ESTIMATION OF MINERAL RESOURCES And MINERAL RESERVES

BEST PRACTICE GUIDELINES

Committee Members

Paul Bankes - Teck Cominco Limited, Vancouver.
Ralph Bullis - Echo Bay Mines Ltd., Edmonton.
Neil Gow - Roscoe Postle Associates Inc., Toronto.
Bernie Haystead - CIBC World Markets, Toronto.
Alfred Hills - Placer Dome Inc., Vancouver.
Stephen Juras - MRDI, Vancouver.
Marc Legault - Agnico-Eagle Mines Limited, Toronto,
Philip Olson - Claude Resources Inc., Saskatoon.
Albert Samis - Teck Cominco Limited, Vancouver.
Paul Severin - Falconbridge Limited, Toronto.
Val Spring - Watts, Griffis and McOuat, Toronto.

Advisors

Francis Manns - Toronto Stock Exchange, Toronto.
Deborah McCombe - Ontario Securities Commission, Toronto.
Alastair Sinclair - University of British Columbia, Vancouver.

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Executive Summary

The following is a summary, in table format, of the main elements of the Estimation Best Practice Committee's report "Estimation of Mineral Resource and Mineral Reserve Best Practice Guidelines". While the summary table is provided for convenience, the Committee recommends that the report be read in its entirety and the table summary not be used as a stand alone document. These guidelines are not intended to be either prescriptive or exhaustive. They do not preclude innovation.

<table>
<tr><td colspan="2">Preamble: These guidelines have been prepared by the Canadian Institute of Mining and Metallurgy and Petroleum (CIM) led Estimation Best Practices Committee. They are intended to assist the Qualified Person(s) (QP) in the planning, supervision, preparation and reporting of Mineral Resource and Mineral Reserve (MRMR) estimates. All MRMR estimation work from which public reporting will ensue must be designed and carried out under the direction of a QP in accordance with National Instrument 43-101 (NI 43-101) and related forms. A QP is defined in NI 43-101 as "an individual who is an engineer or geoscientist with at least five (5) years of experience in mineral exploration, mine development, mine operation, project assessment or any combination of these; has experience relevant to the subject matter of the mineral project and technical report; and is a member in good standing of a professional association". Disclosure of MRMR estimates is to be made in accordance with industry standard definitions approved by the CIM (the CIM Standards adopted by the CIM Council in August 2002) which have been incorporated by reference into NI 43-101.

In planning, implementing and directing any estimation work, the QP should ensure and document that practices followed are based on methodology that is generally accepted in the industry and that the provisions of the Exploration Best Practices Guidelines have been adhered to during the exploration phase that led to the delineation of the Mineral Resource.

In addition to assisting the QP in the preparation of MRMR estimates, these "Estimation Best Practice Guidelines" are intended to ensure a consistently high quality of work and foster greater standardization of reporting in publicly disclosed documents.</td></tr>
<tr><td>1. Qualified Person</td><td>The QP will base the MRMR estimation work on geological premises, facts, interpretations and technical information and will select an estimation method, parameters and criteria as the QP judges appropriate for the deposit under consideration. In planning, implementing and supervising the estimation work, the QP will ensure that the methods employed and the practices followed can be justified on technical merit and are either generally accepted in the industry or sufficiently documented to ensure their validity.

It is considered unlikely that, in Mineral Reserve estimation, one individual will have the requisite skills or experience to</td></tr>
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	cover all of the disciplines that are involved in the preparation of the estimate. Although the reporting QP will ultimately have responsibility for the resulting estimate, he or she should have access to others, in the compilation of the estimate, who have suitable training or experience in disciplines that may fall outside the expertise of the QP.
2. Definitions and Related References	These Guidelines are intended to be read in conjunction with NI 43-101, the CIM Standards and the Exploration Best Practice Guidelines. These references contain key definitions that must be applied including those for "Qualified Person", "Mineral Resource", "Mineral Reserve" and "Preliminary Feasibility Study". Other key definitions have been included in the body of this report.
3. The Resource Database	The Resource Database is established by the collection, validation, recording, storing and processing of data and forms the foundation necessary for the estimation of MRMR. A quality assurance and quality control program is essential and must be established to govern the collection of all data. In reporting, a Mineral Resource must meet the minimum requirement of "reasonable prospects for economic extraction". This will require the concurrent collection and storage of preliminary economic, mining, metallurgical, environmental, legal and social data and other information for use in the estimation of MRMR. The Resource Database will include both "primary" (observation and measurement) and "interpreted" data. It is recommend that data be stored digitally, using a documented, standard format and a reliable storage medium that allows for easy and complete retrieval of the data.
4. Geological Interpretation & Modeling	Geological interpretation is a fundamental element of MRMR estimation. The styles of mineralization under investigation must be identified. The understanding of the relationship between the mineralization of interest and the likely related geological processes that govern its emplacement and geometry within the geological framework is essential to the establishment of the geological controls for mineralization. The conceptual geological model and ideas regarding the genesis of the deposit should be presented and considered in their relation to the resultant MRMR model and be supported by appropriate primary data. Issues with respect to the sufficiency or applicability of data supporting the determination of the geological model must be clearly identified.

	Attention to geological detail is vital for early recognition of important features that control the spatial distribution, variability and continuity of potentially economic mineralization. Mineralization may be defined or limited by some combination of structure, lithology and alteration envelope. These limits or boundaries should be used to constrain the interpolation of grade within the MRMR model. Recognition must be given to “mineralizing episodes” and the existence of more than one ore type, requiring different modeling techniques and/or modeling parameters. The Mineral Resource model adopted for a project, whether computer based or not, should be appropriate for the size, grade distribution and geometry of the mineralized zones being modeled. The model should be compatible with the anticipated mining and grade control methods and size and type of equipment. In block modeling, the size of the blocks in the model will be chosen to best match mining selectivity and the anticipated grade control method, sample density and sample statistics. In the case of computer based modeling, the QP responsible for the development of the MRMR model, should have appropriate knowledge of the methodology employed, the critical input assumptions utilized and be aware of the inherent limitations of the software chosen. The software and version applied and the methodologies and critical assumptions utilized should be clearly stated with appropriate justification supplied. Block models should be validated against raw data and interpolated results to ensure reliability. Validation steps will include visual inspection of raw and composited data, checks for global and local bias and a check on the degree of grade smoothing in the interpolation.
5. Mineral Resource Estimation	Prior to the commencement of the estimation of a Mineral Resource, it is essential for the QP to assess the adequacy and the applicability of the available data to the mineralization to be modeled. If the number and representativeness of the data are found lacking, the QP must assess the additional data required to conduct a meaningful Mineral Resource estimation. The QP must ensure that the available information and sample density are sufficient to allow a reliable estimate of the size, tonnage and grade of the mineralization in accordance with the level of confidence required by the definitions set out in the CIM Standards.

	The principal purpose of data analysis is to improve the quality of the estimation through comprehensive understanding of the statistical and spatial character of variables on which the estimate depends. This includes the interrelationships among variables (e.g. grade, thickness), definition of distinct domains that must be evaluated independently, and the identification and understanding of outliers. In particular, in the case of precious metal deposits, it will be necessary to understand the extent to which "nugget effect" affects the mineralized sample population. Data analysis should be comprehensive and be conducted using appropriate univariate, bivariate and/or multivariate procedures. All data and information used in the estimation of the Mineral Resource must be identified, catalogued and stored for future reference and audit. Any portion of the data acquired and not used in the estimation process must be identified and an explanation should be provided for its exclusion. The sampling and assaying practice and methodologies must be clearly described and justification for the choice of particular methods must be supplied.
6. Quantifying Elements of a Mineral Resource to a Mineral Reserve	There are a number of quantifying elements or modifying factors that should be considered in the conversion of a Mineral Resource to a Mineral Reserve. The QP should ensure that these elements/factors have been considered in adequate detail to demonstrate that, in accordance with the CIM Standards and as referenced in NI 43-101, economic extraction can be justified. While the appropriate level of detail for each of the elements/factors is left to the discretion of the QP, in aggregate, the levels of detail and engineering must meet or exceed the criteria contained in the definition of Preliminary Feasibility Study. The main elements/factors to be considered include mining, metallurgy, geotechnical, hydrological, environmental, location, marketing, legal requirements, revenue, costs and social implications.
7. Mineral Reserve Estimation	A Mineral Reserve estimate represents the collation of work carried out by numerous professional disciplines and, according to the CIM Standards, must be based on or demonstrated by the results of (at least) a Preliminary Feasibility Study. The QP responsible for Mineral Reserve estimation must understand the significance of each discipline's contribution to the reliability of the Mineral Reserve estimate and the assessment of economic viability. Due to the extended timeline from discovery, to production, through to mine closure, the QP must recognize the

	importance of good documentation in the estimation process. Pre-planning is recommended: to allow identification of the key factors affecting the Mineral reserve estimate and to ensure the documentation of the methodology. A simple checklist should be utilized to guarantee that all factors are considered. The methodology of establishing the Proven and Probable categories should be available for review and a qualitative justification should be provided. As the Mineral Reserve estimate is based on many types of input data an assessment of the sensitivity to these various inputs must form part of the estimation process. The QP is encouraged to develop a methodology to rank the risk associated with each input. Verification of all inputs, including the Mineral Resource model, is essential. Where possible, verification against production data is recommended. A key criterion for Mineral Reserve classification is the determination of economic viability. An important aspect of this is the practicality of the mining and processing methods proposed for the deposit. Best practice includes the use of peer reviews to test various aspects of the Mineral Reserve estimate including the inputs, methodology, underlying assumptions, the results of the estimate itself, and the test for economic viability. Prior to the completion of a Preliminary Feasibility Study, several iterations of evaluations may be carried out. Documentation of the inputs, methodologies, risks, assumptions, and results should be easily retrievable, readily available and catalogued in a manner that allows easy assessment of the history of evaluations carried out. Mineral Reserve statements should be unambiguous and contain sufficient detail to allow a knowledgeable person to understand the significance of, and sensitivity to, key parameters such as cut-off grade, dilution and mining recovery.
8. Reporting	NI 43-101, Form 43-101F1 and Companion Policy 43-101CP, establish standards for all oral and written disclosure made by an issuer concerning mineral projects that are reasonably likely to be made available to the public. All disclosure concerning mineral projects including oral statements and written disclosure in, for example, news

	releases, prospectuses and annual reports, etc., is to be based on information supplied by or under the supervision of a QP. Disclosure of information pertaining to MRMR estimation is to be made in accordance with industry standard definitions approved by the CIM (the CIM Standards) that have been incorporated by reference in NI 43-101. One of the objectives of the Estimation Best Practice Guidelines is to foster greater standardization of reporting in publicly disclosed documents. Technical Reports shall be in accordance with Form 43-101F1 of NI 43-101. The obligation to file a Technical Report arises in a number of different situations and these are covered under Part 4 of NI 43-101. For example, reporting of MRMR estimates in Annual Reports is covered under Parts 1.3, 1.4, 2.1, 2.2 and 3.4 of NI 43-101. Press releases are also covered under Section 3.0 of Appendix B of Disclosure Standards No. 1450-025 of the Toronto Stock Exchange (TSX), and Corporate Finance Manual Appendix 3F-Mining Standards Guidelines-Policy 3.3-Timely Disclosure of the TSX Venture Exchange. Additional guidance for reporting of MRMR estimates can be found in the CIM Standards.
9. Reconciliation of Mineral Reserves	The ultimate check of a MRMR estimate is through appropriate production monitoring and reconciliation. Production monitoring provides the information required to minimize dilution, maximize ore recovery and supply a consistent metallurgically balanced feed to the process plant. Reconciliation is required to validate MRMR estimates and to check on the effectiveness of operating practices. Since MRMR estimation is based on much wider spaced sampling than that used for actual production, reconciliation may identify significant disparity between estimates and production. If such problems occur, the need arises to identify the causes of the disparities and to devise remedies in procedures such as sampling practices and the estimation of dilution or the levels of the ore recovery factors. In an operating mine, reconciliation of mine to mill production and mine production to MRMR estimates should be conducted on a routine basis. The QP must take into consideration the results of this reconciliation in any public disclosure of MRMR estimates.

