PINCOCK Perspectives

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PAH NEWS PIX

- *KAZAKHSTAN – LAND OF OPPORTUNITY*
- *U.S., AUSTRALIA MAY ALLOW MINING OF URANIUM*
- *NICKEL DEMAND REMAINS HEALTHY*
- *CHILE-CHINA FREE TRADE AGREEMENT*

CALENDAR

- ***XXVI International Mining Congress (Expomines 2005)***
  October 12–15, 2005
  World Trade Centre
  Boca del Rio, Veracruz, Mexico
  e-mail:
  coordinacion@expomines2005.com.mx

- ***2005 Heavy Minerals Conference***
  October 16–19, 2005
  Sawgrass Marriott Resort
  Ponte Vedra Beach, Jacksonville, Florida
  e-mail: meetings@smenet.org

- ***Mines and Money London***
  November 21–23, 2005
  Hilton London Metropole Hotel
  London, United Kingdom
  e-mail: tracey.fielder@mining-journal.com

- ***Runge Professional Development Courses***
  Mining for Non Miners - Nov. 30
  Dragline Mining System - Dec. 1-2
  Mining Economics - Dec. 5-6
  Truck and Loader Systems - Dec. 7-9
  Calgary, Alberta, Canada
  For more information or to register
  e-mail: frowe@runge.com.au

Minimum Engineering Study Requirements

Pincock Perspectives Issue No. 34 (September 2002), Minimum Requirements for Feasibility Studies, remains one of our most requested newsletters. This month's issue is an update of that newsletter and accompanying table to reflect the changes in reporting requirements over the last three years.

INTRODUCTION

The evaluation of a mining project from exploration through development and production is a lengthy and complicated process. Mine development commitment activities for a potential project are initiated when a mineral resource is identified and continue through to the start of construction. The technical feasibility and the economic viability of each project are determined during the phases of mine development, with more detailed engineering data required at each stage. There are three levels of engineering studies during development that are commonly acknowledged by the mining industry, as follows:

- Conceptual
- Prefeasibility
- Feasibility

The enclosed table lists PAH's assessment of the minimum reporting requirements for the three levels of engineering studies.

In April 2005 The SEC Reserves Working Group/ SME Resources and Reserve Committee submitted to the U.S. Securities and Exchange Commission their recommendations concerning estimation and reporting of mineral resources and mineral reserves. Included in these recommendations was a report specific for reserve reporting referred to as a "Mineral Reserves Declaration Report". For this newsletter PAH is addressing the standard types of reports that are used by companies to evaluate projects and seek financing, which are different requirements than reserve reporting, although reserves can be reported as part of the evaluation process. PAH will address the "Mineral Reserves Declaration Report" in a future newsletter when it is appropriate.

CONCEPTUAL STUDY

The conceptual study, also commonly referred to as a scoping study, is the first level study and the preliminary evaluation of the mining project. The principal parameters for a conceptual study are mostly assumed and/or factored. Accordingly, the level of accuracy is low at ±50 percent. Although the level of drilling and sampling must be sufficient to define a resource, flow sheet development, cost estimation and production scheduling are often based on limited data, test work, and engineering design. The results of a conceptual study typically identify:

- Technical parameters requiring additional examination or test work
- General features and parameters of the proposed project
- Magnitude of capital and operating cost estimates
- Level of effort for project development

A conceptual study is useful as a tool to determine if subsequent engineering studies are warranted. However, it is not valid for economic decision making nor is it sufficient for reserve reporting.

■ ***U.S., AUSTRALIA MAY ALLOW MINING OF URANIUM***

Uranium experts are claiming that the United State is moving towards becoming a nuclear society. Experts have predicted in a century from now 90% of our energy will come from nuclear power. Australia is close to allowing new uranium mines, and Sweden gets half its power from nuclear energy. The high prices of uranium could stimulate new mine production. Nuclear power is believed to be the cleanest and safest form of mass power generation, and cheapest source of power. It has been predicted that New Mexico, with its long history of government uranium mining, will allow the mining of uranium again. Virginia is the only state that has banned uranium mining. Permitting poses a problem for uranium miners – the process can take up to ten years, due to the politics involved.

