CYPRUS ANVIL MINING CORPORATION

METALLURGICAL FORECASTS, JULY 1984

Metallurgical forecasts are generally prepared from historical operating data and with knowledge of the variations in the ore and, of course, the type of ore expected during the forecast period. Whenever there are significant changes to be made to the processes or equipment, and also when uncertainties are encountered a best professional estimate based on all known factors has to be used. Despite the fact that the Anvil mill operated for a number of years, we feel that there will be significant changes brought about, and furthermore that these changes require that we forecast results noticeably different from recent operating history.

The factors which we describe briefly in the following pages all influenced our predictions. These are:

1. Mill staffing during 1981 - 1982.
2. Operating conditions prevalent during the first six months of the running of a $50 million modification.
3. Changes to be made to the processes and equipment.
4. Inadequacy of past data.
5. Operating philosophies.

A description of the actual parameters and procedures used in producing the numbers is also presented and is followed by the forecasts.

1. Mill Staffing During 1981 - 1982

A myriad of operational problems were experienced during the period between the commissioning of the new grinding circuit in November 1981 and the mill shutdown on June 4, 1982. These operational problems were complicated by insufficent and inexperienced technical staff.

The metallurgist assigned to the grinding circuit was a new-hire with limited previous grinding experience. He received his direction from a consulting metallurgist who spent only a few days per month on site. Flotation received little attention during this period. A metallurgical technician was promoted to staff to assume responsibility for this area. Very limited sampling (only one lead rougher survey) of the flotation circuits during this period exemplifies this lack of attention. The aforementioned inadequacies were caused by the resignations of four metallurgists between March and August 1981. They took with them numerous years of Cyprus Anvil experience.

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2. Operating Conditions After Mill Modifications

Efficient grinding circuit operation was severely hampered by a lack of water pressure and an inordinate amount of cyclone surging. These problems were the result of an inadequate water supply and distribution system. Some of the specific problems related to the grinding circuit are listed below:

- rod mill feed chute plugging due to fluctuating water flow and pressure.
- low rod mill densities due to excessive water flows used to help alleviate chute plugging problems.
- fluctuating ball mill densities due to cyclone surging and interruptions to the rod mill feed.
- low tertiary ball mill circulating loads due to poor choice of cyclone apex and vortex finder sizes.
- cyclone surging due to excessive variation in throughput, lack of flexibility in pump speed, and no water flow control.

The preceding problems resulted in a coarser product for flotation than was necessary and which reduced metal recoveries.

The inefficiencies in the grinding circuits as well as the variations of flow and density contributed to inefficiencies in flotation. Poor classification resulted in more metal reporting to the coarsest and finest size fractions. Consequently, lower than expected recoveries occurred.

Instability in the flotation circuits was contributed to by the following factors:

- timer type addition of reagents as opposed to continuous flow control-especially on frother addition.
- poor pH control due to obsolete instrumentation as well as mixing and handling difficulties for soda ash and lime.
- a lack of consistency between operators on differing shifts.
- use of internally reclaimed water from the thickener overflows due to water shortage.

The operating conditions just described for the grinding and flotation circuits were not addressed due to a lack of experienced staff and resources necessary for their correction.

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3. Changes to be Made to the Processes and Equipment

The grinding and flotation areas of the mill were significantly modified during 1980 - 1981. There were many "bugs" which had not yet been sorted out.

Changes to be implemented in grinding to reduce high losses to both coarse and fine fractions are:

- maximize mill power draw by optimizing steel loads.
- increased water pressure and water volume control to stablize the operation of the cyclones (control density) and the mills (reduce feed chute plugging).
- use more appropriately sized grinding media: 1 1/2" rather than 2" in secondary grinding, and 1" rather than 1 1/2" in tertiary grinding.
- in regrinding use smaller media (1" rather than 1 1/2"), maximize power draw and improve classification (more suitable cyclones).
- numerous other small deficiencies will be addressed.

Changes planned for the flotation circuit to improve its efficiency include:

- use more streams on the onstream analyzer (12 rather than 8).
- improved reagent addition and control systems, new pH controls, control valves for collectors, and metering pumps for frothers.
- installation of zinc circuit conditioning tanks.
- reduce pH upsets through better soda ash and lime delivery systems.
- reduction of launder water requirements on cleaner flotation by redesign of the concentrate launders.
- numerous other small items.

4. Inadequacy of Past Data

It is sometimes said that mills are operated on statistical data. Unfortunately due to staffing problems, physical problems or for other reasons, some of the data normally used is not available (i.e. size analysis and metal distributions on sets of composites, few, if any, complete or reliable detail circuit surveys). Therefore the historical data that was available was difficult to analyze and often guesses had to be made (i.e. fineness of grind).

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5. Operating Philosophies

Anvil ores can be broken down into six or more types which by general metallurgical response fall into four groups. In the past the mill processed ore as received from the pit. Recognizing that this is undesirable since it results in frequent circuit upsets in the mill, plans have been made to process the four groups individually in campaigns of a few weeks in duration.

Changes and variations of kinds other than described above will be minimized too. We are committed to automation and as soon as is practical computer control of the sensitive and critical flotation process. All mill processes must be made as smooth and continuous as possible.

We feel that there were many sloppy and metallurgically unsound practices in this operation in the past. We feel that such as have been identified can be corrected to the benefit of the results. Much detailed study on the crushing, grinding and flotation circuits will be performed to evaluate and increase where possible process efficiencies.

PARAMETERS AND PROCEDURES USED IN FORECASTS

Mr. P. Taggart, a metallurgist with Cyprus Anvil in the past developed from laboratory work the best grind vs grade and recovery relations for the various ore types that is presently available (this work is being repeated by the current staff). This data was converted into grind vs recovery curves at constant concentrate grade and used to predict changes in recovery as a function of grind. A similar graph was developed for oxide ore.

It was predicted that it would require four months to achieve the same fineness of grind as achieved in 1982 prior to shutdown. It is expected that the efficiency of the grinding circuit will improve slowly beyond that point to a peak efficiency.

Oxide ore treatment results from April 1982 (see sheet 1 of forecasts) were used as a basis for determining the forecast for oxide metallurgy on start-up (first five months).

Sulphide ore is to be treated in four separate groups as mentioned previously, thus the response of each of the groups individually (based on P. Taggart's work) were added to yield an overall prediction. These results were compared to actual mill performance and with allowance for the improvements discussed were found to be satisfactory. Results for 1979 and January 1982 are presented on sheet 1 of the forecasts for comparison purposes.

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For the first two months of oxide ore treatment the metal recoveries were reduced by 4% and the lead concentrate grade by 2% to allow for start-up and "learning" losses. Similarly for the first two months of sulphide ore treatment recoveries were reduced by 5% and the zinc concentrate grade by 1% to allow for learning "losses".