General Guidelines

Preamble

These guidelines have been prepared by the Canadian Institute of Mining and Metallurgy and Petroleum (CIM) led “Estimation Best Practices Committee”. They are intended to assist the Qualified Person(s) (QP) in the planning, supervision, preparation and reporting of Mineral Resource and Mineral Reserve (MRMR) estimates. All MRMR estimation work from which public reporting will ensue must be designed and carried out under the direction of a QP and in accordance with National Instrument 43-101 (NI 43-101) and related forms. NI 43-101 was prepared by the Canadian Securities Administrators (CSA). A QP is defined in NI 43-101 as “an individual who is an engineer or geoscientist with at least five (5) years of experience in mineral exploration, mine development, mine operation, project assessment or any combination of these; has experience relevant to the subject matter of the mineral project and technical report; and is a member in good standing of a professional association”. Disclosure of MRMR estimates is to be made in accordance with industry standard definitions approved by the CIM (the CIM Standards adopted by the CIM Council in August, 2000) which have been incorporated by reference into NI 43-101.

The ‘General Guidelines’ section of this document deals primarily with the description of best practice as it applies to metalliferous deposits. The Committee recognizes that certain commodities require specialized treatments. Some such commodities have been considered by appropriate sub-committees of experts and their reports are appended. Additional specialized commodities will be considered in the future as the need becomes evident.

In planning, implementing and directing any estimation work, the QP should ensure that practices followed are based on methodology that is generally accepted in the industry and that the provisions of the Exploration Best Practices Guidelines have been adhered to during the exploration phase that led to the delineation of the resource.

In addition to assisting the QP in the preparation of MRMR estimates, these “Best Practice Guidelines” are intended to ensure a consistently high quality of work and foster greater standardization of reporting in publicly disclosed documents.

1. Qualified Person

The Qualified Person will base the MRMR estimation work on geological premises, interpretation and other technical information as the QP deems appropriate. In addition, the QP will select an estimation method, parameters and criteria appropriate for the deposit under consideration. In planning, implementing and supervising any estimation work, the QP will ensure that the methods employed and the practices followed can be justified on technical merit and/or are generally accepted in the industry.

The "Estimation Best Practice Committee" recommends that the qualifications of a person responsible for compilation of MRMR estimates at least meet, but preferably exceed, the minimum requirements of the QP as noted in NI 43-101. Further, because a MRMR model is based fundamentally on accurate geological interpretation and economic understanding, the persons responsible for the Mineral Resource and subsequent Mineral Reserve estimation should have a firm understanding of geology, mining, and other issues affecting the estimate. This level of understanding would normally be developed through acquiring appropriate geological, mining and Mineral Reserve preparation experience in a relevant operating mine.

While the reporting QP ultimately will have responsibility for the resulting estimate, he or she should have access to other QP, in the compilation of the estimate, who have suitable training or experience in disciplines that may fall outside the expertise of the reporting QP. This will allow appropriate consideration of all factors affecting the estimate including, for example, geology and geological interpretation, metallurgy, mining and social, legal and environmental matters.

2. Definitions

These Guidelines are intended to be read in conjunction with NI 43-101, the CIM Standards and the Exploration Best Practice Guidelines. In addition to the definition of the QP contained in NI 43-101 and referenced in the Preamble to these guidelines, there are a number of other definitions and terms that are worthy of highlight:

Definitions:

- Mineralization: for the purposes of this document, means:
  "material of potential interest. Mineral Resources and Mineral Reserves are economic subsets of such mineralization".

- Quality Assurance/Quality Control (QA/QC): for the purpose of this document; Quality Assurance means:
  "All of those planned or systematic actions necessary to provide adequate confidence in the data collection and estimation process",
  and Quality Control means
  "the systems and mechanisms put in place to provide the Quality Assurance. The four steps of quality control include; setting standards; appraising conformance; acting when necessary and planning for improvements".

- Mineral Resource: as defined in the CIM Standards and referenced in NI 43-101, means:
  "a concentration or occurrence of natural, solid, inorganic, or fossilized organic material in or on the Earth's crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. The location,

quantity, grade, geological characteristics, and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge".

- Mineral Reserve: as defined in the CIM Standards and referenced in NI 43-101, means:
  "the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve includes diluting materials and allowances for losses that may occur when the material is mined"

- Estimate: for the purposes of this document, means:
  (verb) "to judge or approximate the value, worth, or significance of; to determine the size, extent, or nature of".
  (noun) "an approximate calculation; a numerical value obtained from a statistical sample and assigned to a population parameter".

- Preliminary Feasibility Study: as defined in the CIM Standards and referenced in NI 43-101, means:
  "a comprehensive study of the viability of a mineral project that has advanced to the stage where the mining method, in the case of underground mining, or the open pit configuration, in the case of an open pit, has been established and which, if an effective method of mineral processing has been determined includes a financial analysis based on reasonable assumptions of technical, engineering, operating, and economic factors and evaluation of other relevant factors which are sufficient for a QP, acting reasonably, to determine if all or part of the Mineral Resource may be classified as a Mineral Reserve".

- Deposit: for the purpose of this document means:
  "a natural occurrence of mineral or mineral aggregate, in such quantity and quality to invite exploitation".

- Classification and Categorization:
  "a mineral deposit may be subdivided into two Classes, Mineral Resources and Mineral Reserves. Each of these Classes may be subdivided into Categories: Measured, Indicated and Inferred in the case of Mineral Resources and Proven and Probable in the case of Mineral Reserves".

3. The Resource Database

This section considers important factors in the creation of the Resource Database.

The Resource Database is established by the collection, verification, recording, storing and processing of the data and forms the foundation necessary for the estimation of MRMR. The establishment of a QA/QC program of all data is essential during this process.

Components of the Resource Database typically will include geological data (e.g. lithology, mineralization, alteration, and structure), survey data, geophysical data, geochemical data, assay data, rock quality and bulk density information and activity dates.

As stated in the CIM Standards and as noted above, a Mineral Resource must have reasonable prospects of economic extraction. Consequently, preliminary data and information concerning a number of factors (e.g. mining, metallurgy, economics and social and environmental sensitivity) will be collected and assessed during the estimation of a Mineral Resource.

General comments

- A database consists of two types of data, primary data and interpreted data. Primary data are parameters amenable to direct physical measurement. Examples include assays, survey data, and geological observations. Interpreted data sets are derivations or interpretations of primary information. Examples are geological projections and block models.

- Bulk density is an important parameter that should be measured and recorded at appropriate intervals, and in an appropriate manner, for the deposit. The choice of methods for determining the bulk density of a particular deposit will depend on the physical characteristics of the mineralization And the available sampling medium.

- The QP should be diligent in ensuring that the final database fairly represents the primary information. Data verification is an essential part of finalising the resource database.

- The Resource Database provides a permanent record of all the data collected from the work carried out, the date of the work, observations and comments from the results obtained. It should be readily available for future reference. The database provides all of the information necessary to enable current and future geological interpretations and modeling.

- Although most databases are generally maintained in an electronically-stored digital format, hand-printed tables with well-organized information may also form a database. It is recommended that data be stored digitally, using a documented, standard format and a reliable medium that allows for easy and complete future retrieval of the data.

Primary Data Visualization

- It is essential that the systematic recording of geological observations from mapping and drill hole logging be entered into an organized database.

- Data collection and display must foster a good geological understanding of a deposit as a prerequisite for the Mineral Resource estimation process (see Section 4).

- The important primary data must be identified and accurately presented in three dimensions, typically on a set of plans and sections. Examples are lithologies, structural measurements, assays, etc.

- Where local mine coordinates are used on geological maps and sections, a mechanism for conversion to universal coordinates must be provided. Maps and sections must include appropriate coordinates, elevation, scale, date, author(s) and appropriate directional information.

- Data positioning information should be relative to a common property co-ordinate system and should include the methodology and accuracy used to obtain that information. Accurate location of data points is essential. If data points are referred to a particular map or grid, those reference data should be included, the map properly identified and the coordinate system clearly stated.

- If primary data have been intentionally omitted from the presentation, they should be identified with an explanatory note for their exclusion.

Interpreted Data Visualization

- The geological interpretation including mineralization and its controls (e.g. structure, alteration, and lithology) is essential for MRMR estimation. The primary data (i.e. from outcrops, trenches and drill holes) should be clearly identifiable and be distinct from the interpreted data so that it may be utilised in subsequent interpretations and Mineral Resource estimates.

- The relevant geophysical/geochemical/topographic data used to support the interpretation of faults or boundaries must be included or referenced appropriately.

- Since the mineralising episode(s) and related features of the geology are critical aspects in the MRMR estimations, they must be clearly represented. Examples are controlling features, style(s) and age(s) of mineralization, boundaries of the mineralization, and zonation of the mineralization.

Data: collection, recording, storing and processing

- Primary data collected must be recorded even if not used in the MRMR estimation.

- Original assay data should be stored in the units of measure as received by the laboratory (e.g. large ppm values should not be reported as percentages). The analytical method used must be described.

- Analytical data should be converted into common units of measure provided the analytical technique supports the conversion. The original and converted assay should be reported, including the conversion factor(s).

- Data that have been acquired over multiple periods and by various workers should be verified and checked prior to entry into the database. In addition, data records should possess unique identifiers (e.g. unique drill hole, zone and sample numbers, etc.). A distinction must be made between data collected by different methodologies (e.g. reverse circulation holes versus diamond drill holes, etc.) and an explanation of how these data sets are integrated, should be provided.

- Upon the reporting of MRMR estimates, all the tabulations and defining parameters become part of the database. Summations, tabulations, maps, assumptions and related parameters, for example cut-off grade(s), commodity price(s), dilution, losses, plant recovery (ies) become interpreted data and must be enumerated.

- Mine production data are primary and must be incorporated into the MRMR database. Best practice includes routine reporting of reconciliations and monitoring systems implemented during the operational phases of the project. These results will be used for revisions in the MRMR estimation.

- Periodic review of data to ensure its integrity is recommended.

- Duplicate, secure off-site storage of data is recommended.

QA/QC

- QA/QC must be addressed during the collection, recording and storage of any of the data ultimately used in the MRMR estimation. This program should be concerned with, but not limited to: data verification, drill sample recovery, sample size, sample preparation, analytical methods, the use of duplicates/blanks/standards, effects of multiple periods of data acquisition and consistency of interpretation in three dimensions. The sample preparation description should include aliquot weight used in the laboratory. The results of the QA/QC program form part of the database and must be recorded.

4. Geological Interpretation & Modeling

The purpose of this section is to give guidance to the QP responsible for estimating MRMR. These Guidelines outline requirements for interpretation of geological data, the consideration of economic and mining criteria and the linkage of that information to the grade distribution of the MRMR model as described in section 5.

Geological Data

- Comprehensive geology and reliable sample information remain the foundation of MRMR estimates.

- Information used for MRMR estimation should include surface geology at suitable scales (lithologies, mineralogical zones, structural regimes, alteration, etc.), topographical data, density information, a complete set of all available sample results and surveyed locations of all sample sites (chips, drill samples, etc.).