■ ***NICKEL DEMAND REMAINS HEALTHY***

China's demand for nickel rose 50% the first half of 2005. Nickel production, stainless steel scrap, and nickel inventories are unable to meet the demand. China is now the world's largest nickel consumer, surpassing the US. China accounts for 16% of the demand of nickel. The Asia-Pacific region consumes about 50% of the worlds nickel production and projections indicate that demands are to continue well into 2006. Four new mines are slated to come on line with in the next two years; however the demand for nickel will still not be met. Several nickel projects are delayed due to capital cost increases and other financing issues.

■ ***CHILE-CHINA FREE TRADE AGREEMENT***

Chile and China could sign a free trade agreement as early as November, tying the world's biggest producer and consumer of copper. This would be the first full-fledged trade agreement for China. Twenty-five percent of Chile's trade is with Asia, where Chile already has a free trade agreement with South Korea, and studies are being done to determine if talks should begin with Japan. With a more than 6 percent growth in Chile's booming economy, its strongest exports include copper, wood pulp, and fertilizer. The influx of dollars from exports has helped boost the Chilean peso to its strongest in years against the dollar.

PREFEASIBILITY STUDY

The prefeasibility study represents an intermediate step in the engineering process to evaluate a mining project. The principal parameters for a prefeasibility study are based on some engineering basis. The level of accuracy is higher than the scoping study at ±25 percent. The engineering objectives of a prefeasibility study are to determine:

- Resources/reserves
- Mine and mill extraction methods
- Mine and mill production rates
- Environmental issues and permitting requirements
- Development period and mine life
- Product(s) recovery rates
- Product(s) marketability
- Capital cost estimates
- Operating cost estimates
- Economic analysis with sensitivity

At the prefeasibility study stage adequate geology and mine engineering work has been conducted to define a resource and a reserve (reserves at this stage depend on reporting jurisdiction). Sufficient test work has been completed to develop mining and processing parameters for equipment selection, flow sheet development, and production and development scheduling. Capital and operating cost estimates are derived from preliminary test work, assumed factors and some vendor quotes. The economic analysis of a prefeasibility study is of sufficient accuracy to assess various development options and the overall project viability. However, these cost estimates and engineering parameters are typically not considered of sufficient accuracy for final decision making or bank financing. Depending upon the government reporting jurisdiction, the study may or may not be sufficient for reserve reporting.

FEASIBILITY STUDY

A feasibility study represents the last and most detailed step in the engineering process for evaluating a mining project for a "go/no-go" decision and financing purposes. Principal parameters for a feasibility study are based on sound and complete engineering and test work. Accuracy is higher than the prefeasibility study and is typically ±15 percent. Feasibility study objectives are the same as those previously listed for the prefeasibility study, but the level of detail and accuracy for each objective are more stringent. The level of detail is typically dictated by whether the project is to be financed by the company or bank financed. Often the term "bankable" is used in describing a feasibility study. This term simply defines that the level of detail of the study is sufficient for financing provided the results are positive. In some cases, if the project is to be company financed the level of detail is higher than in a typical "bankable" feasibility study.

Detailed geologic and mine engineering work has been conducted to define a resource and reserve. Detailed test work has been completed to develop all mining and processing parameters for pit slope design, hydrology, geotechnical, flow sheet development, equipment selection and sizing, consumables and power consumption, material balance, general arrangement drawings, production and development schedules, capital and operating cost estimates. Capital and operating cost estimates are derived from take-offs and vendor quotes. A draft EIS/EA has been submitted to regulatory authorities or is close to being submitted. Economic analysis with sensitivities is based on annual cash flow calculations for the mine life. Provided the project is feasible, a proven and probable reserve statement can be made.

The following sections contain a brief description of the major areas that are incorporated into engineering studies. As the level of the study increases in complexity the level of detail required increases, as shown in the attached table.

