One may consider for instance the final product size analysis; this value was only known to the operator at one or two hourly intervals when manual samples were taken. Even then the results were delayed by the slow process of sample preparation, drying and screening. This applies to most other information on the state of the circuit. Any control (and consequently optimization) was nearly impossible because conditions in a grinding circuit could change within minutes.

Even after the advent of reliable on-line monitoring instruments that made manual control easier, a circuit was still difficult to keep at certain conditions for any appreciable length of time. Any exercise in optimization would be premature before stable control can be achieved to keep a circuit at specified conditions. What is the use of knowing where to operate but not being able to keep it there?

It is against this background that the implementation of multi variable control (MVC) to the grinding circuits at East Driefontein [2] allows for an optimization programme to be undertaken that could provide the operator with MVC set points that would ensure the most efficient operating conditions.

1.3 Aims of the project

According to Hukki [3], three fundamental questions should be asked about closed circuit grinding, of which two are directly addressed by this work:

Comminution is the most energy intensive operation in the gold extraction process. The benefits of more efficient power utilization, liner and media consumptions as well as ease of operation are vast. In the context of this project, optimization of grinding means that more product-sized material should be produced with less energy input.

Optimization does not simply mean finer grinding. A proper optimization exercise will determine the best balance between fineness of grind and product throughput. The meeting of these objectives are generally thought to be mutually exclusive. Grinding too fine means lower throughput, wastage of energy and a score of other operational problems like filtration problems [1].

It should be noted that optimized conditions change according to production objectives. At a higher required throughput, it may make economic sense to reduce the fineness slightly and vice versa. Thus any optimization process must be dynamic and adaptable to circumstances.

1.2 Optimization and control

The success of any attempt to optimize a grinding circuit would depend on the operator's ability to keep such a circuit at specified optimum operating conditions. In the past this has been very difficult.

CHAPTER 1

1 INTRODUCTION

This chapter describes the background to the project, why it became necessary to optimize the circuit, and gives an overview of work done previously. The methodology followed during the execution of this project is also outlined.

1.1 The need for optimization

Rising costs and falling mineral grades are probably the topics mostly discussed in the minerals processing industry. The importance of producing more at lower cost is an objective of every mineral producer. This is particularly true for gold mining, where a fractional increase in metal recovery translates into large amounts of revenue.

An important factor in the recovery process is the extent to which the metal is liberated by grinding for the subsequent leaching step to be efficient. More intensive grinding means higher recovery. But it also means higher costs.

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ABSTRACT

A multi variable control strategy for a grinding circuit at East Driefontein has been implemented by others and has enabled it to operate under stable conditions. The next development needed was to find conditions under which the efficiency of the circuit was the greatest. Optimum set points exist for the multi variable controller to keep the circuit at its most efficient state.

This project was done to determine these set points, and how it affected the operation of the circuit. The strategy involved the collection of process data, the development of mathematical models and the determination of these optimum set points by simulation. This option reduced interference with routine production operations, which is often a prohibiting factor during any development work on an existing process.

The optimum set points were successfully determined, and were compared with previous findings and current plant practice.

DECLARATION

I, Quentin Peter Campbell, declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science in Engineering at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



18 June 1996

THE OPTIMIZATION OF A GRINDING CIRCUIT

QUENTIN PETER CAMPBELL

A dissertation submitted to the Faculty of Engineering, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Engineering.

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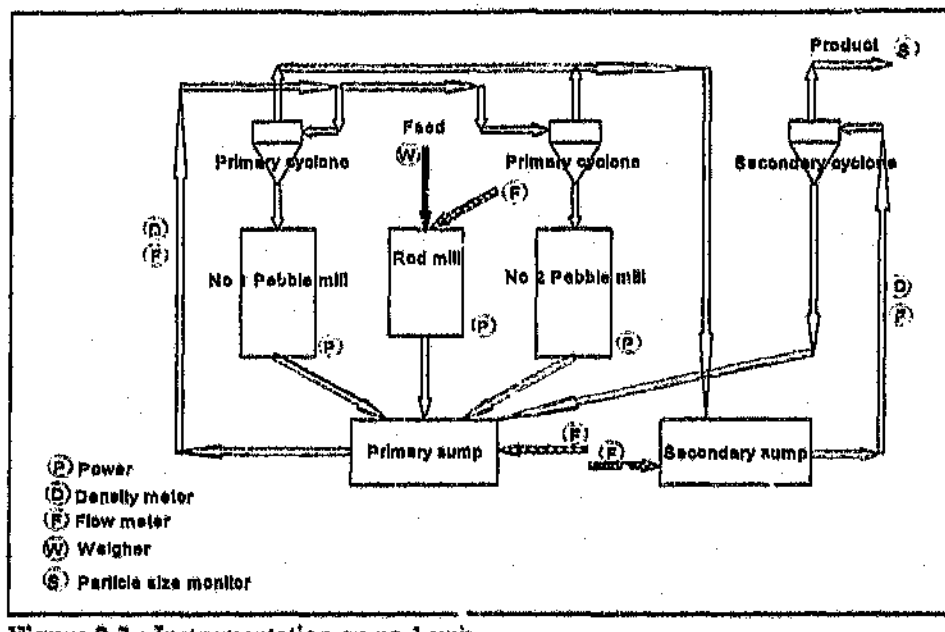


Figure 2.3 : Instrumentation on no 1 unit

or too little load reduces the power draft of the mill. This function had also since been successfully taken over by a controller.

Cyclone underflows are constantly checked for roping which is indicative of an overloaded circuit.

2.3 Instrumentation and control

2.3.1 Instrumentation

The instrumentation installed on the circuit is listed in table 2.3, and their positions are shown on figure 2.3.

2.2.4 Circuit operation

Despite the implementation of a good control strategy, there are still aspects of the operation under the operators' supervision and responsibility. Such decisions are largely based on the experience of the operator. The important and relevant operational aspects are discussed here.

The minimum feed rate of ore is limited to about 35 tons per hour. When less ore is added to the rod mill the cushioning effect of the coarse particles is decreased and the steel rods may knock the liner bolts loose. A maximum of 85 tons per hour is possible, again the rod mill being the limiting unit. A very coarse discharge is produced at such high tonnages.

Before the current control strategy had been introduced the operator usually adjusted the primary and secondary sump water addition to obtain specified densities of the cyclone overflow streams. This information is still available and is currently used to help evaluate the state of the circuit.

Pebbles are added at intervals to maximize the power draft by the pebble mills. It is a difficult operation since the power draft peaks at an optimum mill load. Too much

Table 2.2 : Unit details and dimensions

Item	Rod mill	Pebble mill
Number of units	1	2
Type	Trunnion discharge	Trunnion discharge Grids and scoops
Length (m) Diameter (m) Speed (rpm) % of critical speed	3,66 2,74 18,7 72	5,49 3,60 18,7 81
Grinding medium	0,09 m x 3,35 m rods	-100 mm pebbles
Liners	Wave type with lifter bars	Grids on backing plates with lifter bars
Item	**Primary cyclone**	**Secondary cyclone**
Number of units	2	1
Cyclone diameter (m) Vortex finder diameter (m) Inlet diameter (m) Spigot diameter (m) Vortex to spigot distance (m)	0,686 0,255 0,147 Approx 0,115 2,025	0,914 0,360 0,203 Approx 0,070 2,635
Item	**Primary pump**	**Secondary pump**
Number of units	2 in tandem	2 in tandem
First stage Type Speed (rpm) Motor Impeller diameter (cm)	 Envirotech CE Variable 125 kW DC 61	 Envirotech CE Variable 125 kW DC 61
Second stage Type Speed (rpm) Motor Impeller diameter (cm)	 Envirotech CE 650 75 kW AC 1440 rpm 61	 Envirotech CE 650 75 kW AC 1440 rpm 61

smallest amount of water addition to prevent a 'rod mill tangle', i.e. the rods in the mill become misaligned and subsequently entangled. The typical size analysis of the feed material is shown in table 2.1.

Table 2.1 : Feed ore size distribution

Particle size	-35mm +19mm	-19mm +13mm	-13mm +6mm	-6mm +74μm	-74μm
Mass Percent	15	40	30	14	1

The dilution water added to the primary and secondary sumps can be varied from 0 to 240 and from 0 to 130 cubic metres per hour respectively.

The pebble feed rate to each pebble mill is about 3,5 tons per hour. The pebbles are between 100 mm and 60 mm in size.

2.2.3 Circuit physical data

The details of the units in the circuit are listed in table 2.2.

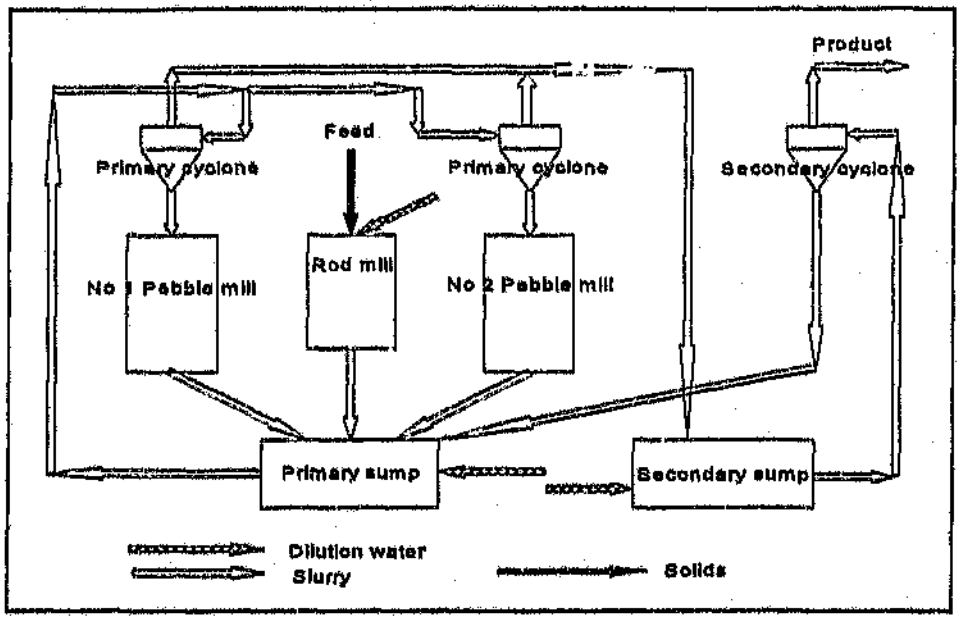


Figure 2.2 : No 1 milling unit

This secondary underflow returns to the closed circuit and the overflow gravitates to the thickeners as the mille 1 product.

Dilution water is added to the rod mill inlet, the primary and the secondary sump.

2.2.2 Circuit feed data

Crushed ore enters the circuit at a rate of about 50 tons per hour with a moisture content of 1,1 percent. This tonnage is variable since the feed rate is one of the control actions of the MVC. Water is added to produce a 21 percent moisture content feed to the rod mill. This figure is largely historical and represents the

The filtrate is combined with the pre-wash solution and is then clarified and de-aerated. Zinc dust is added to precipitate the gold slime that is then acid treated, calcined and smelted with a borax flux. The bullion produced is of about 88 percent gold.

2.2 No 1 grinding circuit

The no 1 grinding circuit at East Driefontein was used for the test programme. Because it was well instrumented and under multi variable control, the acquisition of data was made easy. This enabled the investigator to run the circuit at different conditions while collecting data.

2.2.1 Circuit description

The circuit (figure 2.2) consists of a primary rod mill followed by two pebble mills that are in closed circuit with a primary hydrocyclone each. All the mills discharge into a common primary sump from where the primary pumps feed the two primary cyclones via a distributor. The primary cyclone underflow streams are fed to the pebble mills while the overflows are pumped via the secondary sump to a secondary hydrocyclone.

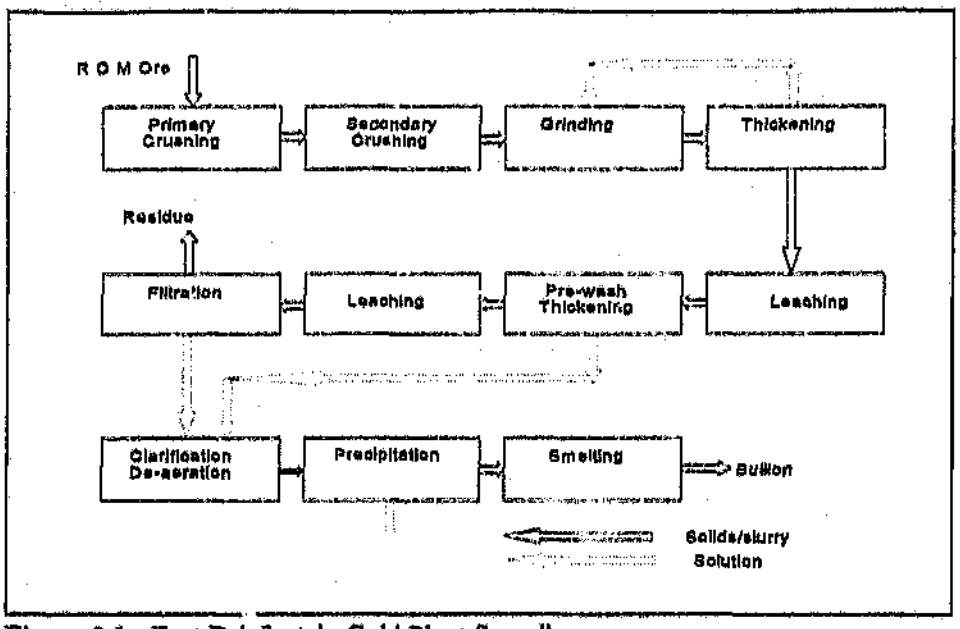


Figure 2.1 : East Driefontein Gold Plant flow diagram

to produce two closely graded products: rod mill feed material of 90% finer than 20 mm, and pebbles between 100 mm and 60 mm.

Grinding is performed by three similar circuits comprising of two stage wet grinding and two stage classification. The required milled product fineness is 80 percent finer than 74 microns with a solids content of about 20 percent.

The milled pulp is thickened and fed to sixteen agitated tanks where cyanide and lime is added so that leaching occurs. An intermediate pre-wash thickening stage removes some high gold concentration solution, while the underflow undergoes further leaching. Total contact time is between 24 and 36 hours. Solid-liquid separation is done with rotary drum vacuum filters.

CHAPTER 2

2 PROCESS DESCRIPTION

This chapter describes the flow diagram and operating data of the grinding circuit that was used to collect the experimental data. It also gives a detailed account of the multi variable controller used in stabilising the plant operation.

2.1 Overall plant flow

The gold plant at East Driefontein follows a conventional route consisting of crushing, grinding, cyanidation, filtration and precipitation (figure 2.1) and treats 240 000 tons of ore per month at an average head grade of 10,5 g Au per ton of ore.

The crushing station includes three stages of crushing and screening in a closed circuit

The final step was to test the model and optimized conditions by comparing the obtained results with those observed on the plant.

1.4 Methodology of this project

Because of the practical limitations of doing test work on an operating circuit, it was decided to follow the off-line method (described by Mular [8]) which involves mathematical modelling of the circuit.

The project was designed in four phases: data collection, modelling, optimization and plant testing.

Data was first collected, both by manual sampling and on-line instrumentation around an industrial grinding circuit, which was run at different conditions. This data was then analysed and smoothed to provide full closed mass balances of the circuit. Thus entire 'snapshots' of the circuit conditions were created.

The modelling phase included the correct selection of suitable mathematical models for the individual unit operations and the fitting of these models to the data. A complete circuit simulation was then done by combining the individual models.

Optimization could then be done by simulating the circuit at different conditions and using the results to determine the efficiency of that particular set of operating conditions. This was done using the optimization routines included in the steady state simulator used.

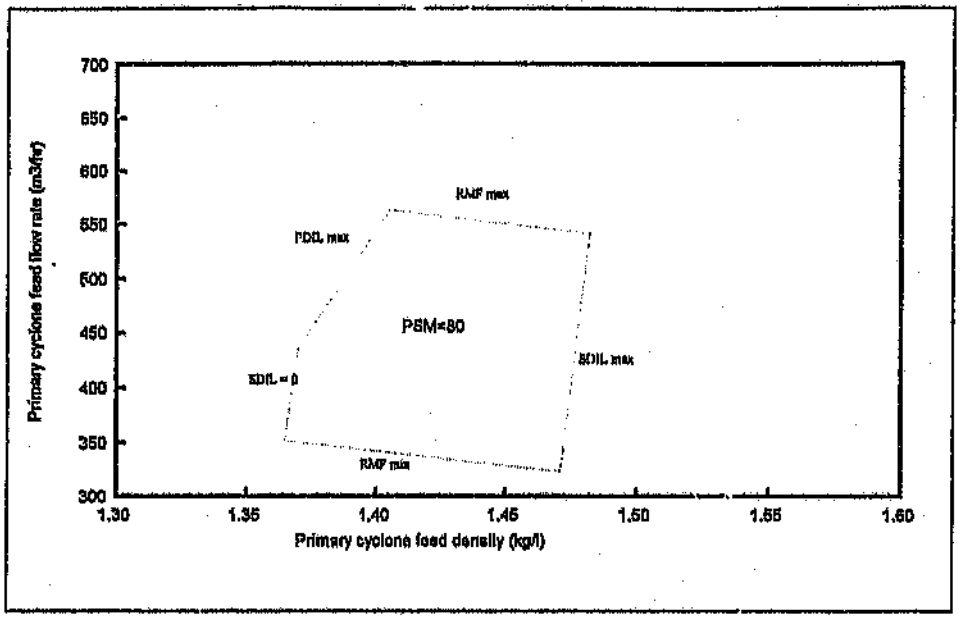


Figure 1.1 : Feasible operating plane for control set points (Hulbert)

This work seeks first to confirm this phenomenon, and secondly, to show that there exists varying degrees of efficiency within this window. The efficiency and thus the throughput is quantified by the simulation of the circuit at different conditions within the window. The optimum values of the MVC set points will be determined for a specified product quality and for a required tonnage throughput. Determining the efficiency of operation for a range of other manipulated physical parameters is also possible, such as cyclone spigots sizes.

a) How can the process be used to produce the maximum tonnage of fine material that meets a given size specification, and

b) How can energy consumption be reduced in producing such a product?

The answer to both questions hinges on what he termed the efficiency of separation. By optimizing this efficiency one can improve the product quality in terms of the overproduction of fines, as well as the overall production rate.

Guest [4] and Hukki and Eklund[5] showed that there is a relationship between the circulating load and efficiency. If one could optimize the circulating load, one could also optimize the production rate.

Work done earlier at East Driefontein by Hulbert [6] showed that a range of feasible operating conditions exists over which the same product quality is achieved. This range constitutes a two-dimensional "operating window" (figure 1.1) in which an operator has some freedom of choice in setting two of the control set points while achieving the same grind. Since these two set points (the primary cyclone feed rate and feed density) directly cor ol the circulating load in the circuit, it means that producing a specified grind at different grinding rates is possible, and thus tonnage throughput rates. The determination of this window is discussed further in chapter 6.

points had proper sampling overflow weirs installed, and provided potentially good samples. The relative accuracies of the samples are discussed in the next chapter.

Additional data collection comprised of a regular check of the variation in rod mill feed size analyses and moisture content (once per shift). Daily composite moisture analyses of the primary and secondary cyclone overflow streams, and also the pebble mill discharge streams, were also recorded to check the validity of the mass balance.

3.2.2 On-line data logging

Using logged data from the PROSCON, the following instrument readings were recorded at exactly the same time as the manual samples were taken:

rod mill solids feed rate

rod mill feed water flow rate

primary dilution flow rate

secondary dilution flow rate

pebble feed rates for both pebble mills

primary cyclone feed flow rate

primary cyclone feed density

secondary cyclone feed flow rate

secondary cyclone feed density

power draft for both pebble mills

3.2.1 Manual samples

Nine points around the circuit were identified as manual sampling points. (Figure 3.1). These streams were :

rod mill discharge

both pebble mill discharges

both primary cyclone overflows

both primary cyclone underflows

secondary cyclone overflow

secondary cyclone underflow

Using audible signals, all nine samples were taken almost simultaneously at the required time by four persons using the standard sampling technique used on the plant. This involved sweeping a sample cutter (aperture 10 to 15 mm) through the streams and then carefully transferring the contents to a suitably labelled bucket. The equipment and techniques conformed to the guidelines set by Gy [9] and all but two of the sampling points were acceptable in terms of the ease and representativeness of the samples. All the persons involved in the sampling steps were trained as samplers or plant operators.

The two cases of difficult sampling were the primary cyclone overflows where there was no facility for sampling, and an 'as best as possible' sample was obtained. Other

All instruments had to be calibrated and in good working order.

The above factors were out of the investigator's control but were monitored by the inspection of daily log sheets.

3.2 Sampling procedure

To obtain a spread of data as wide as possible, the MVC set points of the circuit were adjusted over a wide range. The PSM set point was fixed at 80 percent, while the PCF and PCD were varied before each test. A total of 11 test runs was done during four sessions over a period of four weeks, each at a different PCF and PCD setting. Figure 3.2 shows that a wide spread on the PCF-PCD plane was covered.

A settling interval of about an hour was allowed for between the MVC set point changes and the sampling steps, at which time three consecutive samples were taken at each manual sampling point (figure 3.1) with about 5 - 10 minute intervals in between. This replication ensured that repeatability could be tested and that steady state could be confirmed. Each of these three repeats was labelled with the test number followed by *a*, *b* and *c*. This meant that 33 complete data sets could be compiled.

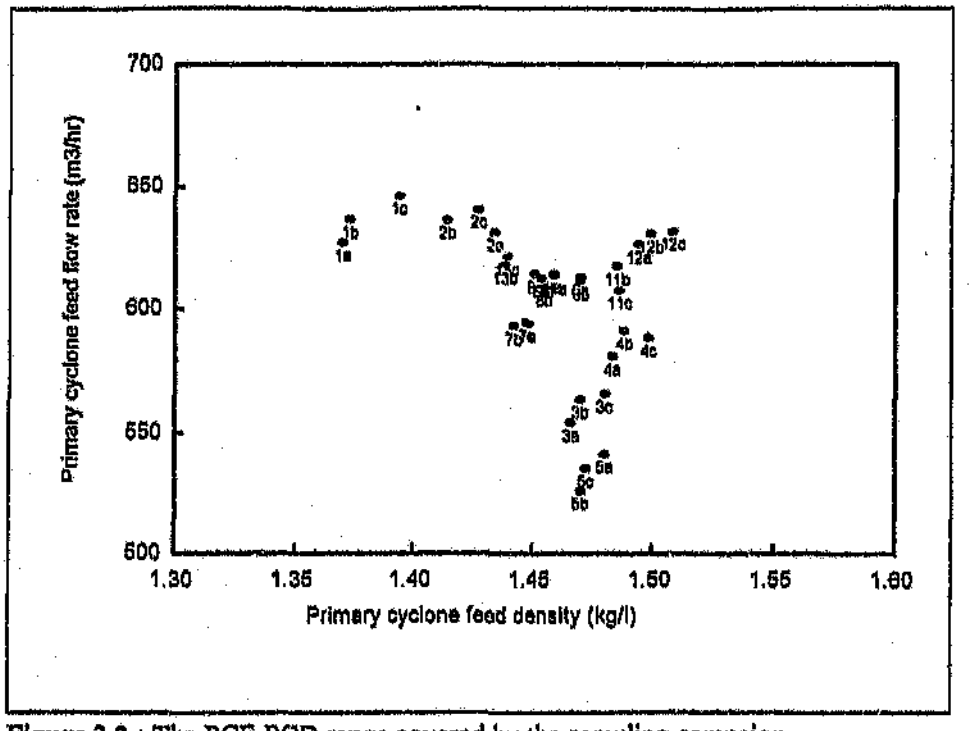


Figure 3.2 : The PCF-PCD range covered by the sampling campaign

There was no control over external factors like rod mill feed moisture and size distribution, although these were monitored during sampling.

3.1.4 Physical conditions

All equipment had to be in sound mechanical order. All pump impellers and liners had to be well maintained, as well as conveyer belts, pulleys and idlers. All pipes, valves and joints had to be in good working order. Mill liners had to be in a good condition, as were the cyclone linings and spigots. The rod loads in the rod mill had to be maintained according to usual practice.

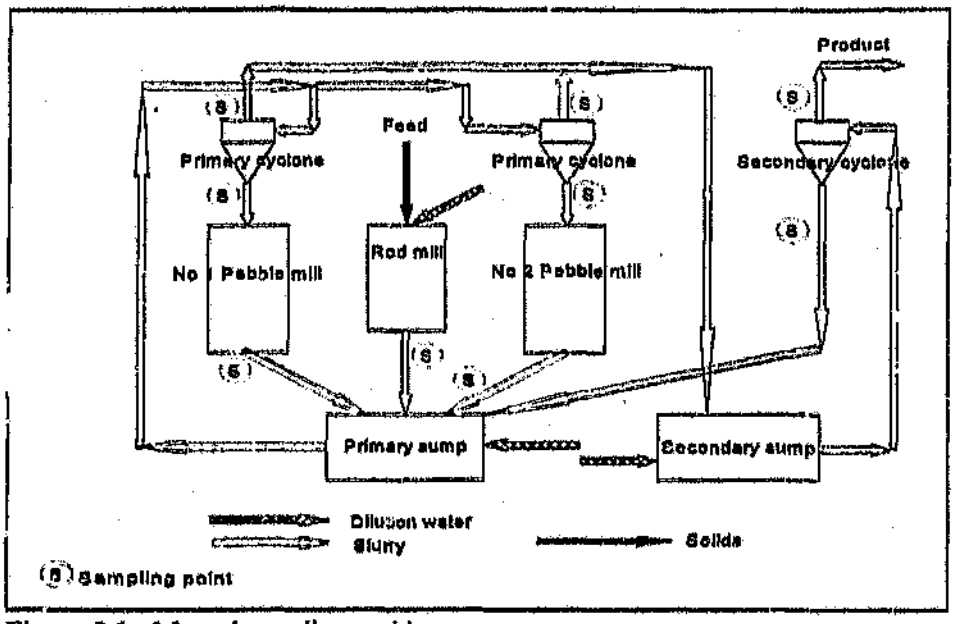


Figure 3.1 : Manual sampling positions

3.1.3 Control and operating conditions

It was decided to collect different sample sets for different operating conditions in terms of the circulating load, which was controlled by the primary cyclone feed flow rate (PCF) and the primary cyclone feed slurry density (PCD) set points of the MVC. The final product quality (PSM) set point was to be kept constant for all tests, since only the former two variables were under investigation. Because the tests were spread over a few days, cases of different primary cyclone spigot sizes were also recorded.

The circuit had to be kept under MVC control throughout, and the pebble mill power control had to be kept at close to optimum.

in mind.

3.1.1 Required information

Sufficient data was required to complete a solids and water balance around the circuit. This was possible with the information normally logged on line by the PROSCON system using available instrumentation. Data on size distributions for each stream had to be obtained by manual sampling, where possible. The size information for the other streams had to be calculated later. Additional information like mill power drafts was also available on-line.

3.1.2 Steady state

Because the models that were to be developed were all steady state models, care had to be taken that the circuit was operating at close to steady state. Clearly this can be very difficult in practice, but it could be achieved approximately by running the circuit for a long enough settling time under very strict control after an MVC set point change. The length of this settling time was chosen to be one hour. Simulations of the dynamic response of this circuit done by Hulbert [6] showed that this time was sufficient to achieve steady state. This was also confirmed by inspection of the trends of the important variables during the sampling period.

CHAPTER 3

3 SAMPLING

This chapter describes the sampling philosophy and strategy followed to obtain the necessary experimental data for the modelling step. Sampling points, sample times and procedures are described. Some major problems with the sampling campaign are identified.

3.1 Planning the sampling campaign

Because of the empirical nature of most grinding and classification models, real operating data had to be collected to develop and correlate such models. Furthermore, qualitative measurements of all geometries and mechanical conditions of the physical units concerned had to be obtained. The sampling points, timing considerations and methods of sampling had to be identified.

A sampling campaign was planned on no 1 circuit with the following important points

by a peak seeking controller. However, the subsequent installation of lifter bars in the pebble mills was thought to change the typical power-load relationship of these mills. The controller often overloaded the mill by not detecting the peak power.

It had since been replaced by a constant power algorithm [7] which kept the power at a specified level (usually 5%) just below the peak. This proved to be more stable and easier to control than a classic peak seeking controller. Pebbles are added at intervals to keep the mill at this power setting and in most cases at a constant load level. It is however realized that the load in the mill is not the only factor affecting the power draft, but that circulating load also has a major influence. The controller is thus only successful while the MVC keeps the circulating load constant.

controller is provided through a cascade ratio signal of the rod mill dilution water flow measurement. This ensures a constant moisture content in the rod mill.

Both sump levels are controlled via the hardware controllers that act on the variable speed motors of the first stage pumps. These loops are tuned to react slowly compared with the MVC to prevent interaction.

Multi variable control

A three input three output multi variable control scheme[2] is used to control the circuit (figure 2.6). The process output variables are:

primary cyclone feed flow rate

primary cyclone feed density

particle size of the secondary cyclone overflow.

These parameters are controlled to operator set points by acting on the three dilution slave loops as manipulated process input variables.

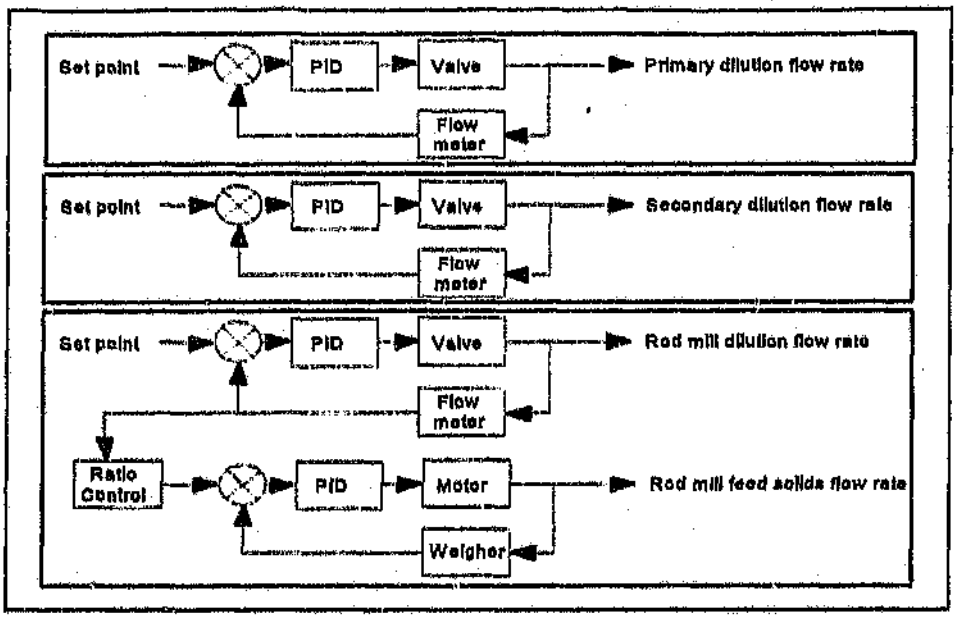


Figure 2.5 : Block diagrams of the three single dilution slave loops

2.3.3 Control strategy

Single variable control loops

As indicated in figure 2.5, all three water addition streams are regulated by proportional-integral (PI) MC-based controllers. They receive signals from water flow meters in the same streams, and control the water flows by adjustment of automatic valves.

The solids flow rate on the rod mill feed conveyor belt is also regulated by a MC-based PI controller that adjusts the speed of the feed belt. The set point of this

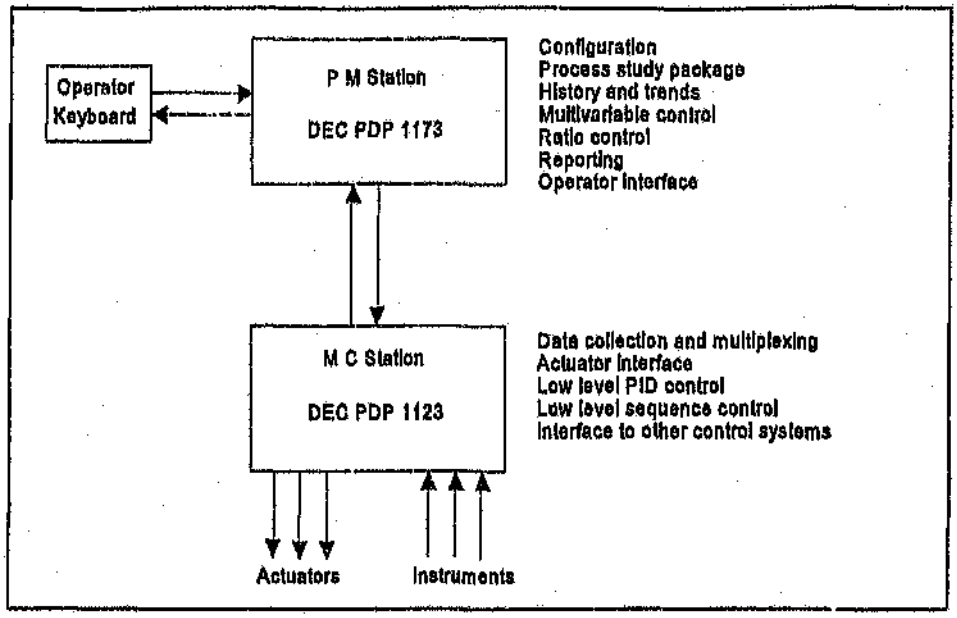


Figure 2.4 : Schematic diagram of the PROSCON 210 control system

including the ratio control and multi variable control algorithms. Data logging, history collection and trending of variables are also done at this level.

The PROSCON software includes a Process Study Package that facilitates statistical and graphical manipulation of logged or historical values.

Figure 2.4 shows a graphical representation of the PROSCON system.

Table 2.3 : Instrumentation list

Instrument	Make	Application
Flowmeter	Krohne AC Magnetic	Rod dilution water flow rate Primary dilution flow rate Secondary dilution flow rate Primary cyclone feed flow rate Secondary cyclone feed flow rate
Density meter	Ramsay SGF Nuclear Ramsay SGD Nuclear	Primary cyclone feed density Secondary Cyclone feed density
Belt weigher	Ramsay WSB Nuclear	Rod mill feed flow rate Pebble feed rate
Level detector	E & H Ultrasonic	Sump levels
Particle size monitor	Autometrics PSM 100	Product stream size analysis
Control valve	Masoneillan Camflex (air actuated)	Dilution water flow control for rod mill, primary- and secondary sumps

2.3.2 Controller hardware and software

Process control is done by a PROSCON 210 control system operating on two DEC PDP 1173 and two DEC PDP 1123 processors. Sump levels are controlled by two Hartmann & Braun PID controllers.

The two PDP 1123 machines, called the measurement and control (MC) stations, provide the plant interface and control all data movement to and from the field instrumentation and also some low level control. The PDP 1173 or process management (PM) station runs the supervisory system and the higher level control,

rather than the logged instantaneous pebble addition rate. This was to allow for the slow rate of breakage of the pebbles and for the long retention times of pebbles in the mills. Experience while 'running down' the loads in the mills before relining showed these retention times to be in the order of many hours.

4.2.5 Size analyses

Only two streams had no measured information about the size analysis, and these had to be calculated.

The size analysis of the secondary cyclone feed stream was assumed to be the average of those of the two primary cyclones.

The size analysis of the primary cyclone feed was calculated from those of the various streams entering the primary circuit. Although this did not provide a consistent material balance, it was thought to be adequate as a starting point for the mass balance smoothing step. The data is shown in appendix D.

4.3 Mass balance smoothing

After the above mass balance calculations, all streams and size analyses associated with these streams were known. The material balances however were not consistent. These had to be smoothed and a well-known method was used to do this. Since no

are composites with all information about the variation of the values lost due to averaging, they provided realistic starting values for the next step of material balance smoothing.

For each day the following information was available: the average primary cyclone overflow moisture content, and the average pebble mill discharge moisture content, which related directly to the primary cyclone underflow. By choosing the correct secondary cyclone feed solids and water flow rates, the values of the moisture contents of the data sets could be adjusted to match the composite daily values.

The optimizer used in the spreadsheet program *Quattro Pro 6.0 for Windows* provided a quick and easy way to estimate the optimum values by doing a nonlinear forward Newton search.

Appendix C lists the assumed values for the secondary cyclone feed stream.

4.2.4 Other units

With the secondary cyclone feed stream data available, enough was known to calculate initial material balances over the circuit, for both water and solids. The balances around the other units could be completed by simple difference calculations. The balances around the pebble mills included the average daily pebble addition rate

confirmed from daily plant log sheets. Thus the feed solids flow rate was assumed to be 95% of the weigher reading, as logged during the tests.

4.2.2 Primary cyclone feed

The flow split to the two primary cyclones was taken to be equal. The total solids flow rate was calculated as:

$$solids\ flowrate = \frac{volumetric\ flowrate\ (pulp\ density - 1)}{0{,}63}$$

with a solid density of 2,65. The flow to each cyclone was taken to be half the total flow.

The water flow rate was calculated from the difference with respect to the total volume flow.

4.2.3 Secondary cyclone feed

To account for the missing information about the secondary cyclone feed, the composite data regarding the moisture contents of the primary overflow and underflow streams were used. This data was logged by plant personnel as part of the routine sampling scheme used to operate the plant. While it is recognised that these

consistent mass balances, but more important, realistic values, that could be used in the subsequent modelling of the circuit.

The following steps were followed to achieve this: some initial simple calculations were done to provide starting values for the next step, namely mass balance smoothing.

4.2 Initial mass balance calculations

These calculations were done from the raw data to yield more information about the material balances for each of the various tests. In some case assumptions were made to simplify the calculations.

4.2.1 Rod mill discharge

The rod mill was assumed to operate very close to steady state, with no accumulation of solids or water. Thus the discharge solids flow rate was taken to be equal to the feed solids flow rate. The discharge water flow was the sum of the feed water flow rate and the rod mill dilution flow rate.

The feed moisture content was assumed to be consistent at 5% for all tests, as was

CHAPTER 4

4 DATA ANALYSES

The methods followed to provide consistent realistic material balances from real plant data are described in this chapter. Some assumptions had to be made about the circuit, and these are noted. All relevant calculations and methods are shown.

4.1 Introduction

In using any data collected from a real plant, two important factors must be borne in mind: there are always errors from various sources associated with analysis and flow rate data, and these errors always lead to inconsistent material balances if redundant data is included[10][11]. When serious errors exist in the collection of data, as with this project, extreme care must be taken when using the data, and any conclusions drawn should be critically examined.

Thus the data collected from the plant had to be manipulated in a way that yielded

All results were collated and are presented for each test in appendix B. The entries marked *n/a* represent the faulty instrument readings. This happened during tests 1a to 2c, 4a and 6a through to 8c.

Extra information used, like values from daily log sheets, will be reported in the following chapters as and when they are used in any calculation.

Apart from the faulty instruments, the investigator was satisfied that the sampling campaign was successful and gave a fair representation of plant conditions.

and that the tests could be assumed to represent steady state, except for tests 5a to 5c . It can also be seen from figure 3.2 that the three repeated samples for each test are closely grouped together, which is a further indication that the circuit was not changing significantly during each test.

Inspection of figures 3.7 to 3.10 shows that the PSM values also showed steady behaviour around the manual sampling instances, except again tests 5a to 5c, where large variations occurred just before the samples were taken. Another feature of figures 3.7 to 3.10 is the difference between the PSM value and the manually determined size analysis. In most cases the PSM shows the size to be finer than the manual sample. This difference became very small during tests 11 to 13. Errors in the PSM readings can arise from a variety of sources, like the efficiency of the sampling arrangement and the PSM calibration. Errors in manual sampling and analysis could have compounded this difference, although one would expect the manual result to show higher fractions of fine material (because of incomplete screening). It is suspected that these errors arose from the lack of representativeness of the sample presented to the PSM due to the physical sampling system. Also, it is known that the PSM calibration depends strongly on the slurry density of the sampled stream. Because the circuit was forced to operate at somewhat extreme set points, this effect could have played a part.