- All geological information within the deposit should be transposed from plan onto sections (or vice versa) to confirm reliability and continuity using all available data (drill holes, mine workings, etc.). Two directions of vertical sections (usually orthogonal) and plans should be used to ensure manual interpretations are internally consistent.

- Geological interpretation is frequently completed in a three dimensional (3-D) computer environment. Computer assisted interpretations should be validated on plan and orthogonal section to evaluate the reliability of the geological interpretation.

- Understanding the relationship between the mineralization and the geological processes that govern its geometry is essential. Mineralized limits (whether sharp or gradational) within which the MRMR are to be determined must be interpreted and depicted on maps, plans and sections.

Geological Interpretations

- MRMR modeling should be developed within a regional context. Accordingly, the regional geology and property geology are important parts of the geological database.

- The interpretation of geological field data (lithology, structure, alteration and mineralized zones, etc.) should include direct input from individuals with mapping or core logging experience on the deposit.

- Field data should be presented in their entirety, in an unmodified form. Every effort must be made to analyze these data in an unbiased, scientific fashion to develop a “Geological Concept” which forms the underlying premise on which the geologic interpretation is developed. The concept should include, among others, geological setting, deposit type, styles of mineralization, mineralogical characteristics and genesis.

- The styles of the mineralization under investigation must be identified to allow the modeler to establish geological controls for mineralization and permit more accurate interpolation of grades within the model.

- The geological interpretation and ideas regarding genesis of the deposit should be reviewed in the context of the resultant MRMR model. Aspects and assumptions, for which field data are incomplete, should be clearly identified.

Controls of Mineralization

- Once the geological framework of the deposit has been reasonably established, geological controls for mineralization and the limits of those controls are determined. Attention to detail is vital for early recognition of important features that control the spatial distribution, variability and continuity of economic mineralization.

- Mineralization may be defined or limited by some combination of features such as structure, lithology and the alteration envelope. These limits or boundaries should be used to constrain the interpolation of grade or quality within the MRMR model.

- When determining limits of mineralization, the estimator must recognize that many mineral deposits comprise more than one type of mineralization. The characteristics of each type will likely require different modeling techniques and/or parameters.

Mining and Economic Requirements

- By definition, a Mineral Resource must have “reasonable prospects of economic extraction”.

- Factors significant to project economics must be considered for both Mineral Resource and Mineral Reserve estimates. These will include the extraction characteristics for both the mining and processing method selected as affected by geotechnical, grade control, and metallurgical, environmental and economic attributes.

- For a Mineral Resource, factors significant to project economics should be current, reasonably developed and based on generally accepted industry practice and experience. Assumptions should be clearly defined. For Mineral Reserves, parameters must be detailed with engineering complete to Preliminary Feasibility standards as defined in the CIM Standards.

- Mining assumptions for a Mineral Reserve include: continuity of mineralization, methods of extraction, geotechnical considerations, selectivity, minimum mining width, dilution and percent mine extraction.

- Cut-off grade or cut-off net smelter return (NSR) used for MRMR reporting are largely determined by reasonable long term metal price(s), mill recovery and capital and operating costs relating to mining, processing, administration and smelter terms, among others. All assumptions and sensitivities must be clearly identified.

- Cut-off grade must be relevant to the grade distribution. The mineralization must exhibit sufficient continuity for economic extraction under the cut-off applied.

Three Dimensional Computer Modeling

- MRMR models can be generated with or without the use of 3-D computer software. However, it is likely that any MRMR estimate that is included in a feasibility study will be in the form of a 3-D computer model. This section refers only to those MRMR models generated using such techniques.

- The modeling technique(s) adopted for a project should be appropriate for the size, distribution and geometry of the mineralized zones. The technique should also be compatible with the anticipated mining method(s) and size and type of equipment.

- The QP must analyze the grade distribution to determine if grade compositing is required. Where necessary, assay data should be composited to normalize the grade distribution and to adequately reflect the block size and production units.

- The size of the blocks in the model will be chosen to best match mining selectivity, drill hole and sample density, sample statistics and anticipated grade control method. A change in cut-off grade or economic limit and selectivity of the mining method(s) frequently requires the development of new models and perhaps increased drill definition to properly evaluate the mineral deposit in question.

- An aspect of block modeling is the loss of critical geological and assay information through smoothing of details inherent in the modeling technique. General validation of the block model against raw data is required to ensure reliability.

Selection of Software

- This section refers only to those MRMR models generated using software. It is recognized that MRMR can be estimated using other methods without the use of computers and software.

- The software and the version used should be clearly stated.

- There is a number of adequate, commercially available data handling and modeling software packages currently in use. The person responsible for the development of the MRMR model should have appropriate knowledge of the software, methodology, limitations and underlying assumptions utilized during the modeling process.

5. Mineral Resource Estimation

This section considers important factors in estimating a Mineral Resource and documenting the estimation process. It provides guidelines to the QP responsible for the Mineral Resource estimate with respect to data analysis, sample support, model setup and interpolation. Critical elements to the Mineral Resource estimate are the consideration of the appropriate geological interpretation and the application of reasonably developed economic parameters, based on generally accepted industry practice and experience. While innovation is encouraged, comparisons with other tested methods are essential, prior to publicizing or reporting estimates. Optimization of the Mineral Resource interpretation in consideration of economic parameters is an iterative process.

Data density

- A key initial step prior to the commencement of estimating a Mineral Resource is the assessment of data adequacy and representativeness of the mineralization to be modeled. If the number and spatial distribution of data are inadequate, an estimation is required of how much additional data are needed before a Mineral Resource calculation can meaningfully be done. The QP responsible for modeling must ensure that the available information and sample density allow a reliable estimate to be made of the size, tonnage and grade of the mineralization in accordance with the level of confidence established by the Mineral Resource categories in the CIM Standards.

Integration of geological information

- The deposit geology forms the fundamental basis of the Mineral Resource estimation. The data must be integrated into, and reconciled with, the geological interpretation as part of the estimation process. The interpretation should include the consideration and use of reasonable assumptions on the limits and geometry of the mineralization, mineralization controls and internal unmineralized or ‘waste’ areas (i.e. dikes or sills). Interpretive information should be continuously re-assessed as knowledge of the geological characteristics of a deposit improves.

Listing/recording the data set

- All data and information used in the Mineral Resource estimation must be identified, catalogued and stored for future reference and audits. Any portion of the pertinent data acquired during the exploration and development of the property that is not used in the Mineral Resource estimation must be identified and an explanation provided for its exclusion.

- Sampling, sample preparation, assaying practice and methodologies must be clearly described and an explanation given for the choice of the particular methods used. A comment as to their effectiveness should also be provided.

- Particular care should be taken in recording, analyzing and storing data and results from QA/QC programs related to the Mineral Resource estimation.

Data Analysis

- The principal purpose of data analysis is to improve the quality of estimation through a comprehensive understanding of the statistical and spatial character of variables on which the estimate depends. This would include establishment of any interrelationships among the variables of interest, recognition of any systematic spatial variation of the variables (e.g. grade, thickness), definition of distinctive domains that must be evaluated independently for the estimate, and identification and understanding of outliers. In particular, it will be necessary to understand the extent to which “nugget effect” affects the mineralized sample population. This is often a major concern for precious metal deposits and may be important in other types of deposits.

- Data analysis should be comprehensive and be conducted using appropriate univariate, bivariate, and/or multivariate procedures. Univariate procedures include statistical summaries (mean, standard deviation, etc.), histograms and probability plots. Bivariate procedures include correlation studies, evaluation of scatter plots and regression analysis whereas multivariate analysis might involve procedures such as multiple regression (e.g. bulk density – metal relationships) and multiple variable plots (e.g. triangular diagrams).

- Variography is an aspect of data analysis that assists in defining the correlation and range of influence of a grade variable in various directions in three dimensions.

- Outlier recognition and treatment of outliers is an important part of the data analysis. An outlier is an observation that appears to be inconsistent with the majority of the data and attention for the purposes of Mineral Resource estimation usually is directed to those that are high relative to most data. The modeler must state how an outlier is defined and how it is treated during the resource estimation process (i.e. grade cutting strategy, restricted search philosophy).

Sample Support

- Sample or data support (size, shape and orientation of samples) must be considered. Data for the Mineral Resource estimate generally are obtained from a variety of supports and statistical parameters can vary substantially from one support to another. If composites are used as a basis for estimation, the data must be combined in a manner to produce composites of approximately uniform support prior to grade estimation.

- Selection of a composite length should be appropriate for the data and deposit (e.g. bench or half bench height, dominant assay interval length, vein thickness). Commonly compositing is specific to a geological domain.

Economic parameters

- The cut-off grade or economic limit used to define a Mineral Resource must provide “reasonable prospects for economic extraction”. In establishing the cut-off grade, it must realistically reflect the location, deposit scale, continuity, assumed mining method, metallurgical processes, costs and reasonable long-term metal prices appropriate for the deposit. Assumptions should be clearly defined.

- Variations within the resource model (rock characteristics, metallurgy, mining methods, etc.) that may necessitate more than one cut-off grade or economic limit in different parts of the deposit model must be an ongoing consideration.

Mineral Resource Model

- The Mineral Resource estimation techniques employed are dependent to a degree on the size and geometry of the deposit and the quantity of available data. Currently, most resource models are computer models constructed using one of several specialized commercially available software packages. Simple geometric methods may be acceptable in some cases (e.g. early stage deposit definition) but three-dimensional modeling techniques may be more appropriate for advanced projects.

- Model parameters (e.g. block size, model orientation) should be developed based on mining method (e.g. open pit versus underground, blast hole versus cut and fill mining), deposit geometry and grade distribution (e.g. polymetallic zoning in a sulphide deposit).

Estimation Techniques

- The QP responsible for the Mineral Resource model must select a technique to estimate grades for the model. Methods range from polygonal or nearest neighbor estimates, inverse distance to a power, various kriging approaches (e.g. ordinary kriging, multiple indicator kriging) through to more complex conditional simulations. The choice of method will be based on the geology and complexity of grade distribution within the deposit and the degree to which high-grade outliers are present.

- In some complex models, it may be necessary to use different estimation techniques for different parts of the deposit.

- The QP should ensure that the selected estimation method is adequately documented and should not rely solely on the computer software to produce a comprehensive document or report 'trail' of the interpolation process.

Mineral Resource Model Validation

- The QP must ensure the Mineral Resource model is consistent with the primary data. The validation steps should include visual inspection of interpolated results on suitable plans and sections and compared with the composited data, checks for global and local bias (comparison of interpolated and nearest neighbor or declustered composite statistics), and a change of support check (degree of grade smoothing in the interpolation). It is recommended that manual validation of all or part of a computer-based Mineral Resource estimate be completed.

- For Mineral Resource models of deposits that have had mine production or are currently being mined, the validation must include a reconciliation of production to the Mineral Resource model.

- A final step, best practice includes the re-evaluation of the economic parameters to confirm their suitability.

- As per the CIM Standards, Mineral Resource estimation involves the classification of resources into three classes. The criteria used for classification should be described in sufficient detail so that the classification is reproducible by others.

6. Quantifying Elements to convert a Mineral Resource to a Mineral Reserve

This section forms the logical extension of the topics discussed in Section 5, "Mineral Resource Estimation", and addresses factors required for the conversion of a Mineral

Resource into a Mineral Reserve. These factors are provided, in the form of a checklist, for assembling information that should be considered prior to the process of estimating Mineral Reserves. This checklist referred to as quantifying elements or modifying factors, is not intended to be exhaustive. The QP should ensure that these elements/factors have been considered in adequate detail to demonstrate that economic extraction can be justified, in accordance with the Mineral Reserve and Preliminary Feasibility Study definitions contained in the CIM Standards and as referenced in NI 43-101. The appropriate level of detail for each of these elements/factors is left to the discretion of the QP. However, in aggregate, the levels of detail and engineering must meet or exceed the criteria contained in the definition of a Preliminary Feasibility Study.

