - Coal
Database integrity	Measures taken to ensure that data has not been corrupted by, for example, transcription or keying errors, between its initial collection and its use for Mineral Resource estimation purposes.	Comment on the process of collecting and storing exploration data from both the field and the laboratory. Attention should be given to transcription methods and QAQC procedures used to ensure the integrity of all data. Discuss control procedures used for transfer and distribution of data.
	Data validation procedures used.	
Site visits	Comment on any site visits undertaken by the Competent Person and the outcome of those visits.	
	If no site visits have been undertaken indicate why this is the case.	
Geological interpretation	Confidence in (or conversely, the uncertainty of) the geological interpretation of the mineral deposit.	
	Nature of the data used and of any assumptions made.	
	The effect, if any, of alternative interpretations on Mineral Resource estimation.	
	The use of geology in guiding and controlling Mineral Resource estimation.	
	The factors affecting continuity both of grade and geology.	The factors affecting continuity both of quality and geology.
Dimensions	The extent and variability of the Mineral Resource expressed as length (along strike or otherwise), plan width, and depth below surface to the upper and lower limits of the Mineral Resource.	The size, orientation, thickness and depth of the deposit should be documented and presented visually to enable the reader of a report an accurate understanding of the deposit geometry. The subcrop of each seam should be clearly defined.
Estimation and modelling techniques	The nature and appropriateness of the estimation technique(s) applied and key assumptions, including treatment of extreme grade values, domaining, interpolation parameters and maximum distance of extrapolation from data points. If a computer assisted estimation method was chosen include a description of computer software and parameters used.	State whether computer software applications were used to model and estimate Coal Resources.
	The availability of check estimates, previous estimates and/or mine production records and whether the Mineral Resource estimate takes appropriate account of such data.	Checking the Coal Resource estimate against previous estimates or alternative methods should be undertaken and the documentation should reflect this.
	The assumptions made regarding recovery of by-products.	
	Estimation of deleterious elements or other non-grade variables of economic significance (e.g. sulphur for acid mine drainage characterisation).	
	In the case of block model interpolation, the block size in relation to the average sample spacing and the search employed.	See Section 5.8 of the 2014 Coal Guidelines.
	Any assumptions behind modelling of selective mining units.	
	Any assumptions about correlation between variables.	
	Description of how the geological interpretation was used to control the resource estimates.	
	Discussion of basis for using or not using grade cutting or capping.	
	The process of validation, the checking process used, the comparison of model data to drill hole data, and use of reconciliation data if available.	

Moisture	Whether the tonnages are estimated on a dry basis or with natural moisture, and the method of determination of the moisture content.	The basis of moisture analysis and its application is critical when reporting a Coal Resource estimate. Coal Resource tonnages are typically reported on an *in situ* moisture basis, yet regardless of the basis applied, it should be clearly described and not assumed to be understood. Coal Resource qualities are typically reported on an air dry basis. Conversion from one basis to another should be clearly detailed in any report.
Cut-off parameters	The basis of the adopted cut-off grade(s) or quality parameters applied.	Document the constraints applied to any parameter (e.g. thickness, depth, ash) to define the areal extent of a Coal Resource and the reason it has been used.
Mining factors or assumptions	Assumptions made regarding possible mining methods, minimum mining dimensions and internal (or, if applicable, external) mining dilution. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential mining methods, but the assumptions made regarding mining methods and parameters when estimating Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the mining assumptions made.	General assumptions that provide detail on how reasonable prospects were determined must be documented. This may include but not be limited to those factors outlined in Section 6 of the 2014 Coal Guidelines.
Metallurgical factors or assumptions	The basis for assumptions or predictions regarding metallurgical amenability. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential metallurgical methods, but the assumptions regarding metallurgical treatment processes and parameters made when reporting Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the metallurgical assumptions made.	Although Coal Resource tonnages are normally reported *in situ*, clarification is required on whether the coal could be sold as raw product or would require beneficiation. It should be stated what product is expected, the key quality parameters of the product that can be obtained and how these were determined. If washing of the coal is required then a discussion of the likely yield and how it has been determined should be reported. If full scale testing has not been undertaken or a full suite of analyses has not been conducted then the impact and how it would influence the reasonable prospects should be discussed.
Environmental factors or assumptions	Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfields project, may not always be well advanced, the status of early consideration of these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made.	Discuss the presence of deleterious minerals and trace elements (e.g. pyrite, arsenic) in the coal and waste rock (where data allow) that have the potential for acid mine drainage or to otherwise pollute the environment.
Bulk density	Whether assumed or determined. If assumed, the basis for the assumptions. If determined, the method used, whether wet or dry, the frequency of the measurements, the nature, size and representativeness of the samples.	Coal Resources are generally estimated using relative density results that are modified to provide an estimate of *in situ* tonnage. The *in situ* moisture assumptions used in the determination of *in situ* density should be disclosed. The basis of density data utilised to determine and report coal tonnage should be clearly documented.
	The bulk density for bulk material must have been measured by methods that adequately account for void spaces (vugs, porosity, etc), moisture and differences between rock and alteration zones within the deposit.	
	Discuss assumptions for bulk density estimates used in the evaluation process of the different materials.	
Classification	The basis for the classification of the Mineral Resources into varying confidence categories.	
	Whether appropriate account has been taken of all relevant factors (i.e. relative confidence in	

	tonnage/grade estimations, reliability of input data, confidence in continuity of geology and metal values, quality, quantity and distribution of the data).	
	Whether the result appropriately reflects the Competent Person's view of the deposit.	
Audits or reviews	The results of any audits or reviews of Mineral Resource estimates.	
Discussion of relative accuracy/ confidence	Where appropriate a statement of the relative accuracy and confidence level in the Mineral Resource estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or geostatistical procedures to quantify the relative accuracy of the resource within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors that could affect the relative accuracy and confidence of the estimate.	
	The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages, which should be relevant to technical and economic evaluation. Documentation should include assumptions made and the procedures used.	
	These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.	