3.4 Results

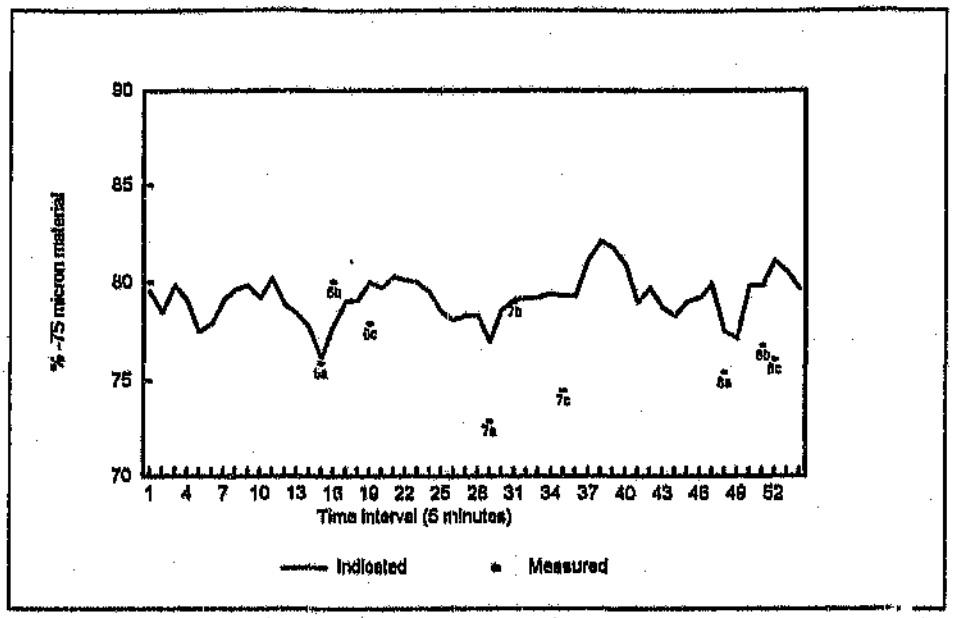


Figure 3.9 : Time series plot showing the relationship between the PSM and the actual product fineness for tests 6 and 8

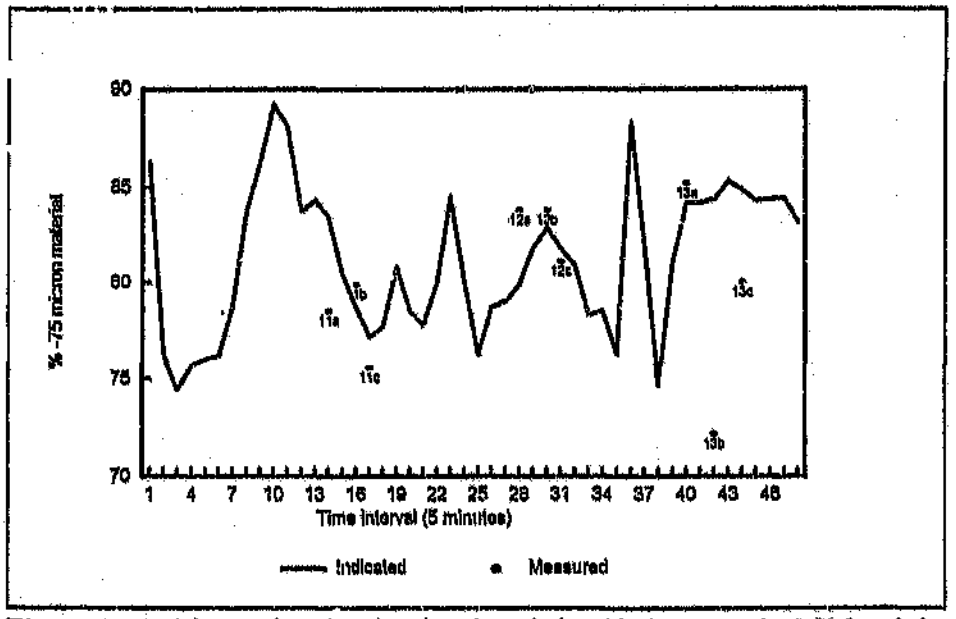


Figure 3.10 : Time series plot showing the relationship between the PSM and the actual product fineness for tests 11 to 13

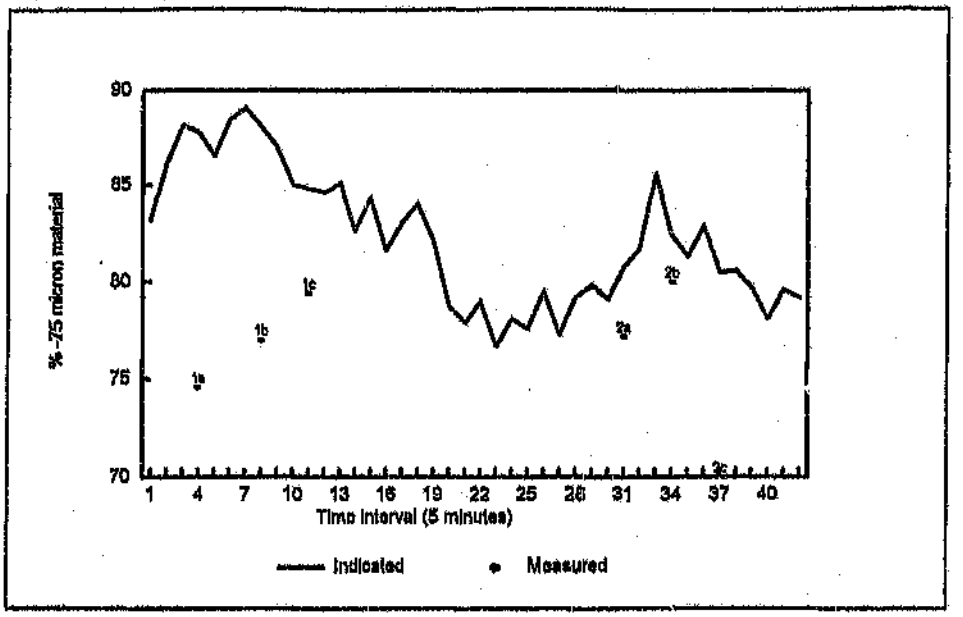


Figure 3.7 : Time series plot showing the relationship between the PSM and the actual product fineness for tests 1 and 2

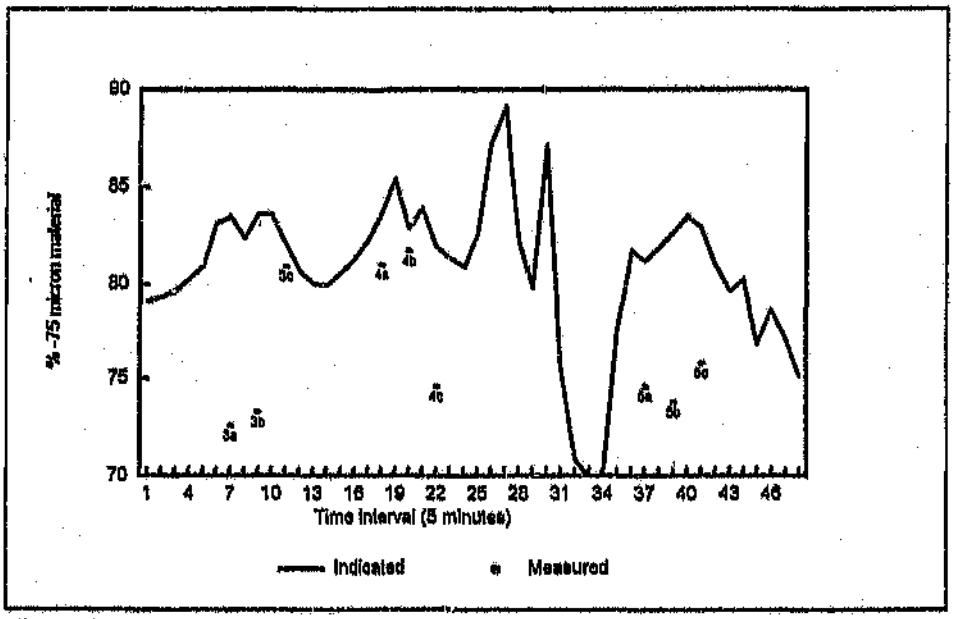


Figure 3.8 :Time series plot showing the relationship between the PSM and the actual product fineness for tests 3 to 5

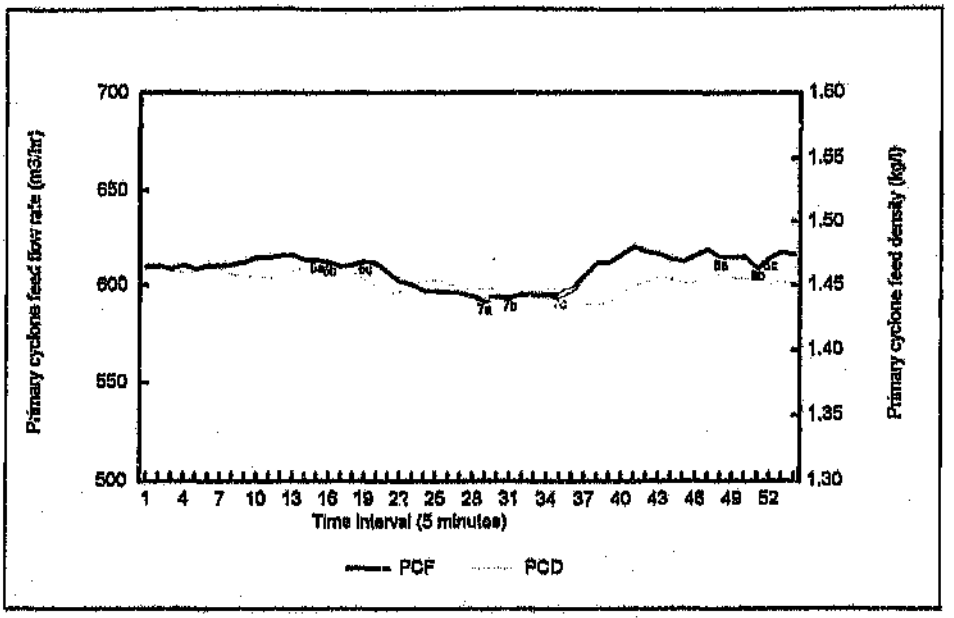


Figure 3.5 : Time series plot of PCF and PCD showing tests 6 to 8

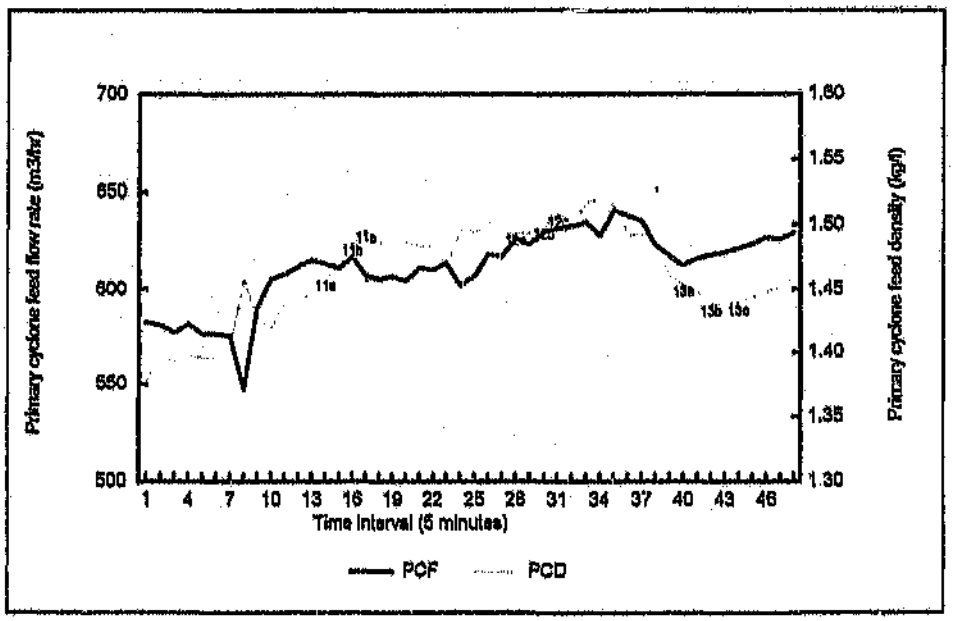


Figure 3.6 : Time series plot of PCF and PCD showing tests 11 to 13

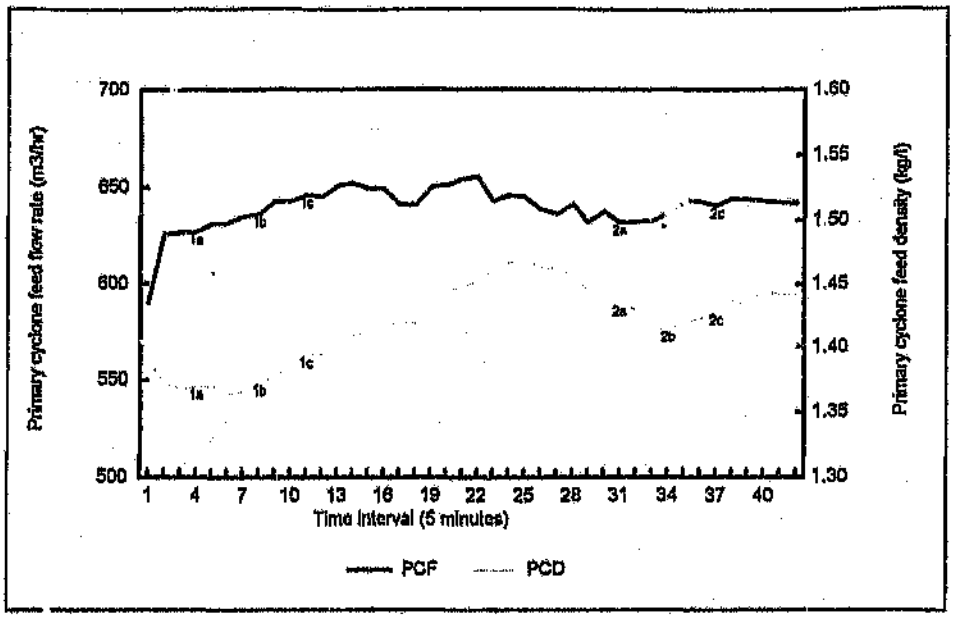


Figure 3.3 : Time series plot of PCF and PCD showing tests 1 and 2

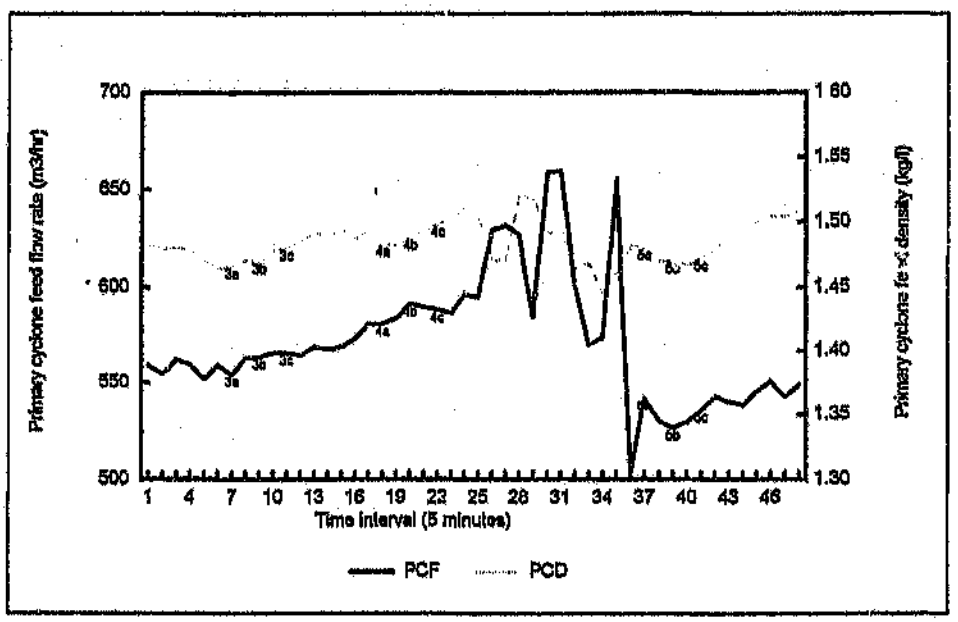


Figure 3.4 : Time series plot of PCF and PCD showing tests 3 to 5

product particle size (as percentage smaller than 75 μm)

These values were automatically and continuously logged and averaged over intervals of 5 minutes by the system. The actual time at which the manual samples were taken, was assumed to be represented by the st...t time of the corresponding logging interval.

Although all instruments were calibrated and checked before the tests, the density meter and flow meters on the feed to the secondary cyclone logged inconsistent results. This is discussed in the next chapter.

3.3 Sample preparation and analysis

The bucket contents from the manual samples were de-watered, dried and analysed for particle size distribution (74 μm, 150 μm, 250 μm and 1700 μm) using the standard plant procedure (Appendix A). Originally it was not planned to analyse the samples for slurry density or solid contents, but this proved to be a serious oversight because of the two faulty instruments mentioned above. By the time it was realised that these instruments were inaccurate, the samples had already been de-watered and no moisture analysis could be done.

To check if the circuit was at steady state during the sampling periods, time plots (figures 3.3 to 3.6) were prepared of the two important MVC controlled variables. They show that only slight variation occurred during the sampling periods,

This technique was successfully applied to both the primary and secondary cyclones and the results are shown in the next chapter.

4.6 Data sets for use in further modelling

It was decided to use the initial mass balances obtained by the steps described in section 4.2 of this chapter, rather than the smoothed balances discussed in section 4.3. The possibility existed that additional errors could be introduced into smoothed data, and that important features could be masked by the smoothing step.

During exploratory attempts at model fitting, this was indeed found to be true. The pebble mill models for example fitted the raw data much better than the smoothed data, and certain flow rate dependencies were hidden in the smoothed data.

The decision was then made to use the unsmoothed data (appendix D) for the mill model fitting step, and to use the data smoothed only around the hydrocyclones for cyclone modelling.

$$f_{ka} = \frac{r_k}{h}$$

$$u_{ka} = \frac{-R_s r_k}{h}$$

$$o_{ka} = \frac{-(1-R_s) r_k}{h}$$

where f_{ka}, o_{ka}, and u_{ka} represent the adjustment needed to each component in the respective streams for a consistent balance. Once R_s is determined, the corrected analyses can be obtained.

If one assumes a constant standard deviation for all the samples around the cyclone, the recovery is obtained by minimising the squares of the component adjustments.

$$R_s = \frac{-2(Y-X) \pm \sqrt{2(Y-X)^2 - 4(X-2Z)(2Z-Y)}}{2(X-2Z)}$$

where

$$X = \sum_{k=1}^{n} (u_k - o_k)^2$$

$$Y = \sum_{k=1}^{n} (f_k - o_k)^2$$

$$Z = \sum_{k=1}^{n} (u_k - o_k)(f_k - o_k)$$

crucial for mill model fitting, because the overall material balances are trivial, and no redundant data is possible for the size analyses of the connected streams.

This meant that smoothing was only meaningful around the hydrocyclones. Some very good and simple techniques exist, and a method for separating units, described by Wills and Manser[17], was applied to hydrocyclones in this case.

In a hydrocyclone

$$f_k - R_f u_k - (1 - R_f) o_k = r_k$$

where f_k, o_k and u_k represent the measured mass fraction k^{th} size interval for the feed, overflow and underflow streams respectively, and r_k is the residual in the closure equation generated by experimental errors in the measurements for each k. R_f represents the estimated recovery of solids to the underflow. Some factor h is defined as

$$h = 1 + R_f^2 + (1 - R_f)^2$$

so that

In some cases, the adjustments in the size analyses were large. The pebble mill discharge streams were adjusted to a large extent in almost every test, and the reason was also unknown. As was expected, the primary cyclone overflow and secondary cyclone feed stream size analyses were adjusted substantially.

Because of the large adjustments made in most instances, some doubt could be expressed over the representativeness of the data, and to its suitability for use in further analyses. In most publications on mass balance smoothing, the warning is made clearly that smoothing will not improve bad data. This caused the investigator to investigate another option.

4.5 Smoothing around the hydrocyclones only

The question could be asked whether consistent mass balances were indeed needed for the subsequent modelling stages. The answer is yes if one attempts to fit models to all the processing units simultaneously, which is possible with a simulator like MICROSIM [16], but it is not recommended because of the number of parameters to be optimized. Usual problems include the existence of local minima, and that of advanced computing power requirements. Alternatively, if one would fit models to each processing item individually, then consistent mass balances would only be needed for classification units, i.e. units with two or more product streams where the component in each stream is also preserved. Clearly, consistent mass balances are not

4.3.2 Water mass balance

Since there was no redundant water flow data no smoothing could be done, and the data was consistent already by definition. The water flow rates calculated previously were used in all further calculations.

4.4 Corrected mass balances

Appendix F lists the smoothed mass balances for all the tests. As was noted earlier, the two pebble mill discharge streams had to be re-constituted from the combined streams specified by the smoothing exercise. This was done by simply splitting the stream, and then calculating each size analysis *pro rata* to the raw data, but so that the combined flow rates in each size fraction did not change. Thus the overall integrity of the balance was not compromised.

Inspection of the fitted data sets in appendix F shows that for all tests, the adjustments made to the solids mass balance was small in general. This was to be expected since the solids balance in the initial data set was already consistent due to the estimation of the secondary cyclone feed. The adjustments made were the consequence of the smoothing step of the size analyses information. A large (about 10 %) adjustment occurred in the rod mill feed tonnage in some cases, but the reason for this was unknown.

Table 4.1 : Estimated variances for different sampling positions

Type of sample	Sampling point	Remarks	Variance (σ^2)
Solid flow rate	Primary cyclone feed	Good sample. Instruments calibrated and checked before test.	1
	Secondary cyclone feed	Bad sample. Instruments calibrated and checked before test, but density meter gave suspicious readings.	50
	Rod mill feed	Very good sample. Weigher calibrated and checked routinely.	1
Size analyses	Rod mill discharge	Very good sample.	1
	Pebble mill discharges	Very good samples.	1
	Primary cyclone underflows	Average sample. High flow rates made sampling difficult.	10
	Primary cyclone overflows	Bad sample. No sampling point. Sample taken directly from overflow box.	50
	Secondary cyclone underflow	Good sample. High flow rate made sampling difficult.	10
	Secondary cyclone overflow	Very good sample. Sampling point used routinely for very critical process information.	1

good the sampling point, the taking of the sample, and of the analysis was. For each stream, constant variances were assumed over all tests.

A summary of observations, and also the variances used is shown in table 4.1.

A 96 by 96 matrix derived from the derivatives of the Lagrangians had to be solved for each test to give a smoothed solids mass balance.

A Turbo Pascal program (appendix E - program 'SMOOTHSO.PAS') was written to prepare the data, and to solve the set of equations in terms of the required variables. Traditional numerical methods of matrix solution are not always very robust, although they tend to be faster. Failure to produce a solution often occurs, especially in a matrix with a mixture of large and small elements. This was experienced while trying to solve the matrix using the Gaussian elimination method.

This matrix, however, was recognised as a sparse matrix, and this characteristic was exploited to apply an iterative method that yielded results every time. The conjugate gradient method was used.[15]

A listing of this part of the program is also shown in appendix E as the procedure 'SOLVMAT.PAS'.

solved simultaneously for these variables.

These were:

$$\frac{\partial L}{\partial \hat{a}_j^k} = \frac{(\hat{a}_j^k - a_j^k)}{\sigma_j^k} + \sum_{i=1}^{n_s} \lambda_i^k \hat{f}_j = 0 \qquad j=1,\ldots,n_s \; ; \; k=1,\ldots,n_a$$

$$\frac{\partial L}{\partial \hat{f}_j} = \frac{(\hat{f}_j - f_j)}{\sigma_j} + \sum_{i=1}^{n_n} \sum_{k=1}^{n_a} \lambda_i^k A_{ij} a_j^k + \sum_{i=1}^{n_s} \theta_i A_{ij} = 0 \qquad j=1,\ldots,n_s$$

$$\frac{\partial L}{\partial \lambda_i^k} = \sum_{j=1}^{n_s} A_{ij} (\hat{a}_j^k \hat{f}_j + \hat{f}_j a_j^k - f_j \hat{a}) = 0 \qquad i=1,\ldots,n_s \; ; \; k=1,\ldots,n_a$$

$$\frac{\partial L}{\partial \theta_i} = \sum_{j=1}^{n_s} A_{ij} \hat{f}_j = 0 \qquad i=1,\ldots,n_n$$

For the circuit under investigation, additional constraints had to be included for the balance around the mills, since the above equations assume that the mass contained in each size class is conserved over a unit. This is obviously not true for a mill or crusher unit, and this constraint was replaced by the fact that all size fractions had to add up to unity [13]. This was the reason for the inclusion of the dummy stream and mixing unit to take care of the pebble addition. The smoothing software was written to accept only one input and one output to a mill or crusher unit type.

Some indication of the reliability of the various sources of information was needed to quantify the variances σ_j^i and $\sigma_j^{k\,2}$. The Laguitton method [14] for estimating variances was used, based on a qualitative 'feel' (supported by operating experience) for how

the smallest size interval (~75μm).

The rest of the connection matrix reflected the physical circuit exactly.

Setting up the objective function in terms of the constraint of the conservation of mass, the resultant Lagrangian according to Hinde [12] is:

$$L = \sum_{k=1}^{n_a}\sum_{j=1}^{n_s}\left(\frac{\hat{a}_j^k - a_j^k}{\sigma_j^k}\right)^2 + \sum_{j=1}^{n_s}\left(\frac{\hat{f}_j - f_j}{\sigma_j}\right)^2 + \sum_{i=1}^{n_n}\sum_{k=1}^{n_a} 2\lambda_i^k \sum_{j=1}^{n_s} A_{ij}\hat{f}_j\hat{a}_j^k + \sum_{i=1}^{n_n} 2\theta_i \sum_{j=1}^{n_s} A_{ij}\hat{f}_j$$

where n_a = number of size intervals per stream

n_s = number of streams

n_n = number of units

a_j^k = size analysis of the kth interval in the jth stream

$\hat{a}_j^k$ = adjusted size analysis of the kth interval in the jth stream

f_j = solids flow rate of the jth stream

$\hat{f}_j$ = adjusted solids flow rate of the jth stream

θ_i, λ_j^k = Lagrangian multipliers

σ_j^k = standard deviation of size analysis values

σ_j = standard deviation of flow rate values

The minimum of this Lagrangian with respect to the flow rates, size analyses and the multipliers could be obtained by differentiating L with respect to the unknown variables and setting it equal to zero. This yielded a set of equations that could be

The rod mill was not included as a unit. The feed to the plant (stream 1, figure 4.1) was taken to be the rod mill discharge.

Both primary cyclones were taken as one unit (unit 2). It was assumed that being similar and in parallel, their behaviour would be the same.

The pebble mills were taken as one unit (unit 4). Although not ideal, these simplifications had to be made for reasons described above. Because the two pebble mills operated at different load and power conditions, their behaviour and thus product streams were significantly different. This problem was overcome by readjusting the pebble mill discharge size analyses and solids flow rates in a way to keep the consistency of the material balances. It will be described later.

An extra 'mixing' unit (unit 5) was added to account for the addition of pebbles. Because the software written to do the mass balance smoothing handled mills and crushers in a different way than other units (to be discussed later), no extra input streams to the mills could be specified. Therefor a dummy stream (6) that represents the combined pebble mill discharge without the effects of the pebble addition had to be specified. The pebble flow rate was then added to the mixing unit, to be simply included in the pebble mill discharge. As a further simplification, the additional mill discharge flow rate caused by the pebble addition was assumed to be all in

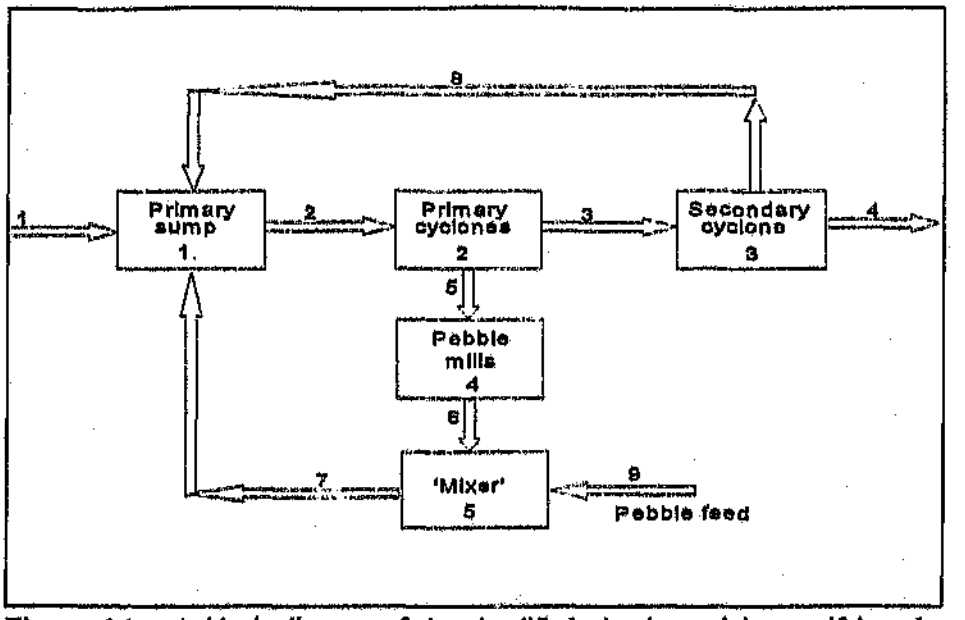


Figure 4.1 : A block diagram of the simplified circuit used in specifying the connection matrix.

connection matrix for the following reasons. The smoothing program was written using Turbo Pascal V.7. There are certain memory constraints built into any such compiler running under DOS. This meant that the size of the resultant matrix that had to be solved by the program was limited. Since the size of the matrix depends on the number of units, streams and size analyses specified, a very simply simple connection matrix had to be used. This was clearly not the ideal situation, but there was no practical alternative to the problem.

The following simplifications were made:

Only solids and size analysis were considered (for reasons mentioned before).

redundant data was available on the water flow rates, smoothing could only be done on the solids flow rates and the size analyses.

4.3.1 Solids mass balance

The large degree of redundancy of the data was used effectively by a Lagrangian multiplier method to apply smoothing techniques to the solids mass balance. The objective was to achieve a consistent mass balance by adjusting data known to contain errors, while minimizing the extent of the adjustments made to the data.

Any plant can be represented by a connection matrix A. The number of rows corresponds to the number of units (nodes) in the plant, while the number of columns represents the number of streams connecting these units. When representing the grinding circuit in a simplified way as in figure 4.1, the connection matrix becomes :

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & -1 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 & -1 \end{bmatrix}$$

with "1" indicating that the stream feeds the unit, " -1", it is a product from the unit and "0", that it is not connected to the unit.

Certain simplifications and assumptions had to be made while establishing the

shows this relationship graphically and again the values are listed in appendix G. It must be borne in mind that this relationship holds only for the operating ranges under investigation.

Figure 5.6 shows that this model was also accurate for the ranges applicable in this project. It was also much simpler than the plug flow model and thus was used in all subsequent simulations.

5.3 Pebble mills

The simple population balance model for a perfectly mixed mill[18] was used to simulate the operation of the pebble mills. These mills were taken to behave in the same way as ball mills, and since the average pebble attrition rate was very low (about 3 tons per mill per hour), they were assumed to behave similarly to steel balls in terms of grinding action. For simplicity, it was assumed that the only contribution made by the pebbles in terms of mass balance was a slight increase in the -75µm fraction in the discharge. Because of the low attrition rate, it was taken that the entire pebble addition tonnage reported directly to the discharge as -75 µm material without taking part in the grinding action. Figure 5.7 shows schematically how the model was structured.

The perfectly mixed model follows from the general population balance equation

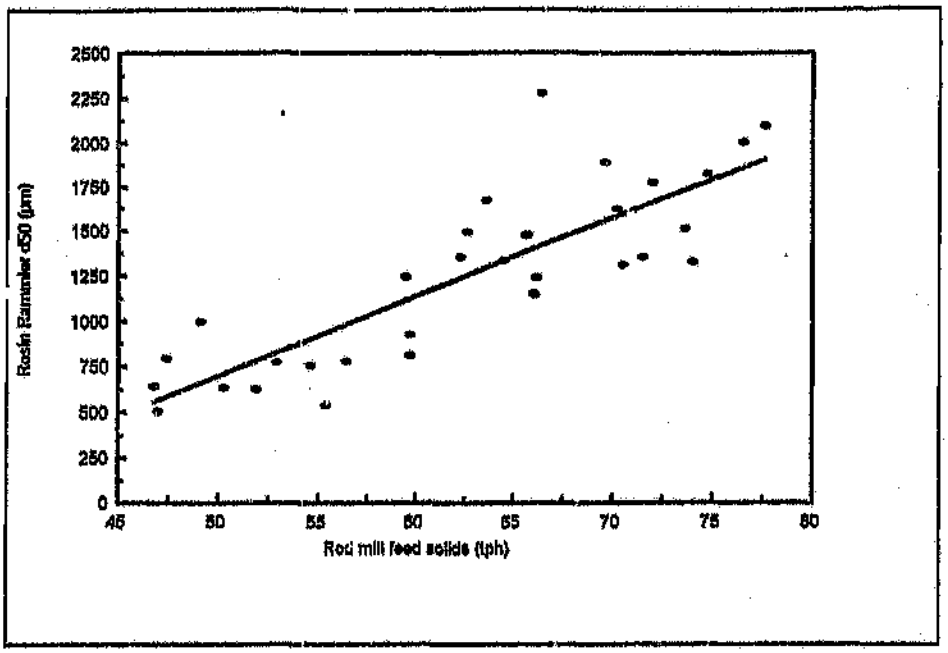


Figure 5.5 : Rosin Rammler d_{50} of rod mill discharge size distribution vs mill feed

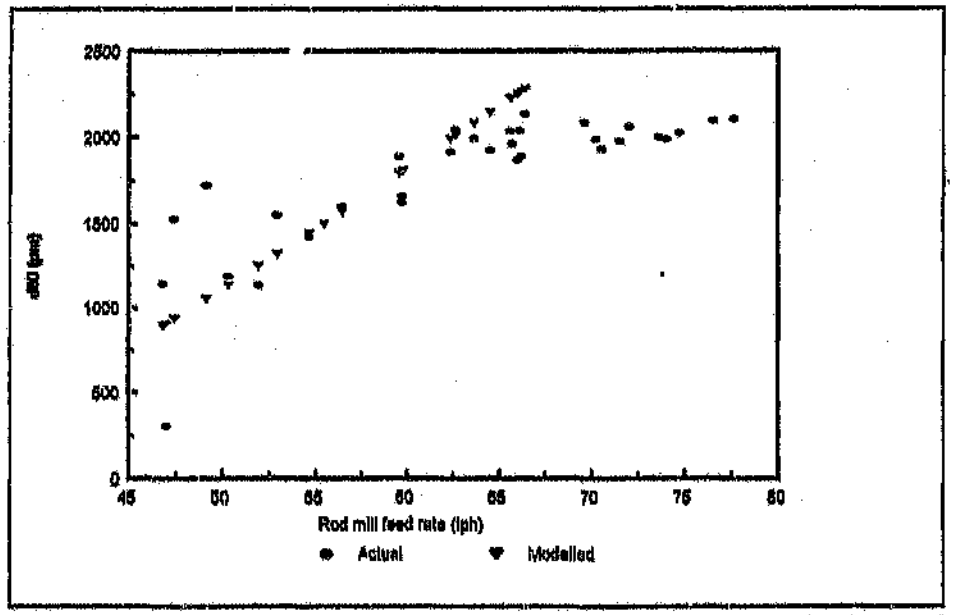


Figure 5.6 : Comparison of the measured and the predicted d_{80} for the simple model

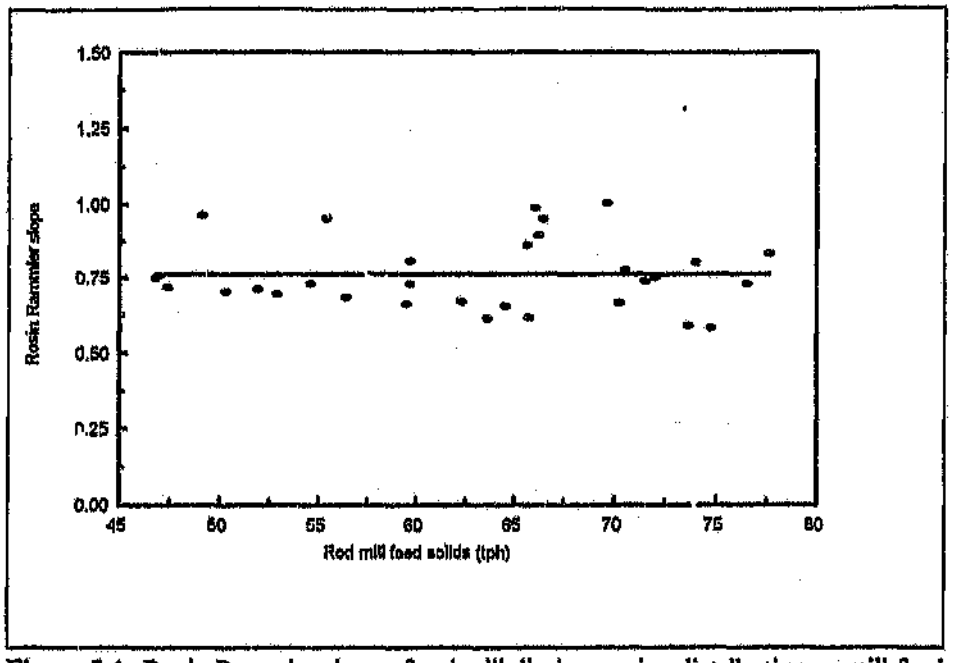


Figure 5.4 : Rosin Rammler slope of rod mill discharge size distribution vs mill feed

These assumptions were tested and were found reasonably valid. For each of the 33 test cases the rod mill discharge size distributions followed the Rosin Rammler distribution closely and the average slope was found to be 0,799 with a standard deviation of 0,117. Figure 5.4 shows the values of the slopes for all the test cases, while the values are listed in appendix G. No clear dependency on feed rate could be identified.

The relationship between the characteristic size and the mill throughput could be expressed as:

$$d_{50} = 43{,}94 \times \textit{mill throughput} - 1499$$

with the mill throughput in dry tons per hour and the size in microns. Figure 5.5

The predicted versus measured d_{80} are plotted on figure 5.3, and shows a high correlation at high feed rates. At lower feed rates however, some scatter occurred.

5.2.2 Simple rod mill model

It had been shown before that for open circuit mills the rate of production of material of certain sizes was directly proportional to the throughput of the mill[21]. This finding was used to develop a very simple rod mill model that assumed the following:

The mill product followed a Rosin-Rammler distribution.

The slope of the Rosin-Rammler distribution stayed almost constant.

The characteristic size (d_{50}) of the distribution depended linearly on the solids throughput through the mill.

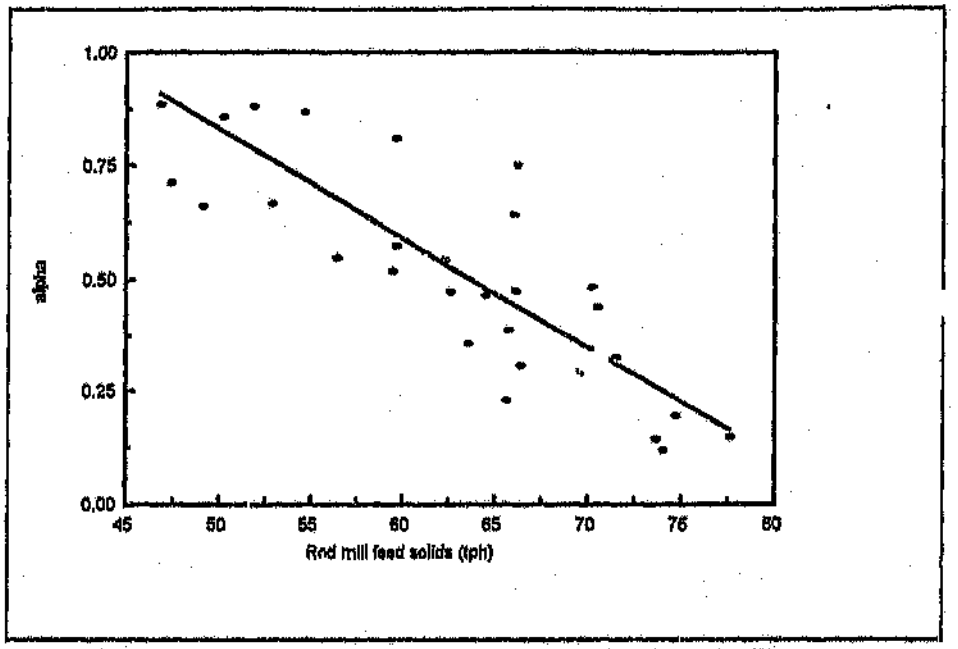


Figure 5.2 : Relationship of α to the mill throughput for the rod mill

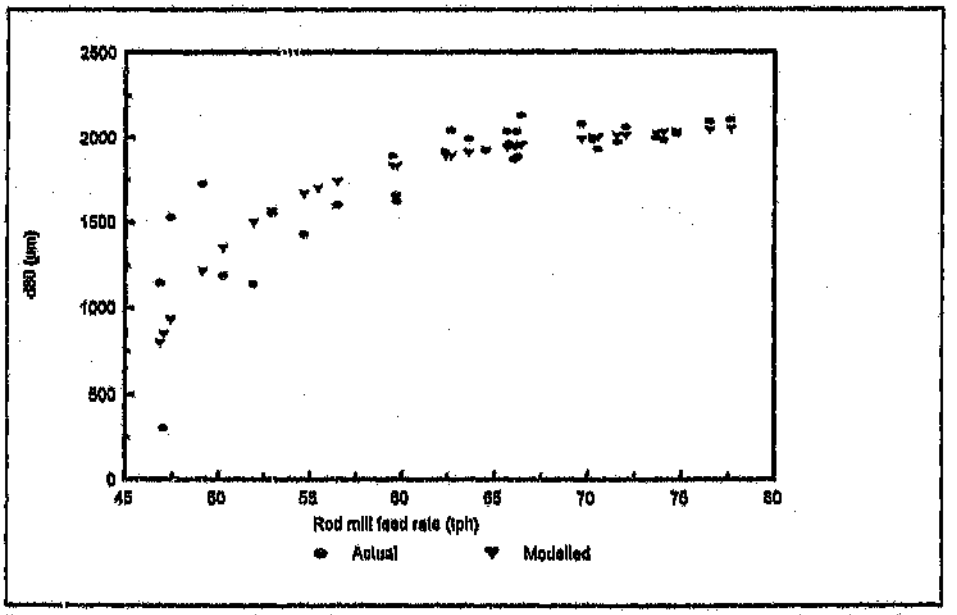


Figure 5.3 : Comparison of the measured and the predicted d_{80} for the plug flow model

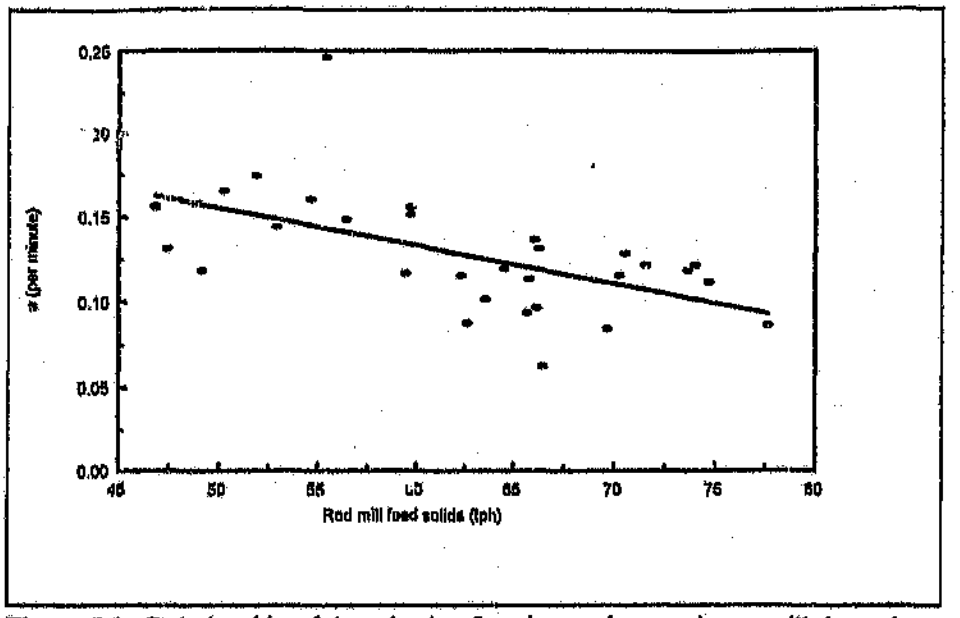


Figure 5.1 : Relationship of the selection function at the top size to mill throughput for the rod mill

an approximate feed size distribution (table 2.1) were specified and the two parameters were then optimized using a simplex procedure to approximate the given rod mill discharge size analysis. This step was repeated for each test. A correlation analysis using *Statistica for Windows* showed a dependence of both a and α on the mill solids throughput rate. A linear regression done on the dependance of the parameters on the feed rate yielded the following correlations:

$$a = -0{,}0022 \times \textit{Rod mill feed solids (tph)} + 0{,}268$$
$$\alpha = -0{,}0243 \times \textit{Rod mill feed solids (tph)} + 2{,}045$$

These equations are also shown in figures 5.1 and 5.2. These graphs show a good accuracy of the predictions of the two selection function parameters.

$$B_{ij} = \Phi_j\left(\frac{d_{i-1}}{d_j}\right)^{\gamma} + (1-\Phi_j)\left(\frac{d_{i-1}}{d_j}\right)^{\beta}$$

$$\text{with} \quad \Phi_j = \Phi_1\left(\frac{d_j}{d_m}\right)^{-\delta}$$

where

d_i = top size of the ith size interval in microns

$a, \alpha, \beta, \gamma, \delta, \Phi_1$ = empirical parameters.

The parameters β, γ, δ *and* Φ_1 are ore dependent[19], while a and α normally depend on the milling conditions as well.

This plug flow model was available in MICROSIM and was used to simulate the rod mill. The ore dependent parameters β, γ, δ *and* Φ_1 were determined by earlier work on East Driefontein ore[20] (table 5.1) and these values were used in the simulation.

Table 5.1 : Breakage parameters of East Driefontein ore

Parameter	Value
β	3,125
γ	0,687
ϕ_1	0,269
δ	0

The two mill dependent parameters a and α were fitted to the raw plant data using the parameter estimation facility in MICROSIM. The feed solids and dilution rates and

$$Fp_{fi}+\sum_{j=1}^{i-1} b_{ij}S_j w_j = w_i c_i+S_i w_i+\frac{d(w_i)}{dt}$$

where

F	=	mill throughput
w_i	=	mass of material in the mill in size class i (function of time)
b_{ij}	=	breakage function of particles breaking from size class j into class i
S_i	=	breakage rate of particles in size class i per unit time
p_{fi}	=	fraction of material in the ith size class in the feed stream
c_i	=	mass fraction in class i of load being discharged from the mill per unit time

For the batch or plug flow case: $F=0$, $d_i = 0$, and W = constant. The mass balance simplifies to:

$$\frac{d(w_i)}{dt} = -S_i w_i+\sum_{j=1}^{i-1} b_{ij}S_j w_j$$

The functions S_i and B_{ij} (where B_{ij} is the cumulative form of b_{ij}) are described by the following functional forms:

$$S_i = ad_i^{\alpha}$$

modelling step effected its own 'data smoothing'. Given that any model prediction only approximates a real situation, of which sampled data is a further approximation, some inaccuracy of measured data could be tolerated. The disadvantage of empirical modelling is that one tends to force the data to fit a given model structure, and not vice versa. Nevertheless, because of the lack of availability of good fundamental models, no better alternative existed, and this disadvantage can only be noted and borne in mind while regarding the results.

As a first step, the most popular and simple models were considered. If the models could be paramaterised in a way that approximated the data reasonably well, the model could be accepted as adequate. Again it should be stressed that no model can reflect reality under all circumstances.

5.2 Rod mill

5.2.1 Plug flow model

The Austin plug flow model was tried as a first attempt for the simulation of the rod mill [18]. This model is based on a population balance approach using breakage and selection functions.

The population balance equation in a mill can be written as:

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CHAPTER 5

5 MODELLING

This chapter describes the modelling, parameter fitting and simulation of each of the individual process units. These models were then used to simulate the entire circuit.

5.1 Introduction

Few, if any, fundamental models exist for minerals processing units, especially for mills and hydrocyclones. Many models are empirical and involve some type of parameter estimation to fit existing data. Obviously this approach is only possible when proper plant data is available to enable parameter fitting, and such models are only useful to extrapolate the prediction of the behaviour of processing units over a limited operating range, but not for design purposes.

Such empirical models suited the nature of this project ideally. Data was available, although noisy and inconsistent. The parameter fitting procedures used during the

This technique was successfully applied to both the primary and secondary cyclones and the results are shown in the next chapter.

4.6 Data sets for use in further modelling

It was decided to use the initial mass balances obtained by the steps described in section 4.2 of this chapter, rather than the smoothed balances discussed in section 4.3. The possibility existed that additional errors could be introduced into smoothed data and that important features could be masked by the smoothing step.

During exploratory attempts at model fitting, this was indeed found to be true. The pebble mill models for example fitted the raw data much better than the smoothed data, and certain flow rate dependencies were hidden in the smoothed data.

The decision was then made to use the unsmoothed data (appendix D) for the mill model fitting step, and to use the data smoothed only around the hydrocyclones for cyclone modelling.

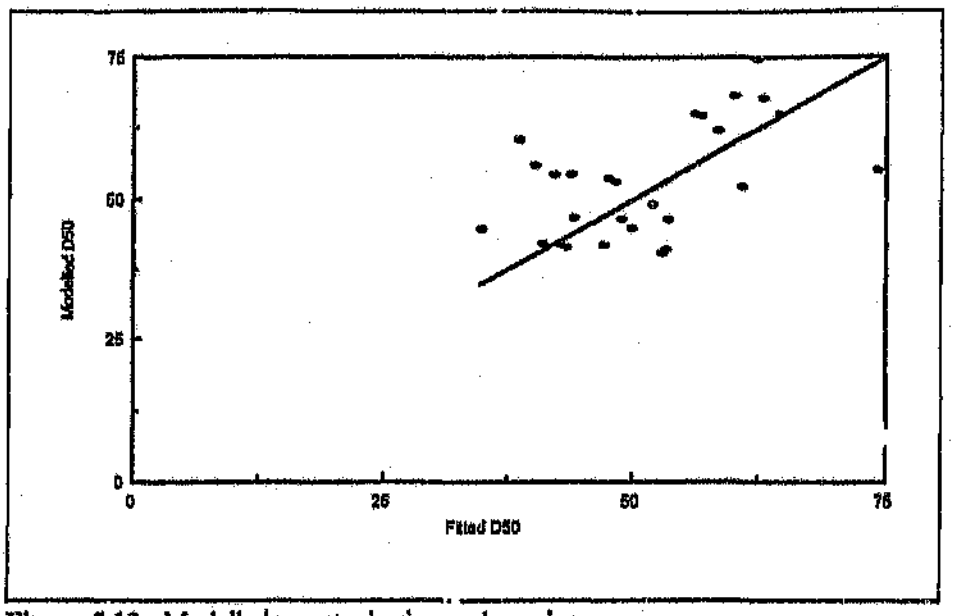


Figure 5.13 : Modelled vs actual primary d_{50c} values

the secondary cyclones. It is suspected that there was not enough variation in the feed density values to investigate this properly.

Given the accuracies shown in figures 5.13 to ? these cyclone models were clearly not very good, but due to the lack of better alternatives, were accepted to model the hydrocyclones in the circuit.