Quantifying Element or Modifying Factor Check List:

a) Mining:

- Data to determine appropriate mine parameters, (e.g. test mining, RQD)
- open pit and/or underground
- production rate scenarios
- cut-off grade (single element, multiple element, dollar item)
- dilution: included in the Mineral Resource model or external factor(s)
- recovery with respect to the Mineral Resource model
- waste rock handling
- fill management (underground mining)
- grade control method
- operating cost
- capital cost
- sustaining capital cost

b) Processing

- sample and sizing selection: representative of planned mill feed, measurement of variability, is a bulk sample appropriate
- product recoveries
- hardness (grindability)
- bulk density
- presence and distribution of deleterious elements
- process selection
- operating cost
- capital cost
- sustaining capital cost

c) Geotechnical/Hydrological

- slope stability (open pit)
- ground support strategy (underground), test mining
- water balance
- area hydrology
- seismic risk

d) Environmental

- baseline studies
- tailings management
- waste rock management
- acid rock drainage issues
- closure and reclamation plan
- permitting schedule

e) Location and Infrastructure

- climate
- supply logistics
- power source(s)
- existing infrastructure
- labor supply and skill level

f) Marketing Elements or Factors

- product specification and demand
- off-site treatment terms and costs
- transportation costs

g) Legal Elements or Factors

- security of tenure
- ownership rights and interests
- environmental liability
- political risk (e.g. land claims, sovereign risk)
- negotiated fiscal regime

h) General Costs and Revenue Elements or Factors

- General and Administrative costs
- commodity price forecasts
- foreign exchange forecasts
- inflation

- royalty commitments
- taxes
- corporate investment criteria

i) Social Issues

- sustainable development strategy
- impact assessment and mitigation
- negotiated cost/benefit agreement
- cultural and social influences

7. Mineral Reserve Estimation

This section considers important factors in estimating a Mineral Reserve and documenting the estimation process. As a Mineral Reserve estimate represents the collation of work carried out by numerous professional disciplines, the QP producing the Mineral Reserve estimate must understand the significance of each discipline's work in order to assess economic viability. In addition, the QP should recognize that the time from discovery, to production, through to closure, of a mine is often measured in years and this timeframe makes good documentation an important aspect of the estimation process.

Preparation

The QP should document and use a methodology in estimating Mineral Reserves to ensure no significant factor is ignored. Pre-planning is important to identify the factors affecting the Mineral Reserve estimate. Utilizing a checklist to ensure all aspects are considered is good practice.

Mineral Reserve definition and classification is covered by the CIM Standards. Definitions do change from time-to-time and in the compilation of a Mineral Reserve estimate the QP should ensure the current definitions are being used. Of significance are the requirements that the material forms the basis of an economically viable project.

The test of economic viability should be well documented as part of the Mineral Reserve estimation process. The requirement for economic viability implies determination of annual cash flows and inclusion of all the parameters that have an economic impact.

Classification

The CIM Standards provide two categories for the definition of the Mineral Reserve, Proven Mineral Reserve and Probable Mineral Reserve and the QP must ensure that the minimum criteria are met prior to assigning these categories. The QP should be mindful of all the inputs used in establishing the Mineral Reserve that affect the confidence in the categories. The methodology of establishing the classification should be well documented and easily understood. Best practice includes providing a narrative description of the qualitative reasons behind the classification selection.

Where practical, empirical evidence (e.g. production data) should be used to calibrate and justify the classification.

Verification of inputs

It is the responsibility of the QP to ensure the verification of all inputs to the Mineral Reserve estimate. As the Mineral Reserve estimate is based on many data inputs, including the Mineral Resource model, it is important that the inputs and the consistency of the inputs be validated as part of the Mineral Reserve estimation process. A defined methodology to achieve this is considered best practice and the use of a protocol such as the checklist contained in Section 6 is recommended. Identification of critical aspects of the Mineral Reserve estimate is an important part of the input verification.

Application of Cut-off Grade

Cut-off grade is a unit of measure that represents a fixed reference point for the differentiation of two or more types of material. Owing to the complexity of Mineral Reserve estimates, numerous cut-off grades may be required to estimate a Mineral Reserve, (e.g. the set point defining waste from heap leach ore and the set point defining heap leach ore from milled ore).

The cut-off grade(s) (the economic limit or pay limit) should be clearly stated, unambiguous and easily understood. Complex ores may require complicated procedures to determine cut-off grades and to define the Mineral Reserve. The procedures used to establish the cut-off strategies should be well documented, easily available for review, and clearly stated in disclosure statements.

Cut-off grade must be relevant to the grade distribution modeled for the Mineral Resource. If cut-off grades are outside the specified range, the QP must review model-reliability and a new model might be necessary.

A key objective of Mineral Reserve estimation is the successful extraction and delivery of a Mineral Resource for processing at the grade estimated. Due consideration should be given to the problems associated with selective mining where the cut-off grade is set high relative to the average grade of the Mineral Resource.

Practicality of Mining

The practicalities of the mining/processing rates and methods for a deposit are important considerations in the estimation of a Mineral Reserve. The QP must assess the various proposals when estimating a Mineral Reserve. Care should also be taken to ensure that the mining equipment selected is appropriate for the deposit. Inappropriate equipment selection may have an effect on both dilution and extraction. The QP must have a high level of confidence in the viability of the mining and processing methods considered in determining the Mineral Reserves.

A QP should, when appropriate, consider of alternative mine/plant configurations. Selecting the appropriate mining and processing methods and rates may involve several iterations and will involve input from members of other disciplines. Trial evaluations, referred to as “trade-off” or “scoping” studies, may be required as a prelude to the completion of a Preliminary Feasibility Study.

Project Risk Assessment

While the classification of the Mineral Reserve allows the QP to identify technical risk in broad terms, best practice includes the establishment of a methodology to identify and rank risks associated with each input of the Mineral Reserve estimate. This will assist the QP in establishing the Mineral Reserve categorization, thus providing an understanding of the technical risk associated with the Mineral Reserve estimate. This methodology, ranking and analysis should be well documented.

Peer Reviews

Best practice includes the use of an internal peer review of the Mineral Reserve estimate including inputs, methodology, underlying assumptions, the results of the estimate itself, and test for economic viability.

Audits/Governance

Upon completion of a Preliminary Feasibility Study, or in the case of significant changes to a Mineral Reserve estimate, best practice includes completion of a properly scoped audit carried out by an impartial QP. The audit should consider the methodology used, test the reasonableness of underlying assumptions, and review conformity to Mineral Reserve definitions and classification. The methodology for Mineral Reserve risk identification, assessment and management should also be included in the Mineral Reserve audit. The audit should be documented, distributed and responded to in a manner that recognizes good corporate governance.

Documentation

There are often several iterations of evaluations carried out over a protracted period of time prior to completion of a Preliminary Feasibility Study. Best practice includes appropriate documentation of the inputs/methodology/risks/assumptions used in these valuations so these will be available for future Mineral Reserve estimates.

Information should be easily retrievable, readily available and catalogued in a manner that allows easy assessment of the history of the evaluations carried out and records the location of all relevant information/reports/etc. It is important to ensure that the information used in an evaluation, and understanding gained of a mineral deposit, is available for future work. Care should be taken in storage and consideration given to the continuous evolution of computer file formats and the impact this may have on previous work. File conversion of historic work into formats that allow continued access is recommended.

Mineral Reserve Statements

Mineral Reserve statements should be unambiguous and sufficiently detailed for a knowledgeable person to understand the significance of, for example, cut-off grade and its relationship to the Mineral Resource. In the case of open pit Mineral Reserve estimates, the waste:ore ratio (the strip ratio) should be unambiguously stated. There should be an obvious linkage of the Mineral Reserve estimate to the Mineral Resource estimate provided in disclosure documents. Best practice includes documentation of those linkages (e.g. dilution and mining recovery) that were used in preparing the Mineral Reserve estimation.

8. Reporting

This section is primarily a compilation of references regarding reporting standards that should be considered when preparing reports on MRMR estimates. Although these standards are intended for public disclosure, they also represent the minimum requirement for best practice for all reporting.

National Instrument 43-101, Form 43-101F1 and Companion Policy 43-101CP, establish standards for all oral and written disclosure made by an issuer concerning mineral projects that are reasonably likely to be made available to the public. All disclosure concerning mineral projects including oral statements and written disclosure in, for example, news releases, prospectuses and annual reports is to be based on information supplied by or under the supervision of a QP. Disclosure of information pertaining to MRMR estimation is to be made in accordance with industry standard definitions contained in the CIM Standards which have been incorporated by reference into the NI 43-101.

One of the objectives of the Estimation Best Practice Guidelines is to foster greater standardization of reporting in publicly disclosed documents. The recommendations included below represent further guidance and attempt to develop a reporting template, which should help reporting Canadian companies achieve greater standardization.

The QP should familiarize themselves with current disclosure regulations as part of preparing a MRMR estimate.

Reporting Units

In the preparation of all reports and press releases, either metric or imperial units may be used. However, the following provisos apply:

- Reports must maintain internal consistency – metric and imperial units should not be used in different parts of the same report.
- The mixing of metric and imperial units (e.g. oz/tonne) is never acceptable.

The Committee considers that reporting in metric units is preferable

Technical Reports

A technical report shall be in accordance with Form 43-101F1, NI43-101. The obligation to file a technical report arises in a number of different situations. These are set out in NI 43-101 in Part 4.

The CIM Standards on Mineral Resources and Mineral Reserves referenced in NI 43-101, provide additional guidance for reporting of MRMR estimates. A listing of the main recommendations and requirements is as follows:

(a) The QP is encouraged to provide information that is as comprehensive as possible in Technical Reports on MRMR.

(b) Fundamental data such as commodity price used and cut-off grade applied must be disclosed.

(c) Problems encountered in the collection of data or with the sufficiency of data must be clearly disclosed.

(d) Modifying factors applied to MRMR estimates such as cutting of high grades or resulting from reconciliation to mill data must be identified and their derivation explained..

(e) MRMR estimates are not precise calculations and, as a result should be referred to as estimates.

(f) Tonnage and grade figures should reflect the order of accuracy of the estimate by rounding off to the appropriate number of significant figures.

(g) Technical Reports of a Mineral Resource must identify one or more categories of 'Inferred', 'Indicated' and 'Measured' and Technical Reports of Mineral Reserves must specify one or both categories of 'Proven' and 'Probable'. Categories must not be reported in combined form unless details of the individual categories are also provided. Inferred Mineral Resources cannot be combined with other categories and must always be reported separately.

(h) Mineral Resources must never be added to Mineral Reserves and reported as total Resources and Reserves. MRMR must not be reported in terms of contained metal or mineral content unless corresponding tonnages, grades and mining, processing and metallurgical recoveries are also presented.

(i) In cases where estimates for both Mineral Resources and Mineral Reserves are reported, a clarifying statement must be included that clearly indicates whether Mineral Resources are inclusive or exclusive of Mineral Reserves.

The Estimation Best Practice Committee recommends that Mineral Resources should be reported separately and exclusive of Mineral Reserves.

(j) Mineral Reserves may incorporate material (dilution) which is not part of the original Mineral Resource and exclude material (mining losses) that is included in the original Mineral Resource. It is essential that the fundamental differences between these estimates be understood and duly noted.

(k) In preparing a Mineral Reserve report, the relevant Mineral Resource report on which it is based should be developed first. The application of mining and other criteria to the Mineral Resource can then be made to develop a Mineral Reserve statement that can also be reconciled with the previous comparable report. A detailed account of the differences between current and previous estimates is not required, but sufficient commentary should be provided to enable significant differences to be understood by the reader. Reconciliation of estimates with production whenever possible is required.

