Modifying Factors and Optimized Cut–Off Grade Determination

Gary M Poxleitner, PEng, PMP
Practice Leader/Principal Consultant
SRK CONSULTING (CANADA) INC.
gpoxleitner@srk.com
gmpoxleitner@gmail.com

Cut-off grade (COG) is a standard, industry-accepted method used to determine which part of a mineral deposit to include in a Mineral Resource or a Mineral Reserve estimate, or potentially in an operation's Life of Mine Plan (LOM). It is the minimum grade (or value) at which mineralized material can be economically mined or processed. The selected COG is essentially a trade-off between the revenue (inclusive of losses) that the potentially-economic material contributes to the mine's cash flow vs. the cost to extract that same material. COG is an essential parameter for determining reserves, for generating production and business plans, and ascertaining the potential profitability of a stope or open-pit bench.

Selecting the correct COG is essential. It affects the mine plan, cash flow, mine cost, sustainability and profitability of the operation. However, the work required to generate the optimum COG is often not given the requisite attention and diligence.

The process of selecting a COG should begin with an understanding of what the over-arching corporate and mine objectives are for the deposit. Typically, it is value in the form of NPV and internal rate of return (IRR) but may also include a COG that produces high metal content or ounces at the risk of resulting in lower net present value (NPV).

The widely-adopted method to calculate the COG is a break-even methodology. This approach accepts mining material which will generate revenue from the sale of the finished product that is equal to the cost of certain modifying factors, such as mining, processing, general administrative expenses (G&A), sustaining capital costs, treatment and refining of contained metal(s) and is often inclusive of applicable royalties. The pitfall here is that it does not guarantee that the orebody will cover those costs that are excluded from the calculation (such as initial capital cost). It also does not clarify what technical and economic modifying factors to include, which can have wide implications on the future and profitability of the mine

The decision of which modifying factors to include is often left to the personal judgement of mine professionals. In determining which common modifying factors are used in the industry, a 2019 survey of approximately 100 global mines and projects were accessed. Table 1 summarizes our findings as to the modifying factors used along with the percent of those surveyed that applied them.

TABLE 1

REVENUE	
Metal Price ($)	100%
Mill Recovery (%) (Fixed)	100%
Payable Metal (%)	85%
Treatment and Refinery ($)	80%
Transportation ($)	75%
Royalties (%)	75%
Mill Recovery (Variable)	20%
UPSTREAM (OPERATING) COSTS	
Mining Cost	100%
Milling Cost	100%
G&A	90%
Dilution	70%
Sustaining Capital	55%
Corporate G&A	25%
Profit Margin	10%
Project Capital	10%

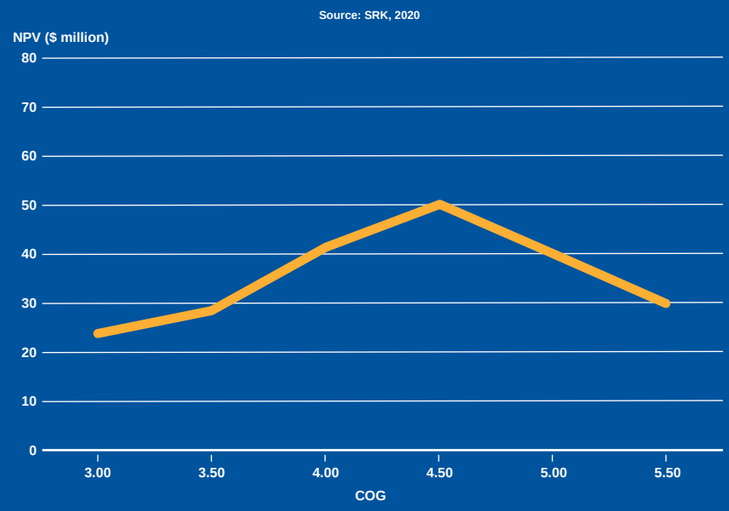
A strategic optimization methodology can be used to select the preferred COG. It involves first running multiple scenarios at a range of different COGs inside a flexible evaluation model. A mine plan is first performed for each COG (balancing effort with value), thus producing a mine schedule. Costs are then included for each scenario and then fed into the economical model. This then produces an individual NPV and IRR for each COG scenario. The highest value scenario for the related COG may then be agreed as the preferred option.

Figure 1 demonstrates an example of an underground gold mine that we accessed with this approach. In this example, a COG of 4.5 g/mt produced the greatest value overall. Additional scenarios, using lower COGs of 3.0 g/mt and 3.5 g/mt, led to higher production tonnages with low plant feed grades. This resulted in the material not being able to cover all costs and therefore lower NPVs. Inversely higher COG scenarios of 5.0 and 5.5 g/mt generated high feed grade but the tonnes were too low to cover all the fixed operating costs and capital costs. This is summarized in Figure 1.

Aside from NPV, other corporate objective criteria are also accessed, such as long life mine life, scenario with low upfront capital, or high ounces. These criteria are compiled and summarized in the form of a decision matrix tool. This approach is developed collaboratively with mine planners and stakeholders, where each objective is ranked for each COG scenario against the weighted objectives. Depending on the selected company criteria, mine site preferences and the ranking, the results will be a COG which combines all these criteria.

Selecting a COG with prudence will set the course for your entire operation and environment. Determining the correct modifying factors will assist in getting the right answer and taking a strategic optimization approach will ensure that all objectives are reviewed, validated and considered. ■

FIGURE 1



BIO

Gary M Poxleitner is involved in leadership within the mining consulting industry and provides technical advice, mine and project reviews, due diligence and audits, cut-off grade analysis, operating cost estimation, mine design and economic and productivity improvement studies, as well as training and mentoring in all aspects of mine orebody extraction in the underground environment. This involves high level concept projects, PEA, PFS, Feasibility, project execution and operational assistance. He assists clients in providing innovative albeit practical solutions to complex problems.

Gary's technical experience covers a wide range of commodities, geographic and mining settings.

Gary a professional engineer registered in Ontario and a professional project manager, he has previously held positions as Vice Chairman of Camiro, Membership Chair of the CIM Sudbury Branch, and is currently on the Canadian CIM Council and Chair of the CIM Underground Mining Society. Gary has a P.Eng in Mining Engineering and a graduate from Laurentian University, Canada (1991).