Table 5.2 : Cyclone calibration factors

Factor	Primary	Secondary
F_1	0,233 s.d.= 0,043	0,424 s.d.=0,086
F_2	0,312 s.d.= 0,023	0,269 s.d.= 0,025
F_4	-	15,41 s.d.= 1,09

These values and correlations were used to model both the primary and secondary cyclones. The predicted partition curves were compared to the original ones in terms of the d_{50c} cut size, the partition curve slope m and volumetric flow split values (S) for each test. These are shown on figures 5.13 to ?. Inspection of these graphs showed that in all cases there was a high correlation of the modelled values with actual data. This also suggested that the 'fishhook' assumption was valid for the operating condition ranges under investigation. To investigate this phenomenon more closely, detailed size analyses below 75 µm have to be obtained for the streams around the cyclone.

Of all the cyclone correlations, the values for the partition curve slope for the secondary cyclone showed the poorest fit. According to Plitt[22], this parameter is the most difficult to fit. While developing this model, he also showed low correlations due to some unaccounted factor.

It was disappointing not to find similar feed stream condition dependencies of F_4 for

combined. Again the simplex parameter estimation procedure in MICROSIM was used to estimate the values of F_1, F_2 and F_4 for each cyclone to fit the flow rates and size analyses provided by the smoothed mass balance. The value for k was taken to be 1 since the solids density was very close to 2,65 and the value of this exponent became irrelevant.

A correlation analysis of the F factors (which is listed in appendix G) on external factors like flow rates and feed densities showed that only F_4 for the primary cyclone was significantly dependent on the feed density (expressed as ϕ). Using the non-linear regression facility in *Statistica for Windows*, this dependency was taken to be

$$F_4 = 1{,}181\left(\frac{d_o}{d_u}\right)^{0{,}151} e^{(0{,}067\phi)}$$

after Cilliers[24] had shown similar correlations to hold for backfill cyclones. The same correlation could not be found for the secondary cyclone since there was very little variation in the spigot sizes during the tests.

The other factors were taken to be represented by their respective mean values, since the variation in values from test to test was small and probably attributable to experimental errors and smoothing adjustment errors. Table 5.2 lists the average values and standard deviations of the calibration factors.

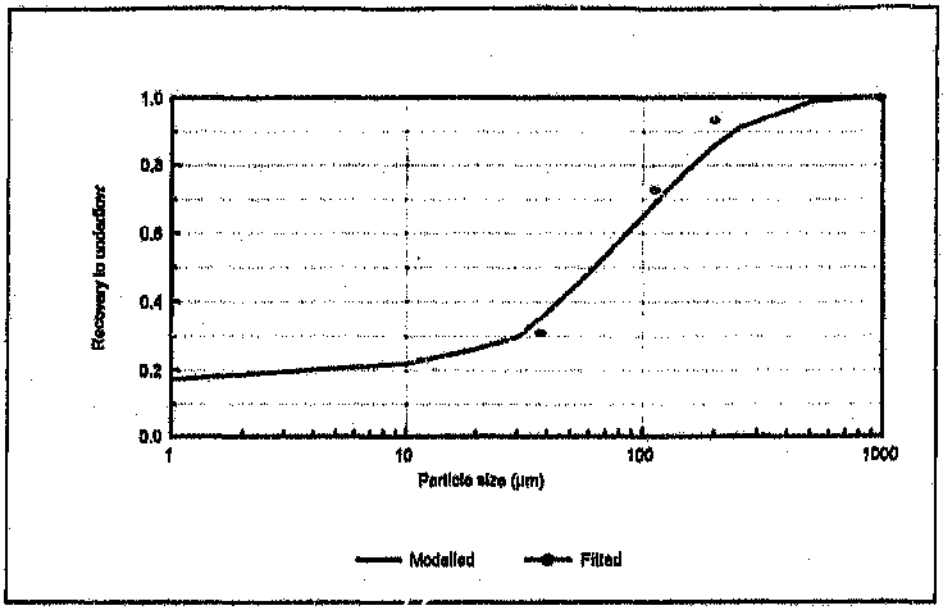


Figure 5.12 : A typical secondary cyclone partition curve

F_1, F_2, F_3, F_4 = calibration factors

D_c, D_i, D_u, D_o, h = cyclone diameter, inlet diameter, spigot diameter, vortex finder diameter and free vortex height, all in cm

ϕ = volumetric concentration of solids in the feed slurry, in %

Q = volumetric flow rate of feed slurry, in *l*/min

k = solids density effect exponent

ρ_s = density of the solids, in g/cm^3

S = volumetric flow split

P = cyclone inlet pressure, in kPa

ρ_p = density of the pulp, in g/cm^3

Because the pressure reading was not available, the last two correlations were

According to Plitt, the parameters in the partition curve equation are described by the following:

$$d_{50c} = \frac{F_1\, 39{,}7\, D_c^{0{,}46}\, D_i^{0{,}6}\, D_o^{1{,}21}\, eta^{0{,}5}\, e^{0{,}063\phi}}{D_u^{0{,}71}\, h^{0{,}38}\, Q^{0{,}45} \left(\frac{(\rho_s - 1)}{1{,}6}\right)^k}$$

$$m = F_2\, 1{,}94 \left(\frac{D_c\, h}{Q}\right)^{0{,}15} e^{\left(-1{,}58\, \frac{S}{1{,}3}\right)}$$

$$P = \frac{F_3\, 1{,}88\, Q^{1{,}78}\, e^{0{,}0035\phi}}{D_c^{0{,}37}\, D_i^{0{,}94}\, h^{0{,}28}\, (D_u^2 + D_o^2)^{0{,}87}}$$

$$S = \frac{F_4\, 3{,}29\, \rho_p^{0{,}24} \left(\frac{D_u}{D_c}\right)^{3{,}31} h^{0{,}54}\, (D_u^2 + D_o^2)^{0{,}36}\, e^{0{,}0054\phi}}{D_c^{1{,}11}\, p^{0{,}24}}$$

where

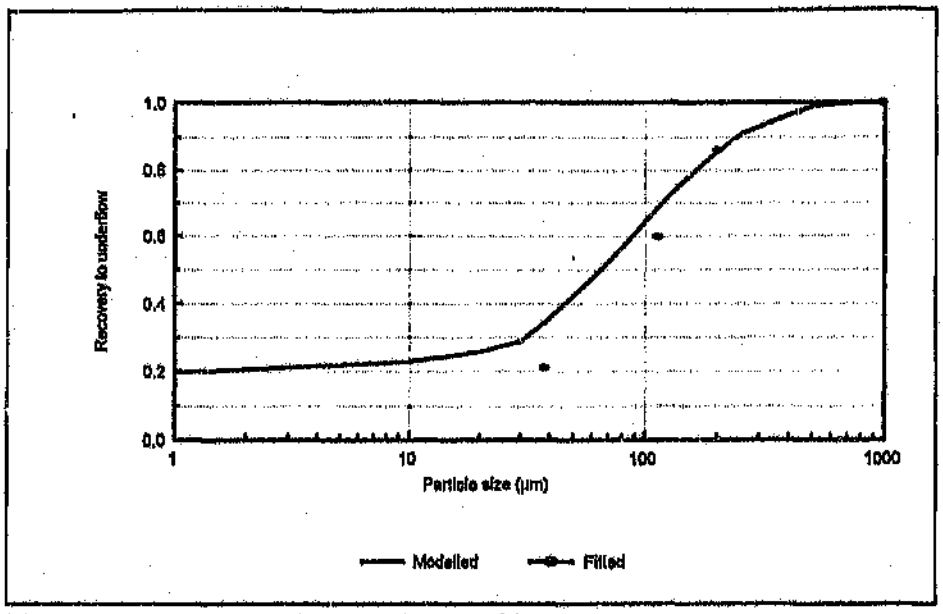


Figure 5.11 : A typical primary cyclone partition curve

$$y = R_f\left(1-\frac{d_i}{d_0}\right) \qquad d_i<d_0$$

$$y = 0 \qquad d_0 \le d_i$$

where d_0 is the largest particle that will be bypassed to the underflow. According to Finch this size is usually between 10 and 40 µm. Since the smallest representative size for this project is 38 µm (for the -75µm interval) the bypass will always be negligible. For all tes. this assumption seemed to hold, and the uncorrected partition curve fitted the Rosin Rammler equation better than the corrected curve. Figures 5.11 and 5.12 show the partition curves for two cases. Note that the fishhook can be clearly seen for both the primary and secondary cyclones. Undocumented tests done previously on the same cyclones also found the fishhook phenomenon, although this could not be confirmed with any historical data.

$$R'(d) = \frac{R(d)-y}{1-y}$$

where

$R'(d)$	=	corrected partition number
$R(d)$	=	actual partition number
y	=	fractional bypass of fine material to the underflow
d_{50c}	=	corrected size, in microns, at which 50% of material goes to the underflow
m	=	slope of the partition curve

Normally the fractional bypass is taken to equal to the recovery of water to the underflow, using the assumption that the water carries with it some solids with the same size distribution as the feed. After numerous attempts to fit the corrected partition numbers with Rosin-Rammler partition equations, it became clear that this assumption did not hold here. Finch [23] had however presented a different bypass model that explains a 'fishhook' phenomenon that sometimes occurs. He showed that

control system. For a more general case, the above equations would include a power dependant term as well. This fact should be noted, because it had a great influence on the determination of the ideal operating window, as will be shown in the next chapter.

With the above parameter values substituted into the mixed mill model, the behaviour of each pebble mill could be simulated. The model was accepted to give a good description of the actual milling performance.

5.4 Hydrocyclones

The modified Plitt cyclone model[22] was used as a basis to model both the primary and the secondary hydrocyclones.

The model is based on the assumption that the corrected partition number has the form of a Rosin Rammler equation:

$$R'(d) = 1 - \exp(-0{,}693(\frac{d}{d_{50c}})^m)$$

and that the corrected partition numbers and the actual partition numbers are related as follows:

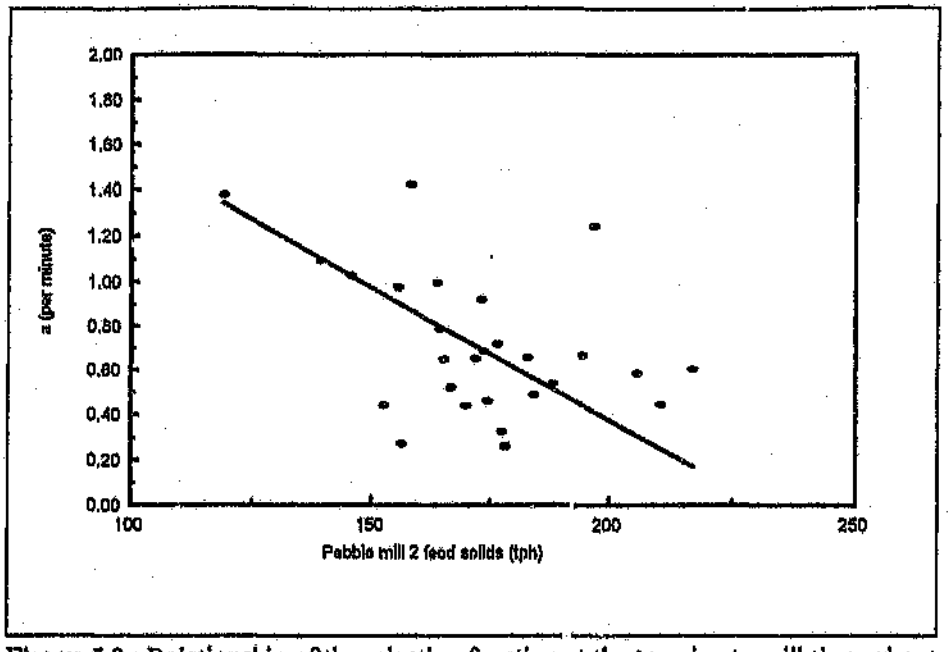


Figure 5.9 : Relationship of the selection function at the top size to mill throughput for no.2 pebble mill

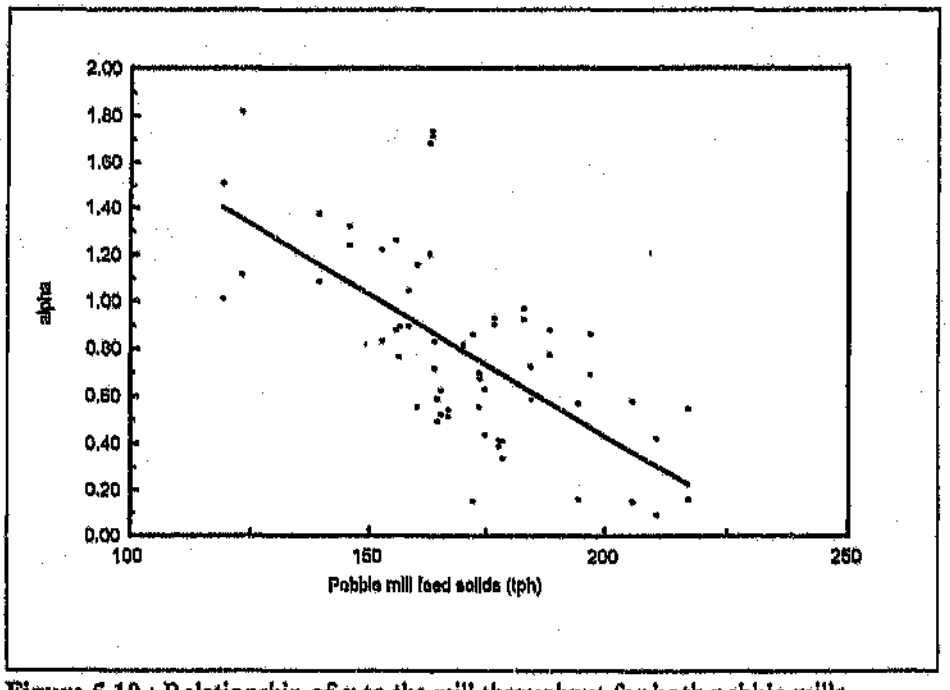


Figure 5.10 : Relationship of α to the mill throughput for both pebble mills

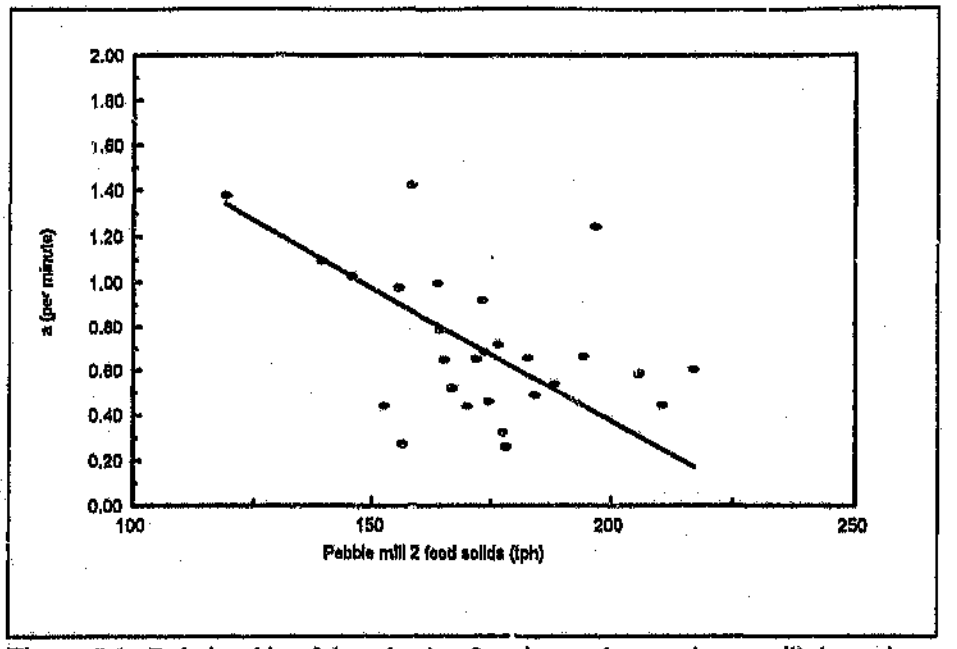


Figure 5.9 : Relationship of the selection function at the top size to mill throughput for no.2 pebble mill

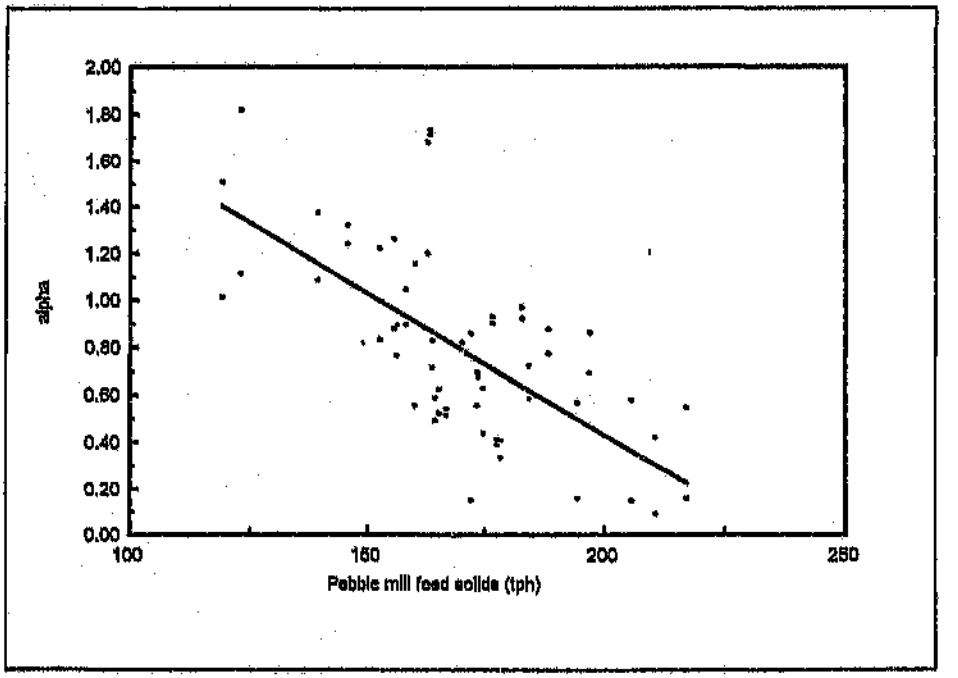


Figure 5.10 : Relationship of α to the mill throughput for both pebble mills

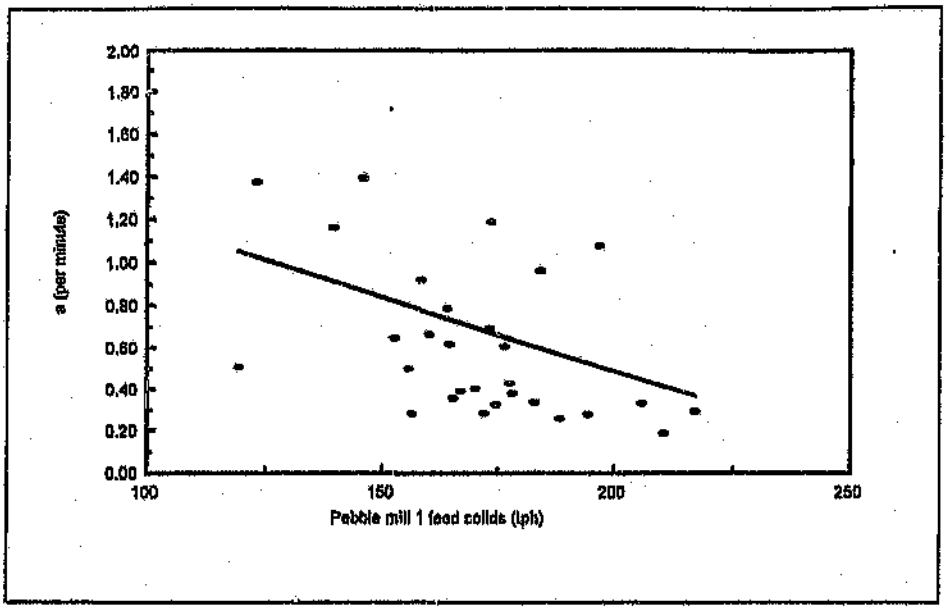


Figure 5.8 : Relationship of the selection function at the top size to mill throughput for no.1 pebble mill

No.1 Pebble Mill : a = -0,007 x *Mill feed solids* (*tph*) + 1,888
No.2 Pebble Mill : a = -0,012 x *Mill feed solids* (*tph*) + 2,777
Both Mills : α = -0,012 x *Mill feed solids* (*tph*) + 2,833

These were plotted on figure 5.8 to 5.10, and again good correlations were achieved.

The expected dependance on the mill power draft could not be quantified, because there was very little variation in this value for both mills, due to the good power

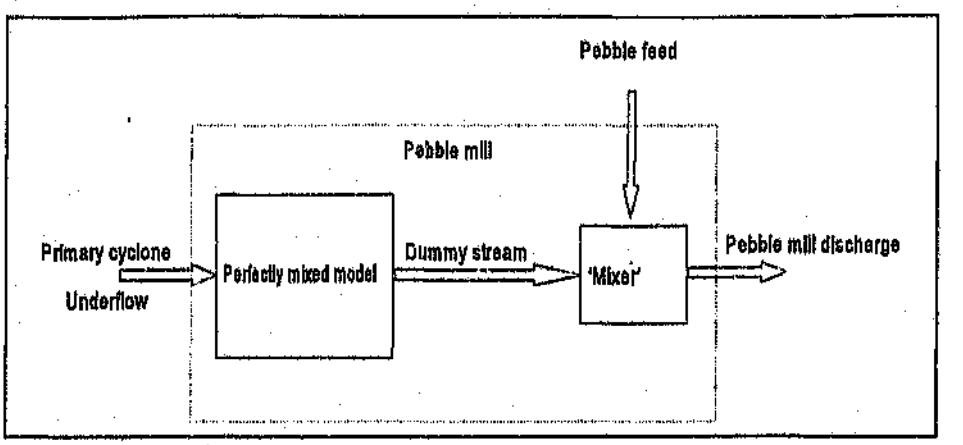


Figure 5.7 : Schematic diagram of the pebble mill structure

given before. For a certain size class i:

$$\frac{dw_i(t)}{dt} = -S_i w_i(t) + \sum_{\substack{j=1 \\ i>1}}^{i-1} b_{ij} S_j w_j(t) + F(p_{fi} - p_{pi}), \qquad i \geq j \geq 1$$

where

p_{pi} = fraction of material in the ith size class in the product stream

The functions S_i and B_{ij} are again described by the same functional forms as before.

As with the rod mill, the previously determined ore dependent parameters were used (table 5.1) and the selection function parameters were optimized for in MICROSIM. These are listed in appendix G. Once again, the only dependence found by a correlation analysis was that of the parameter on the mill throughput rate. The following relationships were found:

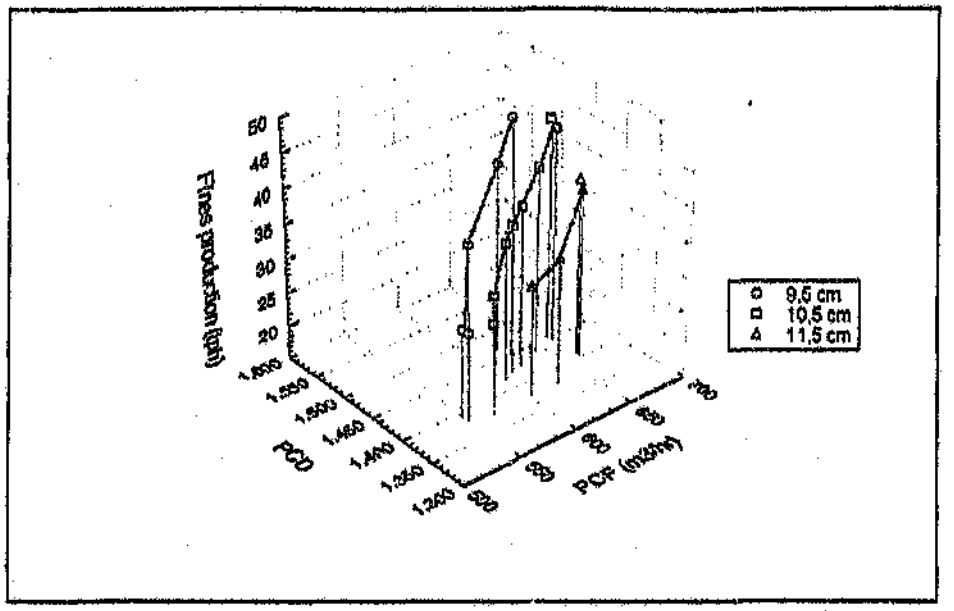


Figure 6.2 : The effect of PCF, PCD and primary spigot size on the production of less than 75µm material

in the milling section. It could simply be calculated from the mass balances as:

$$fines\ production = \frac{throughput \times (required\ grind - 1)}{100}$$

where the feed to the circuit was taken to contain 1 percent of -75µm material (table 2.1). When this quantity was plotted against the obtained PCF and PCD values, figure 6.2 resulted. Again the distinct lines can be observed, with the lower common termination point at the minimum fines production rate, and the maximum at about 52 tons of fines per hour (or 66 tons per hour for the rod mill feed rate) for the largest

PCF and PCD values are shown in figure 6.1.

The following observations were made:

It was found that all simulations above a PCF of 660 m^3 per hour became divergent and the simulator could not solve the circuit.

None of the simulations preformed were within the previously determined window (figure 1.1).

Furthermore, very few simulations could achieve the required PCF and PCD values set initially. It was found that the values for all simulations occurred on distinct lines, one for each spigot size (figure 6.1). Any initial required PCF-PCD combination resulted on a point on this locus because the simulator used did not allow a solution to the circuit away from this line. For all the points on the lines, a final grind of 80% was achieved because of the large weight put on this requirement.

All lines terminated almost at a single point were the rod mill feed reached its lower limit of 35 tons per hour.

The value chosen as the optimization objective was the production rate of correctly sized material. From a production point of view this was the most important quantity

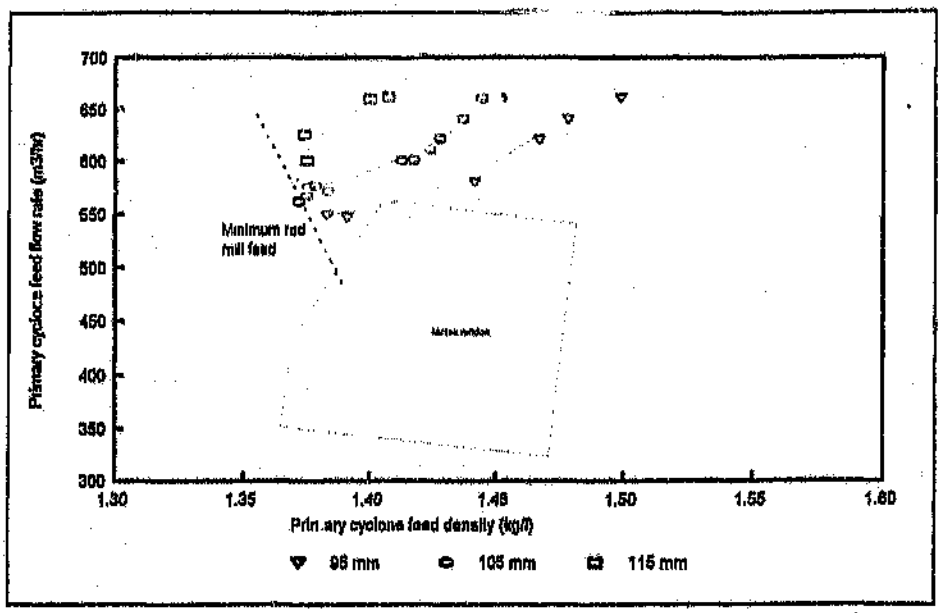


Figure 6.1 : PCF and PCD values achieved for a grind of 80% -75µm at different primary spigot sizes

6.2 Optimization results

The following conditions were specified to be simulated in different runs:

Final product quality : 80 % -75µm

Primary spigot sizes : 9,5 ; 10,5 and 11,5 cm

Primary cyclone feed densities : various values from 1,3 to 1,5

Primary cyclone feed flow rate : various values from 400 to 700 m^3 per hour

The PSM requirement was given a large weight to ensure a mass balance at the specified grind despite other constraints. After a few trail simulations, some 32 simulation runs were done. The resulting mass balances appear in appendix J, and the

and secondary dilution rates. The rod mill dilution stream could be adjusted automatically in MICROSIM to ensure a solids percentage of 72,1 % in the rod mill. The pebble additions to the two pebble mills were taken as a constant 3 tons per hour each, which was a good average value of the feeds during the test runs. The feed size distribution was not specified since the rod mill model was independent of feed size (within the bounds of this investigation). Other inputs were the geometries of the cyclones, of which only the primary spigot size was important in this case. All other geometries were kept constant at the same values at which the sampling runs were performed.

To do the optimization simulations at certain required PCF and PCD values, and at a required grind, the parameter estimation facility in MICROSIM was used. The required values of the PCF, PCD and grind quality (PSM) were specified as optimum values, and the rod mill solids feed rate and primary and secondary dilution rates were specified as parameters. Some practical limits were set for these parameters, for example the rod mill feed rate could only range from 35 to 85 tons per hour. These parameters were then varied using a simplex optimization method to provide PCF, PCD and PSM values closest to those specified.

This approach simulated the MVC control action and prevented any of the sensitivity problems discussed in the previous chapter.

CHAPTER 6

6 OPTIMIZATION

This chapter describes the methods followed in determining the optimum operating condition of the circuit. The simulator developed in the preceding chapters was used to predict performances over a wide range of conditions. The results are discussed, and compared with earlier findings.

6.1 Introduction

The final step in the optimization project was to use the simulator developed in MICROSIM to predict grinding performance under different operating conditions. The approach taken was to perform simulations at various positions in the PCF-PCD operating plane at a required grind of 80% finer than 75μm. Each of these simulation runs could then be analysed to determine conditions such as solids throughput.

The inputs required for each simulation were the rod mill feed rate and the primary

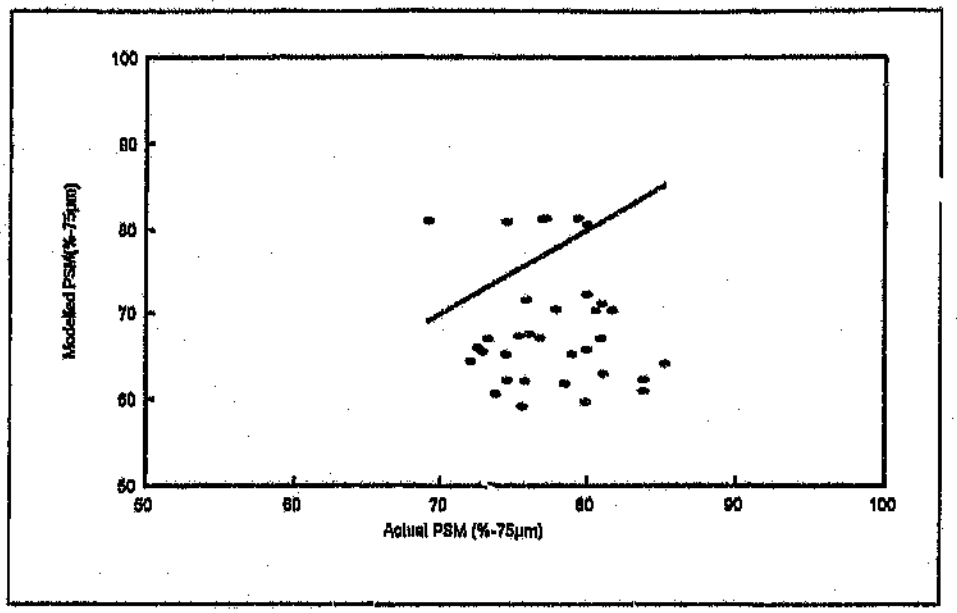


Figure 5.22 : Modelled vs actual PSM values

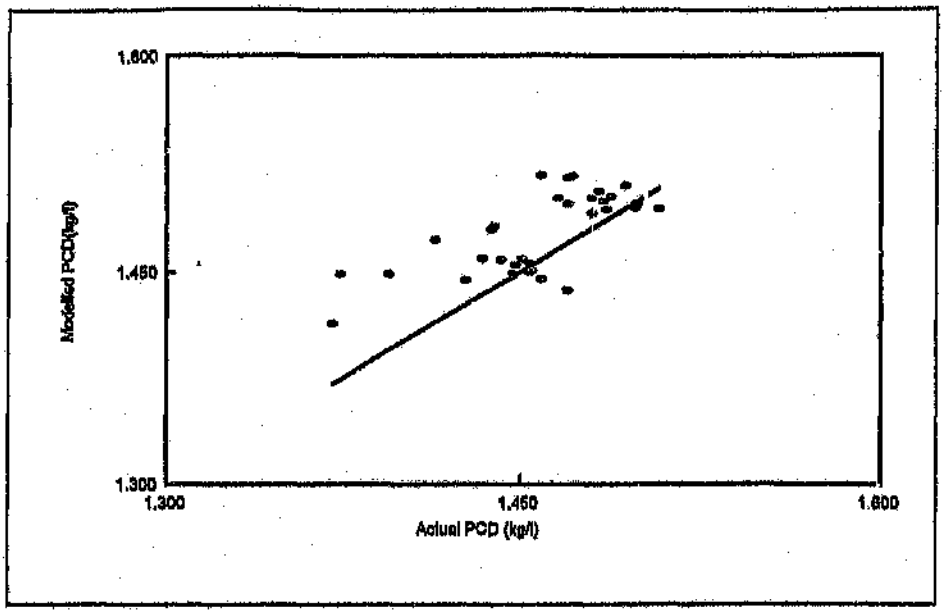


Figure 5.21 : Modelled vs actual PCD values

simulations will be done by adjusting the plant inputs to optimize for required circulating load values rather than the simple simulations used here.

The modelling step was seen by the investigator as the most important and most difficult step. Still, the circuit model was considered accurate enough to investigate the effect that different operating conditions had on the efficiency of the process.

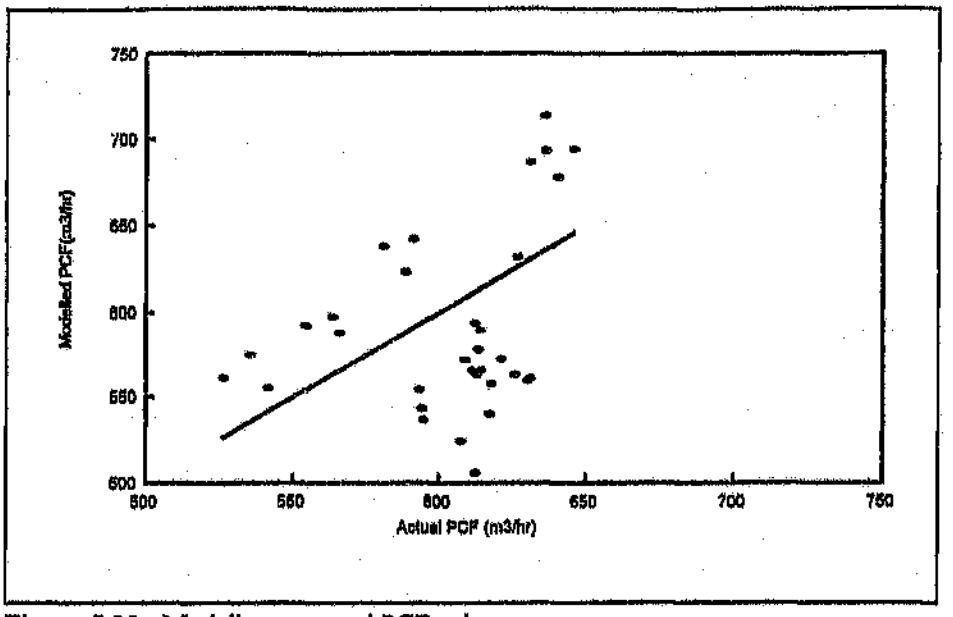


Figure 5.20 : Modelle vs actual PCF values

analysis were examined. These variables were important in terms of the subsequent optimization because they were the three MVC set points. Figures 5.20 to 5.22 show that a reasonable agreement existed between the simulated values of these variables and the actual values.

Considering the nature of the assumptions, the fact that data was obtained from an operating plant, and the limitation of the models (as described before), it was decided to accept that the models provided a basis for an optimization study.

It should also be noted that some streams (like the secondary cyclone underflow) in the simulated circuit were very sensitive to variations in the solids and water feed rates. This is also a major reason that the simulated results did not match the actual data exactly, but the problem will resolve itself in the next chapter when the

5.5 Complete circuit

All the individual unit models determined previously along with their parameters values, were coded and programmed into MICROSIM (see Appendix H for the relevant Turbo Pascal source code). A circuit was set up in MICROSIM in figure 5.19. Note that the assumption that the flow to the primary cyclones split precisely in half was still used.

Each of the test cases was simulated using the real values for the ore flow rate and water addition rates and the simulated results are shown in appendix I. In assessing how well the simulations predicted the actual performance, the values of the primary cyclone feed density, primary cyclone feed flow rate and the final product size

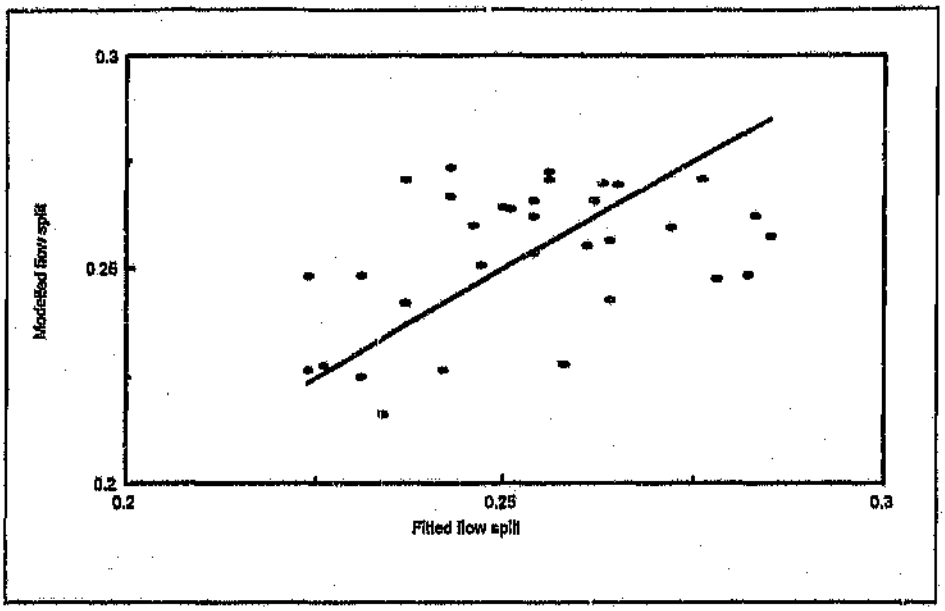


Figure 5.18 : Modelled vs actual secondary flow split values

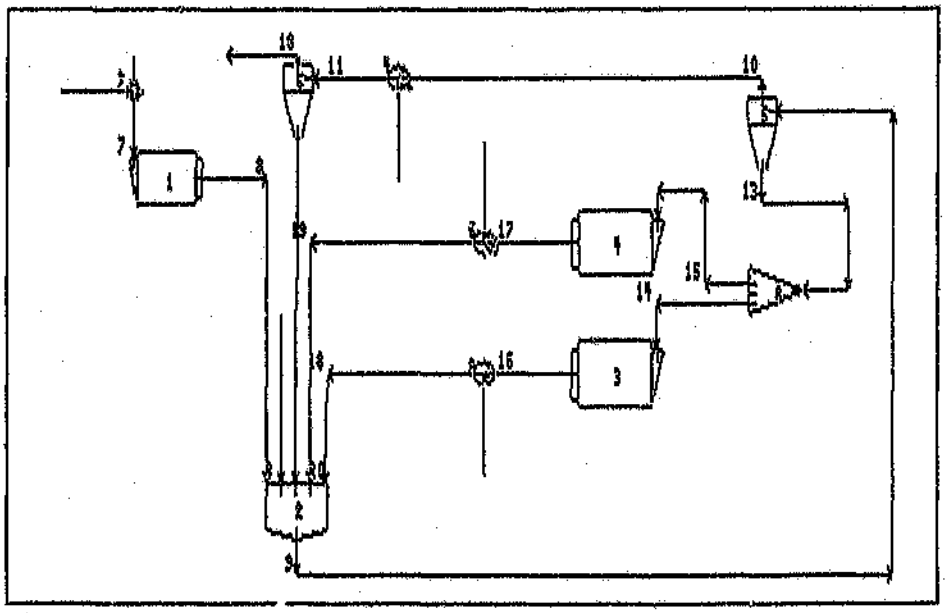


Figure 5.19 : The simulated circuit on MICROSIM

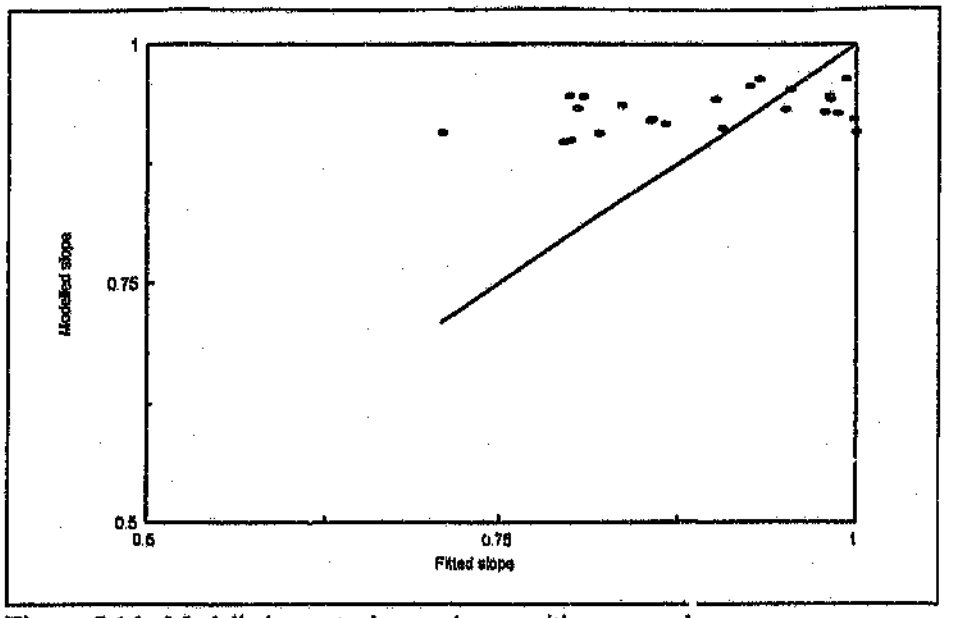


Figure 5.16 : Modelled vs actual secondary partition curve slopes

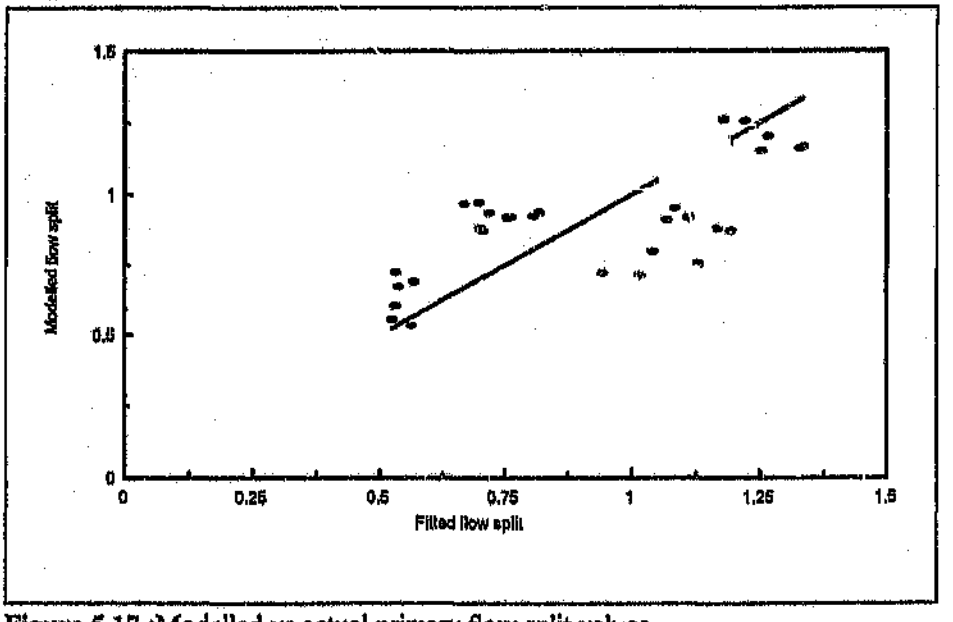


Figure 5.17 :Modelled vs actual primary flow split values

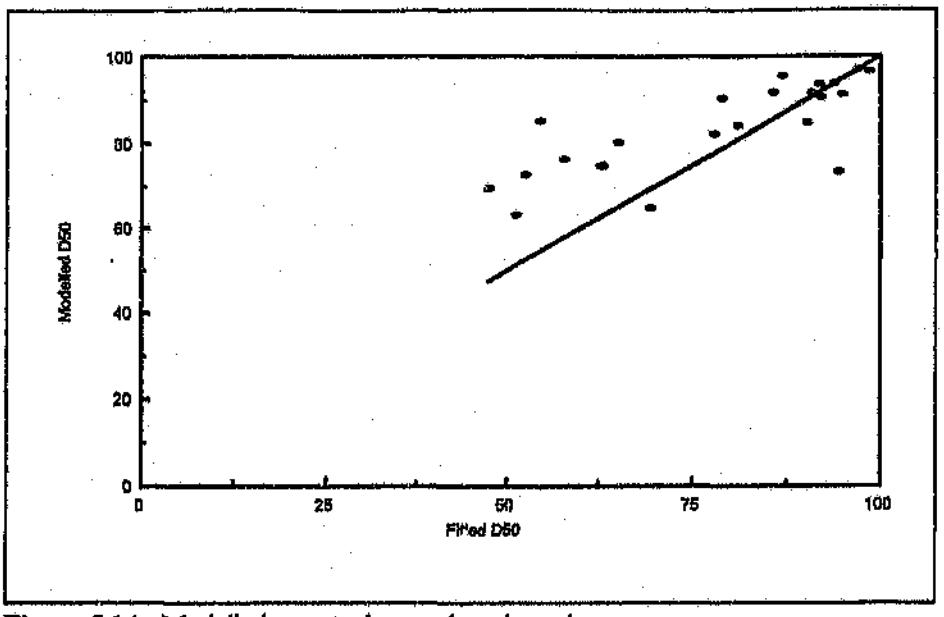


Figure 5.14 : Modelled vs actual secondary d_{50c} values

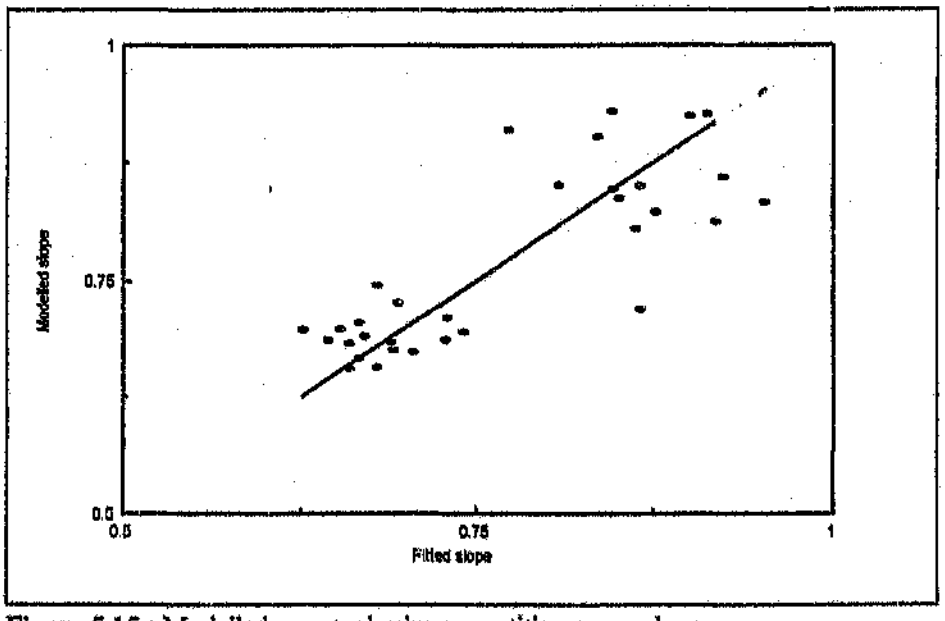


Figure 5.15 : Modelled vs actual primary partition curve slopes

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Subsequent discussions with the plant personnel[26] suggested that the narrow locus found in this work was also observed on the plant. Figure 7.1 shows recently logged PCF-PCD values logged in the plant for a grind of 80% -75μm under 'MVC Driver' control. Although the PCF and PCD values were shifted along the axes, the general trend shows exactly the behaviour predicted by the model. The reasons for the shifts could be attributed to variation in primary spigot size, and to instrument calibration. The correspondence is remarkable given that this data was collected about six years after the original plant trials. These observations prove that despite the assumptions and kr. .vn errors encountered in this work, the results obtained were realistic and, more important, applicable to the plant situation.