(l) Where Mineral Reserve estimates are reported, commodity price projections, operating costs and mineral processing/metallurgical recovery factors are important and must be included in Technical Reports.

The Committee considers that when reporting a Mineral Reserve mineable by open pit methods, the waste-to-ore ration must be disclosed.

(m) Reports must continue to refer to the appropriate categories of Mineral Resources until technical feasibility and economic viability have been established by the completion of at least a Preliminary Feasibility Study.

(n) Reporting of mineral or metal equivalence should be avoided unless appropriate correlation formulae including assumed metal prices, metallurgical recoveries, comparative smelter charges, likely losses, payable metals, etc. are included.

(o) Broken mineralized inventories, as an example, surface and underground stockpiles, must use the same basis of classification outlined in the CIM Standards. Mineralized material being processed (including leaching), if reported, should be reported separately.

(p) Reports of MRMR estimates for coal deposits should conform to the definitions and guidelines on Paper 88-21 of the Geological Survey of Canada. "A Standardized Coal Resource/Reserve Reporting System for Canada".

(q) When reporting MRMR estimates relating to an industrial mineral site, QP must make the reader aware of certain special properties of these commodities and relevant standard industry specifications.

(r) Reports of MRMR estimates of diamonds or gemstones must conform to the definitions and guidelines found in "Reporting of Diamond Exploration Results, Identified Mineral Resources and Ore Reserves" published by the Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories.

> These definitions and guidelines remain in force until/if they are replaced by guidelines of the Diamond Exploration Best Practice Committee, the relevant sections of these guidelines, or other guidelines which may be accepted by the CSA or CIM.

Annual Reports

Written disclosure (including annual reports) of MRMR is covered by Part 3.4 of NI 43-101. Further reference is made in Parts 1.3, 1.4, 2.1, and 2.2 of NI 43-101.

An issuer shall ensure that all written disclosure of MRMR on a property material to an issuer includes:

(a) the effective date of each estimate of MRMR;

(b) details of quantity and grade or quality of each category of MRMR;

(c) details of key assumptions, parameters and methods used to estimate the MRMR;

(d) a general discussion of the extent to which the estimate of MRMR may be materially affected by any known environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues; and

(e) a statement that Mineral Resources which are not Mineral Reserves do not have demonstrated economic viability.

Further to these requirements, the Committee recommends that:

(a) MRMR estimates should be reported as a tabulation;

(b) The name of the appropriate QP must be included with the estimate. The relationship of the QP to the reporting company should be stated. Note that in the estimation of Mineral Reserves, the services of a number of different QP are likely to have been employed. Under CSA guidelines a corporation may designate a reporting QP with overall responsibility for the estimates and, if so, the name must be included. In some Canadian Provinces, it may not be appropriate to designate a reporting QP.

(c) These data remain 'estimates' and should be reported as such.

(d) NI 43-101 Part 3.4 (c) requires those details of key assumptions, parameters and methods used to estimate MRMR must be included. These details could be included as a footnote in the MRMR section:

- Metal prices assumptions.
- Cut-off grades.
- Ore losses and dilution.
- Mill recoveries.
- Estimation methodologies.
- It is essential that the estimates conform to the CIM Standards on Mineral Resources and Mineral Reserves, Definitions and Guidelines, or equivalent foreign code as described in Part 7 of NI 43-101. A note stating the standard being used must be included.
- Year-to-year changes in MRMR must be included, together with the reasons for the changes.
- A statement whether the Mineral Resources are inclusive or exclusive of Mineral Reserves. In the interests of standardization, the Committee recommends that Mineral Resources should be reported exclusive of Mineral Reserves in Annual Reports.
- Date of the estimate of MRMR.

Press Releases

The content of press releases discussing MRMR is covered in Section 3.0 of Appendix B of Disclosure Standard No. 1450-025 of the Toronto Stock Exchange (TSX), and Corporate Finance Manual Appendix 3F-Mining Standards Guidelines-Policy 3.3-Timely Disclosure of the TSX Venture Exchange.

Section 3.1 (Definitions) states that estimates 'must conform to the definitions contained in NI 43-101'. Section 3.2 (Use) covers a number of points regarding reporting:

- All MRMR estimations must disclose the name of the QP responsible for the estimate and the relationship of the QP to the reporting company. The company must also state whether, and how, any independent verification of the data has been published.

- The statement must make a clear distinction between Mineral Resources and Mineral Reserves.

- MRMR should, wherever possible, be published in such a manner so as not to confuse the reader as to the potential of the deposit. Inferred Resources must not be aggregated with Indicated and Measured Resources. Any categories of MRMR that are aggregated must also be disclosed separately.

- When Mineral Reserves are first reported, the key economic parameters of the analysis must be provided. These will include:

  - Operating and capital cost assumptions.

  - Commodity prices (If commodity prices used differ from current prices of the commodities which could be produced, an explanation should be given, including the effect on the economics of the project if current prices were used. Sensitivity analysis may be used in this section).

  - All reported quantities of MRMR must be expressed in terms of tonnage and grade or characteristics. Contained ounces must not be disclosed out of the context of the tonnage and grade of a deposit.

  - MRMR for polymetallic deposits may not be disclosed in terms of 'metal equivalents' except in limited circumstances as set out in NI 43-101F1, 19(k) and in the CIM Standards on MRMR. It is also inappropriate to refer to the gross value or in situ value of MRMR.

The Committee recommends that any press release that reports initial estimates of MRMR include all of the information listed under 'Annual Reports' above. Subsequent press releases may refer back to the initial press release. It should be noted that the CSA is reviewing this requirement.

AIFs

The requirements for reporting for an AIF (Annual Information Filing) are set out in the CSA document National Instrument 44-101 and Form 44-101F1.

9. Reconciliation of Mineral Reserves

Production monitoring and reconciliation of Mineral Reserves are the ultimate activities by which the QP can continuously calibrate and refine the Mineral Reserve estimate. While this section is primarily concerned with Mineral Reserves, the only valid confirmation of both the Mineral Resource and Mineral Reserve estimate is through appropriate production monitoring and reconciliation of the estimates with mine and mill production.

The QP must take into consideration the results of any grade-tonnage reconciliation in any public disclosure of MRMR estimates.

Production monitoring is the grade control and tonnage accounting function performed at an operating mine. This function provides the information required to minimize dilution, maximize mineral recovery and supply a consistent and balanced feed to the process plant as required. Grade and tonnage control comprises representative sampling of production sources, establishing ore/waste boundaries and accurately recording production tonnes and grade.

Reconciliation is required to validate the Mineral Reserve estimate and allows a check on the effectiveness of both estimation and operating practices. Since the MRMR estimates are based on much wider spaced sampling than used for production, reconciliation identifies anomalies, the resolution of which may prompt changes to the mine/processing operating practices and/or to the estimation procedure.

Production Monitoring

The following should be given consideration in effective production monitoring and forms part of an ongoing quality control program, which takes into account the closer spaced production sampling and mapping:

Minimize Dilution/Maximize Mineral Recovery

- When ore/waste contacts are visual, mine operators can classify ore and waste easily and send material to the correct destination, however, production monitoring is still required.

- Where assay boundaries are used to delineate ore, appropriately spaced representative samples are required to estimate the locations of economic margins.

- Given the negative economic consequences of misclassification, diligence is necessary to ensure that mined ore and waste types are delivered to the appropriate destinations.

Characterize the ore to ensure the requested metallurgical balance is achieved.

- This may require geological mapping and logging of blast hole chips if ore types are visually distinguishable.

- Where characterization is non-visual, other testing is required to achieve appropriate blending.

Characterize waste to allow for potential mixing (blending) or separation based on environmental requirements (e.g. acid rock drainage control).

Monitor deleterious or by-product constituents that might compromise or enhance mill recoveries and concentrate quality.

Record accurately production tonnes and grade to permit reconciliation of mine production to the processing facility and ultimately to the Mineral Reserve estimate. Mine production needs to be reconciled to mine surveys on a regular basis, commonly monthly.

Ensure that accurate measurements of in-situ bulk densities for various ore and waste types have been determined so that volumes can be converted appropriately to tonnes. Periodic checks are required of in situ bulk densities, truck and bucket factors and weightometers.

Develop appropriate sampling protocols and continuously evaluate them to ensure representative sampling in both the mine and plant.

Ensure that acceptable QA/QC procedures are being followed at all laboratories being utilized.

Maps of workings/benches at appropriate scales must be kept current to provide:

- Geological information to compare to the MRMR model and update where appropriate.

- Ore type classification information to compare to the MRMR model and provide data for blending requirements of the process plant.

- Structural information that may impact MRMR continuity or provide valuable geotechnical information.

- Current, detailed, grade distribution from production sampling which, when combined with geological information, may be used to improve the grade interpolation in the MRMR estimation process.

- Information that will assist in quantifying dilution and mining losses, which can be used for future MRMR estimations.

Volumetric surveys should be retained so they can be used for future reconciliations.

Production Reconciliation

The following should be considered in undertaking production reconciliation:

Reconciliation of Mine and Mill

- Reconciliation between the mine and mill production should be done on a regular basis but monitored on a daily basis to ensure accuracy of sampling and record keeping. Current best practice is considered to be reconciliation on a monthly basis.

- A reconciliation provides checks for discrepancies, which may require changes to operational procedures or the MRMR model.

- Mine production is usually reconciled to the plant since measurement in the plant is generally accepted to be more accurate. Significant discrepancies and resulting adjustment factors should be explained and reported.

- On a yearly basis, mill production should be reconciled with the final concentrate, bullion or mineral shipped and resulting adjustment factors should be explained and reported.

Reconciliation of Production and MRMR estimates:

- Reconciliation should be done at least annually to coincide with the corresponding MRMR statement.

- Reconcile production to estimated depletion of Mineral Reserves; any discrepancies in grade and/or tonnes should be explained and appropriate changes should be made to operating practice or the MRMR estimation process.

Annual Review of Remaining MRMR

- Remaining MRMR at operating mines should be reviewed at least annually and should reflect changes in the underlying criteria, including long term commodity price forecasts, increases or decrease in costs, changes in metallurgical processing performance, and changes in mining methods, dilution or mining recovery.

- Cut-off grades or economic limits should be reassessed and updated at least annually.

- Remaining MRMR should be adjusted for improved geological interpretation due to drilling or mapping.

- The rationale for any changes to operating practice or to MRMR estimation procedures must be documented.

End-of-year MRMR estimates should be reconciled with previous year's MRMR estimates by showing a balance sheet detailing the changes due to mining extraction, commodity price change, cost changes, additions or deletions due to drilling or mining losses/gains, among others.

Selected References

The Committee considers that there are several documents and publications which are essential or useful in dealing with best practice requirements for the estimation of MRMR.

CIM Standards on Mineral Resources and Reserves – Definitions and Guidelines. Prepared by the CIM Standing Committee on Reserve Definitions, October 2000. CIM Bulletin Vol. 93, No. 1044, pp 53-61

Vallée, M. and Sinclair, A.J. (eds.) (1998), "Quality Assurance, Continuous Quality Improvement and Standards in Mineral Resource Estimation" Exploration and Mining Geology (Volume 7, nos. 1 and 2, 1998).

Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice, Monograph 23. Editor: A.C. Edwards, The Australasian Institute of Mining and Metallurgy: Melbourne.

National Instrument 43-101 – Standards of Disclosure for Mineral Projects. Ontario Securities Commission Bulletin 7815, November 17, 2000.