Geology and Resources

Every mineral deposit has its own unique geologic characteristics which must considered in the preparation of engineering studies. The amount of required geologic information for the determination of resources varies significantly as a function of the engineering study level and the complexity of the deposit and mineralogy. Geologic features control economic mineralization, and with the appropriate geologic modeling, a reliable grade estimate will be determined using a combination of geologic controls and geostatistics.

Resource estimation is based on the development of a three-dimensional model of the deposit with either manual or computer methods. The completed resource allows for rapid tabulation of mineral inventory and provides a basis for all subsequent determinations of reserves, mine design and planning. The objective is to provide the most reliable and accurate resource estimate with available data. The resource estimate is classified according to internationally recognized standards including the following (as well as others):

- Canadian National Instrument 43-101;
- Australasian Code for Reporting of Mineral Resources and Ore Reserves - prepared by the Joint Ore Reserve Committee (JORC);
- U.S. Securities & Exchange Commission Industry Guide 7; and
- The 2005 SME Guide for Reporting Exploration Results, Mineral Resources and Mineral Reserves.

Mining

Upon completion of the deposit's geologic interpretation and resource estimate, the mining method, either surface and/or underground, is selected. This selection is based on the geometry of the deposit and depth of the deposit. As the studies progress the detail incorporated into the actual design of the mine increases.

Optimization analysis is a tool that is being utilized more in the evaluation of projects especially surface mines. With this tool companies can determine what the impact of changes in prices, costs, and recoveries are on the project so that the areas in which the project is most sensitive to can be identified. Including inferred resources in an optimization analysis can help a company determine where to focus exploration drilling to increase measured and indicated resources. Preliminary production schedules can also be developed using this tool. Results from optimization analysis, however, do not constitute reserves because they are generally based on pit shells that do not include roads and ramps and contain unmineable shapes.

As the studies increase in complexity the detail incorporated into the mine design, production scheduling, and capital and operating cost estimation increases. For the mine design the detail and quantity of geotechnical data is one of the critical components as it dictates the pit slopes in surface mines and the design of underground openings and specific underground mining methods. Mine design and scheduling can also be impacted by the need to meet processing requirements such as maintaining mill feed grades or rock type blends, and by environmental requirements such as surface and groundwater control. As the knowledge of the project is increased the more refined and detailed the mine design and production schedule can become.

Process Engineering

Process engineering for the mined ores is initiated in the engineering study after the production rate is established in the mining phase. Processing facilities are typically designed to produce marketable products for shipment directly to the consumers (e.g. copper cathodes from SX-EW) or to subsequent processing facilities (e.g. concentrates to smelters-refineries).

Key components for process engineering in engineering studies include:

- Metallurgical test work
- Mineralogical studies
- Consideration of project site conditions
- Selection of processing flow sheet and basis
- Determination of processing design criteria and description
- Plant processing facilities layout
- Equipment sizes and specifications
- Plant services

Infrastructure

The infrastructure requirements for mining projects are site specific. The capital cost for infrastructure can vary substantially from site to site as a percentage of the total capital cost, and are often more of a function of the location rather than the mining or processing methods. Thus, the capital cost estimate in engineering studies must be based on a proper identification and assessment of the infrastructure requirements. Infrastructure covers a wide range of facilities and services as listed below:

- Access and service roads
- Utilities

KAZAKHSTAN – LAND OF OPPORTUNITY

Kazakhstan, one of the largest of former Soviet Union countries, has vast mineral potential. The country's growth rate is about 9% per annum. The government is keen to see the mining industry to develop. Mineral resources are abundant – there are large coal, iron ore, manganese, nickel, chromium, copper, cobalt, lead, zinc, bauxite, gold, and uranium deposits. It is believed that 15 – 20% of the world's lead, zinc, chromium, and gold could be hosted here. The government is interested in attracting more inward investment. The goal is to have extractive industries contribute to development and a reduction in poverty. The State Priority Act, which passed in December 2004, allows the government rights to buy any natural resource asset that is for sale in on its territory. This is supposed to ensure greater control over investment. The local government, in order to develop local industry, has requested companies operating in Kazakhstan be required to hire and train local people and use local supplies wherever possible.