PCD set points that lie anywhere on the operating locus. The exact position would depend on the tonnage requirement for that day. Obviously the circuit is more efficient at higher PCD and PCF values, since more fines are produced at the same power draft. (The power draft is assumed constant because the pebble mills are run under load control continuously, regardless of the circulating load.)

7.5 Plant implementation

The concepts developed above were implemented on the East Driefontein gold plant. An 'MVC Driver' (a computer based optimizing system) was developed [25]. This system used the principle of the operating region, and it would increase the PCD and PCF set points alternatively during operation, until the maximum point is reached. This point is determined as that PCD-PCF combination that would cause improper pebble mill power control, or when the primary cyclone feed pumps have reached their limiting flow rate. At this point, the PCF set point is reduced slightly, and the circuit is controlled at this condition for as long as possible. The optimizing control system has operated successfully for some time on the plant.

The maximum tonnage obtained on the plant under the optimized control was about 1500 tons per day (excluding the additional tonnage from the consumed pebbles). This translated to just more than 62 tons per hour, which agrees closely with the 66 tons per hour obtained in this project.

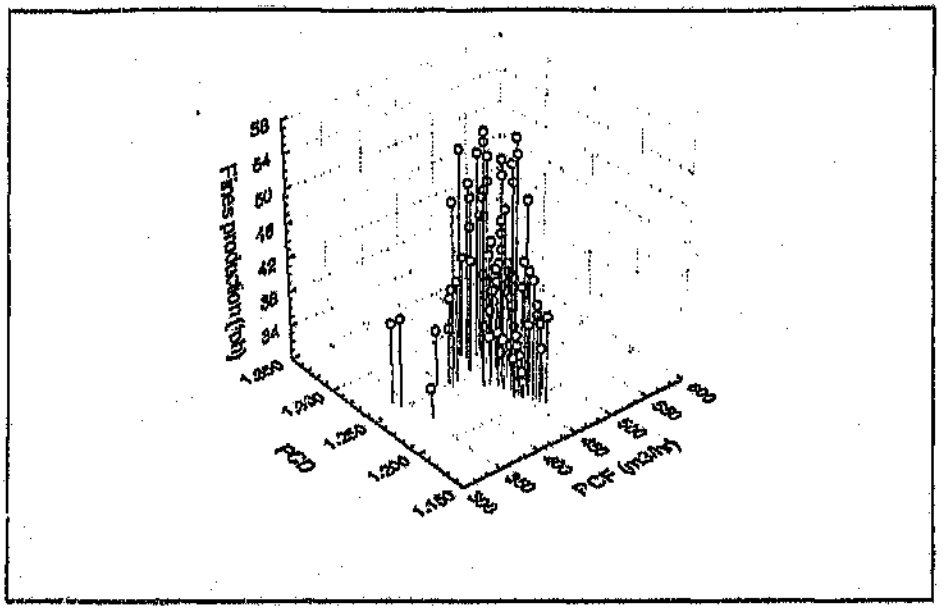


Figure 7.1 : Actual logged data from East Driefontein showing the effect of PCF and PCD on fines production

work, however, determines this locus for one power draft condition only, and should be seen as a further refinement of the knowledge of where the optimum operating region lies.

The most remarkable conclusion is that by manipulation of the circulating load, the circuit throughput can be adjusted quite freely, while still achieving a specified product fineness. Traditionally it was thought that this was not possible, and that throughput and grind were mutually dependent.

This work defines this operating range, and although there may be some error in the exact location of this range relative to the PCF and PCD values, the existence and form of the range are defined. An optimized circuit would be achieved from PCF and

great success. It was assumed that the fishhook effect does occur in these cyclones, but this was based on unpublished data collected earlier for a different project. It is true that the absence of data in the range below 75 microns caused the lack of resolution necessary to define such a by-pass model more clearly.

Calibration parameters calculated for the cyclones were good and showed small variations. In order to make progress with the simulation, average values were assumed to be constant for this relatively narrow range of operating conditions as the noted variations could not be correlated sensibly against relevant variables, except for the F_4 factor for the primary cyclone. Here a known correlation was used with success.

7.4 Optimization

The final objective of the project proved to be the simplest and most straightforward. MICROSIM was used to mimic the control action of the MVC and to model the circuit while attempting to achieve the fineness of grind objective. The fact that the operating range occurred in a narrow band or locus was surprising at first, especially considering the work done earlier that proposed a wide operating window. This

yielded results that were of acceptable quality, provided that the limitation of smoothing was recognised: ' smoothing can only make good data better'. Therefore, the raw data was rather used in the mill model development, and locally (around the cyclones only) smoothed data in the cyclone model fitting step.

7.3 Modelling

The modelling stage was the most crucial stage of the project. Well-known models had to be modified while other new models were developed.

The simple rod mill model worked very well, and was chosen above a population balance approach. This proved to be a reasonable representation of reality. It should be noted however that the model is very site specific.

The Austin pebble mill model was used exactly as described in the literature, with no modifications necessary, apart from the fact that a ball mill model was assumed. The additional mass attributable to pebble addition was simply added to the mill discharge as -75μm material.

The modelling of the hydrocyclones was disappointing at first. One important deviation from the Plitt cyclone model was the modelling of the by-passed solids to the underflow. An alternative by-pass model proposed in the literature was used, with

The proper calibration and maintenance of all instruments were of prime importance. The effect of one instrument that was out of order influenced the results of this project severely, and many assumptions and effort had to be made to develop a consistent mass balance. In this endeavour, advantages of having significant redundancy in the data cannot be overemphasized.

The analysis of samples, especially size analysis, has its own experimental errors associated with it, and these effects should be recognised.

In general, the sampling exercise was done with mixed success. Data was generated that could at least be used with reasonable confidence, but serious problems were also encountered.

Because of time and manpower limitations and the enormous effort required to conduct such a sampling exercise, it could not be repeated on the plant to provide better and complete data.

7.2 Data manipulation

Because of the oversights and errors encountered in the sampling stage, it was initially thought that smoothing was necessary to obtain consistent mass balances. Although this was not the main thrust of the project, much work was done to develop a smoothing program specifically for this circuit. The results of the smoothing again

CHAPTER 7

7 CONCLUSIONS

This chapter concludes the dissertation. The results obtained are discussed and compared to plant experience. A brief summary of findings and important points from each chapter is also given.

7.1 Sampling

Many difficulties are associated with a sampling exercise like the one undertaken. In many cases the sampling points were not well designed and it was impossible to take a representative sample of high flow rate slurry streams. Although the exact time that the various samples were taken was well coordinated, it was still not possible to sample the circuit to represent a true steady state condition. It must be recognised that there are many transients at any moment in time, and that only an approximation of the steady state condition is possible.

The second (and more important) difference is the shape and size of the window. The only explanation that can be offered for this phenomenon is that the line determined in this work only represents a single locus of optimum grind at *a certain power input* within the window. Because no correlation could be found between mill performance and power draft (due to the narrow power range) this simulator can only predict conditions at this power input. It is suggested (without proof) that the operating window consists of a series of lines running almost parallel to each other representing different power inputs.

The result of this work shows that the throughput of the circuit can be varied and controlled to a large degree for a required product quality, something thought before to be mutually exclusive.

primary spigot size.

The variation of the two dilution streams is shown on figures 6.4 and 6.3. The primary dilution was almost constant at between 220 and 240 m^3 per hour, while the secondary dilution varied over a large interval.

6.3 Discussion

There are two differences between this result and the previously determined operating window. First, none of the points determined here fall within the window. The reason for this is not clear but it may be ascribed to inaccuracies in the models. Inspection of the evaluation curves of the modelled circuit (figures 5.20 to 5.22) shows that the average modelled PCF is about 50 m^3 per hour lower than the actual values. The predicted PSM is about 10 % lower and the PCD about 0,02 units higher than actual. If this is taken into account, the location of the determined points moves closer to the window and may even lie inside the window. Additional simulations run at a required grind of 70% -75 µm confirmed this. Furthermore, the spigot sizes at which the operating window was determined, is unknown, and this (with other cyclone geometries) can affect the position of the operating region. The exact position of the operating window is of lesser concern in this project than the qualitative characteristics.

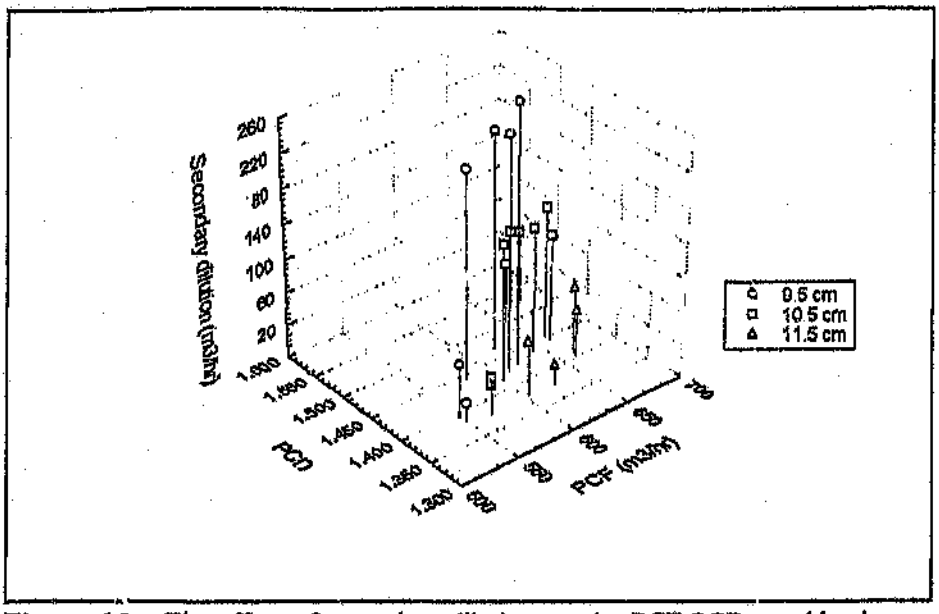


Figure 6.3 : The effect of secondary dilution on the PCF-PCD combination to produce a 80% -75µm grind

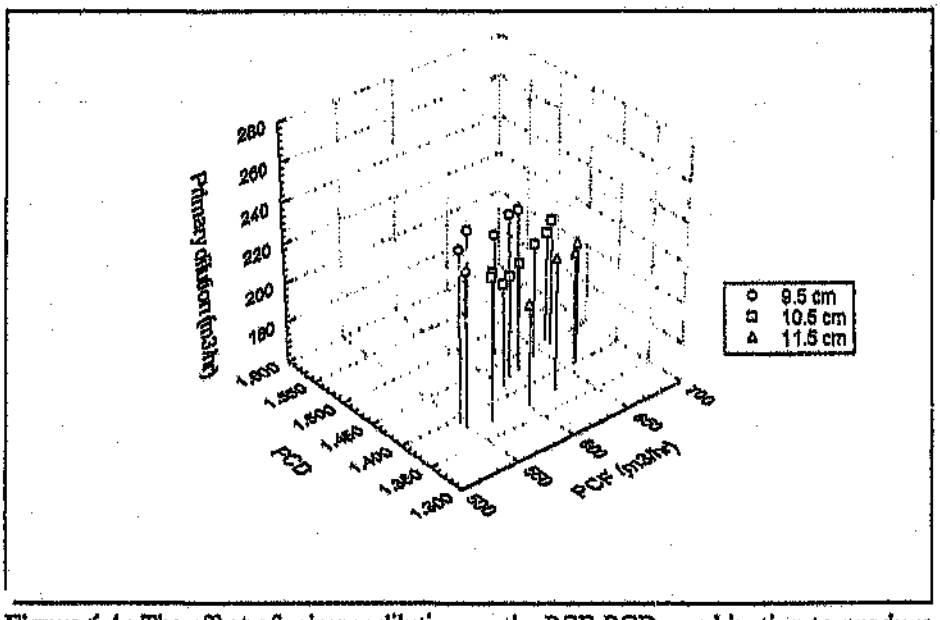


Figure 6.4 : The effect of primary dilution on the PCF-PCD combination to produce a 80% -75µm grind

Test 2a data sheet

Measured values

Primary cyclone feed flow rate	631.0	m3/hr
Primary cyclone feed density	1.434	
Secondary cyclone feed flow rate	390.7	m3/hr
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	69.5	t/hr
Rod mill feed water	21.8	t/hr
Primary sump dilution	270.1	t/hr
Secondary sump dilution	64.5	t/hr
Pebble mill 1 pebble feed rate	5.5	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	328	kWhr
Pebble mill 2 power	228	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	6.2	3.8	16.8	47.2	26.0
Prim cyc A o/f	23.5	45.7	30.5	0.3	0.0
Prim cyc B o/f	29.6	30.1	39.7	0.6	0.0
Prim cyc A u/f	5.8	32.2	34.4	25.2	2.4
Prim cyc B u/f	6.7	28.0	35.4	25.0	4.9
Peb mill 1 disch	11.7	41.7	33.0	13.1	0.5
Peb mill 2 disch	7.1	29.9	36.0	27.0	0.0
Sec cyc o/f	77.2	22.0	0.8	0.0	0.0
Sec cyc u/f	10.7	59.0	29.3	1.0	0.0

Calculated values

Primary cyclone feed solids	439.8	t/hr
Primary cyclone feed water	465.0	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 10 data sheet

Measured values

Primary cyclone feed flow rate	646.0 m3/hr
Primary cyclone feed density	1.394
Secondary cyclone feed flow rate	405.4 m3/hr
Secondary cyclone feed density	n/a
Rod mill feed solids (wet)	69.7 t/hr
Rod mill feed water	21.7 t/hr
Primary sump dilution	287.2 t/hr
Secondary sump dilution	3.7 t/hr
Pebble mill 1 pebble feed rate	0.0 t/hr
Pebble mill 2 pebble feed rate	2.8 t/hr
Pebble mill 1 power	320 kWhr
Pebble mill 2 power	229 kWhr

Spigots :	primary A	9.50 cm
:	primary B	9.60 cm
:	secondary	7.70 cm

From daily log sheets : % moisture :

: primary overflow	74 %
: secondary overflow	83 %
: peb mill discharge	30 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.9	4.4	11.4	48.9	27.4
Prim cyc A o/f	19.9	56.2	23.2	0.5	0.2
Prim cyc B o/f	32.8	46.3	20.1	0.8	0.0
Prim cyc A u/f	7.2	31.9	28.8	29.0	3.1
Prim cyc B u/f	6.2	25.2	22.4	31.1	15.1
Peb mill 1 disch	12.0	40.7	27.9	18.9	0.5
Peb mill 2 d'sch	18.9	23.2	41.7	16.0	0.2
Sec cyc o/f	79.4	20.4	0.2	0.0	0.0
Sec cyc u/f	13.7	65.3	20.5	0.5	0.0

Calculated values

Primary cyclone feed solids	408.8 t/hr
Primary cyclone feed water	491.7 t/hr
Secondary cyclone feed solids	n/a
Secondary cyclone feed water	n/a

Test 1b data sheet

Measured values

Primary cyclone feed flow rate	636.0	m3/hr
Primary cyclone feed density	1,373	
Secondary cyclone feed flow rate	408.6	m3/hr
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	69.6	t/hr
Rod mill feed water	22.0	t/hr
Primary sump dilution	286.6	t/hr
Secondary sump dilution	4.3	t/hr
Pebble mill 1 pebble feed rate	5.6	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	322	kWhr
Pebble mill 2 power	229	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	63	%
: peb mill discharge	30	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	0.2	9.9	10.5	41.3	38.1
Prim cyc A o/f	33.7	36.9	21.2	8.2	0.0
Prim cyc B o/f	20.8	57.2	20.8	1.2	0.0
Prim cyc A u/f	6.8	29.8	29.1	27.2	7.1
Prim cyc B u/f	7.6	31.8	26.0	25.1	9.5
Peb mill 1 disch	17.9	29.5	36.1	16.3	0.2
Peb mill 2 disch	9.4	48.4	28.4	13.5	0.3
Sec cyc o/f	77.0	22.6	0.4	0.0	0.0
Sec cyc u/f	14.3	69.9	15.4	0.4	0.0

Calculated values

Primary cyclone feed solids	381.0	t/hr
Primary cyclone feed water	492.2	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

APPENDIX B Measured test results

Test 1a data sheet

Measured values

Primary cyclone feed flow rate	627.0 m3/hr
Primary cyclone feed density	1.370
Secondary cyclone feed flow rate	395.5 m3/hr
Secondary cyclone feed density	n/a
Rod mill feed solids (wet)	51.7 t/hr
Rod mill feed water	16.4 t/hr
Primary sump dilution	281.3 t/hr
Secondary sump dilution	4.4 t/hr
Pebble mill 1 pebble feed rate	0.0 t/hr
Pebble mill 2 pebble feed rate	0.0 t/hr
Pebble mill 1 power	323 kWhr
Pebble mill 2 power	235 kWhr

Spigots : primary A 9.50 cm
: primary B 9.60 cm
: secondary 7.70 cm

From daily log sheets : % moisture :

primary overflow	74 %
secondary overflow	83 %
peb mill discharge	30 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.1	2.9	20.2	47.9	20.9
Prim cyc A o/f	28.0	36.2	34.5	1.3	0.0
Prim cyc B o/f	28.0	36.2	34.5	1.3	0.0
Prim cyc A u/f	7.4	34.5	30.5	23.7	3.9
Prim cyc B u/f	7.3	31.2	29.6	27.9	4.0
Peb mill 1 disch	16.6	38.7	28.6	15.5	0.6
Peb mill 2 disch	9.8	44.3	32.4	13.4	0.1
Sec cyc o/f	74.6	25.0	0.4	0.0	0.0
Sec cyc u/f	12.7	67.5	19.3	0.5	0.0

Calculated values

Primary cyclone feed solids	372.6 t/hr
Primary cyclone feed water	486.4 t/hr
Secondary cyclone feed solids	n/a
Secondary cyclone feed water	n/a

6	**Screen sample**	Transfer the sample from the dish onto the appropriate testing sieve / series of sieves. Brush any adhering material from the dish into the testing sieve / series of sieves. Place a label into the top testing sieve. Position shaker lid, and ensure that it is properly sealed. Secure shaker lid tightly. Start shaker and shake for 10 minutes.
7	**Weigh sample**	When the shaker stops, remove the screens. Insert each screen on top of a large dish. Brush the bottom of the screen gently using a soft brush covering the whole area of the screen. Holding the inverted screen about 100 mm above the dish gently tap the side of the screen frame. Transfer the sample from the dish to the balance pan and weigh to the nearest 0,1 of a gram.
8	**Calculate and report results**	Transfer individual size fraction weights to the appropriate grading sheets. The minus 75 micron fraction is obtained by subtraction. Calculate the percentages and Submit grading sheets to office.

4 Wash sample

Place the prepared sample in a aluminium dish and add approximately 150 cm^3 of water

Play a gentle spray of water onto the pulp until the dish is about half full.

Slowly decant slime through the 75 micron aperture sieve reserved for wet screening. The passage of slime through the screen can be assisted by gently tapping the side of the screen.

Repeat the procedure until most of the slime has been transferred to the screen. Finally wash all the material from the dish into the screen using the rubber hose.

By holding the screen under the spray in one hand, wash the material remaining on the screen with a rotating action whilst tapping gently on the side of the screen with the other hand. When the water passing through the screen is clear (i.e. free of solids) the washing is complete.

Wash the solids on the screen back into the dish using a rubber hose.

Allow the solids to settle and drain off excess water.

5 Dry slime

Place sample dish into drier. (take care not to burn hands.)

Leave until completely dry.

Remove from drier and allow to cool. (Take care not to burn hands.)

3	**Weigh sample**	Spread out rubber mat and brush off any dust. Tip approximately 1 kg material onto the mat. Roll the sample on the rubber mat from alternate corners at least ten times. Use the spatula to spread the heap to an even depth of about 15 mm over the mat. Sample 100 grams from the mat using a small spatula taking small dips over the entire area of the flattened material. (If more sample is required, the sample must be remixed and sampled as before.

APPENDIX A Standard procedure for size analysis

The following standard procedure is prescribed for all size analysis determinations at East Driefontein Gold Plant.

1 Prepare equipment	Examine each screen for damage or excessive blockage of the sieve mesh by holding it up towards a light. Replace if necessary. If blocked, invert the sieve and use a soft paint brush to clear by rubbing the sieve cloth gently but briskly using a circular motion until improvement is visually evident. (Never use a sharp pointed instrument). To determine if a sieve has been cleaned to it's maximum - place sieve over a piece of white paper, brush and examine the quantity of particles left on the paper. If more than ±2 grams repeat cleaning procedure. Place the screens in the correct sequence on the shaker base. Start dust extraction fan.
2 Zero electronic (Mettler) balance	Wipe balance platform clean with a dry cloth. Switch the power on at the wall plug. Place a clean dry sample dish on the balance platform. Press the zero button and wait for a zero digital reading.

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Test 5c data sheet

Measured values

Primary cyclone feed flow rate	536.0	m3/hr
Primary cyclone feed density	1.472	
Secondary cyclone feed flow rate	400.3	m3/hr
Secondary cyclone feed density	1.216	
Rod mill feed solids (wet)	77.5	t/hr
Rod mill feed water	24.2	t/hr
Primary sump dilution	177.4	t/hr
Secondary sump dilution	9.2	t/hr
Pebble mill 1 pebble feed rate	20.9	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	327	kWhr
Pebble mill 2 power	217	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.2	7.6	6.4	36.2	34.6
Prim cyc A o/f	32.5	36.2	31.3	0.0	0.0
Prim cyc B o/f	25.3	39.5	28.2	7.0	0.0
Prim cyc A u/f	10.5	21.6	33.2	30.6	2.1
Prim cyc B u/f	12.8	25.2	27.0	28.6	6.4
Peb mill 1 disch	16.9	30.9	30.6	20.8	0.8
Peb mill 2 disch	18.9	29.8	31.2	19.9	0.2
Sec cyc o/f	75.8	20.8	3.4	0.0	0.0
Sec cyc u/f	13.0	60.1	26.2	0.7	0.0

Calculated values

Primary cyclone feed solids	406.3	t/hr
Primary cyclone feed water	382.7	t/hr
Secondary cyclone feed solids	138.9	t/hr
Secondary cyclone feed water	347.9	t/hr

Test 5b data sheet

Measured values

Primary cyclone feed flow rate	526.0	m3/hr
Primary cyclone feed density	1.470	
Secondary cyclone feed flow rate	392.9	m3/hr
Secondary cyclone feed density	1.221	
Rod mill feed solids (wet)	75.3	t/hr
Rod mill feed water	23.7	t/hr
Primary sump dilution	172.3	t/hr
Secondary sump dilution	9.1	t/hr
Pebble mill 1 pebble feed rate	10.2	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	338	kWhr
Pebble mill 2 power	218	kWhr

Spigots : primary A	9.60	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.7	9.6	7.8	40.0	32.9
Prim cyc A o/f	31.3	35.4	33.3	0.0	0.0
Prim cyc B o/f	19.9	46.4	26.8	6.9	0.0
Prim cyc A u/f	8.9	18.6	37.6	31.1	3.8
Prim cyc B u/f	9.7	16.9	31.3	34.5	7.6
Peb mill 1 disch	12.1	33.8	31.5	22.0	0.6
Peb mill 2 disch	12.6	32.9	33.9	20.6	0.0
Sec cyc o/f	73.8	23.2	3.0	0.0	0.0
Sec cyc u/f	14.7	38.6	40.0	6.7	0.0

Calculated values

Primary cyclone feed solids	397.1	t/hr
Primary cyclone feed water	376.2	t/hr
Secondary cyclone feed solids	139.5	t/hr
Secondary cyclone feed water	340.3	t/hr

Test 5a data sheet

Measured values

Primary cyclone feed flow rate	542.0	m3/hr
Primary cyclone feed density	1.480	
Secondary cyclone feed flow rate	412.4	m3/hr
Secondary cyclone feed density	1.231	
Rod mill feed solids (wet)	69.1	t/hr
Rod mill feed water	21.8	t/hr
Primary sump dilution	178.9	t/hr
Secondary sump dilution	14.0	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	23.7	t/hr
Pebble mill 1 power	337	kWhr
Pebble mill 2 power	227	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	4.8	13.4	5.8	37.2	38.8
Prim cyc A o/f	30.8	35.8	33.1	0.3	0.0
Prim cyc B o/f	18.6	46.5	28.5	6.4	0.0
Prim cyc A u/f	5.6	12.6	27.7	32.9	21.2
Prim cyc B u/f	8.9	17.0	32.1	34.1	7.9
Peb mill 1 disch	18.1	20.0	44.9	16.3	0.7
Peb mill 2 disch	14.4	39.1	32.2	14.3	0.0
Sec cyc o/f	74.6	22.7	2.7	0.0	0.0
Sec cyc u/f	10.8	43.0	38.8	7.4	0.0

Calculated values

Primary cyclone feed solids	417.8	t/hr
Primary cyclone feed water	384.3	t/hr
Secondary cyclone feed solids	153.0	t/hr
Secondary cyclone feed water	354.7	t/hr

Test 4c data sheet

Measured values

Primary cyclone feed flow rate	588.0	m3/hr
Primary cyclone feed density	1.498	
Secondary cyclone feed flow rate	470.8	m3/hr
Secondary cyclone feed density	1.200	
Rod mill feed solids (wet)	75.6	t/hr
Rod mill feed water	23.8	t/hr
Primary sump dilution	214.5	t/hr
Secondary sump dilution	12.3	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	308	kWhr
Pebble mill 2 power	213	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.5	7.5	9.4	34.2	41.4
Prim cyc A o/f	18.5	36.1	44.4	1.0	0.0
Prim cyc B o/f	23.3	29.5	46.2	1.0	0.0
Prim cyc A u/f	5.3	14.5	27.8	34.7	17.7
Prim cyc B u/f	7.2	16.2	35.7	37.5	3.4
Peb mill 1 disch	7.6	28.4	30.4	30.0	3.6
Peb mill 2 disch	13.6	25.7	34.8	25.7	0.2
Sec cyc o/f	81.7	16.8	1.5	0.0	0.0
Sec cyc u/f	10.6	44.2	42.7	2.5	0.0

Calculated values

Primary cyclone feed solids	470.3	t/hr
Primary cyclone feed water	410.5	t/hr
Secondary cyclone feed solids	151.2	t/hr
Secondary cyclone feed water	413.7	t/hr

Test 4c data sheet

Measured values

Primary cyclone feed flow rate	588.0	m3/hr
Primary cyclone feed density	1.498	
Secondary cyclone feed flow rate	470.8	m3/hr
Secondary cyclone feed density	1.200	
Rod mill feed solids (wet)	75.8	t/hr
Rod mill feed water	23.8	t/hr
Primary sump dilution	214.5	t/hr
Secondary sump dilu+'on	12.3	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	308	kWhr
Pebble mill 2 power	213	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.5	7.5	9.4	34.2	41.4
Prim cyc A o/f	18.5	36.1	44.4	1.0	0.0
Prim cyc B o/f	23.3	29.5	46.2	1.0	0.0
Prim cyc A u/f	5.3	14.5	27.8	34.7	17.7
Prim cyc B u/f	7.2	16.2	35.7	37.5	3.4
Peb mill 1 disch	7.6	28.4	30.4	30.0	3.6
Peb mill 2 disch	13.6	25.7	34.8	25.7	0.2
Sec cyc o/f	81.7	16.8	1.5	0.0	0.0
Sec cyc u/f	10.6	44.2	42.7	2.5	0.0

Calculated values

Primary cyclone feed solids	470.3	t/hr
Primary cyclone feed water	410.5	t/hr
Secondary cyclone feed solids	151.2	t/hr
Secondary cyclone feed water	413.7	t/hr

Test 4b data sheet

Measured values

Primary cyclone feed flow rate	591.0	m3/hr
Primary cyclone feed density	1.468	
Secondary cyclone feed flow rate	477.3	m3/hr
Secondary cyclone feed density	1.198	
Rod mill feed solids (wet)	80.5	t/hr
Rod mill feed water	25.1	t/hr
Primary sump dilution	217.6	t/hr
Secondary sump dilution	10.8	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	316	kWhr
Pebble mill 2 power	214	kWhr

Spigots : primary A 9.50 cm
: primary B 9.60 cm
: secondary 7.70 cm

From daily log sheets : % moisture :
: primary overflow 73 %
: secondary overflow 84 %
: peb mill discharge 29 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	6.8	8.8	9.1	29.4	45.9
Prim cyc A o/f	14.6	41.1	39.9	4.4	0.0
Prim cyc B o/f	24.9	33.1	40.3	1.7	0.0
Prim cyc A u/f	4.4	17.5	30.2	32.5	15.4
Prim cyc B u/f	7.1	15.7	35.7	38.3	3.2
Peb mill 1 disch	7.1	30.2	29.5	27.7	5.5
Peb mill 2 disch	14.5	26.5	35.9	22.5	0.6
Sec cyc o/f	81.0	15.4	3.6	0.0	0.0
Sec cyc u/f	12.3	43.2	43.2	1.3	0.0

Calculated values

Primary cyclone feed solids	463.2	t/hr
Primary cyclone feed water	416.2	t/hr
Secondary cyclone feed solids	151.8	t/hr
Secondary cyclone feed water	420.0	t/hr

Test 4a data sheet

Measured values

Primary cyclone feed flow rate	581.0	m3/hr
Primary cyclone feed density	1.483	
Secondary cyclone feed flow rate	461.2	m3/hr
Secondary cyclone feed density	1.107	
Rod mill feed solids (wet)	81.7	t/hr
Rod mill feed water	25.9	t/hr
Primary sump dilution	213.0	t/hr
Secondary sump dilution	10.7	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	24.5	t/hr
Pebble mill 1 power	320	kWhr
Pebble mill 2 power	220	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	4.8	6.8	7.5	33.6	47.3
Prim cyc A o/f	18.9	46.3	33.2	1.6	0.0
Prim cyc B o/f	24.0	35.1	40.2	0.7	0.0
Prim cyc A u/f	3.6	15.1	27.7	35.1	18.5
Prim cyc B u/f	6.2	17.2	33.7	33.8	9.1
Peb mill 1 disch	9.8	31.1	32.2	24.9	2.0
Peb mill 2 disch	13.9	25.3	36.8	23.6	0.4
Sec cyc o/f	80.6	12.3	7.1	0.0	0.0
Sec cyc u/f	11.7	47.4	38.7	2.2	0.0

Calculated values

Primary cyclone feed solids	450.7	t/hr
Primary cyclone feed water	410.9	t/hr
Secondary cyclone feed solids	79.3	t/hr
Secondary cyclone feed water	431.3	t/hr

Test 3c data sheet

Measured values

Primary cyclone feed flow rate	566.0	m3/hr
Primary cyclone feed density	1.480	
Secondary cyclone feed flow rate	442.3	m3/hr
Secondary cyclone feed density	1.203	
Rod mill feed solids (wet)	69.9	t/hr
Rod mill feed water	22.1	t/hr
Primary sump dilution	201.3	t/hr
Secondary sump dilution	10.3	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	320	kWhr
Pebble mill 2 power	219	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :

: primary overflow	73 %
: secondary overflow	84 %
: peb mill discharge	29 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	2.5	7.7	4.0	33.0	52.8
Prim cyc A o/f	43.0	19.2	36.8	1.0	0.0
Prim cyc B o/f	41.4	25.9	32.6	0.1	0.0
Prim cyc A u/f	2.5	19.1	28.2	33.4	16.8
Prim cyc B u/f	6.5	18.7	22.6	35.9	16.3
Peb mill 1 disch	13.8	21.6	32.7	29.8	2.1
Peb mill 2 disch	13.4	25.1	32.8	28.6	0.1
Sec cyc o/f	80.9	16.3	2.8	0.0	0.0
Sec cyc u/f	9.3	62.9	27.6	0.2	0.0

Calculated values

Primary cyclone feed solids	436.3	t/hr
Primary cyclone feed water	401.3	t/hr
Secondary cyclone feed solids	144.2	t/hr
Secondary cyclone feed water	387.9	t/hr

Test 3b data sheet

Measured values

Primary cyclone feed flow rate	564.0	m3/hr
Primary cyclone feed density	1.470	
Secondary cyclone feed flow rate	441.9	m3/hr
Secondary cyclone feed density	1.197	
Rod mill feed solids (wet)	73.3	t/hr
Rod mill feed water	23.0	t/hr
Primary sump dilution	201.1	t/hr
Secondary sump dilution	10.2	t/hr
Pebble mill 1 pebble feed rate	6.8	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	321	kWhr
Pebble mill 2 power	218	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	3.8	1.4	13.8	36.5	44.5
Prim cyc A o/f	35.4	18.6	40.6	5.4	0.0
Prim cyc B o/f	22.6	39.6	37.4	0.4	0.0
Prim cyc A u/f	5.7	18.1	30.3	32.7	13.2
Prim cyc B u/f	5.4	16.7	26.2	36.8	14.9
Peb mill 1 disch	8.5	26.0	43.3	21.9	0.3
Peb mill 2 disch	8.5	26.0	43.3	21.9	0.3
Sec cyc o/f	73.3	15.6	11.1	0.0	0.0
Sec cyc u/f	9.2	56.0	34.4	0.4	0.0

Calculated values

Primary cyclone feed solids	425.7	t/hr
Primary cyclone feed water	403.3	t/hr
Secondary cyclone feed solids	139.8	t/hr
Secondary cyclone feed water	389.1	t/hr

Test 3a data sheet

Measured values

Primary cyclone feed flow rate	554.0	m3/hr
Primary cyclone feed density	1.466	
Secondary cyclone feed flow rate	428.0	m3/hr
Secondary cyclone feed density	1.199	
Rod mill feed solids (wet)	74.2	t/hr
Rod mill feed water	23.4	t/hr
Primary sump dilution	195.9	t/hr
Secondary sump dilution	11.4	t/hr
Pebble mill 1 pebble feed rate	3.3	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	322	kWhr
Pebble mill 2 power	218	kWhr

Spigots : primary A 9.50 cm
: primary B 9.60 cm
: secondary 7.70 cm

From daily log sheets : % moisture :
: primary overflow 73 %
: secondary overflow 84 %
: peb mill discharge 29 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.4	4.6	12.1	42.6	30.3
Prim cyc A o/f	43.0	28.1	24.4	4.5	0.0
Prim cyc B o/f	13.2	31.8	52.3	2.7	0.0
Prim cyc A u/f	5.9	15.4	30.5	33.2	15.0
Prim cyc B u/f	6.1	13.4	26.6	39.1	14.8
Peb mill 1 disch	13.0	32.4	31.8	21.4	1.4
Peb mill 2 disch	9.2	34.6	37.4	18.7	0.1
Sec cyc o/f	72.6	18.6	8.8	0.0	0.0
Sec cyc u/f	11.5	40.0	47.8	0.7	0.0

Calculated values

Primary cyclone feed solids	414.6	t/hr
Primary cyclone feed water	397.5	t/hr
Secondary cyclone feed solids	136.8	t/hr
Secondary cyclone feed water	376.4	t/hr

Test 2c data sheet

Measured values

Primary cyclone feed flow rate	640.0	m3/hr
Primary cyclone feed density	1.427	
Secondary cyclone feed flow rate	395.4	m3/hr
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	65.9	t/hr
Rod mill feed water	20.7	t/hr
Primary sump dilution	280.6	t/hr
Secondary sump dilution	20.8	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	319	kWhr
Pebble mill 2 power	222	kWhr

Spigots : primary A 9.50 cm
: primary B 9.60 cm
: secondary 7.70 cm

From daily log sheets : % moisture :
: primary overflow 73 %
: secondary overflow 84 %
: peb mill discharge 29 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	2.8	11.0	5.8	40.7	39.7
Prim cyc A o/f	35.1	29.3	33.6	2.0	0.0
Prim cyc B o/f	23.5	54.0	21.0	1.5	0.0
Prim cyc A u/f	7.0	25.1	29.5	29.0	9.4
Prim cyc B u/f	6.6	26.6	28.6	27.9	10.3
Peb mill 1 disch	18.7	26.4	33.3	20.2	1.4
Peb mill 2 disch	9.3	41.4	29.9	19.3	0.1
Sec cyc o/f	69.2	28.7	2.1	0.0	0.0
Sec cyc u/f	12.2	57.9	29.3	0.6	0.0

Calculated values

Primary cyclone feed solids	438.9	t/hr
Primary cyclone feed water	474.4	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 2b data sheet

Measured values

Primary cyclone feed flow rate	636.0	m3/hr
Primary cyclone feed density	1.414	
Secondary cyclone feed flow rate	386.2	m3/hr
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	77.9	t/hr
Rod mill feed water	24.3	t/hr
Primary sump dilution	276.8	t/hr
Secondary sump dilution	21.2	t/hr
Pebble mill 1 pebble feed rate	8.4	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	322	kWhr
Pebble mill 2 power	224	kWhr

Spigots : primary A	9.50	cm
: primary B	9.60	cm
: secondary	7.70	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	84	%
: peb mill discharge	29	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.0	7.4	15.0	35.7	33.9
Prim cyc A o/f	32.8	38.7	20.9	7.6	0.0
Prim cyc B o/f	19.0	46.6	33.2	1.2	0.0
Prim cyc A u/f	6.0	26.3	31.6	28.6	7.5
Prim cyc B u/f	5.7	25.4	28.8	27.5	12.6
Peb mill 1 disch	12.4	38.1	32.4	16.3	0.8
Peb mill 2 disch	12.9	37.2	31.4	17.9	0.6
Sec cyc o/f	80.0	18.6	0.4	1.0	0.0
Sec cyc u/f	13.7	37.1	33.0	16.1	0.1

Calculated values

Primary cyclone feed solids	422.9	t/hr
Primary cyclone feed water	476.4	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 11c data sheet

Measured values

Primary cyclone feed flow rate	608.0	m3/hr
Primary cyclone feed density	1.486	
Secondary cyclone feed flow rate	390.1	m3/hr
Secondary cyclone feed density	1.291	
Rod mill feed solids (wet)	62.6	t/hr
Rod mill feed water	19.6	t/hr
Primary sump dilution	172.3	t/hr
Secondary sump dilution	14.6	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	3.1	t/hr
Pebble mill 1 power	322	kWhr
Pebble mill 2 power	229	kWhr

Spigots : primary A	9.50	cm
: primary B	9.30	cm
: secondary	0.00	cm

From daily log sheets :	% moisture :
: primary overflow	74 %
: secondary overflow	85 %
: peb mill discharge	32 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.6	4.9	7.1	44.5	27.9
Prim cyc A o/f	53.4	33.0	13.5	0.1	0.0
Prim cyc B o/f	52.0	37.1	10.7	0.2	0.0
Prim cyc A u/f	10.3	20.6	27.7	41.4	0.0
Prim cyc B u/f	9.5	24.0	28.5	38.0	0.0
Peb mill 1 disch	30.4	23.3	24.8	21.5	0.0
Peb mill 2 disch	27.1	27.6	27.5	17.8	0.0
Sec cyc o/f	75.6	24.1	0.3	0.0	0.0
Sec cyc u/f	22.2	53.6	24.2	0.0	0.0

Calculated values

Primary cyclone feed solids	474.6	t/hr
Primary cyclone feed water	428.9	t/hr
Secondary cyclone feed solids	182.3	t/hr
Secondary cyclone feed water	321.3	t/hr

Test 11b data sheet

Measured values

Primary cyclone feed flow rate	617.0	m3/hr
Primary cyclone feed density	1.485	
Secondary cyclone feed flow rate	390.5	m3/hr
Secondary cyclone feed density	1.283	
Rod mill feed solids (wet)	66.9	t/hr
Rod mill feed water	20.6	t/hr
Primary sump dilution	176.0	t/hr
Secondary sump dilution	8.6	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	324	kWhr
Pebble mill 2 power	228	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.1	4.0	5.8	40.3	34.8
Prim cyc A o/f	49.1	34.6	16.0	0.3	0.0
Prim cyc B o/f	54.7	35.9	9.3	0.1	0.0
Prim cyc A u/f	8.3	19.5	26.2	46.0	0.0
Prim cyc B u/f	7.9	20.4	28.6	43.1	0.0
Peb mill 1 disch	27.7	30.0	25.5	16.8	0.0
Peb mill 2 disch	23.4	32.5	26.5	17.6	0.0
Sec cyc o/f	79.9	19.7	0.4	0.0	0.0
Sec cyc u/f	25.1	59.4	15.5	0.0	0.0

Calculated values

Primary cyclone feed solids	480.6	t/hr
Primary cyclone feed water	436.6	t/hr
Secondary cyclone feed solids	177.5	t/hr
Secondary cyclone feed water	323.5	t/hr

Test 11a data sheet

Measured values

Primary cyclone feed flow rate	614.0	m3/hr
Primary cyclone feed density	1.459	
Secondary cyclone feed flow rate	394.7	m3/hr
Secondary cyclone feed density	1.259	
Rod mill feed solids (wet)	78.6	t/hr
Rod mill feed water	25.3	t/hr
Primary sump dilution	180.7	t/hr
Secondary sump dilution	8.2	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	6.3	t/hr
Pebble mill 1 power	326	kWhr
Pebble mill 2 power	231	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.4	4.2	6.3	36.9	37.2
Prim cyc A o/f	50.6	43.0	6.3	0.1	0.0
Prim cyc B o/f	54.3	39.8	5.8	0.1	0.0
Prim cyc A u/f	10.8	23.1	27.0	39.1	0.0
Prim cyc B u/f	11.6	27.9	28.3	32.2	0.0
Peb mill 1 disch	31.0	24.5	26.0	18.4	0.0
Peb mill 2 disch	23.4	26.2	27.6	20.8	0.0
Sec cyc o/f	78.5	21.0	0.5	0.0	0.0
Sec cyc u/f	26.0	59.6	14.4	0.0	0.0

Calculated values

Primary cyclone feed solids	452.6	t/hr
Primary cyclone feed water	443.2	t/hr
Secondary cyclone feed solids	164.2	t/hr
Secondary cyclone feed water	332.7	t/hr

Test 8c data sheet

Measured values

Primary cyclone feed flow rate	614.0 m3/hr
Primary cyclone feed density	1.451
Secondary cyclone feed flow rate	n/a
Secondary cyclone feed density	n/a
Rod mill feed solids (wet)	62.8 t/hr
Rod mill feed water	19.9 t/hr
Primary sump dilution	173.2 t/hr
Secondary sump dilution	11.4 t/hr
Pebble mill 1 pebble feed rate	5.6 t/hr
Pebble mill 2 pebble feed rate	0.0 t/hr
Pebble mill 1 power	334 kWhr
Pebble mill 2 power	230 kWhr