Exploration Best Practice Guidelines: Included in 'CIM Standards on Mineral Resources and Reserves - Definitions and Guidelines'. Prepared by the CIM Standing Committee on Reserve Definitions, October, 2000. CIM Bulletin Vol. 93, No. 1044, pp 53-61.

Guidelines for the Reporting of Diamond Exploration Results. Available at www.cim.org and in press.

Guidelines Specific to Particular Commodities

It is recognized that further development of the Estimation Best Practice Guidelines is required. It is intended that the Committee will continue to work toward development of guidelines specific to particular commodities such as diamonds, coal, oil sands, industrial minerals, laterites and potash.

Potash

Sub-committee Members
Gord Phillips – Potash Corporation
Dave Mackintosh – Agrium Potash Operations
Alan Coode – IMC Global
Colin Howard – IMC Global
Greg Schmidt – IMC Global
Peter Brown – IMC Global

Geological Interpretation

The potash deposits that are located in Saskatchewan, Canada, are characterized by their remarkable consistency of grade and thickness over many tens of kilometres. It is therefore possible to characterize a deposit with a relatively few drill holes, supplemented by sufficient seismic coverage to establish continuity between holes. There are however local disruptions of the deposit, either structural or mineralogical, which may preclude mining. The MRMR problem for potash is almost the inverse of that for other mining operations in that much of the exploration effort is directed at defining the location and size of the non-mineable areas within an otherwise continuous Resource.

Identification and delineation of the non-mineable portions of a deposit may be accomplished through direct observation (mine openings, drill holes) or may be by inference such as through the interpretation of seismic or other geophysical data, or combinations of direct and indirect methods. The assumptions behind any such inferences should be clearly stated or the relevant reports referenced. Similarly, barrier or safety pillars may be left around such features; the factors used to determine the size of these pillars should also be stated.

The potash deposits located in New Brunswick, Canada, are much more complex structurally than those in Saskatchewan, and much less extensive, such that a more conventional approach to MRMR is appropriate.

Mining and Economic Requirements

An 'Economic Radius' must be considered when estimating potash reserves. This is the distance from the shafts beyond which it will no longer be economically possible to mine, somewhat analogous to a cut-off grade in that it is a function of market conditions and mining costs. It is also subject to change over time.

A cut-off grade does not normally apply, except to define the presence of impurities (such as carnallite), which can contaminate the ore so that the cost of mining and processing is more than the revenue.

Industrial Minerals

Sub-committee Members
Heather L. Miree – Dynatec Corp.
Don Hains – Hains Technology Associates
W.J. (Jack) Mullins – Watts, Griffis and McOuat

Preamble

An Industrial Mineral is any rock, mineral or other naturally occurring substance of economic value, exclusive of metallic ores, mineral fuels and gemstones; that is, one of the non-metallic minerals.

The General Guidelines and main elements of the current CIM Best Practice draft are for the most part, readily applicable to industrial minerals deposits. However, in estimating either a Mineral Resource or a Mineral Reserve for an industrial mineral deposit, the QP should give priority to: (i) the value of the intended mineral product; (ii) market factors; and (iii) applicability of the market criteria to the mineral deposit being assessed.

Estimation of MRMR for industrial minerals requires special care. The classification of an industrial minerals deposit as a MRMR is affected to a significant degree by a number of factors that are less applicable to metallic mineral deposits, including: particular physical and chemical characteristics; mineral quality issues; market size; the level of the producer's technical applications knowledge; market concentration; and transportation costs.

The CIM Standards on Mineral Resources and Mineral Reserves, Definitions and Guidelines, dated August 20, 2000 (the "CIM Standards", NI 43-101 and Companion Policy 43-101CP) state that: "*When reporting Mineral Resource and Mineral Reserve estimates relating to an industrial mineral site, the Qualified Person(s) must make the reader aware of certain special properties of these commodities*". Best Practice in the estimation of MRMR of industrial minerals centres on determination of components of the Market, Value, and Costs.

Market considerations incorporate not only the requirement for detailed market analyses and/or contracts of sale, but also recognition that markets for many industrial minerals are relatively small, may have a high degree of producer concentration, or may have very high technical barriers to entry, thus imposing limits or constraints on achievable market volumes.

Value is a function of (*i*) product quality in relation to consuming industry or customer specification, (*ii*) product price, and (*iii*) project robustness.

Costs are comprised of (*i*) mining costs, (*ii*) processing costs, and (*iii*) transportation and special handling costs.

The key to estimation of MRMR, in particular for industrial mineral deposits, is the recognition by the Qualified Person(s) of the inter-relationship that exists between (*i*) markets, (*ii*) product evaluation, and (*iii*) product development. Dialogue between seller and buyer must start early in the exploration program and continue right through to production.

The estimation of MRMR is likely to be an iterative process where increasingly rigorous assessment is applied in order to attain greater confidence and higher rank in the Mineral Resource/Mineral Reserve classification. An estimate need not attain or incorporate a rigorous and complete understanding of all factors and inter-relations at an early stage in the life of a project. The classification of the mineral deposit as Inferred, Indicated or Measured Mineral Resources, or Probable/ Proven Mineral Reserves should always reflect the level of understanding of the project, which is a function of the stage of exploration/development.

In addition to the General Guidelines, and in particular with respect to industrial minerals deposits, the assessment of the various characteristics of the deposit as well as quality and market factors should be taken into account with respect to the following:

Mineral Resource Estimation

Critical elements to the Mineral Resource estimate for industrial minerals are: (i) the consideration of the physical and chemical properties of the subject mineral; (ii) the spatial relationship of these properties within the mineral occurrence; and (iii) the relationship of the physical and chemical properties of the mineral to the available market(s).

The QP should also recognize that optimization of the Mineral Resource estimate in consideration of applicable economic parameters is an iterative process and that resource estimates should be adjusted to reflect new market information.

In addition to the parameters included in the General Guidelines, it should be emphasized that in completing a MRMR estimate for an industrial mineral deposit, the application of *reasonably developed* economic parameters is crucial to the *reasonable expectation* and/or *demonstration of economic viability* of the deposit. As stated in the General Guidelines, consideration of economic parameters is an iterative process based on generally accepted industry practice and experience. The judgment of the individual QP will also be a factor in evaluating the economic parameters applicable to industrial mineral deposits.

It is recognized that the rigorousness of the estimate, particularly with respect to market factors, shall take into account an appropriate level of detail in consideration of: (i) the stage of the project; (ii) availability of appropriate information; (iii) the level of investment required to place the project into production; and (iv) financial ability of the entity to conduct research. Given the above, an entity or QP shall none the less prepare the estimate to the best of its practical ability, clearly stating where additional information is required in order to increase confidence in the estimate of the MRMR.

In general, estimation methods used for industrial mineral deposits are the same as the methods used for metallic mineral deposits, and the reader is referred to the appropriate section of the 'General Guidelines' with respect to considerations of:

Data Density
Integration of Geological Information
Listing/Recording of Data Set
Data Analysis
Sample Support
Economic Parameters
Mineral resource Model
Interpolation Method
Mineral Resource Validation

However, the QP should take note of the following considerations when developing a Mineral Resource estimate for an industrial minerals deposit:

- Industrial mineral deposits differ significantly from other, more typical metallic mineral deposits and even amongst themselves. These differences may be reflected in the data density required for certain confidence intervals. For example, the sampling points (e.g. drill holes) required for an industrial mineral deposit that exhibits strong structural and grade continuity (e.g. a bed of homogeneous limestone) may be more widely spaced than they would be for a typical volcanogenic massive sulfide (VMS) deposit where either structure and/or grade are less uniform. In other cases, the converse may apply. The QP shall use reasonable judgment in the context of the deposit type, style and formation of the particular mineral deposit being assessed, and the objective of the estimation process (i.e. Inferred, Indicated or Measured Mineral Resource/Probable or Proven Mineral Reserve).

- Customer specifications for industrial mineral products are frequently based solely on physical properties rather than, or in addition to, chemical characteristics. Sample testing should include those tests that will provide the physical characteristics and chemical analyses that relate to the specifications of the end product.

- An industrial mineral may have multiple market applications or it may be included in multiple end-products. It is essential to determine the physical and chemical characteristics of the industrial mineral in sufficient detail that its appropriateness for *each* intended market can be assessed.

- Determination of the chemical and physical characteristics of an industrial mineral often involves procedures and tests that are not part of the normal activity of an analytical laboratory. The QP should ensure that the physical and chemical analytical work conducted on the industrial mineral is appropriate and relevant to the identification of the properties of interest in the intended application(s), and that the laboratory has the requisite experience and necessary equipment to conduct the required tests.

- The properties of an industrial mineral occurrence can vary markedly from location to location and even within the same deposit. In particular, many industrial minerals deposits are subject to a nugget effect. The nugget effect may be caused by grain size (e.g. large crystals in pegmatites may distort sample results). Within the context of a particular deposit or deposit type, a sufficient and appropriate number of samples may be required to ensure that: meaningful average sample results are obtained; impurities or other detrimental factors are identified and delineated (impurities may be localized and the sampling density and estimation method employed should recognize this fact); and using appropriate statements reflecting analytical precision (mineral quantification and some other analytical techniques are less precise than standard chemical analyses, thus necessitating the use of averages over a large number of samples).

- Multiple factors may be used in evaluating the quality or value of an industrial mineral during the MRMR estimation process. The QP should be aware of the methods available to estimate the "value" of each block of a resource, and justify the selection of the method employed. Among the techniques available for combining values are the following:

    1. Estimate the main variable (e.g. mineral percent) and use the other variables as indicators. The reason for this is that the potential for error may be greater when the estimation method used is conditionally biased for one or all of the quality parameters. The resource will then include only those blocks that exceed the minimum specifications for all parameters. While this approach may lead to the exclusion of marginal blocks from the resource, these marginal blocks could be mined and blended with other material to provide a product that meets the required specifications.
    2. Estimate each factor separately. Each block is then accepted or rejected (with or without blending with another block or blocks).

Adequate data is required, and an appropriate estimation method is needed, for each factor.

3. Use co-kriging or other geostatistical methods which take into account the correlation between factors. This method is useful where one factor is better known than others. Applied sensibly, it effectively maximizes all of the available data.
4. Use categorical variables. This approach is particularly applicable in cases where value is affected by a number of co-variables, some of which are semi-qualitative. By treating each variable as a categorical variable and then combining those into an "index" which can estimated by geostatistical or other means, subjective evaluation is avoided. This method may be especially useful in estimation of resources/reserves in stone quarries and other working deposits.

- Published specifications and standards for industrial minerals should be used primarily as a screening mechanism to establish the marketability of an industrial mineral. The suitability of an industrial mineral for use in specific applications can only be determined through detailed market investigations and discussions with potential consumers.

- The QP should be aware that test results for industrial minerals, especially those related to the results of beneficiation tests, could be subject to significant scale-up effects. The QP should ensure that laboratory test procedures adequately duplicate the proposed production process. In many cases, bulk samples as large as 500 tonnes may be required. This may necessitate start-up of production prior to finalization of sales contracts.

- Identification of the market and the factors that influence market demand and the potential for success in the market are critical to determining 'value' for an industrial mineral and therefore the classification of the mineral deposit as either a Mineral Resource or Mineral Reserve. The QP should take careful note of the following considerations when evaluating the market potential for an industrial mineral deposit:

  1. The market for an industrial mineral resource is not usually a single entity, but typically consists of a number of distinct segments. It is important to recognize the differing requirements of each market segment and to relate these requirements to the physical and chemical properties of: (i) the industrial mineral in the particular deposit being assessed; (ii) the proposed production and processing technology for the mineral product; (iii) the applications knowledge of the mineral producer; (iv) the market size available in each segment; and (v) the price available for each market segment.