Minerals Corner—

Betafite

(Ca, Na, U)$_2$(Ti, Nb, Ta)$_2$O$_6$(OH, F)

Betafite is a popular uranium bearing mineral, often found in Betafo, Malagasy Republic, Madagascar and Silver Crater Mine, Bancroft, Ontario, Canada. It can also be found in Russia, Spain, Peru, Pakistan, India, China, Norway, Brazil, California, Arizona, New Mexico and Colorado. Because of Betafite's rare chemical elements, it is one of several so-called Rare Earth Oxides. If Betafite has color, it would be black with a tint of yellow, brown, or green; however, typically it is lacking in color and its crystals are opaque. Betafite is a radio-active mineral.

- Water supply
- Communications
- Port and marine
- Fuels
- Waste disposal systems
- Administration facilities
- Industrial facilities
- Transportation
- Townsite/Camp facilities

Environmental

Today, complex environmental issues faced by the global mining industry include:

- Environmental Impact Statements (EIS)
- Base line studies
- Environmental assessments
- Mine Permitting at the local, state, federal and international levels
- Mine-waste management design/ remediation
- Water management
- Wetlands mitigation/construction design
- Air quality and noise assessment
- Acid-rock drainage assessment and abatement
- Closure planning

Surface Reclamation

Environmental scientists and regulatory specialists help develop effective and economical environmental controls for mining operations, which comply with all applicable environmental regulations (international, federal, state, and local) affecting the mining industry.

Economic Analysis

Economic analysis is performed as the final step in the engineering study to provide a measure of the project's economic viability. Economic analysis is performed using conventional pro forma cash flow analysis for the mining industry incorporating the following:

- Constant or current dollars
- Leveraged or unleveraged financing
- Project basis (stand alone or combined)
- Pre- or after-tax basis
- Discounting period of project's annual cash flows (i.e. mid- or end-of-year)

Economic measures determined in the analysis typically include:

- Net present values at selected discount rates
- Discounted cash flow return of investment
- Internal rate of return
- Payback period

Inputs to the cash flow derived from the various sections of the engineering study include:

- Ore production and grade schedules
- Commodity recovery (ies) and
- Commodity production schedule
- Capital costs (preproduction, sustaining and working)
- Operating costs

In addition to the inputs from the engineering study, other parameters to the pro-forma cash flow include:

- Royalties (private and governmental)
- Commodity price (s)
- Host country's tax regime (tax rates [federal, state, provincial], depreciation, depletion, etc.)

Sensitivity analyses to the base case are performed to key project variables which typically include:

- Commodity price(s)
- Commodity recovery (ies)
- Capital costs
- Operating costs
- Currency exchange rates

The results of the sensitivity analysis are plotted in a spider diagram to determine the project's sensitivity.

As can be seen above, the development of any level of study requires professionals with extensive mining experience in many different disciplines. Enhancing the capabilities of the study team will reduce the risk faced during the development of the property. For example, during the conceptual study, the study team may identify a fatal flaw that places the project at such risk that the project should not proceed at that particular point in time.

On the other hand, an experienced team can provide the knowledge base to optimize the project as much as possible or apply the best-available proven technology during the prefeasibility and feasibility study stages. Beyond the team's basic mine development experience is the consideration of the knowledge and experience of project financing and financial requirements that is required for bankable study preparation. Therefore, it is of critical importance to select the correct project team to ensure the timely and accurate completion of the study. Following this formula will reduce both project development and cost risks. Additionally, following the traditional progression of the studies from conceptual to prefeasiblity to feasibility generally saves time and money in the long run as critical issues can be identified and addressed early on rather than at a later stage where the impact can be a delay in the project which is generally costly.

This month's article was provided by PAH's Mining and Geology departments.

Pincock, Allen & Holt is a consulting and engineering firm serving the international mineral resource industry. Your comments and suggestions are always welcome. Contact Pincock, Allen & Holt • 165 S. Union Blvd., Suite 950, Lakewood, Colorado 80228 • TEL 303.986.6950 • FAX 303.987.8907 • www.pincock.com. Pincock Perspectives is published as a free information service for friends and clients. Information for News Pix is paraphrased from various sources; references available upon request.