Spigots	: primary A	10.70 cm
	: primary B	11.00 cm
	: secondary	0.00 cm

From daily log sheets	: % moisture :	
	: primary overflow	73 %
	: secondary overflow	83 %
	: peb mill discharge	33 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.9	8.5	11.7	45.4	18.5
Prim cyc A o/f	47.4	27.5	18.7	6.4	0.0
Prim cyc B o/f	55.7	37.6	6.5	0.2	0.0
Prim cyc A u/f	4.9	30.7	34.4	30.0	0.0
Prim cyc B u/f	4.9	30.7	34.4	30.0	0.0
Peb mill 1 disch	33.0	26.3	25.0	15.7	0.0
Peb mill 2 disch	16.6	33.7	34.4	15.3	0.0
Sec cyc o/f	76.1	23.2	0.7	0.0	0.0
Sec cyc u/f	12.6	52.8	34.6	0.0	0.0

Calculated values

Primary cyclone feed solids	444.7 t/hr
Primary cyclone feed water	446.2 t/hr
Secondary cyclone feed solids	n/a
Secondary cyclone feed water	n/a

Test 8b data sheet

Measured values

Primary cyclone feed flow rate	609.0	m3/hr
Primary cyclone feed density	1.455	
Secondary cyclone feed flow rate	n/a	
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	58.3	t/hr
Rod mill feed water	18.5	t/hr
Primary sump dilution	171.5	t/hr
Secondary sump dilution	11.3	t/hr
Pebble mill 1 pebble feed rate	16.5	t/hr
Pebble mill 2 pebble feed rate	5.5	t/hr
Pebble mill 1 power	328	kWhr
Pebble mill 2 power	230	kWhr

Spigots : primary A	10.70	cm
: primary B	11.00	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	83	%
: peb mill discharge	33	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.5	15.4	12.0	54.3	5.8
Prim cyc A o/f	43.7	28.9	20.2	7.2	0.0
Prim cyc B o/f	55.3	35.0	9.4	0.3	0.0
Prim cyc A u/f	13.8	24.1	24.9	37.2	0.0
Prim cyc B u/f	3.5	33.7	36.2	26.6	0.0
Peb mill 1 disch	31.6	30.9	23.9	13.6	0.0
Peb mill 2 disch	28.9	27.5	31.0	12.6	0.0
Sec cyc o/f	76.8	22.7	0.5	0.0	0.0
Sec cyc u/f	19.0	45.6	35.4	0.0	0.0

Calculated values

Primary cyclone feed solids	445.0	t/hr
Primary cyclone feed water	441.1	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 8a data sheet

Measured values

Primary cyclone feed flow rate	614.0 m3/hr
Primary cyclone feed density	1.459
Secondary cyclone feed flow rate	n/a
Secondary cyclone feed density	n/a
Rod mill feed solids (wat)	55.7 t/hr
Rod mill feed water	17.6 t/hr
Primary sump dilution	172.9 t/hr
Secondary sump dilution	10.8 t/hr
Pebble mill 1 pebble feed rate	2.7 t/hr
Pebble mill 2 pebble feed rate	5.7 t/hr
Pebble mill 1 power	326 kWhr
Pebble mill 2 power	231 kWhr

Spigots :	primary A	10.70 cm
:	primary B	11.00 cm
:	secondary	0.00 cm

From daily log sheets :	% moisture :	
:	primary overflow	73 %
:	secondary overflow	83 %
:	peb mill discharge	33 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.9	7.0	9.6	47.5	17.0
Prim cyc A o/f	45.3	30.9	17.7	6.1	0.0
Prim cyc B o/f	51.2	31.9	6.9	0.0	0.0
Prim cyc A u/f	12.1	24.7	26.3	36.9	0.0
Prim cyc B u/f	20.8	28.3	27.9	23.0	0.0
Peb mill 1 disch	36.5	26.8	22.7	14.0	0.0
Peb mill 2 disch	31.3	27.0	25.5	16.2	0.0
Sec cyc o/f	75.4	22.4	2.2	0.0	0.0
Sec cyc u/f	19.2	44.1	36.7	0.0	0.0

Calculated values

Primary cyclone feed solids	452.6 t/hr
Primary cyclone feed water	443.2 t/hr
Secondary cyclone feed solids	n/a
Secondary cyclone feed water	n/a

Test 7c data sheet

Measured values

Primary cyclone feed flow rate	595.0	m3/hr
Primary cyclone feed density	1.447	
Secondary cyclone feed flow rate	n/a	
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	52.9	t/hr
Rod mill feed water	16.4	t/hr
Primary sump dilution	156.8	t/hr
Secondary sump dilution	25.1	t/hr
Pebble mill 1 pebble feed rate	6.4	t/hr
Pebble mill 2 pebble feed rate	3.3	t/hr
Pebble mill 1 power	325	kWhr
Pebble mill 2 power	233	kWhr

Spigots : primary A	10.70	cm
: primary B	11.00	cm
: secondary	0.00	cm

From daily log sheets : % moisture :

: primary overflow	73 %
: secondary overflow	83 %
: peb mill discharge	33 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	22.3	6.0	8.7	51.0	12.0
Prim cyc A o/f	48.0	28.1	17.8	6.1	0.0
Prim cyc B o/f	56.7	36.1	6.9	0.3	0.0
Prim cyc A u/f	13.3	28.3	23.9	34.5	0.0
Prim cyc B u/f	11.7	26.6	35.5	26.2	0.0
Peb mill 1 disch	27.2	26.0	32.1	14.7	0.0
Peb mill 2 disch	33.6	29.0	26.3	11.1	0.0
Sec cyc o/f	74.5	25.0	0.5	0.0	0.0
Sec cyc u/f	19.1	48.1	32.8	0.0	0.0

Calculated values

Primary cyclone feed solids	427.2	t/hr
Primary cyclone feed water	433.8	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 7b data sheet

Measured values

Primary cyclone feed flow rate	593.0 m3/hr
Primary cyclone feed density	1.442
Secondary cyclone feed flow rate	n/a
Secondary cyclone feed density	n/a
Rod mill feed solids (wet)	57.5 t/hr
Rod mill feed water	18.3 t/hr
Primary sump dilution	158.1 t/hr
Secondary sump dilution	27.2 t/hr
Pebble mill 1 pebble feed rate	8.9 t/hr
Pebble mill 2 pebble feed rate	6.9 t/hr
Pebble mill 1 power	324 kWhr
Pebble mill 2 power	233 kWhr

Spigots :	primary A	10.70 cm
:	primary B	11.00 cm
:	secondary	0.00 cm

From daily log sheets : % moisture :

: primary overflow	73 %
: secondary overflow	83 %
: peb mill discharge	33 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.5	6.5	7.9	52.2	14.9
Prim cyc A o/f	41.5	34.2	18.6	5.7	0.0
Prim cyc B o/f	58.7	35.7	5.6	0.0	0.0
Prim cyc A u/f	9.1	31.1	29.8	30.0	0.0
Prim cyc B u/f	13.0	27.5	34.5	25.0	0.0
Peb mill 1 disch	34.5	28.9	24.8	11.8	0.0
Peb mill 2 disch	33.5	32.3	28.1	6.1	0.0
Sec cyc o/f	79.0	20.3	0.7	0.0	0.0
Sec cyc u/f	17.3	45.5	37.1	0.0	0.1

Calculated values

Primary cyclone feed solids	421.0 t/hr
Primary cyclone feed water	434.1 t/hr
Secondary cyclone feed solids	n/a
Secondary cyclone feed water	n/a

Test 7a data sheet

Measured values

Primary cyclone feed flow rate	594.0	m3/hr
Primary cyclone feed density	1.448	
Secondary cyclone feed flow rate	n/a	
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	54.6	t/hr
Rod mill feed water	17.3	t/hr
Primary sump dilution	154.9	t/hr
Secondary sump dilution	36.6	t/hr
Pebble mill 1 pebble feed rate	5.1	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	326	kWhr
Pebble mill 2 power	233	kWhr

Spigots : primary A	10.70	cm
: primary B	11.00	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	83	%
: peb mill discharge	33	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	22.1	6.4	8.6	51.4	11.5
Prim cyc A o/f	44.3	31.5	18.5	5.7	0.0
Prim cyc B o/f	59.4	33.8	6.8	0.0	0.0
Prim cyc A u/f	8.6	29.2	30.3	31.9	0.0
Prim cyc B u/f	8.6	29.2	30.3	31.9	0.0
Peb mill 1 disch	33.4	28.1	25.6	12.9	0.0
Peb mill 2 disch	32.5	26.3	27.1	14.1	0.0
Sec cyc o/f	72.9	26.7	0.4	0.0	0.0
Sec cyc u/f	100.0	0.0	0.0	0.0	0.0

Calculated values

Primary cyclone feed solids	427.4	t/hr
Primary cyclone feed water	432.7	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 6c data sheet

Measured values

Primary cyclone feed flow rate	612.0 m3/hr
Primary cyclone feed density	1.454
Secondary cyclone feed flow rate	n/a
Secondary cyclone feed density	n/a
Rod mill feed solids (wet)	59.4 t/hr
Rod mill feed water	18.8 t/hr
Primary sump dilution	174.1 t/hr
Secondary sump dilution	52.2 t/hr
Pebble mill 1 pebble feed rate	0.0 t/hr
Pebble mill 2 pebble feed rate	6.8 t/hr
Pebble mill 1 power	327 kWhr
Pebble mill 2 power	233 kWhr

Spigots :	primary A	10.70 cm
:	primary B	11.00 cm
:	secondary	0.00 cm

From daily log sheets : % moisture :		
:	primary overflow	73 %
:	secondary overflow	83 %
:	peb mill discharge	33 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.3	8.8	10.1	44.6	18.2
Prim cyc A o/f	55.0	32.1	12.4	0.5	0.0
Prim cyc B o/f	57.1	33.9	8.9	0.1	0.0
Prim cyc A u/f	9.4	28.4	32.1	30.1	0.0
Prim cyc B u/f	14.2	28.3	31.5	26.0	0.0
Peb mill 1 disch	37.1	31.1	22.0	9.8	0.0
Peb mill 2 disch	28.4	30.7	28.4	12.5	0.0
Sec cyc o/f	77.9	21.7	0.4	0.0	0.0
Sec cyc u/f	16.2	50.7	33.1	0.0	0.0

Calculated values

Primary cyclone feed solids	446.2 t/hr
Primary cyclone feed water	443.6 t/hr
Secondary cyclone feed solids	n/a
Secondary cyclone feed water	n/a

Test 6b data sheet

Measured values

Primary cyclone feed flow rate	612.0	m3/hr
Primary cyclone feed density	1.470	
Secondary cyclone feed flow rate	n/a	
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	49.5	t/hr
Rod mill feed water	15.7	t/hr
Primary sump dilution	172.6	t/hr
Secondary sump dilution	81.2	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	7.5	t/hr
Pebble mill 1 power	328	kWhr
Pebble mill 2 power	230	kWhr

Spigots : primary A	10.70	cm
: primary B	11.00	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	83	%
: peb mill discharge	33	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	23.5	6.7	10.4	52.4	7.0
Prim cyc A o/f	32.4	36.9	22.2	8.5	0.0
Prim cyc B o/f	48.1	42.0	9.7	0.2	0.0
Prim cyc A u/f	11.6	26.6	30.4	31.4	0.0
Prim cyc B u/f	13.2	27.2	34.6	25.0	0.0
Peb mill 1 disch	37.5	26.8	23.7	12.0	0.0
Peb mill 2 disch	23.0	30.0	31.0	16.0	0.0
Sec cyc o/f	80.0	19.7	0.3	0.0	0.0
Sec cyc u/f	15.4	42.7	41.9	0.0	0.0

Calculated values

Primary cyclone feed solids	462.0	t/hr
Primary cyclone feed water	437.7	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 6a data sheet

Measured values

Primary cyclone feed flow rate	613.0	m3/hr
Primary cyclone feed density	1.470	
Secondary cyclone feed flow rate	n/a	
Secondary cyclone feed density	n/a	
Rod mill feed solids (wet)	49.9	t/hr
Rod mill feed water	15.6	t/hr
Primary sump dilution	172.0	t/hr
Secondary sump dilution	70.7	t/hr
Pebble mill 1 pebble feed rate	4.8	t/hr
Pebble mill 2 pebble feed rate	1.0	t/hr
Pebble mill 1 power	327	kWhr
Pebble mill 2 power	231	kWhr

Spigots : primary A	10.70	cm
: primary B	11.00	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	73	%
: secondary overflow	83	%
: peb mill discharge	33	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.9	3.5	12.4	48.6	16.6
Prim cyc A o/f	42.1	28.7	20.8	8.4	0.0
Prim cyc B o/f	48.0	40.6	10.8	0.6	0.0
Prim cyc A u/f	14.4	24.6	28.2	32.8	0.0
Prim cyc B u/f	5.7	32.0	35.2	27.1	0.0
Peb mill 1 disch	34.9	23.8	24.0	17.3	0.0
Peb mill 2 disch	16.1	25.3	25.9	32.7	0.0
Sec cyc o/f	75.9	23.3	0.8	0.0	0.0
Sec cyc u/f	15.1	53.5	31.4	0.0	0.0

Calculated values

Primary cyclone feed solids	462.7	t/hr
Primary cyclone feed water	438.4	t/hr
Secondary cyclone feed solids	n/a	
Secondary cyclone feed water	n/a	

Test 2b initial mass balance

Stream	Solids	Water	
Rod mill feed	74.0	3.9	t/hr
Rod mill dilution		24.3	t/hr
Rod mill discharge	74.0	28.2	t/hr
Primary dilution		276.8	t/hr
Prim cyclone feed	422.9	476.4	t/hr
Prim cyclone A o/f	65.8	177.7	t/hr
Prim cyclone B o/f	65.8	177.7	t/hr
Prim cyclone A u/f	145.7	60.5	t/hr
Prim cyclone B u/f	145.7	60.5	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	148.3	60.5	t/hr
Peb mill 2 product	148.3	60.5	t/hr
Secondary dilution		21.2	t/hr
Sec cyclone feed	131.5	376.6	t/hr
Sec cyclone o/f	78.9	326.2	t/hr
Sec cyclone u/f	52.6	50.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.0	7.4	15.0	35.7	33.9
Prim cyc feed	12.0	32.3	29.1	20.2	6.4
Prim cyc A o/f	32.8	38.7	20.9	7.6	0.0
Prim cyc B o/f	19.0	46.6	33.2	1.2	0.0
Prim cyc A u/f	6.0	25.3	31.6	26.8	9.3
Prim cyc B u/f	5.7	25.4	28.8	30.8	9.3
Peb mill 1 disch	12.4	38.1	32.4	16.3	0.8
Peb mill 2 disch	12.9	37.2	31.4	17.9	0.6
Sec cyc feed	25.9	42.7	27.1	4.4	0.0
Sec cyc o/f	80.0	18.6	0.4	1.0	0.0
Sec cyc u/f	13.7	37.1	33.0	16.1	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	81	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 2a initial mass balance

Stream	Solids	Water	
Rod mill feed	66.0	3.5	t/hr
Rod mill dilution		21.8	t/hr
Rod mill discharge	66.0	25.3	t/hr
Primary dilution		270.1	t/hr
Prim cyclone feed	439.8	465.0	t/hr
Prim cyclone A o/	61.8	166.9	t/hr
Prim cyclone B o/f	61.8	166.9	t/hr
Prim cyclone A u/f	138.2	65.6	t/hr
Prim cyclone B u/f	138.2	65.6	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	160.8	65.6	t/hr
Peb mill 2 product	160.8	65.6	t/hr
Secondary dilution		64.5	t/hr
Sec cyclone feed	123.5	398.4	t/hr
Sec cyclone o/f	70.9	359.9	t/hr
Sec cyclone u/f	52.6	38.5	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	6.2	3.8	16.8	47.2	26.0
Prim cyc feed	9.1	33.8	31.2	21.9	4.1
Prim cyc A o/f	23.5	45.7	30.5	0.3	0.0
Prim cyc B o/f	29.6	30.1	39.7	0.6	0.0
Prim cyc A u/f	5.8	32.2	34.4	21.9	5.7
Prim cyc B u/f	6.7	28.0	35.4	24.2	5.7
Peb mill 1 disch	11.7	41.7	33.0	13.1	0.5
Peb mill 2 disch	7.1	29.9	36.0	27.0	0.0
Sec cyc feed	26.6	37.9	35.1	0.5	0.0
Sec cyc o/f	77.2	22.0	0.8	0.0	0.0
Sec cyc u/f	10.7	59.0	29.3	1.0	0.0

Check for accuracy:

	Calc	Mear	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	84	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 1c initial mass balance

Stream	Solids	Water	
Rod mill feed	66.2	3.5	t/hr
Rod mill dilution		21.7	t/hr
Rod mill discharge	66.2	25.2	t/hr
Primary dilution		287.2	t/hr
Prim cyclone feed	408.8	491.7	t/hr
Prim cyclone A o/f	65.0	185.0	t/hr
Prim cyclone B o/f	65.0	185.0	t/hr
Prim cyclone A u/f	139.4	60.8	t/hr
Prim cyclone B u/f	139.4	60.8	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	142.0	60.8	t/hr
Peb mill 2 product	142.0	60.8	t/hr
Secondary dilution		3.7	t/hr
Sec cyclone feed	130.0	373.8	t/hr
Sec cyclone o/f	71.1	316.1	t/hr
Sec cyclone u/f	58.9	57.7	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.9	4.4	11.4	48.9	27.4
Prim cyc feed	14.0	32.3	29.0	20.1	4.7
Prim cyc A o/f	19.9	56.2	23.2	0.5	0.2
Prim cyc B o/f	32.8	46.3	20.1	0.8	0.0
Prim cyc A u/f	7.2	31.9	28.8	25.2	6.9
Prim cyc B u/f	6.2	25.2	22.4	39.3	6.9
Peb mill 1 disch	12.0	40.7	27.9	18.9	0.5
Peb mill 2 disch	18.9	23.2	41.7	16.0	0.2
Sec cyc feed	26.4	51.3	21.7	0.7	0.1
Sec cyc o/f	79.4	20.4	0.2	0.0	0.0
Sec cyc u/f	13.7	65.3	20.5	0.5	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	82	83	%
Peb mill moist	30	30	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 1b initial mass balance

Stream	Solids	Water	
Rod mill feed	66.1	3.5	t/hr
Rod mill dilution		22.0	t/hr
Rod mill discharge	66.1	25.5	t/hr
Primary dilution		286.6	t/hr
Prim cyclone feed	381.0	492.2	t/hr
Prim cyclone A o/f	67.7	192.5	t/hr
Prim cyclone B o/f	67.7	192.5	t/hr
Prim cyclone A u/f	122.9	53.6	t/hr
Prim cyclone B u/f	122.9	53.6	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	125.5	53.6	t/hr
Peb mill 2 product	125.5	53.6	t/hr
Secondary dilution		4.3	t/hr
Sec cyclone feed	135.3	389.3	t/hr
Sec cyclone o/f	71.0	316.4	t/hr
Sec cyclone u/f	64.3	72.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	0.2	9.9	10.5	41.3	38.1
Prim cyc feed	11.4	39.2	25.7	17.0	6.8
Prim cyc A o/f	33.7	36.9	21.2	8.2	0.0
Prim cyc B o/f	20.8	57.2	20.8	1.2	0.0
Prim cyc A u/f	6.8	29.8	29.1	23.8	10.5
Prim cyc B u/f	7.6	31.8	26.0	24.1	10.5
Peb mill 1 disch	17.9	29.5	36.1	16.3	0.2
Peb mill 2 disch	9.4	48.4	28.4	13.5	0.3
Sec cyc feed	27.3	47.1	21.0	4.7	0.0
Sec cyc o/f	77.0	22.6	0.4	0.0	0.0
Sec cyc u/f	14.3	69.9	15.4	0.4	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	82	83	%
Peb mill moist	30	30	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

APPENDIX D Calculated mass balance

Test 1a initial mass balance

Stream	Solids	Water	
Rod mill feed	49.1	2.6	t/hr
Rod mill dilution		16.4	t/hr
Rod mill discharge	49.1	19.0	t/hr
Primary dilution		281.3	t/hr
Prim cyclone feed	372.6	486.4	t/hr
Prim cyclone A o/f	67.2	191.1	t/hr
Prim cyclone B o/f	67.2	191.1	t/hr
Prim cyclone A u/f	119.1	52.1	t/hr
Prim cyclone B u/f	119.1	52.1	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	121.7	52.1	t/hr
Peb mill 2 product	121.7	52.1	t/hr
Secondary dilution		4.4	t/hr
Sec cyclone feed	134.3	386.5	t/hr
Sec cyclone o/f	54.0	304.7	t/hr
Sec cyclone u/f	80.3	81.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.1	2.9	20.2	47.9	20.9
Prim cyc feed	12.4	42.0	26.8	15.9	3.0
Prim cyc A o/f	28.0	36.2	34.5	1.3	0.0
Prim cyc B o/f	28.0	36.2	34.5	1.3	0.0
Prim cyc A u/f	7.4	34.5	30.5	22.9	4.7
Prim cyc B u/f	7.3	31.2	29.6	27.2	4.7
Peb mill 1 disch	16.6	38.7	28.6	15.5	0.6
Peb mill 2 disch	9.8	44.3	32.4	13.4	0.1
Sec cyc feed	28.0	36.2	34.5	1.3	0.0
Sec cyc o/f	74.6	25.0	0.4	0.0	0.0
Sec cyc u/f	12.7	67.5	19.3	0.5	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	85	83	%
Peb mill moist	30	30	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

APPENDIX C Estimated secondary cyclone feed values

Test	Water Flow rate t/h	Solids Flow rate t/h
1a	386.5	80.2
1b	389.3	64.2
1c	373.8	58.9
2a	398.4	52.6
2b	376.6	52.6
2c	366.3	60.3
3a	277	20.7
3b	276.9	22
3c	269.7	22.5
4a	274.5	13
4b	274.9	14.2
4c	266.4	15
5a	262.1	19.1
5b	258	13.5
5c	260.9	12.5
6a	322.8	37.3
6b	332.6	37
6c	320.7	34
7a	303	37.8
7b	299.3	37.1
7c	292.7	39.8
8a	274.9	35.9
8b	277.2	34.1
8c	283.8	32.2
11a	280.9	16.1
11b	256.8	18.6
11c	257.9	20.9
12a	251.1	9.9
12b	247.2	13.2
12c	238.4	11.3
13a	285.1	45.5
13b	303.7	39.2
13c	304.4	36.7

Test 13c data sheet

Measured values

Primary cyclone feed flow rate	621.0	m3/hr
Primary cyclone feed density	1.439	
Secondary cyclone feed flow rate	410.1	m3/hr
Secondary cyclone feed density	1.252	
Rod mill feed solids (wet)	65.6	t/hr
Rod mill feed water	20.6	t/hr
Primary sump dilution	202.9	t/hr
Secondary sump dilution	7.9	t/hr
Pebble mill 1 pebble feed rate	1.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	325	kWhr
Pebble mill 2 power	234	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	14.7	4.6	6.4	44.7	29.6
Prim cyc A o/f	56.0	36.6	7.0	0.4	0.0
Prim cyc B o/f	55.0	39.1	5.7	0.2	0.0
Prim cyc A u/f	9.6	25.6	27.5	37.3	0.0
Prim cyc B u/f	10.1	28.8	29.7	31.4	0.0
Peb mill 1 disch	24.9	31.7	26.2	17.2	0.0
Peb mill 2 disch	27.7	29.5	27.4	15.4	0.0
Sec cyc o/f	80.0	19.9	0.1	0.0	0.0
Sec cyc u/f	20.4	72.3	7.3	0.0	0.0

Calculated values

Primary cyclone feed solids	437.8	t/hr
Primary cyclone feed water	455.8	t/hr
Secondary cyclone feed solids	166.0	t/hr
Secondary cyclone feed water	347.5	t/hr

Test 13b data sheet

Measured values

Primary cyclone feed flow rate	618.0	m3/hr
Primary cyclone feed density	1.438	
Secondary cyclone feed flow rate	400.6	m3/hr
Secondary cyclone feed density	1.252	
Rod mill feed solids (wet)	62.8	t/hr
Rod mill feed water	20.1	t/hr
Primary sump dilution	197.6	t/hr
Secondary sump dilution	7.9	t/hr
Pebble mill 1 pebble feed rate	6.6	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	328	kWhr
Pebble mill 2 power	233	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.5	7.3	9.6	51.2	19.4
Prim cyc A o/f	59.4	34.0	6.4	0.2	0.0
Prim cyc B o/f	56.9	38.6	4.3	0.2	0.0
Prim cyc A u/f	8.7	28.6	32.9	29.8	0.0
Prim cyc B u/f	10.1	29.4	34.1	26.4	0.0
Peb mill 1 disch	23.7	32.5	28.9	14.9	0.0
Peb mill 2 disch	28.1	29.7	29.8	12.4	0.0
Sec cyc o/f	72.1	27.7	0.2	0.0	0.0
Sec cyc u/f	23.1	65.9	11.0	0.0	0.0

Calculated values

Primary cyclone feed solids	434.7	t/hr
Primary cyclone feed water	453.9	t/hr
Secondary cyclone feed solids	162.1	t/hr
Secondary cyclone feed water	339.4	t/hr

Test 13a data sheet

Measured values

Primary cyclone feed flow rate	613.0	m3/hr
Primary cyclone feed density	1.454	
Secondary cyclone feed flow rate	401.6	m3/hr
Secondary cyclone feed density	1.271	
Rod mill feed solids (wet)	49.3	t/hr
Rod mill feed water	15.8	t/hr
Primary sump dilution	190.9	t/hr
Secondary sump dilution	7.8	t/hr
Pebble mill 1 pebble feed rate	10.8	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	326	kWhr
Pebble mill 2 power	230	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	19.5	7.4	9.9	51.6	11.6
Prim cyc A o/f	57.2	36.4	6.1	0.3	0.0
Prim cyc B o/f	60.5	34.0	5.4	0.1	0.0
Prim cyc A u/f	8.7	27.9	34.0	29.4	0.0
Prim cyc B u/f	10.9	28.3	35.4	25.4	0.0
Peb mill 1 disch	25.1	29.5	30.2	15.2	0.0
Peb mill 2 disch	22.8	31.7	30.8	14.7	0.0
Sec cyc o/f	85.2	14.7	0.1	0.0	0.0
Sec cyc u/f	24.8	61.1	14.1	0.0	0.0

Calculated values

Primary cyclone feed solids	447.0	t/hr
Primary cyclone feed water	444.3	t/hr
Secondary cyclone feed solids	174.8	t/hr
Secondary cyclone feed water	335.6	t/hr

Test 12c data sheet

Measured values

Primary cyclone feed flow rate	631.0	m3/hr
Primary cyclone feed density	1.508	
Secondary cyclone feed flow rate	403.0	m3/hr
Secondary cyclone feed density	1.283	
Rod mill feed solids (wet)	67.9	t/hr
Rod mill feed water	21.2	t/hr
Primary sump dilution	189.2	t/hr
Secondary sump dilution	8.2	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	322	kWhr
Pebble mill 2 power	221	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :		
: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.1	5.1	6.8	43.2	29.8
Prim cyc A o/f	58.1	33.4	8.4	0.1	0.0
Prim cyc B o/f	54.4	36.5	9.0	0.1	0.0
Prim cyc A u/f	7.2	20.7	28.1	44.0	0.0
Prim cyc B u/f	9.0	20.1	30.3	40.6	0.0
Peb mill 1 disch	27.4	22.0	26.9	23.7	0.0
Peb mill 2 disch	23.2	28.2	28.0	20.6	0.0
Sec cyc o/f	81.1	18.5	0.4	0.0	0.0
Sec cyc u/f	23.0	55.4	21.6	0.0	0.0

Calculated values

Primary cyclone feed solids	514.8	t/hr
Primary cyclone feed water	436.7	t/hr
Secondary cyclone feed solids	183.2	t/hr
Secondary cyclone feed water	333.9	t/hr

Test 12b data sheet

Measured values

Primary cyclone feed flow rate	630.0	m3/hr
Primary cyclone feed density	1.499	
Secondary cyclone feed flow rate	403.6	m3/hr
Secondary cyclone feed density	1.277	
Rod mill feed solids (wet)	69.2	t/hr
Rod mill feed water	21.6	t/hr
Primary sump dilution	185.6	t/hr
Secondary sump dilution	8.1	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	322	kWhr
Pebble mill 2 power	220	kWhr

Spigots : primary A	9.50	cm
: primary B	9.50	cm
: secondary	0.00	cm

From daily log sheets : % moisture :

: primary overflow	74	%
: secondary overflow	85	%
: peb mill discharge	32	%

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	16.0	4.2	6.4	41.3	32.1
Prim cyc A o/f	52.2	35.8	11.9	0.1	0.0
Prim cyc B o/f	53.3	38.0	8.6	0.1	0.0
Prim cyc A u/f	9.5	21.0	28.4	41.1	0.0
Prim cyc B u/f	7.3	23.6	31.1	38.0	0.0
Peb mill 1 disch	24.7	24.4	26.2	24.7	0.0
Peb mill 2 disch	24.4	26.8	28.8	20.0	0.0
Sec cyc o/f	83.8	15.9	0.3	0.0	0.0
Sec cyc u/f	21.3	60.3	18.4	0.0	0.0

Calculated values

Primary cyclone feed solids	4.9	t/hr
Primary cyclone feed water	439.5	t/hr
Secondary cyclone feed solids	179.6	t/hr
Secondary cyclone feed water	335.8	t/hr

Test 12a data sheet

Measured values

Primary cyclone feed flow rate	626.0	m3/hr
Primary cyclone feed density	1.494	
Secondary cyclone feed flow rate	397.0	m3/hr
Secondary cyclone feed density	1.287	
Rod mill feed solids (wet)	73.9	t/hr
Rod mill feed water	23.1	t/hr
Primary sump dilution	179.1	t/hr
Secondary sump dilution	8.5	t/hr
Pebble mill 1 pebble feed rate	0.0	t/hr
Pebble mill 2 pebble feed rate	0.0	t/hr
Pebble mill 1 power	325	kWhr
Pebble mill 2 power	221	kWhr

Spigots : primary A 9.50 cm
: primary B 9.50 cm
: secondary 0.00 cm

From daily log sheets : % moisture :
: primary overflow 74 %
: secondary overflow 65 %
: peb mill discharge 32 %

Size analyses - % in size interval (μm)

	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	13.3	4.0	6.0	42.7	34.0
Prim cyc A o/f	53.4	34.6	11.8	0.2	0.0
Prim cyc B o/f	55.9	34.5	9.4	0.2	0.0
Prim cyc A u/f	8.6	20.2	28.8	42.4	0.0
Prim cyc B u/f	9.0	22.9	30.5	37.6	0.0
Peb mill 1 disch	31.8	20.7	26.9	20.6	0.0
Peb mill 2 disch	23.2	29.2	28.2	19.4	0.0
Sec cyc o/f	83.8	16.0	0.2	0.0	0.0
Sec cyc u/f	19.6	58.9	21.5	0.0	0.0

Calculated values

Primary cyclone feed solids	496.7	t/hr
Primary cyclone feed water	438.6	t/hr
Secondary cyclone feed solids	183.0	t/hr
Secondary cyclone feed water	327.9	t/hr

Test 6b initial mass balance

Stream	Solids	Water	
Rod mill feed	47.0	2.5	t/hr
Rod mill dilution		15.7	t/hr
Rod mill discharge	47.0	18.2	t/hr
Primary dilution		172.6	t/hr
Prim cyclone feed	462.0	437.7	t/hr
Prim cyclone A o/f	46.5	125.7	t/hr
Prim cyclone B o/f	46.5	125.7	t/hr
Prim cyclone A u/f	184.5	93.1	t/hr
Prim cyclone B u/f	184.5	93.1	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	190.0	93.1	t/hr
Peb mill 2 product	190.0	93.1	t/hr
Secondary dilution		81.2	t/hr
Sec cyclone feed	93.0	332.6	t/hr
Sec cyclone o/f	55.9	272.0	t/hr
Sec cyclone u/f	37.1	60.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	23.5	6.7	10.4	52.4	7.0
Prim cyc feed	28.5	27.5	26.9	16.8	0.7
Prim cyc A o/f	32.4	36.9	22.2	8.5	0.0
Prim cyc B o/f	48.1	42.0	9.7	0.2	0.0
Prim cyc A u/f	11.6	26.6	30.4	30.5	0.9
Prim cyc B u/f	13.2	27.2	34.6	24.1	0.9
Peb mill 1 disch	37.5	26.8	23.7	12.0	0.0
Peb mill 2 disch	23.0	30.0	31.0	16.0	0.0
Sec cyc feed	40.3	39.5	16.0	4.3	0.0
Sec cyc o/f	80.0	19.7	0.3	0.0	0.0
Sec cyc u/f	15.4	42.7	41.9	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	83	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rat s was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 6a initial mass balance

Stream	Solids	Water	
Rod mill feed	47.4	2.5	t/hr
Rod mill dilution		15.6	t/hr
Rod mill discharge	47.4	18.1	t/hr
Primary dilution		172.0	t/hr
Prim cyclone feed	462.7	438.4	t/hr
Prim cyclone A o/f	46.7	126.0	t/hr
Prim cyclone B o/f	46.7	126.0	t/hr
Prim cyclone A u/f	184.7	93.1	t/hr
Prim cyclone B u/f	184.7	93.1	t/hr
Pebble addition 1	5.2		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	189.9	93.1	t/hr
Peb mill 2 product	189.9	93.1	t/hr
Secondary dilution		70.7	t/hr
Sec cyclone feed	93.3	322.8	t/hr
Sec cyclone o/f	56.0	260.8	t/hr
Sec cyclone u/f	37.3	62.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.9	3.5	12.4	48.6	16.6
Prim cyc feed	24.1	24.8	24.3	25.5	1.7
Prim cyc A o/f	42.1	28.7	20.8	8.4	0.0
Prim cyc B o/f	48.0	40.6	10.8	0.6	0.0
Prim cyc A u/f	14.4	24.6	28.2	30.7	2.1
Prim cyc B u/f	5.7	32.0	35.2	25.0	2.1
Peb mill 1 disch	34.9	23.8	24.0	17.3	0.0
Peb mill 2 disch	16.1	25.3	25.9	32.7	0.0
Sec cyc feed	45.0	34.7	15.8	4.5	0.0
Sec cyc o/f	75.9	23.3	0.8	0.0	0.0
Sec cyc u/f	15.1	53.5	31.4	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	82	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 5c initial mass balance

Stream	Solids	Water	
Rod mill feed	73.6	3.9	t/hr
Rod mill dilution		24.2	t/hr
Rod mill discharge	73.6	28.1	t/hr
Primary dilution		177.4	t/hr
Prim cyclone feed	406.3	382.7	t/hr
Prim cyclone A o/f	46.5	125.8	t/hr
Prim cyclone B o/f	46.5	125.8	t/hr
Prim cyclone A u/f	156.6	65.5	t/hr
Prim cyclone B u/f	156.6	65.5	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	159.9	65.5	t/hr
Peb mill 2 product	159.9	65.5	t/hr
Secondary dilution		9.2	t/hr
Sec cyclone feed	93.1	260.9	t/hr
Sec cyclone o/f	80.6	214.7	t/hr
Sec cyclone u/f	12.5	46.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.2	7.6	6.4	36.2	34.6
Prim cyc feed	17.2	27.1	26.3	22.6	6.7
Prim cyc A o/f	32.5	36.2	31.3	0.0	0.0
Prim cyc B o/f	25.3	39.5	28.2	7.0	0.0
Prim cyc A u/f	10.5	21.6	35.2	24.1	8.6
Prim cyc B u/f	12.8	25.2	27.0	26.4	8.6
Peb mill 1 disch	16.9	30.9	30.6	20.8	0.8
Peb mill 2 disch	18.9	29.8	31.2	19.9	0.2
Sec cyc feed	28.9	37.9	29.8	3.5	0.0
Sec cyc o/f	75.8	20.8	3.4	0.0	0.0
Sec cyc u/f	13.0	60.1	26.2	0.7	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	73	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 5b initial mass balance

Stream	Solids	Water	
Rod mill feed	71.5	3.8	t/hr
Rod mill dilution		23.7	t/hr
Rod mill discharge	71.5	27.5	t/hr
Primary dilution		172.3	t/hr
Prim cyclone feed	397.1	376.2	t/hr
Prim cyclone A o/f	46.0	124.4	t/hr
Prim cyclone B o/f	46.0	124.4	t/hr
Prim cyclone A u/f	152.5	63.6	t/hr
Prim cyclone B u/f	152.5	63.6	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	155.8	63.6	t/hr
Peb mill 2 product	155.8	63.6	t/hr
Secondary dilution		9.1	t/hr
Sec cyclone feed	92.1	258.0	t/hr
Sec cyclone o/f	78.5	208.9	t/hr
Sec cyclone u/f	13.6	49.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.7	9.6	7.8	40.0	32.9
Prim cyc feed	11.9	29.2	28.4	24.1	6.2
Prim cyc A o/f	31.3	35.4	33.3	0.0	0.0
Prim cyc B o/f	19.9	46.4	26.8	6.9	0.0
Prim cyc A u/f	8.9	18.6	37.6	26.9	8.0
Prim cyc B u/f	9.7	16.9	31.3	34.1	8.0
Peb mill 1 disch	12.1	33.8	31.5	22.0	0.6
Peb mill 2 disch	12.6	32.9	33.9	20.6	0.0
Sec cyc feed	25.6	40.9	30.0	3.5	0.0
Sec cyc o/f	73.8	23.2	3.0	0.0	0.0
Sec cyc u/f	14.7	38.6	40.0	6.7	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	73	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 5a initial mass balance

Stream	Solids	Water	
Rod mill feed	65.6	3.5	t/hr
Rod mill dilution		21.8	t/hr
Rod mill discharge	65.6	25.3	t/hr
Primary dilution		178.9	t/hr
Prim cyclone feed	417.8	384.3	t/hr
Prim cyclone A o/f	45.9	124.1	t/hr
Prim cyclone B o/f	45.9	124.1	t/hr
Prim cyclone A u/f	163.0	68.1	t/hr
Prim cyclone B u/f	163.0	68.1	t/h
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	166.3	68.1	t/hr
Peb mill 2 product	166.3	68.1	t/hr
Secondary dilution		14.0	t/hr
Sec cyclone feed	91.8	262.1	t/hr
Sec cyclone o/f	72.6	218.2	t/hr
Sec cyclone u/f	19.2	43.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	4.8	13.4	5.8	37.2	38.8
Prim cyc feed	14.2	27.6	33.4	18.4	6.4
Prim cyc A o/f	30.8	35.8	33.1	0.3	0.0
Prim cyc B o/f	18.6	46.5	28.5	6.4	0.0
Prim cyc A u/f	5.6	12.6	27.7	45.9	8.2
Prim cyc B u/f	8.9	17.0	32.1	33.8	8.2
Peb mill 1 disch	18.1	20.0	44.9	16.3	0.7
Peb mill 2 disch	14.4	39.1	32.2	14.3	0.0
Sec cyc feed	24.7	41.2	30.8	3.4	0.0
Sec cyc o/f	74.6	22.7	2.7	0.0	0.0
Sec cyc u/f	10.8	43.0	38.8	7.4	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	75	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 4c initial mass balance

Stream	Solids	Water	
Rod mill feed	72.0	3.8	t/hr
Rod mill dilution		23.8	t/hr
Rod mill discharge	72.0	27.6	t/hr
Primary dilution		214.5	t/hr
Prim cyclone feed	470.3	410.5	t/hr
Prim cyclone A o/f	47.0	127.0	t/hr
Prim cyclone B o/f	47.0	127.0	t/hr
Prim cyclone A u/f	188.1	78.2	t/hr
Prim cyclone B u/f	188.1	78.2	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	191.4	78.2	t/hr
Peb mill 2 product	191.4	78.2	t/hr
Secondary dilution		12.3	t/hr
Sec cyclone feed	94.0	266.4	t/hr
Sec cyclone o/f	79.0	254.4	t/hr
Sec cyclone u/f	15.0	12.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.5	7.5	9.4	34.2	41.4
Prim cyc feed	10.1	24.6	29.3	26.0	7.9
Prim cyc A o/f	18.6	36.1	44.4	1.0	0.0
Prim cyc B o/f	23.3	29.5	46.2	1.0	0.0
Prim cyc A u/f	5.3	14.5	27.8	42.5	9.9
Prim cyc B u/f	7.2	16.2	35.7	31.0	9.9
Peb mill 1 disch	7.6	20.4	30.4	30.0	3.6
Peb mill 2 disch	13.6	25.7	34.8	25.7	0.2
Sec cyc feed	20.9	32.8	45.3	1.0	0.0
Sec cyc o/f	81.7	16.8	1.5	0.0	0.0
Sec cyc u/f	10.6	44.2	42.7	2.5	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 4b initial mass balance

Stream	Solids	Water	
Rod mill feed	76.5	4.0	t/hr
Rod mill dilution		25.1	t/hr
Rod mill discharge	76.5	29.1	t/hr
Primary dilution		217.6	t/hr
Prim cyclone feed	463.2	416.2	t/hr
Prim cyclone A o/f	48.8	132.1	t/hr
Prim cyclone B o/f	48.8	132.1	t/hr
Prim cyclone A u/f	182.8	76.1	t/hr
Prim cyclone B u/f	182.8	76.1	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	186.1	76.1	t/hr
Peb mill 2 product	186.1	76.1	t/hr
Secondary dilution		10.8	t/hr
Sec cyclone feed	97.7	274.9	t/hr
Sec cyclone o/f	83.5	257.5	t/hr
Sec cyclone u/f	14.2	17.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	6.8	8.8	9.1	29.4	45.9
Prim cyc feed	10.2	25.6	29.1	25.1	10.0
Prim cyc A o/f	14.6	41.1	39.9	4.4	0.0
Prim cyc B o/f	24.9	33.1	40.3	1.7	0.0
Prim cyc A u/f	4.4	17.5	30.2	35.2	12.7
Prim cyc B u/f	7.1	15.7	35.7	28.8	12.7
Peb mill 1 disch	7.1	30.2	29.5	27.7	5.5
Peb mill 2 disch	14.5	26.5	35.9	22.5	0.6
Sec cyc feed	19.8	37.1	40.1	3.1	0.0
Sec cyc o/f	81.0	15.4	3.6	0.0	0.0
Sec cyc u/f	12.3	43.2	43.2	1.3	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 4a initial mass balance

Stream	Solids	Water	
Rod mill feed	77.6	4.1	t/hr
Rod mill dilution		25.9	t/hr
Rod mill discharge	77.6	30.0	t/hr
Primary dilution		213.0	t/hr
Prim cyclone feed	450.7	410.9	t/hr
Prim cyclone A o/f	48.8	131.9	t/hr
Prim cyclone B o/f	48.8	131.9	t/hr
Prim cyclone A u/f	176.5	73.6	t/hr
Prim cyclone B u/f	176.5	73.6	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	179.8	73.6	t/hr
Peb mill 2 product	179.8	73.6	t/hr
Secondary dilution		10.7	t/hr
Sec cyclone feed	97.6	274.5	t/hr
Sec cyclone o/f	84.6	253.7	t/hr
Sec cyclone u/f	13.0	20.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	4.8	6.8	7.5	33.6	47.3
Prim cyc feed	10.6	25.0	29.9	25.2	9.1
Prim cyc A o/f	18.9	46.3	33.2	1.6	0.0
Prim cyc B o/f	24.0	35.1	40.2	0.7	0.0
Prim cyc A u/f	3.6	15.1	27.7	42.0	11.6
Prim cyc B u/f	6.2	17.2	33.7	31.3	11.6
Peb mill 1 disch	9.8	31.1	32.2	24.9	2.0
Peb mill 2 disch	13.9	25.3	36.8	23.6	0.4
Sec cyc feed	21.5	40.7	36.7	1.1	0.0
Sec cyc o/f	80.6	12.3	7.1	0.0	0.0
Sec cyc u/f	11.7	47.4	38.7	2.2	0.0

Check for accuracy:

	Calc	Mean	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	75	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated ' adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 3c initial mass balance

Stream	Solids	Water	
Rod mill feed	66.4	3.5	t/hr
Rod mill dilution		22.1	t/hr
Rod mill discharge	66.4	25.6	t/hr
Primary dilution		201.3	t/hr
Prim cyclone feed	436.3	401.3	t/hr
Prim cyclone A o/f	48.0	129.7	t/hr
Prim cyclone B o/f	48.0	129.7	t/hr
Prim cyclone A u/	170.2	71.0	t/hr
Prim cyclone B u :	170.2	71.0	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	173.5	71.0	t/hr
Peb mill 2 product	173.5	71.0	t/hr
Secondary dilution		10.3	t/hr
Sec cyclone feed	95.9	269.7	t/hr
Sec cyclone o/f	73.4	237.2	t/hr
Sec cyclone u/f	22.5	32.5	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	2.5	7.7	4.0	33.0	52.8
Prim cyc feed	11.7	23.0	28.1	28.3	8.9
Prim cyc A o/f	43.0	19.2	36.8	1.0	0.0
Prim cyc B o/f	41.4	25.9	32.6	0.1	0.0
Prim cyc A u/f	2.5	19.1	28.2	38.8	11.4
Prim cyc B u/f	6.5	18.7	22.6	40.8	11.4
Peb mill 1 disch	13.8	21.6	32.7	29.8	2.1
Peb mill 2 disch	13.4	25.1	32.8	28.6	0.1
Sec cyc feed	42.2	22.6	34.7	0.6	0.0
Sec cyc o/f	80.9	16.3	2.8	0.0	0.0
Sec cyc u/f	9.3	62.9	27.6	0.2	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	7	84	%
Peb mill moist	9	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 3b initial mass balance