  2. Markets for industrial mineral resources are significantly affected by location and transportation factors. The QP should recognize that the existence of an industrial mineral deposit does not imply that it comprises a Mineral

Resource as defined by the CIM Standards and NI 43-101. . Under the definitions of the CIM Standards, a mineral occurrence must have “reasonable prospects of economic exploitation” to be classified as a Mineral Resource; or it must be “demonstrated as being capable of profitable exploitation” to be classified as a Mineral Reserve. If the mineral deposit is in a remote location, distant from transportation infrastructure and customers, so that there may be no realistic market or development potential for the mineral, the mineral deposit **cannot** be classified as a MRMR.

3. Some industrial minerals are produced in small quantity and/or have specialized, low volume applications. The QP should understand the limits to market size for an industrial mineral and develop estimates of a Mineral Resource or Mineral Reserve that are consistent with the appropriate market size for that particular mineral product.

4. Many industrial minerals are produced by only a small number of companies. In these cases, there may be high barriers to market entry by a new producer. These barriers can include proprietary processing knowledge and/or equipment, knowledge of mineral end use applications, long term contractual producer/customer relationships, or captive consumption. Before estimating either a MRMR in such circumstances, the QP should conduct sufficient investigationss to ascertain that an identifiable market can be developed, that the intended product can indeed be sold, and that there is a reasonable expectation that the mineral deposit could be placed into commercial production.

5. Many applications for industrial minerals can be satisfied by several competing minerals offering similar functional properties, and often at similar costs. The QP should therefore be aware of the potential for product substitution when evaluating the market potential of an industrial mineral. Estimates of a MRMR should incorporate provision for product substitution when establishing the anticipated level of market demand and/or market price for the subject mineral.

6. Many industrial minerals consumers are reluctant to change sources of supply. Even when consumers are willing to change sources of supply, the time frame in which this occurs may be quite lengthy. The QP, in developing estimates of MRMR, should therefore incorporate provision for an extended period of customer applications trials and/or the requirement for large-scale bulk sampling.

7. Published prices for industrial minerals may be used as indicators of value in the estimation of MRMR, but should be supplemented by additional pricing research to determine the potential value of the subject commodity. Published

prices and actual transaction prices for a particular grade of an industrial mineral may vary substantially. As far as possible, the QP should ensure that price estimates used in estimation of a Mineral Resource, and especially those used in estimation of a Mineral Reserve, can be confirmed by discussion with potential customers and/or commitments of sale.

8. The QP should recognize that specifications for industrial minerals in many applications are flexible. Consumers may be able to incorporate minerals with a wide variety of physical and/or chemical properties into their product either by adjusting the mixture of ingredients used in the manufacturing process, or by making modifications to the process. In many cases, consistency or predictability of characteristics of the industrial mineral is more important than a specific quality characteristic.

9. Prices and specifications for industrial minerals are usually established by negotiation between producer and consumer. Slight differences in specifications may result in very large differences in price and/or volume, and contracts are sometimes written for large tonnages of a product at a special confidential price. The QP should recognize such considerations when developing the MRMR estimate.

Mineral Reserve Estimation

In addition to the General Guidelines, it is intended that estimation of a Mineral Reserve for an industrial mineral deposit should incorporate more rigorous research and assessment of the criteria than that outlined for estimation of a Mineral Resource in the previous section.

Some industrial mineral ventures are relatively simple operations with low levels of investment and risk, where the operating entity has determined that a formal pre-feasibility or feasibility study in conformance with NI 43-101 and 43-101 CP is not required for a production decision. The demonstration of the economic viability of an industrial minerals deposit, as required under the General Guidelines, may be satisfied by actual profitable production. Alternatively, where production has not yet commenced, there should be evidence of market and economic analyses consistent with sound judgement reflecting the spirit and intent of the requirements of NI 43-101 and 43-101 CP. However, the lack of a formal pre-feasibility or feasibility study with respect to a venture should be clearly communicated to current and potential stakeholders as this may be considered a risk factor.

As stated in the General Guidelines, the QP should recognize that the time from discovery to development of a mineral deposit could be measured in years. The QP should be aware of the impact of changing conditions in the industrial minerals commodities, as outlined above, on Mineral Reserve estimates. The parameters that are used as a basis for the estimates should be updated at appropriate intervals to take into account significant changes that may affect the economic viability of a project. Changes in market factors are particularly important.

Coal

Sub-committee Members
Don Mills-Fording Coal
Colin McKenny-Fording Coal
Geoff Jordan-Norwest
Gary Johnston -Luscar Coal
Dave Hughes- Geological Survey of Canada
Carel van Eendenburg-Teck Cominco
Paul Bankes-Teck Cominco

Preamble

Coal depositional environments and processes for coal accumulation include aspects that are fundamentally different from those that apply to most other mineral deposits, especially to metals deposit equivalents. Because of these geological factors and since coal is a low unit-value, bulk mining material, some procedures for the documentation of the geology and resources of coal deposits have evolved that are specific to the needs of the coal industry. Geological Survey of Canada Paper 88-21, "A Standardized Coal Resource/Reserve Reporting System for Canada", is referenced by National Instrument 43-101 for the preparation of MRMR estimates on coal deposits.

GSC Paper 88-21 outlines definitions, concepts and parameters used to determine coal resource and reserve quantities, and provides a framework to facilitate consistent categorization of coal quantities found within various depositional and tectonic regimes. With respect to coal MRMR estimation and reporting, the standards in GSC Paper 88-21 supersede the preceding Best Practice Guidelines.

GSC Paper 88-21, includes some concepts and procedures that are significantly different from those of the CIM Standards. While it is essential that the full text of GSC Paper 88-21 be consulted for details, the four major differences between the preceding Best Practice Guidelines and GSC Paper 88-21, apply to the following aspects:

- Resource/Reserve Classification;
- Economic Evaluation Reports;
- The application of mining criteria to coal resource estimation; and
- Methods and Procedures of Evaluation

Definitions and Concepts

Unlike the CIM Standard, GSC Paper 88-21 describes a coal resource classification system with four subdivisions. The four classes include Measured, Indicated, Inferred and Speculative. The list in this order represents decreasing available data for resource evaluation and a progressive decrease in the confidence level that can be given to the estimates that are made. The inclusion of the Speculative class recognizes that coal deposits tend to be geologically continuous over much larger areas than most other types of mineral deposits, even if the character of the coal zones change through such processes as "splitting" and "seam thinning". The criteria that should be applied to the determination of each coal class are fully described in GSC Paper 88-21.

In GSC Paper 88-21 the distinction between the classification of estimated coal tonnage depends on whether work to determine the economic merits of the deposit has been completed or not. This work specifically includes mining engineering evaluations and, most importantly, the preparation of an appropriate cash flow analysis. These aspects are normal components of both feasibility studies and preliminary feasibility studies. When GSC Paper 88-21 was prepared, no distinction was made between these studies, and the existence of either was intended to be the basis for the definition of resources as reserves. To be able to define reserves in a given coal deposit, it is necessary to have performed at least a preliminary feasibility study on the deposit.

GSC Paper 88-21 specifies the use of numerous mining criteria for the definition of in-place coal tonnage estimates as resources. While there is an economic element associated with the application of each of these, the use of them for resource estimation purposes is not intended to define the economic merits of a particular coal deposit nor to be used as a substitute for the completion of a feasibility study. The use of these criteria is only intended to limit the inclusion of resource material to that which may qualify as, or have potential to be classified as a reserve in the future. The parameters address both underground and surface mining methods and include criteria for limits to seam thickness, depth and distances from points of observation. The determination of density in coal is also discussed. For surface mining resource estimation, values for the limits to cut-off strip ratios are also provided.

Resource Database

Potential mining targets for coal often cover very large areas compared with those of metal equivalents. It is quite common to have drilling data for a single mining target with hundreds or even thousands of drill holes. Different evaluation aspects of a single mineable deposit, such as geophysical logging, mapping, drilling, coal quality and geotechnical data collection, may also be obtained in different exploration programs or seasons. These aspects may impede the practical ability to incorporate all exploration data for a particular mining deposit into a single, fully integrated database; it is frequent industry practice to perform coal evaluations using several separate databases.

Methods of Testing and Analysis

The Coal Industry generally uses "ASTM standards Volume 05.06 - Coal and Coke" as its standard relating to all its analysis of coal and related products. The standards in this volume cover the areas of sampling, sample preparation, assaying and data presentation.

ASTM (the American Society for Testing and Materials), founded in 1898, is a scientific and technical organization formed for "the development of standards on characteristics and performance of materials, products, systems, and services; and the promotion of related knowledge." It is the world's largest source of voluntary consensus standards. The Society operates through a system of main technical committees and subcommittees whose function is to review and update the standards where necessary that ensure balanced representation among producers, users, general interest, and consumer participants. Reference: Annual book of ASTM standards Volume 05.06 Coal and Coke. ASTM stands for American Society for Testing and Materials.

Accurate coal tonnage estimates are very dependent on the use of the correct factors for volumetric conversion. GSC Paper 88-21 includes a discussion of this issue and the use of bulk density values to make the correct conversion. It is important the QP realize that Bulk Density and Specific Gravity of coal are parameters with very different values. In no circumstances should specific gravity values be used as a substitute for bulk density to estimate coal tonnage.

Geophysical logging of coal exploration holes should be performed as best practice in jurisdictions where it is not legally required. QA/QC procedures for these activities should be followed.

Geological Interpretation

A fundamental concept in coal resource classification under GSC Paper 88-21 is the geological complexity of a deposit, which determines the parameters used to categorize resources according to the probable mining method, assurance of existence and feasibility of exploitation. Geological complexity addresses differences in the complexity of seam geometry within coal deposits. These differences may result both from sedimentary processes at the time of deposition and from subsequent deformation, which may have folded and faulted the coal measures. Primary categories are termed low, moderate, complex and severe. The low category is further subdivided into three subdivisions termed A, B and C based on the sedimentologically controlled complexity of seam geometry.

Production / Reserve Reconciliation

The QP should ensure that in operating mines, appropriate procedures are in place and maintained to monitor production results. In particular, the operating data that relate to the factors and parameters by which in-place reserves are converted to recoverable and saleable reserves should be collected and reviewed on a regular basis. These should include but not be limited to:

- bulk density
- minimum mineable coal thickness
- maximum parting thickness
- waste rock dilution
- mining recovery factors
- processing recovery factors
- environmental considerations

In more complex geological settings, detailed structural information obtained during production activities may give cause to a re-interpretation of adjacent mineral reserves.

At least once a year, the QP should review the results of the production monitoring program and re-evaluate the validity of the parameters used in the MRMR estimates.

Uranium

Sub-committee Members
Alain Mainville, Cameco Corporation, Saskatoon
Tom Pool, Nuclear Fuels Corporation, Denver
E.A.G. (Ted) Trueman, Trueman Consulting Ltd., Denman Island, B.C.
Donald M. Ward, B.A.Sc., retired, Crofton, B.C.
Neil D.S. Westoll, Neil D. S. Westoll & Associates Ltd., Oakville, Ontario

Preamble

The distinguishing aspect of uranium, and its associated daughters, is radioactivity. This characteristic is highly beneficial in assay determination, grade control and ore sorting, although it does impose environmental, health and safety concerns. Exploration, development and mining of uranium are tightly regulated activities.

The General Guidelines for other metals, outlined in the Best Practice Guidelines (June 24, 2002 draft) are also applicable to uranium deposits. However, because of the radioactive nature of uranium, and in some cases the amenability of this metal to In Situ Leach (ISL) mining methods, additional guidelines are appropriate.