Stream	Solids	Water	
Rod mill feed	69.6	3.7	t/hr
Rod mill dilution		23.0	t/hr
Rod mill discharge	69.6	26.7	t/hr
Primary dilution		201.1	t/hr
Prim cyclone feed	425.7	403.3	t/hr
Prim cyclone A o/f	49.3	133.3	t/hr
Prim cyclone B o/f	49.3	133.3	t/hr
Prim cyclone A u/f	163.6	68.3	t/hr
Prim cyclone B u/f	163.6	68.3	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	166.9	68.3	t/hr
Peb mill 2 product	166.9	68.3	t/hr
Secondary dilution		10.2	t/hr
Sec cyclone feed	98.6	276.9	t/hr
Sec cyclone o/f	76.6	238.0	t/hr
Sec cyclone u/f	22.0	38.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	3.8	1.4	13.8	36.5	44.5
Prim cyc feed	7.8	23.5	38.0	23.2	7.5
Prim cyc A o/f	35.4	18.6	40.6	5.4	0.0
Prim cyc B o/f	22.6	39.6	37.4	0.4	0.0
Prim cyc A u/f	5.7	18.1	30.9	36.1	9.8
Prim cyc B u/f	5.4	16.7	26.2	41.9	9.8
Peb mill 1 disch	8.5	26.0	43.3	21.9	0.3
Peb mill 2 disch	8.5	26.0	43.3	21.9	0.3
Sec cyc feed	29.0	29.1	39.0	2.9	0.0
Sec cyc o/f	73.3	15.6	11.1	0.0	0.0
Sec cyc u/f	9.2	56.0	34.4	0.4	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	84	%
Peb mill moist	2[illegible]	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 3a Initial mass balance

Stream	Solids	Water	
Rod mill feed	70.5	3.7	t/hr
Rod mill dilution		23.4	t/hr
Rod mill discharge	70.5	27.1	t/hr
Primary dilution		195.9	t/hr
Prim cyclone feed	414.6	397.5	t/hr
Prim cyclone A o/f	49.1	132.8	t/hr
Prim cyclone B o/f	49.1	132.8	t/hr
Prim cyclone A u/f	158.2	66.0	t/hr
Prim cyclone B u/f	158.2	66.0	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	161.5	66.0	t/hr
Peb mill 2 product	161.5	66.0	t/hr
Secondary dilution		11.4	t/hr
Sec cyclone feed	98.2	277.0	t/hr
Sec cyclone o/f	77.5	234.4	t/hr
Sec cyclone u/f	20.7	42.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.4	4.6	12.1	42.6	30.3
Prim cyc feed	11.0	28.9	31.4	22.9	5.7
Prim cyc A o/f	43.0	28.1	24.4	4.5	0.0
Prim cyc B o/f	13.2	31.8	52.3	2.7	0.0
Prim cyc A u/f	5.9	15.4	30.5	40.7	7.5
Prim cyc B u/f	6.1	13.4	26.6	46.4	7.5
Peb mill 1 disch	13.0	32.4	31.8	21.4	1.4
Peb mill 2 disch	9.2	34.6	37.4	18.7	0.1
Sec cyc feed	28.1	30.0	38.3	3.6	0.0
Sec cyc o/f	72.6	18.6	8.8	0.0	0.0
Sec cyc u/f	11.5	40.0	47.8	0.7	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	75	73	%
Sec cyc o/f moist	76	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 2c initial mass balance

Stream	Solids	Water	
Rod mill feed	62.6	3.3	t/hr
Rod mill dilution		20.7	t/hr
Rod mill discharge	62.6	24.0	t/hr
Primary dilution		280.6	t/hr
Prim cyclone feed	438.9	474.4	t/hr
Prim cyclone A o/f	63.9	172.8	t/hr
Prim cyclone B o/f	63.9	172.8	t/hr
Prim cyclone A u/f	155.6	64.4	t/hr
Prim cyclone B u/f	155.6	64.4	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	158.2	64.4	t/hr
Peb mill 2 product	158.2	64.4	t/hr
Secondary dilution		20.8	t/hr
Sec cyclone feed	127.8	356.3	t/hr
Sec cyclone o/f	67.5	325.4	t/hr
Sec cyclone u/f	60.3	40.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	2.8	11.0	5.8	40.7	39.7
Prim cyc feed	12.2	34.0	27.6	20.1	6.2
Prim cyc A o/f	35.1	29.3	33.6	2.0	0.0
Prim cyc B o/f	23.5	54.0	21.0	1.5	0.0
Prim cyc A u/f	7.0	25.1	29.5	29.6	8.8
Prim cyc B u/f	6.6	26.6	28.6	29.4	8.8
Peb mill 1 disch	18.7	26.4	33.3	20.2	1.4
Peb mill 2 disch	9.3	41.4	29.9	19.3	0.1
Sec cyc feed	29.3	41.7	27.3	1.8	0.0
Sec cyc o/f	69.2	28.7	2.1	0.0	0.0
Sec cyc u/f	12.2	57.9	29.3	0.6	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	83	84	%
Peb mill moist	29	29	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 12a initial mass balance

Stream	Solids	Water	
Rod mill feed	70.2	3.7	t/hr
Rod mill dilution		23.1	t/hr
Rod mill discharge	70.2	26.8	t/hr
Primary dilution		179.1	t/hr
Prim cyclone feed	496.7	438.6	t/hr
Prim cyclone A o/f	42.6	121.3	t/hr
Prim cyclone B o/f	42.6	121.3	t/hr
Prim cyclone A u/f	205.7	98.0	t/hr
Prim cyclone B u/f	205.7	98.0	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	208.5	98.0	t/hr
Peb mill 2 product	208.5	98.0	t/hr
Secondary dilution		8.5	t/hr
Sec cyclone feed	85.2	251.1	t/hr
Sec cyclone o/f	75.3	214.4	t/hr
Sec cyclone u/f	9.9	36.7	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	13.3	4.0	6.0	42.7	34.0
Prim cyc feed	25.4	22.7	24.4	22.8	4.8
Prim cyc A o/f	53.4	34.6	11.8	0.2	0.0
Prim cyc B o/f	55.9	34.5	9.4	0.2	0.0
Prim cyc A u/f	8.6	20.2	28.8	36.6	5.8
Prim cyc B u/f	9.0	22.9	30.5	31.8	5.8
Peb mill 1 disch	31.6	20.7	26.9	20.6	0.0
Peb mill 2 disch	23.2	29.2	28.2	19.4	0.0
Sec cyc feed	54.7	34.5	10.6	0.2	0.0
Sec cyc o/f	83.8	16.0	0.2	0.0	0.0
Sec cyc u/f	19.6	58.9	21.5	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	74	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 11c initial mass balance

Stream	Solids	Water	
Rod mill feed	59.5	3.1	t/hr
Rod mill dilution		19.6	t/hr
Rod mill discharge	59.5	22.7	t/hr
Primary dilution		172.3	t/hr
Prim cyclone feed	474.6	428.9	t/hr
Prim cyclone A o/f	42.8	121.6	t/hr
Prim cyclone B o/f	42.8	121.6	t/hr
Prim cyclone A u/f	194.5	92.8	t/hr
Prim cyclone B u/f	194.5	92.8	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	197.3	92.8	t/hr
Peb mill 2 product	197.3	92.8	t/hr
Secondary dilution		14.6	t/hr
Sec cyclone feed	85.5	257.9	t/hr
Sec cyclone o/f	64.6	209.6	t/hr
Sec cyclone u/f	20.9	48.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.6	4.9	7.1	44.5	27.9
Prim cyc feed	26.8	24.1	23.7	21.9	3.5
Prim cyc A o/f	53.4	33.0	13.5	0.1	0.0
Prim cyc B o/f	52.0	37.1	10.7	0.2	0.0
Prim cyc A u/f	10.3	20.6	27.7	37.1	4.3
Prim cyc B u/f	9.5	24.0	28.5	33.7	4.3
Peb mill 1 disch	30.4	23.3	24.8	21.5	0.0
Peb mill 2 disch	27.1	27.6	27.5	17.8	0.0
Sec cyc feed	52.7	35.0	12.1	0.2	0.0
Sec cyc o/f	75.6	24.1	0.3	0.0	0.0
Sec cyc u/f	22.2	53.6	24.2	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	76	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 11b initial mass balance

Stream	Solids	Water	
Rod mill feed	63.6	3.3	t/hr
Rod mill dilution		20.6	t/hr
Rod mill discharge	63.6	23.9	t/hr
Primary dilution		176.0	t/hr
Prim cyclone feed	480.6	435.6	t/hr
Prim cyclone A o/f	43.6	124.1	t/hr
Prim cyclone B o/f	43.6	124.1	t/hr
Prim cyclone A u/f	196.7	93.7	t/hr
Prim cyclone B u/f	196.7	93.7	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	199.5	93.7	t/hr
Peb mill 2 product	199.5	93.7	t/hr
Secondary dilution		8.6	t/hr
Sec cyclone feed	87.2	256.8	t/hr
Sec cyclone o/f	68.7	208.5	t/hr
Sec cyclone u/f	18.5	48.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.1	4.0	5.8	40.3	34.8
Prim cyc feed	24.2	28.8	23.0	19.6	4.6
Prim cyc A o/f	49.1	34.6	16.0	0.3	0.0
Prim cyc B o/f	54.7	35.9	9.3	0.1	0.0
Prim cyc A u/f	8.3	19.5	26.2	40.4	5.6
Prim cyc B u/f	7.9	20.4	28.6	37.5	5.6
Peb mill 1 disch	27.7	30.0	25.5	16.8	0.0
Peb mill 2 disch	23.4	32.5	26.5	17.6	0.0
Sec cyc feed	51.9	35.3	12.7	0.2	0.0
Sec cyc o/f	79.9	19.7	0.4	0.0	0.0
Sec cyc u/f	25.1	59.4	15.5	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	75	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 11a initial mass balance

Stream	Solids	Water	
Rod mill feed	74.7	3.9	t/hr
Rod mill dilution		25.3	t/hr
Rod mill discharge	74.7	29.2	t/hr
Primary dilution		180.7	t/hr
Prim cyclone feed	452.6	443.2	t/hr
Prim cyclone A o/f	47.9	136.3	t/hr
Prim cyclone B o/f	47.9	136.3	t/hr
Prim cyclone A u/f	178.4	85.2	t/hr
Prim cyclone B u/f	178.4	85.2	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	181.2	85.2	t/hr
Peb mill 2 product	181.2	85.2	t/hr
Secondary dilution		8.2	t/hr
Sec cyclone feed	95.8	280.9	t/hr
Sec cyclone o/f	79.8	218.1	t/hr
Sec cyclone u/f	16.0	62.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.4	4.2	6.3	36.9	37.2
Prim cyc feed	25.2	23.9	23.0	21.8	6.1
Prim cyc A o/f	50.6	43.0	6.3	0.1	0.0
Prim cyc B o/f	54.3	39.8	5.8	0.1	0.0
Prim cyc A u/f	10.8	23.1	27.0	31.3	7.8
Prim cyc B u/f	11.6	27.9	28.3	24.4	7.8
Peb mill 1 disch	31.0	24.6	26.0	18.4	0.0
Peb mill 2 disch	23.4	28.2	27.6	20.8	0.0
Sec cyc feed	52.5	41.4	6.1	0.1	0.0
Sec cyc o/f	78.5	21.0	0.5	0.0	0.0
Sec cyc u/f	26.0	59.6	14.4	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	73	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 8c initial mass balance

Stream	Solids	Water	
Rod mill feed	59.7	3.1	t/hr
Rod mill dilution		19.9	t/hr
Rod mill discharge	59.7	23.0	t/hr
Primary dilution		173.2	t/hr
Prim cyclone feed	444.7	446.2	t/hr
Prim cyclone A o/f	50.4	136.2	t/hr
Prim cyclone B o/f	50.4	136.2	t/hr
Prim cyclone A u/f	172.0	86.9	t/hr
Prim cyclone B u/f	172.0	86.9	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	177.5	86.9	t/hr
Peb mill 2 product	177.5	86.9	t/hr
Secondary dilution		11.4	t/hr
Sec cyclone feed	100.8	283.8	t/hr
Sec cyclone o/f	68.6	207.6	t/hr
Sec cyclone u/f	32.2	76.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.9	8.5	11.7	45.4	18.5
Prim cyc feed	22.8	28.9	27.8	18.5	2.5
Prim cyc A o/f	47.4	27.5	18.7	6.4	0.0
Prim cyc B o/f	55.7	37.6	6.5	0.2	0.0
Prim cyc A u/f	4.9	30.7	34.4	26.8	3.2
Prim cyc B u/f	4.9	30.7	34.4	26.8	3.2
Peb mill 1 disch	33.0	26.3	25.0	15.7	0.0
Peb mill 2 disch	16.6	33.7	34.4	15.3	0.0
Sec cyc feed	51.6	32.5	12.6	3.3	0.0
Sec cyc o/f	76.1	23.2	0.7	0.0	0.0
Sec cyc u/f	12.6	52.8	34.6	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	75	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 8b initial mass balance

Stream	Solids	Water	
Rod mill feed	55.4	2.9	t/hr
Rod mill dilution		18.5	t/hr
Rod mill discharge	55.4	21.4	t/hr
Primary dilution		171.5	t/hr
Prim cyclone feed	445.0	441.1	t/hr
Prim cyclone A o/f	49.2	133.0	t/hr
Prim cyclone B o/f	49.2	133.0	t/hr
Prim cyclone A u/f	173.4	87.6	t/hr
Prim cyclone B u/f	173.4	87.6	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	178.9	87.6	t/hr
Peb mill 2 product	178.9	87.6	t/hr
Secondary dilution		11.3	t/hr
Sec cyclone feed	98.3	277.2	t/hr
Sec cyclone o/f	64.3	204.2	t/hr
Sec cyclone u/f	34.0	73.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.5	15.4	12.0	54.3	5.8
Prim cyc feed	27.3	28.9	26.3	17.3	0.7
Prim cyc A o/f	43.7	28.9	20.2	7.2	0.0
Prim cyc B o/f	55.3	35.0	9.4	0.3	0.0
Prim cyc A u/f	13.8	24.1	24.9	36.3	0.9
Prim cyc B u/f	3.5	33.7	36.2	25.7	0.9
Peb mill 1 disch	31.6	30.9	23.9	13.6	0.0
Peb mill 2 disch	28.9	27.5	31.0	12.6	0.0
Sec cyc feed	49.5	31.9	14.8	3.8	0.0
Sec cyc o/f	76.8	22.7	0.5	0.0	0.0
Sec cyc u/f	19.0	45.6	35.4	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 8a initial mass balance

Stream	Solids	Water	
Rod mill feed	52.9	2.8	t/hr
Rod mill dilution		17.6	t/hr
Rod mill discharge	52.9	20.4	t/hr
Primary dilution		172.9	t/hr
Prim cyclone feed	452.6	443.2	t/hr
Prim cyclone A o/f	48.8	132.1	t/hr
Prim cyclone B o/f	48.8	132.1	t/hr
Prim cyclone A u/f	177.5	89.5	t/hr
Prim cyclone B u/f	177.5	89.5	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	183.0	89.5	t/hr
Peb mill 2 product	183.0	89.5	t/hr
Secondary dilution		10.8	t/hr
Sec cyclone feed	97.7	274.9	t/hr
Sec cyclone o/f	61.8	204.1	t/hr
Sec cyclone u/f	35.9	70.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.9	7.0	9.6	47.5	17.0
Prim cyc feed	31.1	26.1	23.5	17.8	2.0
Prim cyc A o/f	45.3	30.9	17.7	6.1	0.0
Prim cyc B o/f	61.2	31.9	6.9	0.0	0.0
Prim cyc A u/f	12.1	24.7	26.3	34.4	2.5
Prim cyc B u/f	20.8	28.3	27.9	20.5	2.5
Peb mill 1 disch	36.5	26.8	22.7	14.0	0.0
Peb mill 2 disch	31.3	27.0	25.5	16.2	0.0
Sec cyc feed	53.3	31.4	12.3	3.0	0.0
Sec cyc o/f	75.4	22.4	2.2	0.0	0.0
Sec cyc u/f	19.2	44.1	36.7	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	77	63	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 7c initial mass balance

Stream	Solids	Water	
Rod mill feed	50.3	2.6	t/hr
Rod mill dilution		16.4	t/hr
Rod mill discharge	50.3	19.0	t/hr
Primary dilution		156.8	t/hr
Prim cyclone feed	427.2	433.8	t/hr
Prim cyclone A o/f	49.5	133.8	t/hr
Prim cyclone B o/f	49.5	133.8	t/hr
Prim cyclone A u/f	164.1	83.1	t/hr
Prim cyclone B u/f	164.1	83.1	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	169.6	83.1	t/hr
Peb mill 2 product	169.6	83.1	t/hr
Secondary dilution		25.1	t/hr
Sec cyclone feed	99.0	292.7	t/hr
Sec cyclone o/f	59.2	200.9	t/hr
Sec cyclone u/f	39.8	91.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	22.3	6.0	8.7	51.0	12.0
Prim cyc feed	28.5	27.0	27.3	16.2	1.4
Prim cyc A o/f	48.0	28.1	17.8	6.1	0.0
Prim cyc B o/f	56.7	36.1	6.9	0.3	0.0
Prim cyc A u/f	13.3	28.3	23.9	32.7	1.8
Prim cyc B u/f	11.7	26.6	35.5	24.4	1.8
Peb mill 1 disch	27.2	26.0	32.1	14.7	0.0
Peb mill 2 disch	33.6	29.0	26.3	11.1	0.0
Sec cyc feed	52.4	32.1	12.3	3.2	0.0
Sec cyc o/f	74.5	25.0	0.5	0.0	0.0
Sec cyc u/f	19.1	48.1	32.8	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	77	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 7b initial mass balance

Stream	Solids	Water	
Rod mill feed	54.6	2.9	t/hr
Rod mill dilution		18.3	t/hr
Rod mill discharge	54.6	21.2	t/hr
Primary dilution		158.1	t/hr
Prim cyclone feed	421.0	434.1	t/hr
Prim cyclone A o/f	50.3	136.0	t/hr
Prim cyclone B o/f	50.3	136.0	t/hr
Prim cyclone A u/f	160.2	81.0	t/hr
Prim cyclone B u/f	160.2	81.0	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	165.7	81.0	t/hr
Peb mill 2 product	165.7	81.0	t/hr
Secondary dilution		27.2	t/hr
Sec cyclone feed	100.6	299.3	t/hr
Sec cyclone o/f	63.5	206.5	t/hr
Sec cyclone u/f	37.1	92.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.5	6.5	7.9	52.2	14.9
Prim cyc feed	30.7	28.9	25.1	13.8	1.9
Prim cyc A o/f	41.5	34.2	18.6	5.7	0.0
Prim cyc B o/f	58.7	35.7	5.6	0.0	0.0
Prim cyc A u/f	9.1	31.1	29.8	27.4	2.6
Prim cyc B u/f	13.0	27.5	34.5	22.4	2.6
Peb mill 1 disch	34.5	28.9	24.8	11.8	0.0
Peb mill 2 disch	33.5	32.3	28.1	6.1	0.0
Sec cyc feed	50.1	35.0	12.1	2.8	0.0
Sec cyc o/f	79.0	20.3	0.7	0.0	0.0
Sec cyc u/f	17.3	45.5	37.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 7b initial mass balance

Stream	Solids	Water	
Rod mill feed	54.6	2.9	t/hr
Rod mill dilution		18.3	t/hr
Rod mill discharge	54.6	21.2	t/hr
Primary dilution		158.1	t/hr
Prim cyclone feed	421.0	434.1	t/hr
Prim cyclone A o/f	50.3	136.0	t/hr
Prim cyclone B o/f	50.3	136.0	t/hr
Prim cyclone A u/f	160.2	81.0	t/hr
Prim cyclone B u/f	160.2	81.0	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	165.7	81.0	t/hr
Peb mill 2 product	165.7	81.0	t/hr
Secondary dilution		27.2	t/hr
Sec cyclone feed	100.6	299.3	t/hr
Sec cyclone o/f	63.5	206.5	t/hr
Sec cyclone u/f	37.1	92.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.5	6.5	7.9	52.2	14.9
Prim cyc feed	30.7	28.9	25.1	13.8	1.9
Prim cyc A o/f	41.5	34.2	18.6	5.7	0.0
Prim cyc B o/f	58.7	35.7	5.6	0.0	0.0
Prim cyc A u/f	9.1	31.1	29.8	27.4	2.6
Prim cyc B u/f	13.0	27.5	34.5	22.4	2.6
Peb mill 1 disch	34.5	28.9	24.8	11.8	0.0
Peb mill 2 disch	33.5	32.3	28.1	6.1	0.0
Sec cyc feed	50.1	35.0	12.1	2.8	0.0
Sec cyc o/f	79.0	20.3	0.7	0.0	0.0
Sec cyc u/f	17.3	45.5	37.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 7a initial mass balance

Stream	Solids	Water	
Rod mill feed	51.9	2.7	t/hr
Rod mill dilution		17.3	t/hr
Rod mill discharge	51.9	20.0	t/hr
Primary dilution		154.9	t/hr
Prim cyclone feed	427.4	432.7	t/hr
Prim cyclone A o/f	49.3	133.2	t/hr
Prim cyclone B o/f	49.3	133.2	t/hr
Prim cyclone A u/f	164.4	83.2	t/hr
Prim cyclone B u/f	164.4	83.2	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	169.9	83.2	t/hr
Peb mill 2 product	169.9	83.2	t/hr
Secondary dilution		36.6	t/hr
Sec cyclone feed	98.5	303.0	t/hr
Sec cyclone o/f	60.8	211.5	t/hr
Sec cyclone u/f	37.7	91.5	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	22.1	6.4	8.6	51.4	11.5
Prim cyc feed	30.6	26.6	24.9	17.0	1.4
Prim cyc A o/f	44.3	31.5	18.5	5.7	0.0
Prim cyc B o/f	59.4	33.8	6.8	0.0	0.0
Prim cyc A u/f	8.6	29.2	30.3	30.1	1.8
Prim cyc B u/f	8.6	29.2	30.3	30.1	1.8
Peb mill 1 disch	33.4	28.1	25.6	12.9	0.0
Peb mill 2 disch	32.5	26.3	27.1	14.1	0.0
Sec cyc feed	51.9	32.7	12.7	2.8	0.0
Sec cyc o/f	72.9	26.7	0.4	0.0	0.0
Sec cyc u/f	19.5	47.1	33.4	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	78	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 6c initial mass balance

Stream	Solids	Water	
Rod mill feed	56.4	3.0	t/hr
Rod mill dilution		18.8	t/hr
Rod mill discharge	56.4	21.8	t/hr
Primary dilution		174.1	t/hr
Prim cyclone feed	446.2	443.6	t/hr
Prim cyclone A o/f	49.7	134.3	t/hr
Prim cyclone B o/f	49.7	134.3	t/hr
Prim cyclone A u/f	173.5	87.6	t/hr
Prim cyclone B u/f	173.5	87.6	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	179.0	87.6	t/hr
Peb mill 2 product	179.0	87.6	t/hr
Secondary dilution		52.2	t/hr
Sec cyclone feed	99.3	320.7	t/hr
Sec cyclone o/f	65.3	248.1	t/hr
Sec cyclone u/f	34.0	72.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.3	8.8	10.1	44.6	18.2
Prim cyc feed	29.8	29.8	24.0	14.6	2.3
Prim cyc A o/f	55.0	32.1	12.4	0.5	0.0
Prim cyc B o/f	57.1	33.9	8.9	0.1	0.0
Prim cyc A u/f	9.4	28.4	32.1	27.1	3.0
Prim cyc B u/f	14.2	28.3	31.5	23.0	3.0
Peb mill 1 disch	37.1	31.1	22.0	9.8	0.0
Peb mill 2 disch	28.4	30.7	28.4	12.5	0.0
Sec cyc feed	56.0	33.0	10.6	0.3	0.0
Sec cyc o/f	77.9	21.7	0.4	0.0	0.0
Sec cyc u/f	16.2	50.7	33.1	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	79	83	%
Peb mill moist	33	33	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

```
      {Calculate some check values}
      pcfc:=sto[pcf,sol]/solog+sto[pcf,wat];
      scfc:=sto[scf,sol]/solsg+sto[scf,wat];
      pcdc:=(sto[pcf,sol]+sto[pcf,wat])/pcfc;
      scdc:=(sto[scf,sol]+sto[scf,wat])/scfc;
      pmc:=(sto[pcoa,wat]+sto[pcob,wat])/

(sto[pcoa,wat]+sto[pcoa,sol]+sto[pcob,wat]+sto[pcob,sol])*100;
      smc:=sto[sco,wat]/(sto[sco,wat]+sto[sco,sol])*100;
      pmmc:=(sto[pdis1,wat]+sto[pdis2,wat])/

(sto[pdis1,wat]+sto[pdis1,sol]+sto[pdis2,wat]+sto[pdis2,sol])*100;

      {Write report file}
      if testnum='1a' then rewrite(fitrep) else append(fitrep);
      writeln(fitrep,'Test ',testnum,' smoothed mass balance');
      writeln(fitrep,'==========================');
      writeln(fitrep);
      writeln(fitrep,'Stream              Solids   Water   Adj');

writeln(fitrep,'=================================================');
      writeln(fitrep,'Rod mill feed      ',sto[rmf,sol]:6:1,'
',sto[rmf,wat]:6:1,solmod[rmf]:6:1,' t/hr');
      writeln(fitrep,'Rod mill dilution
',sto[rdil,wat]:6:1,'       t/hr');
      writeln(fitrep,'Rod mill discharge',sto[rmd,sol]:6:1,'
',sto[rmd,wat]:6:1,solmod[rmd]:6:1,' t/hr');
      writeln(fitrep,'Primary  dilution
',sto[pdil,wat]:6:1,'       t/hr');
      writeln(fitrep,'Prim cyclone feed ',sto[pcf,sol]:6:1,'
',sto[pcf,wat]:6:1,solmod[pcf]:6:1,' t/hr');
      writeln(fitrep,'Prim cyclone A o/f',sto[pcoa,sol]:6:1,'
',sto[pcoa,wat]:6:1,solmod[pcoa]:6:1,' t/hr');
      writeln(fitrep,'Prim cyclone B o/f',sto[pcob,sol]:6:1,'
',sto[pcob,wat]:6:1,solmod[pcob]:6:1,' t/hr');
      writeln(fitrep,'Prim cyclone A u/f',sto[pcua,sol]:6:1,'
',sto[pcua,wat]:6:1,solmod[pcua]:6:1,' t/hr');
      writeln(fitrep,'Prim cyclone B u/f',sto[pcub,sol]:6:1,'
',sto[pcub,wat]:6:1,solmod[pcua]:6:1,' t/hr');
      writeln(fitrep,'Pebble addition 1 ',sto[peb1,sol]:6:1,'
  ',solmod[pub1]:6:1,' t/hr');
      writeln(fitrep,'Pebble addition 2 ',sto[peb2,sol]:6:1,'
  ',solmod[peb1]:6:1,' t/hr');
      writeln(fitrep,'Peb mill 1 product',sto[pdis1,sol]:6:1,'
',sto[pdis1,wat]:6:1,solmod[pdis1]:6:1,' t/hr');
      writeln(fitrep,'Peb mill 2 product',sto[pdis2,sol]:6:1,'
',sto[pdis2,wat]:6:1,solmod[pdis2]:6:1,' t/hr');
      writeln(fitrep,'Secondary dilution
',sto[sdil,wat]:6:1,'       t/hr');
      writeln(fitrep,'Sec cyclone feed  ',sto[scf,sol]:6:1,'
',sto[scf,wat]:6:1,solmod[scf]:6:1,' t/hr');
      writeln(fitrep,'Sec cyclone o/f   ',sto[sco,sol]:6:1,'
',sto[sco,wat]:6:1,solmod[sco]:6:1,' t/hr');
      writeln(fitrep,'Sec cyclone u/f   ',sto[scu,sol]:6:1,'
',sto[scu,wat]:6:1,solmod[scu]:6:1,' t/hr');
      writeln(fitrep);
      writeln(fitrep,'Size analysis');
      writeln(fitrep,'=============');
      writeln(fitrep,'Stream                    -75  -150+75
```

```
        sto[scf,sol]:=solution^[3+1];
        sto[scu,sol]:=solution^[8+1];
        sto[sco,sol]:=solution^[4+1];
        for i:= 1 to sizes do begin
            sto[rmd,i+2]:=solution^[(i-1)*streams+1];
            sto[pcf,i+2]:=solution^[(i-1)*streams+2];
            sto[pcoa,i+2]:=solution^[(i-1)*streams+3];
            sto[pcob,i+2]:=solution^[(i-1)*streams+3];
            sto[pcua,i+2]:=solution^[(i-1)*streams+5];
            sto[pcub,i+2]:=solution^[(i-1)*streams+5];
            sto[peb1,i+2]:=solution^[(i-1)*streams+9];
            sto[peb2,i+2]:=solution^[(i-1)*streams+9];
            sto[pdis1,i+2]:=solution^[(i-1)*streams+7];
            sto[pdis2,i+2]:=solution^[(i-1)*streams+7];
            if (st[pdis1,i+2]+st[pdis1,i+2])<>0 then begin

sto[pdis1,i+2]:=sto[pdis1,i+2]*st[pdis1,i+2]/(st[pdis1,i+2]+st[pdi
s2,i+2]);

sto[pdis2,i+2]:=sto[pdis2,i+2]*st[pdis2,i+2]/(st[pdis1,i+2]+st[pdi
s2,i+2]);
            end;
            sto[scf,i+2]:=solution^[(i-1)*streams+3];
            sto[scu,i+2]:=solution^[(i-1)*streams+8];
            sto[sco,i+2]:=solution^[(i-1)*streams+4];
        end;{for i}
        {Check negative flows}
        for i:= 1 to 17 do begin
            fault:=0;
            for j:= 3 to 7 do if sto[i,j]<0 then begin
                fault:=sto[i,j]+fault;
                sto[i,j]:=0;
            end;
            sto[i,7]:=sto[i,7]-fault;
        end; {for i}

        {Do a water balance}
        for i:=1 to 17 do sto[i,wat]:=st[i,wat];

        {Write results to file fitxx.dat}
        rewrite(fitdat);
        for i:=1 to 17 do begin

writeln(fitdat,sto[i,sol]:7:1,sto[i,wat]:7:1,sto[i,p1700]:7:1,

sto[i,w1700]:7:1,sto[i,s250]:7:1,sto[i,s150]:7:1,sto[i,s75]:7:1);
        end; {for i}
        for i:= 1 to 10 do write(fitdat,parm[i]:6:1);
        close(fitdat);

        {Calculate extent of variation}
        for i:= 1 to 17 do begin
            sizmod[i]:=0;
            for j:= 3 to 7 do
sizmod[i]:=sizmod[i]+abs(st[i,j]-sto[i,j]);
            sizmod[i]:=sizmod[i]/5;
            solmod[i]:=abs(st[i,sol]-sto[i,sol]);
        end; {for i}
```

```
        for i:= 1 to sizes do begin
            l:=1;
            m:=0;
            for j:= 1 to units do begin
                if mill[l]<>j then begin
                   for k:= 1 to streams do begin
                      col:=sizes*streams+streams+j+m+n;

coefficients^[row+k,col]:=unmat[j,k]*sizmat[i,k];

coefficients^[col,row+k]:=coefficients^[row+k,col];
                   end;{for k}
                   m:=0;
                end else begin
                    m:=-1;
                    l:=l+1;
                end;{if}
            end;{for j}
            n:=n+units-mills;
        end;{for i}
        n:=0;
        for i:= 1 to sizes do begin
            for j:= 1 to streams do begin
                col:=sizes*(streams+units-mills)+streams+j;
                row:=j+n;
                coefficients^[row,col]:=1;
                coefficients^[col,row]:=1;
                constants^[col]:=100;
            end;{for j}
            n:=n+streams;
        end;{for i}
        for i:= 1 to units do begin
            row:=streams*sizes;
            col:=sizes*(streams+units-mills)+2*streams+i;
            for j:= 1 to streams do begin
                coefficients^[row+j,col]:=unmat[i,j];
                coefficients^[col,row+j]:=coefficients^[row+j,col];
            end;{for j}
        end;{for i}

        {Solve the matrix}
        dimen:=sizes*(streams+units-mills)+2*streams+units;
        writeln('Smoothing data for test ',testnum);
        sparse(dimen,coefficients^,constants^,solution^,flag1);
        {Save results into matrix st}
        l:=sizes*streams;
        sto[rmf,sol]:=solution^[1+l];
        sto[rmd,sol]:=solution^[1+l];
        sto[paf,sol]:=solution^[2+l];
        sto[paca,sol]:=solution^[3+l]/2;
        sto[pacb,sol]:=solution^[3+l]/2;
        sto[pcua,sol]:=solution^[5+l]/2;
        sto[pcub,sol]:=solution^[5+l]/2;

sto[pab1,sol]:=solution^[9+l]*st[pab1,sol]/(st[pab1,sol]+st[pab2,s
ol]);
        sto[pab2,sol]:=solution^[9+l]-sto[pab1,sol];
        sto[pdis1,sol]:=sto[pcua,sol]+sto[pab1,sol];
        sto[pdis2,sol]:=sto[pcub,sol]+sto[pab2,sol];
```

```
                sizvar[i,1]:=vari[rmd,i+2]*st[rmd,i+2]/100;
                sizvar[i,2]:=vari[pcf,i+2]*st[pcf,i+2]/100;
                sizvar[i,3]:=vari[scf,i+2]*st[scf,i+2]/100;
                sizvar[i,4]:=vari[sco,i+2]*st[sco,i+2]/100;
                sizvar[i,5]:=vari[pcua,i+2]*st[pcua,i+2]/100;
                sizvar[i,6]:=vari[pdis1,i+2]*st[pdis1,i+2]/100;
                sizvar[i,7]:=vari[pdis1,i+2]*st[pdis1,i+2]/100;
                sizvar[i,8]:=vari[scu,i+2]*st[scu,i+2]/100;
                sizvar[i,9]:=vari[peb1,i+2]*st[peb1,i+2]/100;
                {check for zero's}
                for j:= 1 to 9 do if sizvar[i,j]=0 then
sizvar[i,j]:=0.01;
            end; {for i}

            {Size variances}
            row:=0;
            for i:= 1 to sizes do begin
              for j:= 1 to streams do begin
                  row:=row+1;
                  coefficients^[row,row]:=1/(sizvar[i,j]);
                  constants^[row]:=sizmat[i,j]/(sizvar[i,j]);
              end;{for j}
            end;{for i}
          for i:= 1 to streams do begin
              row:=row+1;
              coefficients^[row,row]:=1/(flowvar[i]);
              constants^[row]:=flowrate[i]/(flowvar[i]);
          end;{for i}


          row:=0;
          n:=0;
          for i:= 1 to sizes do begin
              l:=1;
              m:=0;
              for j:= 1 to units do begin
                  if j = mill[l] then begin
                     m:=-1;
                     l:=l+1;
                  end else begin
                      for k:= 1 to streams do begin
                          row:=row+1;
                          col:=sizes*streams+streams+j+m+n;

coefficients^[row,col]:=unmat[j,k]*flowrate[k];

coefficients^[col,row]:=coefficients^[row,col];
                          constants^[col]:=constants^[col]
                          +coefficients^[row,col]*sizmat[i,k];
                      end;{for k}
                      row:=row-streams;
                      m:=0;
                  end;{if}
              end;{for j}
              row:=streams*i;
              n:=n+units-mills;
          end;{for i}
          ro  :=streams*sizes;
          n:= ;
```

```
        {read data from disk}
        for I:=1 to 17 do

readln(baldat,st[i,sol],st[i,wat],st[i,p1700],st[i,s1700],
                    st[i,s250],st[i,s150],st[i,s75]);
        for I:= 1 to 10 do read(baldat,parm[i]);
        close(baldat);

        {correct addition errors in sizes}
        for I:=1 to 17 do st[i,s75]:=100-st[i,s150]-st[i,s250]-
                                    st[i,s1700]-st[i,p1700];

        {Set up flowrate array}
        flowrate[1]:=st[rmd,sol];
        flowrate[2]:=st[pcf,sol];
        flowrate[3]:=st[scf,sol];
        flowrate[4]:=st[sco,sol];
        flowrate[5]:=st[pcua,sol]+st[pcub,sol];
        flowrate[6]:=st[pcua,sol]+st[pcub,sol];
        flowrate[7]:=st[pdis1,sol]+st[pdis2,sol];
        flowrate[8]:=st[scu,sol];
        flowrate[9]:=st[peb1,sol]+st[peb2,sol];

        {Set up size matrix}
        for i:=1 to sizes do begin
            sizmat[i,1]:=st[rmd,i+2];
            sizmat[i,2]:=st[pcf,i+2];
            sizmat[i,3]:=st[scf,i+2];
            sizmat[i,4]:=st[sco,i+2];
            sizmat[i,5]:=(st[pcua,i+2]+st[pcub,i+2])/2;
            sizmat[i,6]:=((st[pdis1,i+2]*st[pdis1,sol]+

st[pdis2,i+2]*st[pdis2,sol])/flowrate[7]-
                          (st[peb1,i+2]*st[peb1,sol]+
                           st[peb2,i+2]*st[peb2,sol])/flowrate[9])
                           /flowrate[6];
            sizmat[i,7]:=(st[pdis1,i+2]*st[pdis1,sol]+
                          st[pdis2,i+2]*st[pdis2,sol])/
                         (st[pdis1,sol]+st[pdis2,sol]);
            sizmat[i,9]:=(st[peb1,i+2]*st[peb1,sol]+
                          st[peb2,i+2]*st[peb2,sol])/
                         (st[peb1,sol]+st[peb2,sol]);
            sizmat[i,8]:=st[scu,i+2];
        end; {for i}

        {Set up flowrate variances}
        flowvar[1]:=vari[rmd,sol]*st[rmd,sol]/100;
        flowvar[2]:=vari[pcf,sol]*st[pcf,sol]/100;
        flowvar[3]:=vari[scf,sol]*st[scf,sol]/100;
        flowvar[4]:=vari[sco,sol]*st[sco,sol]/100;
        flowvar[5]:=vari[pcua,sol]*st[pcua,sol]/100;
        flowvar[6]:=vari[pdis1,sol]*st[pdis1,sol]/100;
        flowvar[7]:=vari[pdis1,sol]*st[pdis1,sol]/100;
        flowvar[8]:=vari[scu,sol]*st[scu,sol]/100;
        flowvar[9]:=vari[peb1,sol]*st[peb1,sol]/100;


        {Set up size variances}
        for i:=1 to sizes do begin
```

```
begin {main}

{Initialise}
new(coefficients);new(constants);new(solution);
clrscr;

{set up files}
assign(vardat,'C:\MSC\DATA\FITVAR.DAT');
assign(fitrep,'C:\MSC\DATA\FIT.REP');

{Read in variances}
{$I-}reset(vardat);{$I+}
if ioresult=2 then begin
   writeln('Variance file not found');
   halt(0);
end; {if}
for I:= 1 to 17 do readln(vardat,vari[i,sol],vari[i,wat],
                  vari[i,p1700],vari[i,s1700],vari[i,s250],
                  vari[i,s150],vari[i,s75]);
close(vardat);

{Set up unit matrix}
for I:= 1 to units do begin
    for j:= 1 to streams do unmat[i,j]:=0;
end;{for I}
unmat[1,1]:=1;unmat[1,2]:=-1;unmat[1,7]:=1;unmat[1,8]:=1;
unmat[2,2]:=1;unmat[2,3]:=-1;unmat[2,5]:=-1;
unmat[3,3]:=1;unmat[3,4]:=-1;unmat[3,8]:=-1;
unmat[4,5]:=1;unmat[4,6]:=-1;
unmat[5,6]:=1;unmat[5,7]:=-1;unmat[5,9]:=1;
mill[1]:=4;
millinstr[1]:=5;
milloutstr[1]:=6;

{Start loop and define testnum and input/output files}
       {(only half the test!)
for test:= 1 to 11 do begin
    for subtest:= 1 to 3 do begin
        if test<9 then str(test:1,testnum) else
str(test+2:2,testnum);
        if subtest=1 then testnum:=testnum+'a';
        if subtest=2 then testnum:=testnum+'b';
        if subtest=3 then testnum:=testnum+'c';

        {Setup}
        dimen:=0;
        fillchar(coefficients^, sizeof(coefficients^),0);
        fillchar(constants^, sizeof(constants^),0);

        {assign files}
        assign(baldat,'C:\MSC\DATA\BAL'+testnum+'.DAT');
        assign(fitdat,'C:\MSC\DATA\FIT'+testnum+'.DAT');

        {open files}
        {$I-}reset(baldat);{$I+}
        if ioresult=2 then begin
           writeln('Data file BAL'+testnum+'.DAT not found');
           halt(0);
        end; {if}
```

APPENDIX E Turbo Pascal program listing

```
program smoothsol;

{Reads initial data in BALxx.DAT and variance data VAR.DAT to do
material balance smoothing}
{Writes out to fitxx.DAT and FIT.REP}

uses solvmat,wincrt;
label label1;
const rdil = 1;      {to define stream numbers in matrix st}
      pdil = 2;
      sdil = 3;
      rmf  = 4;
      rmd  = 5;
      pcf  = 6;
      pcoa = 7;
      pcob = 8;
      pcua = 9;
      pcub = 10;
      pdis1= 11;
      pdis2= 12;
      scf  = 13;
      scu  = 14;
      sco  = 15;
      peb1 = 16;
      peb2 = 17;
      sol    = 1;    {Stream elements in matrix st}
      wat    = 2;    {Tons per hour}
      p1700  = 3;    {+1700 fraction}
      s1700  = 4;    {-1700+250 fraction}
      s250   = 5;    {-250+150}
      s150   = 6;    {-150+75}
      s75    = 7;    {-75}
      solsg  = 2.65;
      units  = 5;
      streams= 9;
      sizes  = 5;
      mills    = 1;

var vardat,fitrep,baldat,fitdat : text;
    testnum                     : string[3];
    st,sto,vari                 : array [1..17,1..7] of real;
    parm                        : array [1..10] of real;
    sizmod,solmod               : array [1..17] of real;
    test,subtest                : integer;
    unmat,sizmat,sizvar         : array [1..units,1..streams] of
real;
    flowrate,flowvar            : ar ay [1..streams] of real;
    mill,millinstr,milloutstr   : array [1..units] of integer;
    dimen,i,j,k,l,m,n,row,col,
    iter,flag1                  : integer;
    negflag                     : boolean;
    pcfo,scfc,pcdc,scdc,pmc,
    smc,pmmc,fault              : real;
    coefficients                : ^matrix;
    constants,solution          : ^vector;
```

Test 13c initial mass balance

Stream	Solids	Water	
Rod mill feed	62.3	3.3	t/hr
Rod mill dilution		20.6	t/hr
Rod mill discharge	62.3	23.9	t/hr
Primary dilution		202.9	t/hr
Prim cyclone feed	437.8	455.8	t/hr
Prim cyclone A o/f	52.1	148.3	t/hr
Prim cyclone B o/f	52.1	148.3	t/hr
Prim cyclone A u/f	166.8	79.6	t/hr
Prim cyclone B u/f	166.8	79.6	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	169.6	79.6	t/hr
Peb mill 2 product	169.6	79.6	t/hr
Secondary dilution		7.9	t/hr
Sec cyclone feed	104.2	304.4	t/hr
Sec cyclone o/f	67.4	234.7	t/hr
Sec cyclone u/f	36.8	69.7	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	14.7	4.6	6.4	44.7	29.6
Prim cyc feed	24.2	30.4	22.3	19.0	4.2
Prim cyc A o/f	56.0	36.6	7.0	0.4	0.0
Prim cyc B o/f	55.0	39.1	5.7	0.2	0.0
Prim cyc A u/f	9.6	25.6	27.5	31.8	5.5
Prim cyc B u/f	10.1	28.8	29.7	25.9	5.5
Peb mill 1 disch	24.9	31.7	26.2	17.2	0.0
Peb mill 2 disch	27.7	29.5	27.4	15.4	0.0
Sec cyc feed	55.5	37.8	6.3	0.3	0.0
Sec cyc o/f	80.0	19.9	0.1	0.0	0.0
Sec cyc u/f	20.4	72.3	7.3	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	78	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 13b initial mass balance

Stream	Solids	Water	
Rod mill feed	59.7	3.1	t/hr
Rod mill dilution		20.1	t/hr
Rod mill discharge	59.7	23.2	t/hr
Primary dilution		197.6	t/hr
Prim cyclone feed	434.7	453.9	t/hr
Prim cyclone A o/f	52.0	147.9	t/hr
Prim cyclone B o/f	52.0	147.9	t/hr
Prim cyclone A u/f	165.4	79.1	t/hr
Prim cyclone B u/f	165.4	79.1	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	168.2	79.1	t/hr
Peb mill 2 product	168.2	79.1	t/hr
Secondary dilution		7.9	t/hr
Sec cyclone feed	103.9	303.7	t/hr
Sec cyclone o/f	64.8	228.7	t/hr
Sec cyclone u/f	39.1	75.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.5	7.3	9.6	51.2	19.4
Prim cyc feed	23.8	31.0	25.0	17.6	2.7
Prim cyc A o/f	59.4	34.0	6.4	0.2	0.0
Prim cyc B o/f	56.9	38.6	4.3	0.2	0.0
Prim cyc A u/f	8.7	28.6	32.9	26.3	3.5
Prim cyc B u/f	10.1	29.4	34.1	22.9	3.5
Peb mill 1 disch	23.7	32.5	28.9	14.9	0.0
Peb mill 2 disch	28.1	29.7	29.8	12.4	0.0
Sec cyc feed	58.2	36.3	5.4	0.2	0.0
Sec cyc o/f	72.1	27.7	0.2	0.0	0.0
Sec cyc u/f	23.1	65.9	11.0	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	78	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 13a initial mass balance

Stream	Solids	Water	
Rod mill feed	46.8	2.5	t/hr
Rod mill dilution		15.8	t/hr
Rod mill discharge	46.8	18.3	t/hr
Primary dilution		190.9	t/hr
Prim cyclone feed	447.0	444.3	t/hr
Prim cyclone A o/f	48.7	138.7	t/hr
Prim cyclone B o/f	48.7	138.7	t/hr
Prim cyclone A u/f	174.8	83.5	t/hr
Prim cyclone B u/f	174.8	83.5	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	177.6	83.5	t/hr
Peb mill 2 product	177.6	83.5	t/hr
Secondary dilution		7.8	t/hr
Sec cyclone feed	97.4	285.1	t/hr
Sec cyclone o/f	51.9	217.0	t/hr
Sec cyclone u/f	45.5	68.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	19.5	7.4	9.9	51.6	11.6
Prim cyc feed	23.6	31.3	26.7	17.3	1.2
Prim cyc A o/f	57.2	36.4	6.1	0.3	0.0
Prim cyc B o/f	60.5	34.0	5.4	0.1	0.0
Prim cyc A u/f	8.7	27.9	34.0	27.8	1.6
Prim cyc B u/f	10.9	28.3	35.4	23.8	1.6
Peb mill 1 disch	25.1	29.5	30.2	15.2	0.0
Peb mill 2 disch	22.8	31.7	30.8	14.7	0.0
Sec cyc feed	58.9	35.2	5.8	0.2	0.0
Sec cyc o/f	85.2	14.7	0.1	0.0	0.0
Sec cyc u/f	24.8	61.1	14.1	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	81	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 12c initial mass balance

Stream	Solids	Water	
Rod mill feed	64.5	3.4	t/hr
Rod mill dilution		21.2	t/hr
Rod mill discharge	64.5	24.6	t/hr
Primary dilution		189.2	t/hr
Prim cyclone feed	514.8	436.7	t/hr
Prim cyclone A o/f	40.5	115.1	t/hr
Prim cyclone B o/f	40.5	115.1	t/hr
Prim cyclone A u/f	217.0	103.3	t/hr
Prim cyclone B u/f	217.0	103.3	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	219.8	103.3	t/hr
Peb mill 2 product	219.8	103.3	t/hr
Secondary dilution		8.2	t/hr
Sec cyclone feed	80.9	238.4	t/hr
Sec cyclone o/f	69.6	222.0	t/hr
Sec cyclone u/f	11.3	16.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.1	5.1	6.8	43.2	29.8
Prim cyc feed	24.0	23.3	24.8	24.3	3.7
Prim cyc A o/f	58.1	33.4	8.4	0.1	0.0
Prim cyc B o/f	54.4	36.5	9.0	0.1	0.0
Prim cyc A u/f	7.2	20.7	28.1	39.6	4.4
Prim cyc B u/f	9.0	20.1	30.3	36.2	4.4
Peb mill 1 disch	27.4	22.0	24.9	23.7	0.0
Peb mill 2 disch	23.2	28.2	28.0	20.6	0.0
Sec cyc feed	56.3	35.0	8.7	0.1	0.0
Sec cyc o/f	81.1	18.5	0.4	0.0	0.0
Sec cyc u/f	23.0	55.4	21.6	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	76	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 12b initial mass balance

Stream	Solids	Water	
Rod mill feed	65.7	3.5	t/hr
Rod mill dilution		21.6	t/hr
Rod mill discharge	65.7	25.1	t/hr
Primary dilution		185.6	t/hr
Prim cyclone feed	504.9	439.5	t/hr
Prim cyclone A o/f	42.0	119.5	t/hr
Prim cyclone B o/f	42.0	119.5	t/hr
Prim cyclone A u/f	210.4	100.2	t/hr
Prim cyclone B u/f	210.4	100.2	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	213.2	100.2	t/hr
Peb mill 2 product	213.2	100.2	t/hr
Secondary dilution		8.1	t/hr
Sec cyclone feed	84.0	247.2	t/hr
Sec cyclone o/f	70.8	218.8	t/hr
Sec cyclone u/f	13.2	28.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	16.0	4.2	6.4	41.3	32.1
Prim cyc feed	23.4	23.7	24.5	24.3	4.2
Prim cyc A o/f	52.2	35.8	11.9	0.1	0.0
Prim cyc B o/f	53.3	38.0	8.6	0.1	0.0
Prim cyc A u/f	9.5	21.0	28.4	36.1	5.0
Prim cyc B u/f	7.3	23.6	31.1	33.0	5.0
Peb mill 1 disch	24.7	24.4	26.2	24.7	0.0
Peb mill 2 disch	24.4	26.8	28.8	20.0	0.0
Sec cyc feed	52.8	36.9	10.3	0.1	0.0
Sec cyc o/f	83.8	15.9	0.3	0.0	0.0
Sec cyc u/f	21.3	60.3	18.4	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	76	85	%
Peb mill moist	32	32	%

Note : The secondary cyclone feed solids and water flow rates was estimated and adjusted to yield reasonable water contents in the primary overflow and pebble mill discharges

Test 3a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	65.8	3.7	4.7	t/hr
Rod mill dilution		23.4		t/hr
Rod mill discharge	65.8	27.1	4.7	t/hr
Primary dilution		198.9		t/hr
Prim cyclone feed	413.5	397.5	1.2	t/hr
Prim cyclone A o/f	48.7	132.8	0.4	t/hr
Prim cyclone B o/f	48.7	132.8	0.4	t/hr
Prim cyclone A u/f	158.1	66.0	0.1	t/hr
Prim cyclone B u/f	158.1	66.0	0.1	t/hr
Pebble addition 1	3.1		0.2	t/hr
Pebble addition 2	3.5		0.2	t/hr
Peb mill 1 product	161.2	66.0	0.3	t/hr
Peb mill 2 product	161.6	66.0	0.1	t/hr
Secondary dilution		11.4		t/hr
Sec cyclone feed	97.3	277.0	0.9	t/hr
Sec cyclone o/f	72.5	234.4	5.0	t/hr
Sec cyclone u/f	24.8	42.6	4.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	11.0	4.0	11.5	43.7	29.8	0.7
Prim cyc feed	14.8	23.7	30.1	25.8	5.6	2.6
Prim cyc A o/f	50.9	28.0	20.7	0.4	0.1	3.2
Prim cyc B o/f	50.9	28.0	20.7	0.4	0.1	15.1
Prim cyc A u/f	3.6	22.4	33.0	33.7	7.4	3.8
Prim cyc B u/f	3.6	22.4	33.0	33.7	7.4	6.1
Peb mill 1 disch	9.3	12.8	14.9	12.9	1.1	9.8
Peb mill 2 disch	6.6	13.7	17.5	11.2	0.1	10.2
Sec cyc feed	50.9	28.0	20.7	0.4	0.1	9.1
Sec cyc o/f	65.3	23.5	10.9	0.2	0.1	2.9
Sec cyc u/f	11.0	39.9	48.4	0.7	0.0	0.2

Check for ac analysi

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	84	%
Peb mill moist	29	29	%

Test 2c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	60.0	3.3	2.6	t/hr
Rod mill dilution		20.7		t/hr
Rod mill discharge	60.0	24.0	2.6	t/hr
Primary dilution		280.6		t/hr
Prim cyclone feed	438.3	474.4	0.6	t/hr
Prim cyclone A o/f	64.1	172.8	0.2	t/hr
Prim cyclone B o/f	64.1	172.8	0.2	t/hr
Prim cyclone A u/f	155.1	64.4	0.5	t/hr
Prim cyclone B u/f	155.1	64.4	0.5	t/hr
Pebble addition 1	2.5		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	157.6	64.4	0.5	t/hr
Peb mill 2 product	157.3	64.4	0.8	t/hr
Secondary dilution		20.8		t/hr
Sec cyclone feed	128.1	366.3	0.3	t/hr
Sec cyclone o/f	64.9	325.4	2.6	t/hr
Sec cyclone u/f	63.3	40.9	3.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	2.9	11.0	5.7	40.8	39.6	0.1
Prim cyc feed	15.3	31.2	27.1	20.2	6.2	1.3
Prim cyc A o/f	39.8	43.7	16.1	0.4	0.0	7.7
Prim cyc B o/f	39.8	43.7	16.1	0.4	0.0	6.5
Prim cyc A u/f	5.3	26.1	31.7	28.3	8.7	1.2
Prim cyc B u/f	5.3	26.1	31.7	28.3	8.7	1.2
Peb mill 1 disch	12.3	11.6	16.1	10.3	1.0	9.7
Peb mill 2 disch	6.1	18.2	14.5	9.8	0.1	10.3
Sec cyc feed	39.8	43.7	16.1	0.4	0.0	5.0
Sec cyc o/f	67.2	30.3	2.4	0.1	0.0	0.8
Sec cyc u/f	11.6	57.5	30.3	0.6	0.0	0.4

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	83	84	%
Peb mill moist	29	29	%

Test 2b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	66.9	3.9	8.1	t/hr
Rod mill dilution		24.3		t/hr
Rod mill discharge	65.9	28.2	8.1	t/hr
Primary dilution		276.8		t/hr
Prim cyclone feed	419.2	476.4	3.7	t/hr
Prim cyclone A o/f	63.9	177.7	1.8	t/hr
Prim cyclone B o/f	63.9	177.7	1.8	t/hr
Prim cyclone A u/f	145.7	60.5	0.0	t/hr
Prim cyclone B u/f	145.7	60.5	0.0	t/hr
Pebble addition 1	2.5		0.1	t/hr
Pebble addition 2	2.3		0.1	t/hr
Peb mill 1 product	148.2	60.5	0.1	t/hr
Peb mill 2 product	147.9	60.5	0.3	t/hr
Secondary dilution		21.2		t/hr
Sec cyclone feed	127.8	376.6	3.7	t/hr
Sec cyclone o/f	70.5	326.2	8.4	t/hr
Sec cyclone u/f	57.3	50.4	4.7	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	9.1	6.9	14.2	35.9	34.0	0.5
Prim cyc feed	15.3	30.5	28.2	20.1	5.9	1.4
Prim cyc A o/f	45.8	30.9	15.8	7.4	0.1	5.2
Prim cyc B o/f	45.8	30.9	15.8	7.4	0.1	13.2
Prim cyc A u/f	1.7	30.5	33.7	25.6	8.4	2.5
Prim cyc B u/f	1.7	30.5	33.7	25.6	8.4	4.0
Peb mill 1 disch	8.4	17.4	15.3	8.4	0.4	10.0
Peb mill 2 disch	8.7	17.0	14.8	9.2	0.3	10.0
Sec cyc feed	45.8	30.9	15.8	7.4	0.1	9.2
Sec cyc o/f	74.3	24.0	0.5	1.1	0.1	2.3
Sec cyc u/f	12.7	37.9	34.1	15.2	0.1	0.7

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	73	%
Sec cyc o/f moist	82	84	%
Peb mill moist	29	29	%

Test 2a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	58.2	3.5	7.9	t/hr
Rod mill dilution		21.8		t/hr
Rod mill discharge	58.2	25.3	7.9	t/hr
Primary dilution		270.1		t/hr
Prim cyclone feed	435.5	465.0	4.4	t/hr
Prim cyclone A o/f	60.3	166.9	1.4	t/hr
Prim cyclone B o/f	60.3	166.9	1.4	t/hr
Prim cyclone A u/f	157.4	65.6	0.7	t/hr
Prim cyclone B u/f	157.4	65.6	0.7	t/hr
Pebble addition 1	2.5		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	160.0	65.6	0.8	t/hr
Peb mill 2 product	159.7	65.6	1.1	t/hr
Secondary dilution		64.5		t/hr
Sec cyclone feed	120.6	398.4	2.9	t/hr
Sec cyclone o/f	63.2	359.9	7.7	t/hr
Sec cyclone u/f	57.4	38.5	4.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	7.0	3.7	16.6	46.3	26.3	0.5
Prim cyc feed	13.2	34.9	30.2	18.0	3.8	2.1
Prim cyc A o/f	42.3	41.6	15.5	0.6	0.1	7.6
Prim cyc B o/f	42.3	41.6	15.5	0.6	0.1	9.7
Prim cyc A u/f	1.9	32.3	35.9	24.7	5.2	1.7
Prim cyc B u/f	1.9	32.3	35.9	24.7	5.2	2.1
Peb mill 1 disch	9.2	21.2	15.6	5.2	0.4	9.7
Peb mill 2 disch	5.6	15.2	17.0	10.7	0.0	10.3
Sec cyc feed	42.3	41.6	15.5	0.6	0.1	7.8
Sec cyc o/f	72.7	26.0	1.0	0.2	0.1	1.8
Sec cyc u/f	10.0	58.3	30.7	1.0	0.0	0.5

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	85	84	%
Peb mill moist	29	29	%

Test 1c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	59.5	3.6	6.7	t/hr
Rod mill dilution		21.		t/hr
Rod mill discharge	59.5	25.2	6.7	t/hr
Primary dilution		287.2		t/hr
Prim cyclone feed	407.3	491.7	1.5	t/hr
Prim cyclone A o/f	64.3	185.1	0.7	t/hr
Prim cyclone B o/f	64.3	185.1	0.7	t/hr
Prim cyclone A u/f	139.3	60.8	0.1	t/hr
Prim cyclone B u/f	139.3	60.8	0.1	t/hr
Pebble addition 1	2.6		0.0	t/hr
Pebble addition 2	2.3		0.0	t/hr
Peb mill 1 product	141.9	60.8	0.1	t/hr
Peb mill 2 product	141.6	60.8	0.4	t/hr
Secondary dilution		3.7		t/hr
Sec cyclone feed	128.7	373.8	1.3	t/hr
Sec cyclone o/f	64.4	316.1	6.7	t/hr
Sec cyclone u/f	64.2	57.7	5.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	8.8	4.2	10.7	48.9	27.4	0.4
Prim cyc feed	15.6	35.0	24.8	20.4	4.3	1.8
Prim cyc A o/f	43.6	45.1	10.9	0.4	0.1	9.5
Prim cyc B o/f	43.6	45.1	10.9	0.4	0.1	4.4
Prim cyc A u/f	2.6	30.3	31.2	29.7	6.3	2.7
Prim cyc B u/f	2.6	30.3	31.2	29.7	6.3	5.6
Peb mill 1 disch	6.8	22.0	11.4	10.2	0.3	9.8
Peb mill 2 disch	10.8	12.5	17.1	8.7	0.1	10.2
Sec cyc feed	43.6	45.1	10.9	0.4	0.1	6.9
Sec cyc o/f	75.1	24.3	0.3	0.2	0.2	1.7
Sec cyc u/f	12.7	65.4	21.4	0.5	0.0	0.4

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	83	83	%
Peb mill moist	30	30	%

Test 1h smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	58.2	3.5	7.9	t/hr
Rod mill dilution		22.0		t/hr
Rod mill discharge	58.2	25.5	7.9	t/hr
Primary dilution		286.6		t/hr
Prim cyclone feed	377.1	492.2	3.9	t/hr
Prim cyclone A o/f	65.8	192.5	1.9	t/hr
Prim cyclone B o/f	65.8	192.5	1.9	t/hr
Prim cyclone A u/f	122.8	53.6	0.1	t/hr
Prim cyclone B u/f	122.8	53.6	0.1	t/hr
Pebble addition 1	2.5		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	125.3	53.6	0.2	t/hr
Peb mill 2 product	125.0	53.6	0.5	t/hr
Secondary dilution		4.3		t/hr
Sec cyclone feed	131.5	389.3	3.8	t/hr
Sec cyclone o/f	63.0	316.4	8.1	t/hr
Sec cyclone u/f	68.6	72.9	4.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	0.2	10.0	10.0	40.8	39.1	0.4
Prim cyc feed	16.4	36.7	24.4	16.3	6.2	2.0
Prim cyc A o/f	41.2	49.2	9.1	0.5	0.1	7.9
Prim cyc B o/f	41.2	49.2	9.1	0.5	0.1	8.2
Prim cyc A u/f	3.0	30.0	32.8	24.8	9.5	1.9
Prim cyc B u/f	3.0	30.0	32.8	24.8	9.5	3.0
Peb mill 1 disch	13.8	12.8	16.8	8.2	0.1	9.7
Peb mill 2 disch	7.2	21.0	13.2	6.8	0.1	10.3
Sec cyc feed	41.2	49.2	9.1	0.8	0.1	6.5
Sec cyc o/f	72.8	26.3	0.5	0.3	0.1	1.7
Sec cyc u/f	13.4	69.9	16.3	0.4	0.0	0.4

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	75	74	%
Sec cyc o/f moist	83	83	%
Peb mill moist	30	30	%

APPENDIX F

Smoothed mass balances

Test 1a smoothed mass balance

Stream	Solids	Water	Adj [a]	
Rod mill feed	46.1	2.6	3.0	t/hr
Rod mill dilution		16.4		t/hr
Rod mill discharge	46.1	19.0	3.0	t/hr
Primary dilution		281.3		t/hr
Prim cyclone feed	367.6	486.4	5.0	t/hr
Prim cyclone A o/f	64.6	191.1	2.5	t/hr
Prim cyclone B o/f	64.6	191.1	2.5	t/hr
Prim cyclone A u/f	119.2	52.2	0.0	t/hr
Prim cyclone B u/f	119.2	52.2	0.0	t/hr
Pebble addition 1	2.5		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	121.7	52.2	0.1	t/hr
Peb mill 2 product	121.4	52.2	0.4	t/hr
Secondary dilution		4.4		t/hr
Sec cyclone feed	129.3	386.5	5.0	t/hr
Sec cyclone o/f	50.8	304.7	3.2	t/hr
Sec cyclone u/f	78.5	81.8	1.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj[b]
Rod mill discharge	8.6	2.9	19.8	47.9	20.9	6.2
Prim cyc feed	15.7	40.0	25.5	16.0	2.9	1.4
Prim cyc A o/f	35.8	49.9	13.8	0.4	0.0	8.6
Prim cyc B o/f	35.8	49.9	13.8	0.4	0.0	8.6
Prim cyc A u/f	4.6	34.2	32.2	24.4	4.5	1.3
Prim cyc B u/f	4.6	34.2	32.2	24.4	4.5	2.3
Peb mill 1 disch	11.4	18.0	13.1	8.0	0.4	9.8
Peb mill 2 disch	6.7	20.6	14.9	6.9	0.1	10.2
Sec cyc feed	35.8	49.9	13.8	0.4	0.0	8.6
Sec cyc o/f	72.8	26.5	0.5	0.1	0.1	0.7
Sec cyc u/f	12.4	65.9	21.1	0.6	0.0	0.7

Check for accuracy:

	Calc	Meas[c]	
Prim cyc o/f moist	75	74	%
Sec cyc o/f moist	86	83	%
Peb mill moist	30	30	%

[a] Adj : absolute adjustment in the tons per hour from the original data

[b] Adj : average absolute adjustment in the mass percentage in a size class

[c] Meas: shift average moisture percentage according to the daily logsheets, Calc : same value calculated for the fitted data set.

```
            for j := 1 to dimen do begin
               solution[j] := xi[j]
            end;{for j}
            if (irst >= 3) then goto 99;
            goto 1
        end;{if}
        rp := rsq;
        atsub(xj,xi,dimen);
        gg := 0.0;
        dgg := 0.0;
        for j := 1 to dimen do begin
            gg := gg+sqr(g[j]);
            dgg := dgg+(xi[j]+g[j])*xi[j]
        end;{for j}
        if (gg = 0.0) then goto 99;
        gam := dgg/gg;
        for j := 1 to dimen do begin
            g[j] := -xi[j];
            h[j] := g[j]+gam*h[j]
        end;{for j}
        olrsol;
    end;{for iter}
    flag:=2;
    99:
    rewrite(fitini);
    for i:= 1 to dimen do write(fitini,' ',solution[i]:10:3);
    writeln(fitini);
    close(fitini);
    end;{proc sparse}
    end.
```

```
            for j := 1 to dimen do begin
               solution[j] := xi[j]
            end;{for j}
            if (irst >= 3) then goto 99;
            goto 1
        end;{if}
        rp := rsq;
        atsub(xj,xi,dimen);
        gg := 0.0;
        dgg := 0.0;
        for j := 1 to dimen do begin
            gg := gg+sqr(g[j]);
            dgg := dgg+(xi[j]+g[j])*xi[j]
        end;{for j}
        if (gg = 0.0) then goto 99;
        gam := dgg/gg;
        for j := 1 to dimen do begin
            g[j] := -xi[j];
            h[j] := g[j]+gam*h[j]
        end;{for j}
        clreol;
    end;{for iter}
    flag:=2;
    99:
    rewrite(fitini);
    for i:= 1 to dimen do write(fitini,' ',solution[i]:10:3);
    writeln(fitini);
    close(fitini);
    end;{proc sparse}
    end.
```

```
for i:=1 to dimen do begin
    outvector[i]:=0;
    for j:=1 to dimen do outvector[i]:=outvector[i]+invector[j]
                                        *coefficients[j,i];
end;{for i}
end;{proc atsub}

begin {proc sparse}
assign(fitini,'C:\MSC\DATA\FITINI.DAT');
reset(fitini);
for i:= 1 to dimen do read(fitini,solution[i]);
close(fitini);
writeln;
flag:=1;
eps2 := dimen*sqr(eps);
irst := 0;
1:
irst := irst+1;
asub(solution,xi,dimen);
rp := 0.0;
bsq := 0.0;
for j := 1 to dimen do begin
    bsq := bsq+sqr(constants[j]);
    xi[j] := xi[j]-constants[j];
    rp := rp+sqr(xi[j])
end;{for j}
atsub(xi,g,dimen);
for j := 1 to dimen do begin
      g[j] := -g[j];
      h[j] := g[j]
end;{for j}
for iter := 1 to 20*dimen do begin
    gotoxy(1,wherey-1);
    clreol;
    writeln('Working...',iter:3,', error =',rsq:7:3);
    asub(h,xi,dimen);
    anum := 0.0;
    aden := 0.0;
    for j := 1 to dimen do begin
        anum := anum+g[j]*h[j];
        aden := aden+sqr(xi[j])
    end;{for j}
    if (aden = 0.0) then begin
       writeln('Very singular matrix');
       readln;
    end;{if}
    anum := anum/aden;
    for j := 1 to dimen do begin
         xi[j] := solution[j];
         solution[j] := solution[j]+anum*h[j]
    end;{for j}
    asub(solution,xj,dimen);
    rsq := 0.0;
    for j := 1 to dimen do begin
         xj[j] := xj[j]-constants[j];
         rsq := rsq+sqr(xj[j])
    end;{for j}
    if ((rsq = rp) or (rsq <= bsq*eps2)) then goto 99;
    if (rsq > rp) then begin
```

```
unit solvmat;

interface

uses wincrt;

const
     maxdimen=100;

type
    vector      =       array[1..maxdimen] of real;
    matrix      =       array[1..maxdimen] of vector;

procedure sparse(dimen                          : integer;
                 coefficients                   : matrix;
                 constants                      : vector;
             var solution                       : vector;
                 flag                           : integer);

implementation

procedure sparse(dimen                          : integer;
                 coefficients                   : matrix;
                 constants                      : vector;
             var solution                       : vector;
                 flag                           : integer);
const
     eps                                        = 1.0e-6;

label
     1,99;
var
   eps2,xp,gg,bsq,anum,aden,rsq,dgg,gam         : double;
   irst,j,iter,i                                : integer;
   xi,xj,g,h                                    : vector;
   fitini                                       : text;


procedure asub(invector        : vector;
           var outvector       : vector;
               dimen: integer);
var
   i,j                          : integer;

begin {proc asub}
for i:=1 to dimen do begin
    outvector[i]:=0;
    for j:=1 to dimen do begin
    outvector[i]:=outvector[i]+invector[j]*coefficients[i,j];
    end;{for j}
end;{for i}
end;{proc asub}
procedure atsub(invector        : vector;
            var outvector       : vector;
                dimen: integer);
var
   i,j                          : integer;

begin {proc atsub}
```

```
-250+150 -1700+250   +1700  Adj');

writeln(fitrep,'==========================================================
==========================');
      write(fitrep,'Rod mill discharge ');
      for i:= 7 downto 3 do
write(fitrep,sto[rmd,i]:9:1);writeln(fitrep,sizmod[rmd]:9:1);
      write(fitrep,'Prim cyc feed      ');
      for i:= 7 downto 3 do
write(fitrep,sto[pcf,i]:9:1);writeln(fitrep,sizmod[pcf]:9:1);
      write(fitrep,'Prim cyc A o/f     ');
      for i:= 7 downto 3 do
write(fitrep,sto[pcoa,i]:9:1);writeln(fitrep,sizmod[pcoa]:9:1);
      write(fitrep,'Prim cyc B o/f     ');
      for i:= 7 downto 3 do
write(fitrep,sto[pcob,i]:9:1);writeln(fitrep,sizmod[pcob]:9:1);
      write(fitrep,'Prim cyc A u/f     ');
      for i:= 7 downto 3 do
write(fitrep,sto[pcua,i]:9:     ..teln(fitrep,sizmod[pcua]:9:1);
      write(fitrep,'Prim cyc B u/f     ');
      for i:= 7 downto 3 do
write(fitrep,sto[pcub,i]:9:1);writeln(fitrep,sizmod[pcub]:9:1);
      write(fitrep,'Peb mill 1 disch   ');
      for i:= 7 downto 3 do
write(fitrep,sto[pdis1,i]:9:1);writeln(fitrep,sizmod[pdis1]:9:1);
      write(fitrep,'Peb mill 2 disch   ');
      for i:= 7 downto 3 do
write(fitrep,sto[pdis2,i]:9:1);writeln(fitrep,sizmod[pdis2]:9:1);
      write(fitrep,'Sec cyc feed       ');
      for i:= 7 downto 3 do
write(fitrep,sto[scf,i]:9:1);writeln(fitrep,sizmod[scf]:9:1);
      write(fitrep,'Sec cyc o/f        ');
      for i:= 7 downto 3 do
write(fitrep,sto[sco,i]:9:1);writeln(fitrep,sizmod[sco]:9:1);
      write(fitrep,'Sec cyc u/f        ');
      for i:= 7 downto 3 do
write(fitrep,sto[scu,i]:9:1);writeln(fitrep,sizmod[scu]:9:1);

writeln(fitrep,'==========================================================
==========================');
      writeln(fitrep);
      writeln(fitrep,'Check for accuracy:');
      writeln(fitrep,'                        Calc    Meas');
      writeln(fitrep,'================================');
      writeln(fitrep,'Prim cyc o/f moist   ',pmc:4:0,'
',parm[6]:4:0,' %');
      writeln(fitrep,'Sec cyc o/f moist    ',smc:4:0,'
',parm[7]:4:0,' %');
      writeln(fitrep,'Peb mill moist       ',pmmc:4:0,'
',parm[8]:4:0,' %');
      writeln(fitrep);
      writeln(fitrep,chr(12));
      close(fitrep);
      end; {subtest}
end; {test}
dispose(coefficients);dispose(constants);dispose(solution);
end. {main}
```

Test 6c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	59.4	3.0	3.0	t/hr
Rod mill dilution		18.8		t/hr
Rod mill discharge	59.4	21.8	3.0	t/hr
Primary dilution		174.1		t/hr
Prim cyclone feed	447.9	443.6	1.7	t/hr
Prim cyclone A o/f	50.8	134.3	1.1	t/hr
Prim cyclone B o/f	50.8	134.3	1.1	t/hr
Prim cyclone A u/f	173.2	87.6	0.3	t/hr
Prim cyclone B u/f	173.2	87.6	0.3	t/hr
Pebble addition 1	5.4		0.1	t/hr
Pebble addition 2	3.3		0.1	t/hr
Peb mill 1 product	178.6	87.6	0.4	t/hr
Peb mill 2 product	176.5	87.3	2.4	t/hr
Secondary dilution		52.2		t/hr
Sec cyclone feed	101.5	320.7	2.2	t/hr
Sec cyclone o/f	68.3	248.1	3.0	t/hr
Sec cyclone u/f	33.2	72.6	0.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	16.9	8.8	10.4	46.3	17.7	0.8
Prim cyc feed	26.4	30.5	24.7	15.7	2.7	1.2
Prim cyc A o/f	58.6	30.4	11.0	0.0	0.0	1.4
Prim cyc B o/f	58.6	30.4	11.0	0.0	0.0	1.4
Prim cyc A u/f	17.0	30.5	28.7	20.3	3.5	4.1
Prim cyc B u/f	17.0	30.5	28.7	20.3	3.5	2.2
Peb mill 1 disch	16.4	16.2	11.5	5.3	0.5	10.2
Peb mill 2 disch	12.6	16.0	14.8	6.7	0.5	10.1
Sec cyc feed	58.6	30.4	11.0	0.0	0.0	1.2
Sec cyc o/f	79.2	20.5	0.4	0.0	0.0	0.5
Sec cyc u/f	16.1	50.9	32.9	0.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	78	83	%
Peb mill moist	33	33	%

Test 6b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	48.3	2.5	1.3	t/hr
Rod mill dilution		15.7		t/hr
Rod mill discharge	48.3	18.2	1.3	t/hr
Primary dilution		172.6		t/hr
Prim cyclone feed	462.5	437.7	0.5	t/hr
Prim cyclone A o/f	47.4	125.7	0.9	t/hr
Prim cyclone B o/f	47.4	125.7	0.9	t/hr
Prim cyclone A u/f	183.9	93.1	0.6	t/hr
Prim cyclone B u/f	183.9	93.1	0.6	t/hr
Pebble addition 1	5.3		0.2	t/hr
Pebble addition 2	5.3		0.2	t/hr
Peb mill 1 product	189.2	93.1	0.8	t/hr
Peb mill 2 product	187.2	93.1	2.8	t/hr
Secondary dilution		81.2		t/hr
Sec cyclone feed	94.7	332.6	1.7	t/hr
Sec cyclone o/f	57.1	272.0	1.1	t/hr
Sec cyclone u/f	37.7	60.6	0.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	22.1	6.7	10.6	53.9	6.7	0.7
Prim cyc feed	26.0	28.0	27.4	17.7	1.0	0.8
Prim cyc A o/f	54.4	28.9	16.7	0.0	0.0	8.8
Prim cyc B o/f	54.4	28.9	16.7	0.0	0.0	5.3
Prim cyc A u/f	18.8	27.7	30.1	22.3	1.2	3.4
Prim cyc B u/f	18.8	27.7	30.1	22.3	1.2	2.5
Peb mill 1 disch	17.1	13.7	12.2	6.3	0.4	10.2
Peb mill 2 disch	10.8	15.4	15.9	8.5	0.4	10.0
Sec cyc feed	54.4	28.9	16.7	0.0	0.0	6.0
Sec cyc o/f	80.0	19.6	0.3	0.1	0.0	0.0
Sec cyc u/f	14.9	43.4	41.6	0.1	0.0	0.3

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	83	83	%
Peb mill moist	33	33	%

Test 6a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	48.0	2.5	0.6	t/hr
Rod mill dilution		15.6		t/hr
Rod mill discharge	48.0	18.1	0.6	t/hr
Primary dilution		172.0		t/hr
Prim cyclone feed	462.4	438.4	0.3	t/hr
Prim cyclone A o/f	47.1	126.1	0.5	t/hr
Prim cyclone B o/f	47.1	126.1	0.5	t/hr
Prim cyclone A u/f	184.1	93.1	0.6	t/hr
Prim cyclone B u/f	184.1	93.1	0.6	t/hr
Pebble addition 1	5.0		0.2	t/hr
Pebble addition 2	3.3		0.2	t/hr
Peb mill 1 product	189.1	93.1	0.8	t/hr
Peb mill 2 product	187.4	93.1	2.5	t/hr
Secondary dilution		70.7		t/hr
Sec cyclone feed	94.3	322.8	1.0	t/hr
Sec cyclone o/f	56.5	260.8	0.5	t/hr
Sec cyclone u/f	37.8	62.0	0.5	t/hr

Size analysis

Stream	-75	-150+75	-250+180	-1700+250	+1700	Adj
Rod mill discharge	18.2	3.6	12.8	49.3	16.4	0.4
Prim cyc feed	23.5	26.4	25.4	22.7	2.0	1.2
Prim cyc A o/f	52.2	34.6	13.2	0.0	0.0	6.4
Prim cyc B o/f	52.2	34.6	13.2	0.0	0.0	2.6
Prim cyc A u/f	16.1	24.4	28.6	28.4	2.6	1.0
Prim cyc B u/f	16.1	24.4	28.6	28.4	2.6	5.7
Peb mill 1 disch	17.1	12.9	12.7	7.5	0.4	10.0
Peb mill 2 disch	7.9	13.7	13.7	14.1	0.4	10.2
Sec cyc feed	52.2	34.6	13.2	0.0	0.0	2.9
Sec cyc o/f	77.0	22.1	0.8	0.1	0.0	0.5
Sec cyc u/f	14.9	53.3	31.7	0.1	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	82	83	%
Peb mill moist	33	33	%

Test 5c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	66.4	3.9	7.2	t/hr
Rod mill dilution		24.2		t/hr
Rod mill discharge	66.4	28.1	7.2	t/hr
Primary dilution		177.4		t/hr
Prim cyclone feed	402.4	382.7	3.9	t/hr
Prim cyclone A o/f	44.4	125.8	2.2	t/hr
Prim cyclone B o/f	44.4	125.8	2.2	t/hr
Prim cyclone A u/f	156.8	65.5	0.2	t/hr
Prim cyclone B u/f	156.8	65.5	0.2	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	160.0	65.5	0.1	t/hr
Peb mill 2 product	160.4	65.5	0.5	t/hr
Secondary dilution		9.2		t/hr
Sec cyclone feed	88.7	260.9	4.4	t/hr
Sec cyclone o/f	73.1	214.7	7.5	t/hr
Sec cyclone u/f	15.6	46.2	3.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	16.1	7.4	6.3	35.2	34.9	0.5
Prim cyc feed	19.5	26.6	26.2	21.3	6.3	0.9
Prim cyc A o/f	57.8	32.2	9.4	0.6	0.1	10.4
Prim cyc B o/f	57.8	32.2	9.4	0.6	0.1	13.0
Prim cyc A u/f	8.3	25.1	31.2	27.3	8.1	2.7
Prim cyc B u/f	8.3	25.1	31.2	27.3	8.1	2.0
Peb mill 1 disch	9.7	14.7	15.0	10.0	0.5	10.0
Peb mill 2 disch	10.9	14.2	15.3	9.5	0.1	10.0
Sec cyc feed	57.8	32.2	9.4	0.6	0.1	11.6
Sec cyc o/f	69.7	25.4	4.4	0.3	0.1	2.4
Sec cyc u/f	12.6	60.1	26.6	0.7	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	73	%
Sec cyc o/f moist	75	84	%
Peb mill moist	29	29	%

Test 5b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	63.2	3.8	8.4	t/hr
Rod mill dilution		23.7		t/hr
Rod mill discharge	63.2	27.5	8.4	t/hr
Primary dilution		172.3		t/hr
Prim cyclone feed	393.0	376.2	4.0	t/hr
Prim cyclone A o/f	43.7	124.4	2.3	t/hr
Prim cyclone B o/f	43.7	124.4	2.3	t/hr
Prim cyclone A u/f	152.8	63.6	0.3	t/hr
Prim cyclone B u/f	152.8	63.6	0.3	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	155.9	63.6	0.2	t/hr
Peb mill 2 product	156.3	63.6	0.6	t/hr
Secondary dilution		9.1		t/hr
Sec cyclone feed	87.5	258.0	4.6	t/hr
Sec cyclone o/f	69.8	208.9	8.7	t/hr
Sec cyclone u/f	17.7	49.1	4.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	10.8	8.8	7.7	39.5	33.2	0.6
Prim cyc feed	15.4	25.9	28.9	24.0	5.7	1.5
Prim cyc A o/f	52.5	33.4	12.3	1.7	0.1	9.2
Prim cyc B o/f	52.5	33.4	12.3	1.7	0.1	13.1
Prim cyc A u/f	4.4	23.9	33.9	30.4	7.4	3.5
Prim cyc B u/f	4.4	23.9	33.9	30.4	7.4	3.9
Peb mill 1 disch	8.0	14.5	15.7	11.4	0.5	10.0
Peb mill 2 disch	8.4	14.1	16.9	10.6	0.0	10.0
Sec cyc feed	52.5	33.4	12.3	1.7	0.1	10.8
Sec cyc o/f	65.0	30.6	3.9	0.3	0.1	3.5
Sec cyc u/f	14.2	38.6	40.5	6.8	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	73	%
Sec cyc o/f moist	75	84	%
Peb mill moist	29	29	%

Test 5a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	61.0	3.5	4.7	t/hr
Rod mill dilution		21.8		t/hr
Rod mill discharge	61.0	25.3	4.7	t/hr
Primary dilution		178.9		t/hr
Prim cyclone feed	417.0	384.3	0.8	t/hr
Prim cyclone A o/f	46.0	124.1	0.1	t/hr
Prim cyclone B o/f	46.0	124.1	0.1	t/hr
Prim cyclone A u/f	162.6	68.1	0.5	t/hr
Prim cyclone B u/f	162.6	68.1	0.5	t/hr
Pebble addition 1	3.1		0.2	t/hr
Pebble addition 2	3.5		0.2	t/hr
Peb mill 1 product	165.6	68.2	0.7	t/hr
Peb mill 2 product	166.0	68.1	0.3	t/hr
Secondary dilution		14.0		t/hr
Sec cyclone feed	91.9	262.1	0.1	t/hr
Sec cyclone o/f	67.7	218.2	5.0	t/hr
Sec cyclone u/f	24.3	43.9	5.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	4.8	12.3	5.4	38.8	38.8	0.6
Prim cyc feed	17.0	22.4	33.2	21.3	6.1	2.3
Prim cyc A o/f	52.8	32.2	12.9	2.0	0.0	9.5
Prim cyc B o/f	52.8	32.2	12.9	2.0	0.0	13.7
Prim cyc A u/f	6.9	19.6	38.9	26.8	7.9	7.8
Prim cyc B u/f	6.9	19.6	38.9	26.8	7.9	3.7
Peb mill 1 disch	11.0	7.7	22.1	10.2	0.6	9.7
Peb mill 2 disch	8.7	15.0	15.8	8.9	0.0	10.3
Sec cyc feed	52.8	32.2	12.9	2.0	0.0	11.3
Sec cyc o/f	68.4	27.9	3.4	0.1	0.1	2.5
Sec cyc u/f	10.2	43.1	39.4	7.4	0.0	0.3

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	84	%
Peb mill moist	29	29	%

Test 4c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	58.0	3.8	14.0	t/hr
Rod mill dilution		23.8		t/hr
Rod mill discharge	58.0	27.6	14.0	t/hr
Primary dilution		214.5		t/hr
Prim cyclone feed	461.2	410.5	9.1	t/hr
Prim cyclone A o/f	42.7	127.1	4.3	t/hr
Prim cyclone B o/f	42.7	127.1	4.3	t/hr
Prim cyclone A u/f	187.9	78.2	0.2	t/hr
Prim cyclone B u/f	187.9	78.2	0.2	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	191.1	78.2	0.3	t/hr
Peb mill 2 product	191.8	78.2	0.1	t/hr
Secondary dilution		12.3		t/hr
Sec cyclone feed	85.3	266.4	8.7	t/hr
Sec cyclone o/f	65.0	254.4	14.0	t/hr
Sec cyclone u/f	20.3	12.0	5.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	8.5	6.9	9.2	34.0	41.4	0.4
Prim cyc feed	12.2	22.2	29.0	29.0	7.6	1.2
Prim cyc A o/f	53.7	30.1	15.1	0.9	0.2	14.2
Prim cyc B o/f	53.7	30.1	15.1	0.9	0.2	12.5
Prim cyc A u/f	2.0	20.4	32.8	35.4	9.3	4.4
Prim cyc B u/f	2.0	20.4	32.8	35.4	9.3	3.4
Peb mill 1 disch	4.6	12.2	14.6	16.0	2.8	10.0
Peb mill 2 disch	8.2	11.1	16.7	13.7	0.2	10.0
Sec cyc feed	53.7	30.1	15.1	0.9	0.2	13.2
Sec cyc o/f	73.5	23.8	2.2	0.3	0.2	3.3
Sec cyc u/f	10.0	44.1	43.4	2.5	0.0	0.3

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	75	73	%
Sec cyc o/f moist	80	84	%
Peb mill moist	29	29	%

Test 4b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	61.0	4.0	15.5	t/hr
Rod mill dilution		25.1		t/hr
Rod mill discharge	61.0	29.1	15.5	t/hr
Primary dilution		217 6		t/hr
Prim cyclone feed	453.0	416.2	10.2	t/hr
Prim cyclone A o/f	43.5	132.1	5.3	t/hr
Prim cyclone B o/f	43.5	132.1	5.3	t/hr
Prim cyclone A u/f	182.9	76.1	0.2	t/hr
Prim cyclone B u/f	182.9	76.1	0.2	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	186.2	76.1	0.1	t/hr
Peb mill 2 product	186.5	76.1	0.5	t/hr
Secondary dilution		10.8		t/hr
Sec cyclone feed	87.1	274.9	10.6	t/hr
Sec cyclone o/f	67.6	257.5	15.8	t/hr
Sec cyclone u/f	19.5	17.4	5.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	8.0	8.1	9.0	29.1	45.8	0.5
Prim cyc feed	12.2	23.4	28.9	25.7	9.8	1.0
Prim cyc A o/f	52.3	29.6	17.0	1.0	0.2	15.1
Prim cyc B o/f	52.3	29.6	17.0	1.0	0.2	11.0
Prim cyc A u/f	1.7	22.1	32.4	31.7	12.1	2.7
Prim cyc B u/f	1.7	22.1	32.4	31.7	12.1	3.7
Peb mill 1 disch	4.2	13.2	14.2	14.6	4.0	10.0
Peb mill 2 disch	8.6	11.6	17.2	11.9	0.4	10.0
Sec cyc feed	52.3	29.6	17.0	1.0	0.2	13.1
Sec cyc o/f	71.3	22.8	5.3	0.5	0.2	3.9
Sec cyc u/f	11.7	43.3	43.7	1.3	0.0	0.3

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	75	73	%
Sec cyc o/f moist	79	84	%
Peb mill moist	29	29	%

Test 4b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	61.0	4.0	15.5	t/hr
Rod mill dilution		25.1		t/hr
Rod mill discharge	61.0	29.1	15.5	t/hr
Primary dilution		217.6		t/hr
Prim cyclone feed	453.0	416.2	10.2	t/hr
Prim cyclone A o/f	43.5	132.1	5.3	t/hr
Prim cyclone B o/f	43.5	132.1	5.3	t/hr
Prim cyclone A u/f	182.9	76.1	0.2	t/hr
Prim cyclone B u/f	182.9	76.1	0.2	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	186.2	76.1	0.1	t/hr
Peb mill 2 product	186.5	76.1	0.5	t/hr
Secondary dilution		10.8		t/hr
Sec cyclone feed	87.1	274.9	10.6	t/hr
Sec cyclone o/f	67.6	257.5	15.8	t/hr
Sec cyclone u/f	19.5	17.4	5.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	8.0	8.1	9.0	29.1	45.8	0.5
Prim cyc feed	12.2	23.4	28.9	25.7	9.8	1.0
Prim cyc A o/f	52.3	29.6	17.0	1.0	0.2	15.1
Prim cyc B o/f	52.3	29.6	17.0	1.0	0.2	11.0
Prim cyc A u/f	1.7	22.1	32.4	31.7	12.1	2.7
Prim cyc B u/f	1.7	22.1	32.4	31.7	12.1	3.7
Peb mill 1 disch	4.2	13.2	14.2	14.6	4.0	10.0
Peb mill 2 disch	8.6	11.6	17.2	11.9	0.4	10.0
Sec cyc feed	52.3	29.6	17.0	1.0	0.2	13.1
Sec cyc o/f	71.3	22.8	5.3	0.5	0.2	3.9
Sec cyc u/f	11.7	43.3	43.7	1.3	0.0	0.3

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	75	73	%
Sec cyc o/f moist	79	84	%
Peb mill moist	29	29	%

Test 4a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	64.6	4.1	13.0	t/hr
Rod mill dilution		25.9		t/hr
Rod mill discharge	64.6	30.0	13.0	t/hr
Primary dilution		213.0		t/hr
Prim cyclone feed	442.7	410.9	8.0	t/hr
Prim cyclone A o/f	44.5	131.9	4.3	t/hr
Prim cyclone B o/f	44.5	131.9	4.3	t/hr
Prim cyclone A u/f	176.8	73.6	0.3	t/hr
Prim cyclone B u/f	176.8	73.6	0.3	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.5		0.1	t/hr
Peb mill 1 product	180.0	73.6	0.1	t/hr
Peb mill 2 product	180.4	73.6	0.5	t/hr
Secondary dilution		10.7		t/hr
Sec cyclone feed	89.0	274.5	8.6	t/hr
Sec cyclone o/f	71.2	253.7	13.4	t/hr
Sec cyclone u/f	17.8	20.8	4.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	5.4	6.1	7.3	33.6	47.6	0.4
Prim cyc feed	13.4	22.6	29.3	26.2	8.4	1.6
Prim cyc A o/f	54.6	26.3	18.1	0.8	0.1	14.3
Prim cyc B o/f	54.6	26.3	18.1	0.8	0.1	12.3
Prim cyc A u/f	2.3	22.0	32.5	32.6	10.4	4.7
Prim cyc B u/f	2.3	22.0	32.5	32.6	10.4	2.5
Peb mill 1 disch	6.2	13.4	15.3	13.4	1.5	10.0
Peb mill 2 disch	8.8	10.9	17.5	12.7	0.3	10.0
Sec cyc feed	54.6	26.3	18.1	0.8	0.1	13.3
Sec cyc o/f	71.2	18.2	10.1	0.4	0.2	3.8
Sec cyc u/f	11.2	47.6	39.0	2.2	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	75	73	%
Sec cyc o/f moist	78	84	%
Peb mill moist	29	29	%

Test 3c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	60.7	3.5	5.8	t/hr
Rod mill dilution		22.1		t/hr
Rod mill discharge	60.7	25.6	5.8	t/hr
Primary dilution		201.3		t/hr
Prim cyclone feed	432.3	401.3	4.0	t/hr
Prim cyclone A o/f	45.7	129.7	2.3	t/hr
Prim cyclone B o/f	45.7	129.7	2.3	t/hr
Prim cyclone A u/f	170.5	71.0	0.3	t/hr
Prim cyclone B u/f	170.5	71.0	0.3	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	173.7	71.0	0.2	t/hr
Peb mill 2 product	174.1	71.0	0.6	t/hr
Secondary dilution		10.3		t/hr
Sec cyclone feed	91.3	269.7	4.6	t/hr
Sec cyclone o/f	67.5	237.2	5.9	t/hr
Sec cyclone u/f	23.8	32.5	1 3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	2.7	7.6	3.8	33.2	52.7	0.2
Prim cyc feed	15.1	21.8	25.7	28.7	8.7	1.5
Prim cyc A o/f	59.0	29.3	11.3	0.2	0.1	10.5
Prim cyc B o/f	59.0	29.3	11.3	0.2	0.1	8.5
Prim cyc A u/f	3.1	19.6	29.9	36.3	11.0	1.1
Prim cyc B u/f	3.1	19.6	29.9	36.3	11.0	3.3
Peb mill 1 disch	9.0	9.9	14.6	15.2	1.5	9.9
Peb mill 2 disch	8.7	11.5	14.7	14.6	0.1	10.1
Sec cyc feed	59.0	29.3	11.3	0.2	0.1	9.5
Sec cyc o/f	78.1	18.1	3.6	0.2	0.1	1.1
Sec cyc u/f	9.1	62.1	28.5	0.2	0.0	0.4