Qualified Person

A QP must be familiar with the radioactive nature of uranium, thorium and potassium minerals, and the characteristics of the radioactive decay series, which result in various uranium isotopes and other daughter products. A QP must also be familiar with equipment and techniques used in acquiring radiometric data, and with methods for Quality Assurance (QA) and Quality Control (QC) specifically applicable to uranium.

Definitions

Disequilibrium: An imbalance between the uranium content and the radioactivity emitted by a given volume of mineralized rock. This imbalance is caused by either differential mobilization of the more soluble uranium from the deposition site, relative to its daughter isotopes, or by a lack of time for the accumulation of the daughter isotopes to reach a state of equilibrium after the uranium has been deposited. Generally when the decay series is in equilibrium the gamma plus beta radiation is proportional to the amount of uranium present. Disequilibrium is particularly prevalent in sandstone-hosted uranium deposits within a dynamic hydrologic regime, where mobilization of the uranium out of the deposition site results in an overestimation of the uranium content, based on radiometric measurements. Conversely, in a geologically young environment, a deficiency of daughters relative to uranium will cause an underestimation of uranium content based on radiometric methods. The degree of Disequilibrium may vary from place to place within a deposit.

Equivalent Assay: Determination of uranium content by radiometric methods. The validity of Equivalent Assays must be demonstrated with chemical assay determinations. Where employed, equivalent uranium determinations should be reported and appropriately illustrated in the database (e.g. eU_3O_8).

In Situ Leach (ISL): Removal of the valuable components of a mineral deposit without physical extraction of the rock (see Selected Reference, World Nuclear Association, 2001). The orebody must be permeable to the leach solutions and situated such that ground water in proximity will not be contaminated by mining operations.

K Factor: A factor determined for each radiometric logging apparatus in order to standardize Equivalent Assays. Each logging unit, probe etc. must be individually calibrated to determine its own K Factor. K Factors can be determined from specially designed calibration pits, reference sources or cored holes. If cored holes are utilized, core recovery must be close to 100%, and core assays must be representative of the full range of assay data.

Resource Database

Radioactivity associated with uranium provides additional data sets that can be used to characterize a deposit. Radiometric data may form much of the grade information from which a MRMR estimate is compiled. QC for radiometric data should be as rigorous as that for chemical assays from an analytical laboratory. Data should be clearly identified as to its derivation (e.g. radiometric, chemical analysis, etc.).

QC of radiometric data can be achieved only through a rigorous, ongoing program of calibration of individual assaying and logging tools. A QP will understand that the process of calibration of these tools is closely akin to both the process and the importance of check assays for a chemical laboratory. Radiometric data must be validated against chemical assay data in order to: 1) ensure proper calibration of assaying and logging tools, and 2) determine the degree to which Disequilibrium may be present. Best Practice dictates that an overall factor for Disequilibrium should be compiled for each deposit and adjusted as additional information is obtained. Such factors are recognized and accepted in the industry. Disequilibrium problems may be overcome through the use of direct measuring methods such as neutron activation or prompt-fission neutron logging tools. Such use, however, does not obviate the need for data validation through chemical assays.

Radiometric assaying of rock samples (e.g. core, muck, channel, etc.) allows for fast and inexpensive uranium determinations once appropriate procedures are established and instruments are calibrated. As is done in preparation for chemical assaying, samples are crushed, pulverized, homogenized, and representative fractions taken. Standard samples are run, and background readings are taken on a regular basis to ensure that precision is maintained. Calibration samples, blocks or pads are frequently employed. Radiometric assaying equipment, provided that it has been properly calibrated, can also be employed to provide immediate grade determinations by scanning ore faces, muck piles, conveyor belts, etc. in operating mines.

Radiometric data are often acquired by down-hole electric logging techniques and may be either indirect, as in the form of gamma logging, or direct, as in the form of prompt-fission neutron logging. Down-hole logging plays a vital role because it allows for use of fast, lower cost drilling methods, such as percussion or rotary drilling, and the continuous nature of the data also provides a complete profile where core recovery is poor or non-existent. If equipment allows, both electronically recorded data files and graphical representations of radiometric data should be collected. Equivalent Assays from radiometric logging may be calculated from either electronically recorded data files or from digitization of graphical representations; however, once a method is chosen it should be used exclusively. When the precision of Equivalent Assay data has been demonstrated, the Equivalent Assay data may be merged with chemical assay data from drill core in the database for the MRMR estimate. Data from non-core drill holes may provide a considerable portion of the database; however, in order to satisfy QA/QC of radiometric data, and provide geological information for deposit interpretation, core drilling is also required. Representative core or rock samples must also be available from throughout the deposit in order to provide an accurate determination of density for tonnage estimation. All cored holes should be radiometrically logged to ensure continuity within the database and for calibration of logging equipment. All data must be clearly identified as to the source of the information (e.g. diamond drill core versus percussion holes; radiometric versus chemical analyses).

The drilling process often contaminates a portion of a drill hole, down-hole from a uranium intersection, through smearing of cuttings. Dissemination of radon in the hole and mass effect of high-grade intersections may also inflate Equivalent Assays. These characteristics can result in the grade and thickness of an intersection being overstated during radiometric probing and results must be adjusted accordingly. The QP must be cognizant of these problems and ensure that appropriate QA measures are incorporated.

Probe measurements are sensitive to a number of factors such as presence of rods and/or casing in the hole, thickness and types of metal in rods and casing, hole diameter, medium (air or water), logging speed, and probe characteristics (e.g. diameter, type, dead-time & measuring interval). Therefore, the names, models and serial numbers of all equipment used, and the particulars of each hole, should be recorded on drill hole logs. In addition, factors for the above sensitivities should be determined, maintained, and applied to obtain corrected results. Each logging unit, probe etc. must be individually calibrated to determine its own K Factor. Equivalent Assays determined from different units may then be merged into the database for a MRMR estimate. Holes are usually logged from the bottom up, after slowly lowering the probe in order to identify radioactive sections, to maintain optimum logging speed and zero the depth measurements. Radiometric logging of bore holes primarily measures gamma rays due to their higher penetration properties than beta or alpha particles.

Geological Interpretation & Modeling

Like other deposits of metallic minerals, uranium occurs in many different geological environments. The QP must identify the style of mineralization, determine a geological model and, fundamental to a MRMR estimate, ensure a valid geological interpretation of the mineralized zone. In this respect there is no significant difference between uranium deposits and other metal deposits. However, the geological setting of a uranium deposit may also be of importance in determining if Disequilibrium exists or in identifying potential for ISL exploitation. Graphical representations of radiometric logs are invaluable for geological correlation between drill holes.

Mineral Resource Estimation

The General Guidelines of the Estimation of Mineral Resources and Mineral Reserves document apply to uranium deposits. In addition, the following guidelines apply.

The value of a commodity is obviously fundamental to a resource estimate. However, the price of uranium at any given time may not be known with accuracy as most uranium is sold under long-term, confidential contracts. A spot price, which generally represents the minimum prevailing market value, is readily available. Other sources, such as the International Atomic Energy Agency (Red Book), Government of Saskatchewan Mineral

Statistics Yearbook, the Euratom Supply Agency, and the U.S. Energy Information Administration, provide indications of recent contract prices. The QP should ensure that the uranium price used in a MRMR estimate is in line with available pricing information.

Some unconformity-related deposits, such as those in northern Saskatchewan, are unusually high-grade and contain huge quantities of uranium, but are volumetrically small. As such they require particular attention with respect to certain parameters (e.g. drill hole spacing, density contrasts, and safety precautions) relative to lower grade sandstone, pegmatite, conglomeratic or calcrete hosted deposits.

ISL mining of uranium is increasing in importance and requires somewhat different treatment in MRMR estimates from conventional production methods. Uranium deposits amenable to ISL methods present special situations in that some parameters (e.g. tonnage, minimum mining width, cut-off grade, dilution, etc.) are not necessarily applicable in the same form as for conventional mining. Other parameters, especially recovery, are of special importance.

ISL methods of uranium mining necessarily incorporate additional physical and chemical parameters that are not germane to open pit and underground mining. These include: 1) permeability of the mineralized horizon; 2) hydrologic confinement of the mineralized horizon; 3) amenability of the uranium minerals to dissolution by weak alkaline or acidic solutions; and 4) ability to return groundwater within the mined area to its original baseline quality.

It is common practice in MRMR estimates for ISL projects to use a grade times thickness (GT) contour method. This method is based on the product of mineralization grade and true thickness, indicated for each major intercept within the mineralized horizons. A minimum GT cut-off, used in much the same way that a grade cut-off is established for conventional mining operations, should be reported.

MRMR estimates for deposits amenable to ISL methods should be reported in terms of quantity, quality and anticipated recovery. This can be achieved by reporting, in addition to the contained uranium and anticipated recovery, either: 1) deposit area, average thickness and average GT; or 2) tonnage, average grade and average GT. Recovery may be reported either as quantity of recoverable uranium or a percentage of the estimated contained uranium. It should be noted that it has been common practice to report ISL MRMR as quantity of contained U_3O_8 only, but this practice is not transparent and is not considered appropriate. If available data are insufficient to determine a recovery factor, it is appropriate to point out that recovery in similar deposits is commonly in the order of 60-70%, and could be significantly lower. Best Practice in ISL MRMR estimation will incorporate significant quantities of hydrologic and geochemical data. In that ISL methods are not familiar to many in the mining industry, it would be good practice in reporting a MRMR estimate to fully discuss all parameters that might affect exploitation of the deposit.

If there is an operating mine with similar geological features to a deposit under study, conventional or ISL, and the parameters used for MRMR estimation at the operating mine are known, it would be beneficial to compare the two sets of parameters.

Quantifying Elements to Convert a Mineral Resource to a Mineral Reserve

By weight, natural uranium contains only 0.711% ^{235}U, the "active" isotope in nuclear reactions; the remainder is largely ^{238}U with minor ^{234}U. Instances of deviations from the ^{235}U value of 0.711%, the result of natural fission reactions in high-grade deposits, are rare, but do occur. Deviations from the normal ^{234}U value of about 55 micrograms ^{234}U per gram total U are common due to differential solubilities of the isotopes, particularly in low-grade sandstone deposits, and are of increasing concern to the industry because of radiological implications in fuel fabrication. Best Practice calls for isotopic analysis for ^{235}U and ^{234}U in new districts, as deviations will impact marketability.

Mineral Reserve Estimation

In estimating a Mineral Reserve, the preceding guidelines for estimating a Mineral Resource and the General Guidelines of the Estimation of Mineral Resources and Mineral Reserves document apply.

Reporting

The QP reporting on a MRMR estimate of a uranium deposit should make the reader aware of database limitations and special economics considerations. With respect to the database, the use of radiometric determinations, types of equipment employed, possible Disequilibrium, drill hole contamination, and any other pertinent characteristics should be clearly elucidated. Economic considerations with respect to political concerns, permitting, pricing, supply/demand projections, transportation and marketing may be of special significance for a uranium project.

In order to avoid errors in conversion, a majority of committee members favored reporting of uranium MRMR in standardized units of pounds U_3O_8.

Reconciliation of Mineral Reserves

In reconciling a Mineral Reserve estimate with mine-mill production, the General Guidelines of the Estimation of Mineral Resources and Mineral Reserves apply.

The production life of each individual ISL well pattern is relatively short, typically 6-18 months, and most of the uranium is recovered within the first six months. The production recorded for a well pattern should be compared to the Mineral Reserve estimated for that portion of the deposit and used to reconcile the total Mineral Reserve estimate for the deposit.

Selected Reference

World Nuclear Association, “In Situ Leach (ISL) Mining of Uranium”, Information and Issue Briefs, November 2001, http://www.world-nuclear.org/info/inf27print.htm.