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	73	%
Sec cyc o/f moist	78	84	%
Peb mill moist	29	29	%

Test 3b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	61.9	3.7	7.7	t/hr
Rod mill dilution		23.0		t/hr
Rod mill discharge	61.9	26.7	7.7	t/hr
Primary dilution		201.1		t/hr
Prim cyclone feed	422.1	403.3	3.7	t/hr
Prim cyclone A o/f	47.2	133.4	2.1	t/hr
Prim cyclone B o/f	47.2	133.4	2.1	t/hr
Prim cyclone A u/f	163.8	68.3	0.2	t/hr
Prim cyclone B u/f	163.8	68.3	0.2	t/hr
Pebble addition 1	3.2		0.1	t/hr
Pebble addition 2	3.6		0.1	t/hr
Peb mill 1 product	167.0	68.3	0.1	t/hr
Peb mill 2 product	167.4	68.3	0.5	t/hr
Secondary dilution		10.2		t/hr
Sec cyclone feed	94.5	276.9	4.1	t/hr
Sec cyclone o/f	68.6	238.0	8.0	t/hr
Sec cyclone u/f	25.8	38.9	3.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	4.4	1.3	12.6	37.1	44.6	0.5
Prim cyc feed	11.5	22.8	34.0	24.9	6.8	2.1
Prim cyc A o/f	48.4	29.6	21.5	0.5	0.1	9.6
Prim cyc B o/f	48.4	29.6	21.5	0.5	0.1	10.4
Prim cyc A u/f	0.6	20.8	37.8	31.9	8.7	4.1
Prim cyc B u/f	0.6	20.8	37.8	31.9	8.7	6.3
Peb mill 1 disch	6.5	12.1	18.9	12.2	0.2	10.0
Peb mill 2 disch	6.5	12.1	18.9	12.2	0.2	10.0
Sec cyc feed	48.4	29.6	21.5	0.5	0.1	8.0
Sec cyc o/f	65.3	19.4	14.9	0.3	0.1	3.2
Sec cyc u/f	8.9	55.7	35.0	0.4	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	73	%
Sec cyc o/f moist	78	84	%
Peb mill moist	29	29	%

Test 12c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	65.2	3.4	0.7	t/hr
Rod mill dilution		21.2		t/hr
Rod mill discharge	65.2	24.6	0.7	t/hr
Primary dilution		189.2		t/hr
Prim cyclone feed	516.0	436.7	1.2	t/hr
Prim cyclone A o/f	42.2	115.1	1.7	t/hr
Prim cyclone B o/f	42.2	115.1	1.7	t/hr
Prim cyclone A u/f	215.8	103.3	1.1	t/hr
Prim cyclone B u/f	215.8	103.3	1.1	t/hr
Pebble addition 1	2.7		0.1	t/hr
Pebble addition 2	2.3		0.1	t/hr
Peb mill 1 product	218.6	103.3	1.2	t/hr
Peb mill 2 product	218.1	103.3	1.7	t/hr
Secondary dilution		8.2		t/hr
Sec cyclone feed	84.3	238.4	3.4	t/hr
Sec cyclone o/f	70.4	222.0	0.8	t/hr
Sec cyclone u/f	13.9	16.4	2.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	14.3	5.1	6.8	44.3	29.5	0.5
Prim cyc feed	21.1	22.4	25.3	27.1	4.1	1.5
Prim cyc A o/f	71.6	24.6	3.7	0.0	0.0	5.4
Prim cyc B o/f	71.6	24.6	3.7	0.0	0.0	6.9
Prim cyc A u/f	11.4	21.8	29.5	32.5	4.9	2.9
Prim cyc B u/f	11.4	21.8	29.5	32.5	4.9	1.8
Peb mill 1 disch	12.0	10.5	13.8	1[illegible]	0.5	10.1
Peb mill 2 disch	10.1	13.4	14.4	11.8	0.8	10.1
Sec cyc feed	71.6	24.6	3.7	0.0	0.0	6.1
Sec cyc o/f	80.5	19.0	0.4	0.0	0.0	0.2
Sec cyc u/f	22.7	55.5	21.8	0.0	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	74	%
Sec cyc o/f moist	76	85	%
Peb mill moist	32	32	%

Test 12b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	65.0	3.5	0.7	t/hr
Rod mill dilution		21.6		t/hr
Rod mill discharge	65.0	25.1	0.7	t/hr
Primary dilution		185.6		t/hr
Prim cyclone feed	506.4	439.5	1.5	t/hr
Prim cyclone A o/f	43.3	119.6	1.3	t/hr
Prim cyclone B o/f	43.3	119.6	1.3	t/hr
Prim cyclone A u/f	209.9	100.2	0.8	t/hr
Prim cyclone B u/f	209.9	100.2	0.5	t/hr
Pebble addition 1	2.7		0.1	t/hr
Pebble addition 2	2.3		0.1	t/hr
Peb mill 1 product	212.7	100.2	0.6	t/hr
Peb mill 2 product	212.2	100.2	1.1	t/hr
Secondary dilution		8.1		t/hr
Sec cyclone feed	86.6	247.2	2.6	t/hr
Sec cyclone o/f	70.1	218.8	0.7	t/hr
Sec cyclone u/f	16.4	28.4	3.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	15.4	4.2	6.5	42.0	31.8	0.3
Prim cyc feed	21.3	23.4	24.6	26.2	4.5	0.9
Prim cyc A o/f	71.6	24.8	3.6	0.1	0.0	7.7
Prim cy B o/f	71.6	24.8	3.6	0.1	0.0	7.3
Prim cyc A u/f	11.1	23.1	28.9	31.6	5.4	1.8
Prim cyc B u/f	11.1	23.1	28.9	31.6	5.4	1.6
Peb mill 1 disch	11.2	11.9	13.2	13.7	0.5	10.1
Peb mill 2 disch	11.0	13.1	14.5	11.1	0.5	10.2
Sec cyc feed	71.6	24.8	3.6	0.1	0.0	7.5
Sec cyc o/f	82.7	16.9	0.3	0.1	0.0	0.4
Sec cyc u/f	20.9	60.5	18.6	0.0	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	74	%
Sec cyc o/f moist	76	85	%
Peb mill moist	32	32	%

Test 12a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	70.4	3.7	0.2	t/hr
Rod mill dilution		23.1		t/hr
Rod mill discharge	70.4	26.8	0.2	t/hr
Primary dilution		179.1		t/hr
Prim cyclone feed	498.5	438.6	1.8	t/hr
Prim cyclone A o/f	44.1	121.3	1.5	t/hr
Prim cyclone B o/f	44.1	121.3	1.5	t/hr
Prim cyclone A u/f	205.1	98.0	0.6	t/hr
Prim cyclone B u/f	205.1	98.0	0.6	t/hr
Pebble addition 1	2.7		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	207.8	98.0	0.7	t/hr
Peb mill 2 product	207.3	98.0	1.2	t/hr
Secondary dilution		8.5		t/hr
Sec cyclone feed	88.3	251.1	3.1	t/hr
Sec cyclone o/f	75.5	214.4	0.2	t/hr
Sec cyclone u/f	12.8	36.7	2.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	12.5	4.0	6.0	43.7	33.7	0.4
Prim cyc feed	23.2	21.9	25.0	24.7	5.2	1.2
Prim cyc A o/f	74.5	22.4	3.1	0.1	0.0	8.4
Prim cyc B o/f	74.5	22.4	3.1	0.1	0.0	7.4
Prim cyc A u/f	12.4	21.7	29.7	30.0	6.3	2.6
Prim cyc B u/f	12.4	21.7	29.7	30.0	6.3	1.5
Peb mill 1 disch	14.6	9.9	13.8	11.6	0.5	10.2
Peb mill 2 disch	10.6	13.9	14.5	10.8	0.5	10.1
Sec cyc feed	74.5	22.4	3.1	0.1	0.0	7.9
Sec cyc o/f	83.0	16.7	0.2	0.1	0.0	0.3
Sec cyc u/f	19.3	59.0	21.7	0.0	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	74	%
Sec cyc o/f moist	74	85	%
Peb mill moist	32	32	%

Test 11c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	60.5	3.1	1.0	t/hr
Rod mill dilution		19.6		t/hr
Rod mill discharge	60.5	22.7	1.0	t/hr
Primary dilution		172.3		t/hr
Prim cyclone feed	477.2	428.9	2.6	t/hr
Prim cyclone A o/f	44.3	121.7	1.6	t/hr
Prim cyclone B o/f	44.3	121.7	1.6	t/hr
Prim cyclone A u/f	194.3	92.8	0.2	t/hr
Prim cyclone B u/f	194.3	92.8	0.2	t/hr
Pebble addition 1	2.7		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	197.0	92.8	0.3	t/hr
Peb mill 2 product	196.5	92.8	0.8	t/hr
Secondary dilution		14.6		t/hr
Sec cyclone feed	88.6	257.9	3.1	t/hr
Sec cyclone o/f	65.7	209.6	1.2	t/hr
Sec cyclone u/f	22.9	48.3	2.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	14.7	4.9	7.2	45.7	27.5	0.5
Prim cyc feed	23.4	24.1	24.0	24.6	3.9	1.4
Prim cyc A o/f	62.5	31.2	6.4	0.0	0.0	3.6
Prim cyc B o/f	62.5	31.2	6.4	0.0	0.0	4.2
Prim cyc A u/f	14.6	22.4	28.0	10.2	4.8	2.8
Prim cyc B u/f	14.6	22.4	28.0	30.2	4.8	2.2
Peb mill 1 disch	13.1	11.6	12.6	12.6	0.5	10.1
Peb mill 2 disch	11.7	13.7	14.0	10.3	0.5	10.1
Sec cyc feed	62.5	31.2	6.4	0.0	0.0	3.9
Sec cyc o/f	76.1	23.6	0.3	0.0	0.0	0.2
Sec cyc u/f	21.9	53.5	24.6	0.0	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	74	%
Sec cyc o/f moist	76	85	%
Peb mill moist	32	32	%

Test 11b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	65.1	3.3	1.5	t/hr
Rod mill dilution		20.6		t/hr
Rod mill discharge	65.1	23.9	1.5	t/hr
Primary dilution		176.0		t/hr
Prim cyclone feed	482.9	435.6	2.3	t/hr
Prim cyclone A o/f	45.3	124.1	1.7	t/hr
Prim cyclone B o/f	45.3	124.1	1.7	t/hr
Prim cyclone A u/f	196.1	93.7	0.6	t/hr
Prim cyclone B u/f	196.1	93.7		t/hr
Pebble addition 1	2.7		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	198.8	93.7	0.7	t/hr
Peb mill 2 product	198.3	93.7	1.2	t/hr
Secondary dilution		8.6		t/hr
Sec cyclone feed	90.6	256.8	3.4	t/hr
Sec cyclone o/f	70.0	208.5	1.3	t/hr
Sec cyclone u/f	20.6	48.3	2.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	14.1	3.8	5.3	42.0	34.2	0.7
Prim cyc feed	22.1	26.6	23.8	22.5	5.0	1.7
Prim cyc A o/f	67.3	29.1	3.6	0.0	0.0	7.3
Prim cyc B o/f	67.3	29.1	3.6	0.0	0.0	5.0
Prim cyc A u/f	11.8	25.9	28.4	27.7	6.2	5.1
Prim cyc B u/f	11.8	25.9	28.4	27.7	6.2	4.0
Peb mill 1 disch	12.6	13.7	13.3	10.0	0.5	10.2
Peb mill 2 disch	10.7	14.9	13.9	10.5	0.5	10.1
Sec cyc feed	67.3	29.1	3.6	0.0	0.0	6.2
Sec cyc o/f	79.1	20.5	0.4	0.0	0.0	0.3
Sec cyc u/f	24.7	59.5	15.9	0.0	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	74	%
Sec cyc o/f moist	75	85	%
Peb mill moist	32	32	%

Test 11a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	74.1	3.9	0.6	t/hr
Rod mill dilution		25.3		t/hr
Rod mill discharge	74.1	29.2	0.6	t/hr
Primary dilution		180.7		t/hr
Prim cyclone feed	454.1	443.2	1.4	t/hr
Prim cyclone A o/f	48.7	136.4	0.8	t/hr
Prim cyclone B o/f	48.7	136.4	0.8	t/hr
Prim cyclone A u/f	178.3	85.2	0.1	t/hr
Prim cyclone B u/f	178.3	85.2	0.1	t/hr
Pebble addition 1	2.7		0.1	t/hr
Pebble addition 2	2.2		0.1	t/hr
Peb mill 1 product	181.0	85.2	0.2	t/hr
Peb mill 2 product	180.5	85.2	0.7	t/hr
Secondary dilution		8.2		t/hr
Sec cyclone feed	97.5	280.9	1.7	t/hr
Sec cyclone o/f	79.0	218.1	0.7	t/hr
Sec cyclone u/f	18.5	62.8	2.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	14.9	4.3	6.3	37.4	37.1	0.2
Prim cyc feed	25.0	24.5	22.7	21.5	6.4	0.3
Prim cyc A o/f	68.2	28.6	3.1	0.1	0.0	7.0
Prim cyc B o/f	68.2	28.6	3.1	0.1	0.0	5.6
Prim cyc A u/f	13.2	23.3	28.0	27.3	8.2	1.6
Prim cyc B u/f	13.2	23.3	28.0	27.3	8.2	2.0
Peb mill 1 disch	15.4	12.5	12.8	9.1	0.5	10.1
Peb mill 2 disch	11.6	14.3	13.6	10.2	0.5	10.1
Sec cyc feed	68.2	28.6	3.1	0.1	0.0	6.3
Sec cyc o/f	77.8	21.6	0.5	0.1	0.0	0.3
Sec cyc u/f	25.8	59.8	14.5	0.0	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	73	85	%
Peb mill moist	32	32	%

Test 8c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	62.6	3.1	2.9	t/hr
Rod mill dilution		19.9		t/hr
Rod mill discharge	62.6	23.0	2.9	t/hr
Primary dilution		173.2		t/hr
Prim cyclone feed	446.2	446.2	1.5	t/hr
Prim cyclone A o/f	51.8	136.2	1.4	t/hr
Prim cyclone B o/f	51.8	136.2	1.4	t/hr
Prim cyclone A u/f	171.3	86.9	0.6	t/hr
Prim cyclone B u/f	171.3	86.9	0.6	t/hr
Pebble addition 1	5.3		0.2	t/hr
Pebble addition 2	3.3		0.2	t/hr
Peb mill 1 product	176.6	86.9	0.9	t/hr
Peb mill 2 product	174.6	86.9	2.9	t/hr
Secondary dilution		11.4		t/hr
Sec cyclone feed	103.6	283.8	2.8	t/hr
Sec cyclone o/f	71.3	207.6	2.7	t/hr
Sec cyclone u/f	32.3	76.2	0.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	14.4	8.8	12.1	46.6	18.2	0.7
Prim cyc feed	19.8	29.5	27.8	20.0	2.9	1.0
Prim cyc A o/f	58.0	30.9	11.2	0.0	0.0	5.6
Prim cyc B o/f	58.0	30.9	11.2	0.0	0.0	2.8
Prim cyc A u/f	8.4	29.0	32.8	26.0	3.8	1.6
Prim cyc B u/f	8.4	29.0	32.8	26.0	3.8	1.6
Peb mill 1 disch	14.3	13.6	12.6	8.6	0.5	10.3
Peb mill 2 disch	7.2	17.4	17.4	8.4	0.5	10.0
Sec cyc feed	58.0	30.9	11.2	0.0	0.0	2.6
Sec cyc o/f	78.5	20.9	0.6	0.0	0.0	0.9
Sec cyc u/f	12.5	52.8	34.7	0.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	72	73	%
Sec cyc o/f moist	74	83	%
Peb mill moist	33	33	%

Test 8b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	57.5	2.9	2.2	t/hr
Rod mill dilution		18.5		t/hr
Rod mill discharge	57.5	21.4	2.2	t/hr
Primary dilution		171.5		t/hr
Prim cyclone feed	446.7	441.1	1.7	t/hr
Prim cyclone A o/f	50.3	132.9	1.2	t/hr
Prim cyclone B o/f	50.3	132.9	1.2	t/hr
Prim cyclone A u/f	173.0	87.6	0.3	t/hr
Prim cyclone B u/f	173.0	87.6	0.3	t/hr
Pebble addition 1	5.4		0.1	t/hr
Pebble addition 2	3.3		0.1	t/hr
Peb mill 1 product	178.4	87.6	0.5	t/hr
Peb mill 2 product	176.4	87.6	2.5	t/hr
Secondary dilution		11.3		t/hr
Sec cyclone feed	100.7	277.2	2.4	t/hr
Sec cyclone o/f	66.2	204.2	1.9	t/hr
Sec cyclone u/f	34.4	[illegible]	0.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	11.7	15.3	12.1	55.6	5.4	0.5
Prim cyc feed	24.2	29.9	25.8	19.1	1.0	1.2
Prim cyc A o/f	57.6	30.0	12.5	0.0	0.0	6.0
Prim cyc B o/f	57.6	30.0	12.5	0.0	0.0	2.1
Prim cyc A u/f	14.6	29.8	29.7	24.6	1.3	4.7
Prim cyc B u/f	14.6	29.8	29.7	24.6	1.3	4.6
Peb mill 1 disch	14.0	16.3	11.8	7.8	0.3	10.1
Peb mill 2 disch	12.8	14.5	15.3	7.2	0.3	10.1
Sec cyc feed	57.6	30.0	12.5	0.0	0.0	3.2
Sec cyc o/f	77.5	21.9	0.5	0.1	0.0	0.3
Sec cyc u/f	18.7	45.6	35.6	0.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	83	%
Peb mill moist	33	33	%

Test 8a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	54.7	2.8	1.8	t/hr
Rod mill dilution		17.6		t/hr
Rod mill discharge	54.7	20.4	1.8	t/hr
Primary dilution		172.9		t/hr
Prim cyclone feed	452.5	443.2	0.1	t/hr
Prim cyclone A o/f	48.9	132.1	0.0	t/hr
Prim cyclone B o/f	48.	132.1	0.0	t/hr
Prim cyclone A u/f	177 .	89.5	0.1	t/hr
Prim cyclone B u/f	177.3	89.5	0.1	t/hr
Pebble addition 1	5.4		0.1	t/hr
Pebble addition 2	3.4		0.1	t/hr
Peb mill 1 product	182.8	89.5	0.2	t/hr
Peb mill 2 product	180.7	89.5	2.3	t/hr
Secondary dilution		10.8		t/hr
Sec cyclone feed	97.7	274.9	0.0	t/hr
Sec cyclone o/f	63.3	204.1	1.5	t/hr
Sec cyclone u/f	34.5	70.8	1.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	18.0	7.1	9.7	48.0	16.6	0.5
Prim cyc feed	28.6	26.8	23.7	18.6	2.4	0.8
Prim cyc A o/f	56.2	29.6	14.1	0.1	0.0	4.4
Prim cyc B o/f	56.2	29.6	14.1	0.1	0.0	2.9
Prim cyc A u/f	21.0	26.0	26.3	23.7	3.0	4.3
Prim cyc B u/f	21.0	26.0	26.3	23.7	3.0	1.5
Peb mill 1 disch	16.7	14.0	11.6	7.3	0.4	10.2
Peb mill 2 disch	14.4	14.1	13.0	8.5	0.4	10.1
Sec cyc feed	56.2	29.6	14.1	0.1	0.0	1.9
Sec cyc o/f	76.4	21.5	2.0	0.1	0.0	0.4
Sec cyc u/f	19.2	44.4	36.4	0.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	83	%
Peb mill moist	33	33	%

Test 7c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	51.6	2.6	1.4	t/hr
Rod mill dilution		16.4		t/hr
Rod mill discharge	51.6	19.0	1.4	t/hr
Primary dilution		156.8		t/hr
Prim cyclone feed	427.8	433.8	0.7	t/hr
Prim cyclone A o/f	49.3	133.8	0.2	t/hr
Prim cyclone B o/f	49.3	133.8	0.2	t/hr
Prim cyclone A u/f	164.6	83.1	0.5	t/hr
Prim cyclone B u/f	164.6	83.1	0.5	t/hr
Pebble addition 1	5.5		0.0	t/hr
Pebble addition 2	3.4		0.0	t/hr
Peb mill 1 product	170.1	83.1	0.5	t/hr
Peb mill 2 product	168.0	83.1	1.6	t/hr
Secondary dilution		25.1		t/hr
Sec cyclone feed	98.6	292.7	0.4	t/hr
Sec cyclone o/f	60.4	200.9	1.2	t/hr
Sec cyclone u/f	38.2	91.8	1.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	21.4	6.1	8.6	52.3	11.6	0.6
Prim cyc feed	25.2	27.3	27.5	18.2	1.7	1.1
Prim cyc A o/f	53.8	33.1	13.0	0.1	0.0	4.3
Prim cyc B o/f	53.8	33.1	13.0	0.1	0.0	2.4
Prim cyc A u/f	16.6	25.5	31.9	23.7	2.2	4.7
Prim cyc B u/f	16.6	25.5	31.9	23.7	2.2	2.2
Peb mill 1 disch	11.8	13.3	16.4	8.6	0.4	10.1
Peb mill 2 disch	14.5	14.8	13.4	6.5	0.4	10.2
Sec cyc feed	53.8	33.1	13.0	0.1	0.0	1.2
Sec cyc o/f	75.8	23.7	0.5	0.1	0.0	0.5
Sec cyc u/f	19.1	48.1	32.7	0.1	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	77	83	%
Peb mill moist	33	33	%

Test 7b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	57.2	2.9	2.6	t/hr
Rod mill dilution		18.3		t/hr
Rod mill discharge	57.2	21.2	2.6	t/hr
Primary dilution		158.1		t/hr
Prim cyclone feed	423.2	434.1	2.3	t/hr
Prim cyclone A o/f	51.0	136.1	0.7	t/hr
Prim cyclone B o/f	51.0	136.1	0.7	t/hr
Prim cyclone A u/f	160.6	81.0	0.4	t/hr
Prim cyclone B u/f	160.6	81.0	0.4	t/hr
Pebble addition 1	5.4		0.1	t/hr
Pebble addition 2	3.3		0.1	t/hr
Peb mill 1 product	165.0	81.0	0.3	t/hr
Peb mill 2 product	163.9	81.0	1.7	t/hr
Secondary dilution		27.2		t/hr
Sec cyclone feed	101.9	299.3	1.3	t/hr
Sec cyclone o/f	65.8	206.5	2.3	t/hr
Sec cyclone u/f	36.1	92.8	1.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	17.1	6.6	8.1	53.7	14.5	0.7
Prim cyc feed	26.0	29.3	26.0	16.4	2.3	1.7
Prim cyc A o/f	57.9	28.7	13.4	0.0	0.0	6.5
Prim cyc B o/f	57.9	28.7	13.4	0.0	0.0	3.1
Prim cyc A u/f	16.0	29.4	30.0	21.5	3.1	3.0
Prim cyc B u/f	16.0	29.4	30.0	21.5	3.1	2.2
Peb mill 1 disch	14.5	14.8	13.1	7.7	0.5	10.1
Peb mill 2 disch	14.1	16.5	14.8	4.0	0.5	10.2
Sec cyc feed	57.9	28.7	13.4	0.0	0.0	3.6
Sec cyc o/f	80.1	19.3	0.6	0.0	0.0	0.5
Sec cyc u/f	17.1	46.0	36.7	0.1	0.1	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	76	63	%
Peb mill moist	33	33	%

Test 7a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	55.0	2.7	3.1	t/hr
Rod mill dilution		17.3		t/hr
Rod mill discharge	55.0	20.0	3.1	t/hr
Primary dilution		154.9		t/hr
Prim cyclone feed	428.7	432.7	1.3	t/hr
Prim cyclone A o/f	50.0	133.2	0.8	t/hr
Prim cyclone B o/f	50.0	133.2	0.8	t/hr
Prim cyclone A u/f	164.3	83.2	0.1	t/hr
Prim cyclone B u/f	164.3	83.2	0.1	t/hr
Pebble addition 1	5.4		0.1	t/hr
Pebble addition 2	3.3		0.1	t/hr
Peb mill 1 product	169.7	83.2	0.3	t/hr
Peb mill 2 product	167.6	83.2	2.3	t/hr
Secondary dilution		36.6		t/hr
Sec cyclone feed	100.0	303.0	1.5	t/hr
Sec cyclone o/f	63.8	211.5	3.0	t/hr
Sec cyclone u/f	36.3	91.5	1.5	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	20.0	6.5	8.7	53.6	11.1	1.0
Prim cyc feed	24.3	28.9	26.1	19.0	1.8	2.3
Prim cyc A o/f	55.2	32.5	12.4	0.0	0.0	4.7
Prim cyc B o/f	55.2	32.5	12.4	0.0	0.0	2.2
Prim cyc A u/f	14.9	27.8	30.3	24.7	2.3	2.7
Prim cyc B u/f	14.9	27.8	30.3	24.7	2.3	2.7
Peb mill 1 disch	12.9	15.8	13.7	7.3	0.4	10.1
Peb mill 2 disch	12.6	14.8	14.5	8.0	0.4	10.1
Sec cyc feed	55.2	32.5	12.4	0.0	0.0	1.3
Sec cyc o/f	75.6	24.1	0.4	0.0	0.0	1.1
Sec cyc u/f	19.5	47.1	33.4	0.1	0.0	0.0

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	73	73	%
Sec cyc o/f moist	77	83	%
Peb mill moist	33	33	%

APPENDIX H MICROSIM program listing

```
{=============================================================================
=============}
{                    MICROSIM : Ore dressing models
          }
{                              (C) R.P.King
          }
{=============================================================================
=============}
{ Model by QP Campbell
          }
{-----------------------------------------------------------------------------
-------------}
{-----------------------------------------------------------------------------
-------------}
{ Primary Cyclone Model
          }
{   Plitt's updated cyclone model, adapted for EDGM primary
cyclone          }
{-----------------------------------------------------------------------------
-------------}
OVERLAY PROCEDURE PRIMCYC(VAR stm       : Stms;
                             point     : ToUnit;
                             type_num : UniTypes);

VAR
 FeedPt,OfPt,UfPt                                          : ToR4;
 FeedH2o,OfH2o,UfH2o                                       : ToR6;
 dc,di,d_o,du,h,f1,f2,f3,f4,dens_exp,visc,p_in,parall      : REAL;
 y,phi,sg,s,slope,rs_guess,rs_calc,uf_flow,d50_factor      : REAL;
 d50c,partition,rs_error,feed_mass,uf_mass,of_mass         : REAL;
 ydash,sum,rf,pu,t1,rhs,ri                                 : REAL;
 i,j,k,l,m,iter                                            : INTEGER;
 po,theorat_po                                             : Real;
 temps                                                     :
String[20];

BEGIN
 WITH point^ DO
 BEGIN
  du:=param[1];                          {Spigot diameter in cm
   }
  f1:=param[2];                          {Correction factors
   }
  f2:=param[3];
  f4:=param[4];
 END;

 dc:=68.6;
 h:=202.5;
 di:=14.7;
 d_o:=25.5;
 parall:=2;
 dens_exp:=0.5;
 visc:=1;
 FeedPt:=SolidSelect(str[point^.inout,2]);
```

```
                    alpha:=am*(feedpt^.tonnes)*3.6+ac;
    gamma:=0.687;
    beta :=3.125;
    Phi5 :=0.269;

      With system Do
      Begin
       For i:=1 To ndc Do
       Begin
        select[i]:=S1*Pow(size[i]/size[1],alpha);
        If (i=ndc) Then select[i]:=0.0;
        For j:=1 To ngc Do
         For k:=1 To nsc Do
          For l:=1 To n4c Do
           For m:=1 To n5c Do
           Begin
            fraction := SolidValue(i,j,k,l,m,feedpt)/(1.0 +
tau*select[i]);
            SolidPut(i,j,k,l,m,prodpt,fraction);
           End;
       End;

       For i:=2 To ndc D
       Begin
        l:=i-1;
        For ii:=1 to l Do
        Begin
         szj:=size[i-1]/size[ii];
         szl:=0.0;
         If i<>ndc Then szl:=size[i]/size[ii];
         bij:=phi5*Pow(szj,gamma)+(1-phi5)*Pc (szj,beta) ;
         bil:=phi5*Pow(szl,gamma)+(1-phi5)*Pow(szl,beta) ;

         bs:=bij-bil ;
         fr:=tau/(1.0+tau*select[i])*select[ii]*bs;

         For j:=1 To ngc Do
          For k:=1 To nsc Do
           For l:=1 To n4c Do
            For m:=1 To n5c Do
            Begin

fraction:=SolidValue(i,j,k,l,m,prodpt)+fr*SolidValue(ii,j,k,l,m,pr
odpt);
             SolidPut(i,j,k,l,m,prodpt,fraction);
            End;
        End;
       End;
      End;
 End;
{**********************************************************************
**********}

{**********************************************************************
**********}
{ ROD MILL
          }
{ This is a simple model for a rod-mill.
          }
```

```
END;
{-------------------------------------------------------------------
-------------}
{  PEBBLE MODEL
        }
{     Breakage & Selection function model. Based on Austin,
Klimpel and Luckie}
{     correlations for the selection and breakage functions.
Assumed that the }
{     mill is a single, well-mixed reactor.
        }
{
        }
{     Model parameters are :
        }
{     1)  Selection function at top size
        }
{-------------------------------------------------------------------
-------------}
Overlay Procedure QCPebblemill(Var stm      : stms;
                               point    : tounit;
                               type_num : UniTypes);

 Var
  feedpt,prodpt              : Tor4;
  feedh2o,prodh2o            : Tor6;
  alpha,beta,gamma,Si        : Real ;
  Phi5,slm,slc,am,ac         : Real;
  tau,sxj,sxl,bij,bil,ba,fr  : Real ;
  fraction                   : Real ;
  i,j,k,l,m,ii               : Integer ;
  select                     : Array[sizrange] of Real ;
  Holdup                     : Real;

 Begin
  feedpt:=SolidSelect(stm[point^.inout[2]]) ;
  prodpt:=SolidSelect(stm[point^.inout[4]]) ;

  feedh2o:=LixivSelect(stm[point^.inout[2]]) ;
  prodh2o:=LixivSelect(stm[point^.inout[4]]) ;

  prodpt^.tonnes:=feedpt^.tonnes;
  prodh2o^.flow:=feedh2o^.flow;

  Holdup := 11.4;

  With point^ Do Tau:=((HoldUp*1000)/FeedPt^.Tonnes)/60;  {Tau in
minutes}

   {parameters}
  With point^ do begin
   Slm:=param[1];
   Slc:=param[2];       {Selection rate at top size, per min   }
   am :=param[3];
   ac :=param[4];
   end;
   if (~slm/slc)>1/((feedpt^.tonnes)*3.6) then s1:=1 else
                  Si:=slm*(feedpt^.tonnes)*3.6+Slc;
   if (~am/ac)>1/((feedpt^.tonnes)*3.6) then alpha:=1 else
```

```
    FOR i:=1 TO ndc DO
    BEGIN
     t1:=-0.693*POW(size[i]/d50c,slope);
     IF (t1<-40) THEN ydash:=1.0
     ELSE ydash:=1.0-EXP(t1);
     IF ydash<0.0 THEN ydash:=0.0
     ELSE
      IF ydash>1.0 THEN ydash:=1.0;
     sum:=0.0;
     FOR k:=1 TO n3c DO
      FOR l:=1 TO n4c DO
       FOR m:=1 TO n5c DO
        sum:=sum+SolidValue(i,j,k,l,m,FeedPt);
     uf_flow:=uf_flow+sum*ydash;
    END;
   END;

   IF feedpt^.Tonnes<=0.0 THEN Rf:=1.0
   ELSE Rf:=(s/(s+1.0)-phi/100.0/feedpt^.tonnes*uf_flow)/
            (1.0-phi/100.0/feedpt^.tonnes*uf_flow);

   IF Rf>1.0 THEN Rf:=1.0
   ELSE IF Rf<0.0 THEN Rf:=0.0;

   if size[i]<30*1e-6 then
   Ri:=Rf*(1-size[i]/(30*1e-6))
   else ri:=0;

   UfPt^.Tonnes:=0.0;                    OfPt^.Tonnes:=0.0;
   FOR j:=1 TO ngc DO
   BEGIN
    d50c:=d50_factor/POW((grav[j]-1.0)/1.6,dens_exp);
    FOR i:=1 TO ndc DO
    BEGIN
     t1:=-0.693*POW(size[i]/d50c,slope);
     IF (t1<-40.0) THEN partition:=1.0
     ELSE partition:=(1.0-EXP(t1))*(1.0-Ri)+Ri;

     IF partition<0.0 THEN partition:=0.0
     ELSE IF partition>1.0 THEN partition:=1.0;

     FOR k:=1 TO n3c DO
      FOR l:=1 TO n4c DO
       FOR m:=1 TO n5c DO
       BEGIN
        feed_mass:=SolidValue(i,j,k,l,m,FeedPt);
        uf_mass:=partition*feed_mass;
        of_mass:=feed_mass-uf_mass;
        SolidPut(i,j,k,l,m,UfPt,uf_mass);
        SolidPut(i,j,k,l,m,OfPt,of_mass);
        UfPt^.Tonnes:=UfPt^.Tonnes+uf_mass;
        OfPt^.Tonnes:=OfPt^.Tonnes+of_mass;
       END;
    END;
   END;
  END;

  UfH2o^.Flow:=FeedH2O^.Flow*Rf;
  OfH2o^.Flow:=FeedH2o^.Flow-UfH2o^.Flow;
```

```
 sg:=Ore_Density(FeedPt);                          {Ore feed SG,
tons/m3          }
 IF sg<=0.0 THEN q:=FeedH2o^.Flow/1000.0                {Flow in m3
per second }
 ELSE q:=(FeedPt^.Tonnes/sg+FeedH2o^.Flow)/1000.0;      {Flow in m3
per second }
 q:=q/paral1;                                    {Volume flow to each
cyclone, m3/s}

p_in:=1.88*POW(q*60000.0,1.78)*EXP(0.0055*phi)/

(POW(dc,0.37)*POW(di,0.94)*POW(h,0.28)*POW((du*du+d_o*d_o),0.87));
                                                 {Cyclone inlet pressure,
KPa          }

 IF p_in<=0.0 THEN s:=0.0
 ELSE
s:=f4*3.29*POW(Pulp_RD(point^.inout[2]),0.24)*POW(du/d_o,3.31)*POW
(h,0.54)*

POW(du*du+d_o*d_o,0.36)*EXP(0.0054*phi)/POW(dc,1.11)/POW(p_in,0.24
);
                                                 {Volumetric flow split
          }

 IF q<=0.0 THEN slope:=0.0
 ELSE
slope:=f2*1.94*EXP(-1.58*s/(1.0+s))*POW(dc*dc*h/(q*60000.0),0.15);
                                                 {Partition curve slope.
          }

 IF q<=0.0 THEN d50_factor:=1
 ELSE
d50_factor:=f1*39.7*POW(dc,0.46)*Pow(di,0.6)*POW(d_o,1.21)*SQRT(v.
sc)

*EXP(0.063*phi)/(POW(du,0.71)*POW(h,0.38)*POW(q*60000.0,0.45))*1E-
6;
                                                 {Corrected D50 in meters
          }

writeln(msg_fil,phi:6:2,(q*60000.0):8:1,p_in:6:1,s:6:3,slope:6:3,d
50_factor/1e-6:8:2);
 WITH system DO
 BEGIN
  uf_flow:=0.0;
  FOR j:=1 TO ngc DO
  BEGIN
   IF (grav[j]<1.0) THEN
   BEGIN
    STR(j,temps);
    UpdateWindow(3,'Error in Plitt cyclone model : SG of gravity
class '+temps+' <1.0');
    Beep(300,1000);
    d50c:=d50_factor;
   END
   ELSE
    d50c:=d50_factor/POW((grav[j]-1.0)/1.6,dens_exp);
```

```
  END;
 END;

 UfH2o^.Flow:=FeedH2O^.Flow*Rf;
 OfH2o^.Flow:=FeedH2o^.Flow-UfH2o^.Flow;

END;
{-------------------------------------------------------------------
-------------}
{ Seconary Cyclone Model
        }
{   Plitt's updated cyclone model, adapted for EDGM seconadary
cyclone        }
{-------------------------------------------------------------------
-------------}
OVERLAY PROCEDURE SECCYC(VAR stm      : Stms;
                             point    : ToUnit;
                             type_num : UniTypes);

VAR
 FeedPt,OfPt,UfPt                                          : ToR4;
 FeedH2o,OfH2o,UfH2o                                       : ToR6;
 dc,di,d_o,du,h,f1,f2,f3,f4,dens_exp,visc,p_in,parall      : REAL;
 q,phi,sg,s,slope,rs_guess,rs_calc,uf_flow,d50_factor      : REAL;
 d50c,partition,rs_error,feed_mass,uf_mass,of_mass         : REAL;
 ydash,sum,rf,pu,tl,rhs,ri                                 : REAL;
 i,j,k,l,m,iter                                            : INTEGER;
 po,theorat_po                                             : Real;
 temps                                                     :
String[20];

BEGIN
 WITH point^ DO
 BEGIN
  du:=param[1];                          {Spigot diameter in cm
   }
  f1:=param[2];                          {Correction factors
   }
  f2:=param[3];
  f4:=param[4];
 END;

 dc:=91.4;
 h:=263.5;
 di:=20.3;
 d_o:=36;
 parall:=1;
 dens_exp:=0.5;
 visc:=1;
 FeedPt:=SolidSelect(stm[point^.inout[2]]);
 UfPt  :=SolidSelect(stm[point^.inout[4]]);
 OfPt  :=SolidSelect(stm[point^.inout[5]]);

 FeedH2o:=LixivSelect(stm[point^.inout[2]]);
 UfH2o  :=LixivSelect(stm[point^.inout[4]]);
 OfH2o  :=LixivSelect(stm[point^.inout[5]]);

 phi:=Volume_Percent_Solids(point^.inout[3]); {Volume percent
solids in feed  }
```

```
  d50c:=d50_factor;
 END
 ELSE
  d50c:=d50_factor/POW((grav[j]-1.0)/1.6,dens_exp);

 FOR i:=1 TO ndc DO
 BEGIN
  t1:=-0.693*POW(size[i]/d50c,slope);
  IF (t1<-40) THEN ydash:=1.0
  ELSE ydash:=1.0-EXP(t1);
  IF ydash<0.0 THEN ydash:=0.0
  ELSE
   IF ydash>1.0 THEN ydash:=1.0;
  sum:=0.0;
  FOR k:=1 TO nsc DO
   FOR l:=1 TO n4c DO
    FOR m:=1 TO n5c DO
     sum:=sum+SolidValue(i,j,k,l,m,FeedPt);
  uf_flow:=uf_flow+sum*ydash;
 END;
END;

IF feedpt^.Tonnes<=0.0 THEN Rf:=1.0
ELSE Rf:=(s/(s+1.0)-phi/100.0/feedpt^.tonnes*uf_flow)/
         (1.0-phi/100.0/feedpt^.tonnes*uf_flow);

IF Rf>1.0 THEN Rf:=1.0
ELSE IF Rf<0.0 THEN Rf:=0.0;

if size[i]<30*1e-6 then
Ri:=Rf*(1-size[i]/(30*1e-6))
else ri:=0;

UfPt^.Tonnes:=0.0;                    OfPt^.Tonnes:=0.0;
FOR j:=1 TO ngc DO
BEGIN
 d50c:=d50_factor/POW((grav[j]-1.0)/1.6,dens_exp);
 FOR i:=1 TO ndc DO
 BEGIN
  t1:=-0.693*POW(size[i]/d50c,slope);
  IF (t1<-40.0) THEN partition:=1.0
  ELSE partition:=(1.0-EXP(t1))*(1.0-Ri)+Ri;

  IF partition<0.0 THEN partition:=0.0
  ELSE IF partition>1.0 THEN partition:=1.0;

  FOR k:=1 TO nsc DO
   FOR l:=1 TO n4c DO
    FOR m:=1 TO n5c DO
    BEGIN
     feed_mass:=SolidValue(i,j,k,l,m,FeedPt);
     uf_mass:=partition*feed_mass;
     of_mass:=feed_mass-uf_mass;
     SolidPut(i,j,k,l,m,UfPt,uf_mass);
     SolidPut(i,j,k,l,m,OfPt,of_mass);
     UfPt^.Tonnes:=UfPt^.Tonnes+uf_mass;
     OfPt^.Tonnes:=OfPt^.Tonnes+of_mass;
    END;
 END;
```

```
 UfPt   :=SolidSelect(stm[point^.inout[4]]);
 OfPt   :=SolidSelect(stm[point^.inout[5]]);

 FeedH2o:=LixivSelect(stm[point^.inout[2]]);
 UfH2o  :=LixivSelect(stm[point^.inout[4]]);
 OfH2o  :=LixivSelect(stm[point^.inout[5]]);

 phi:=Volume_Percent_Solids(point^.inout[2]); {Volume percent
solids in feed  }
 sg:=Ore_Density(FeedPt);                     {Ore feed SG,
tons/m3          }
 IF sg<=0.0 THEN q:=FeedH2o^.Flow/1000.0                {Flow in m3
per second }
 ELSE q:=(FeedPt^.Tonnes/sg+FeedH2o^.Flow)/1000.0;      {Flow in m3
per second }
 q:=q/parall;                                  {Volume flow to each
cyclone, m3/s}
p_in:=1.88*POW(q*60000.0,1.78)*EXP(0.0055*phi)/

(POW(dc,0.37)*POW(di,0.94)*POW(h,0.28)*POW((du*du+d_o*d_o),0.87));
                                              {Cyclone inlet pressure,
KPa            }
 if f4=0 then
 f4:=1.181*Pow((d_o/du),0.151)*Exp(Phi*0.067);
 IF p_in<=0.0 THEN s:=0.0
 ELSE
s:=f4*3.286*POW(Pulp_RD(point^.inout[2]),0.24)*POW(du/d_o,3.31)*PO
W(h,0.54)*

POW(du*du+d_o*d_o,0.36)*EXP(0.0084*phi)/POW(dc,1.11)/POW(p_in,0.24
);
                                              {Volumetric flow split
          }
 IF q<=0.0 THEN slope:=0.0
 ELSE
slope:=f2*1.94*EXP(-1.58*s/(1.0+s))*POW(dc*dc*h/(q*60000.0),0.15);
                                              {Partition curve slope.
          }
 IF q<=0.0 THEN d50_factor:=1
 ELSE
d50_factor:=f1*39.7*POW(dc,0.46)*Pow(di,0.6)*POW(d_o,1.21)*SQRT(vi
sc)

*EXP(0.063*phi)/(POW(du,0.71)*POW(h,0.38)*POW(q*60000.0,0.45))*1E-
6;
                                              {Corrected D50 in meters
          }

 WITH system DO
 BEGIN
  uf_flow:=0.0;
  FOR j:=1 TO ngc DO
  BEGIN
   IF (grav[j]<1.0) THEN
   BEGIN
    STR(j,temps);
    UpdateWindow(3,'Error in Plitt cyclone model : SG of gravity
class '+temps+' <1.0');
    Beep(300,1000);
```

APPENDIX G List of all model parameters

Test	Rod Mill		Pebble mill 1		Pebble mill 2		Primary cyclone			Secondary cyclone		
	d_{50}	slope	S(1)	α	S(1)	α	F_1	F_2	F_4	F_3	F_5	F_6
1a	998.4	0.960	0.510	1.015	1.380	1.509	0.304	0.322	6.460	0.344	0.239	17.430
1b	1151.2		1.376	1.119		1.822	0.271	0.345	5.880	0.454	0.254	15.800
1c	1244.6	0.897	1.162	1.377	1.097	1.089	0.313	0.369	5.950	0.306	0.243	16.440
2a	1154.9	0.991					0.331	0.373	5.840	0.289	0.238	16.650
2b	1329.9	0.803	1.393	1.324	1.025	1.242	0.288	0.387	5.870	0.321	0.250	15.220
2c	1494.7		0.500	0.882	0.978	1.264	0.366	0.351	6.370	0.355	0.250	15.290
3a	1312.0	0.778	0.920	0.898	1.425	1.048	0.204	0.360	7.320	0.885	0.355	17.300
3b	1895.5	1.006		1.717		1.735	0.231	0.386	7.320	0.632	0.317	17.490
3c	2278.9	0.953	0.408	0.821	0.443	0.813	0.216	0.404	7.930	0.408	0.263	15.430
4a	2109.5	0.836	0.810	0.905	0.721	0.930	0.178	0.385	7.460	0.543	0.305	13.900
4b	2011.4	0.730	0.338	0.973	0.660	0.924	0.258	0.407	6.850	0.180	0.210	15.860
4c	1781.9	0.754	0.261	0.770	0.541	0.879	0.201	0.379	7.420	0.545	0.296	16.760
5a	1477.8	0.804		1.685		1.205	0.205	0.406	8.380	0.513	0.291	16.150
5b	1358.4	0.741	0.648	1.022	0.443	0.837	0.205	0.428	8.040	0.480	0.293	15.190
5c	1519.7	0.593	0.282	0.895	0.274	0.768	0.194	0.433	7.620	0.770	0.343	17.060
6a	799.3	0.719					0.301	0.388	8.790	0.344	0.230	14.330
6b	910.1	0.760	0.965	0.586	0.492	0.726	0.261	0.356	8.460	0.357	0.232	15.090
6c	780.2	0.686	1.169	0.692	0.687	0.677	0.267	0.404	8.050	0.401	0.274	15.180
7a	626.7	0.713	0.618	0.498	0.790	0.591	0.226	0.381	9.460	0.495	0.260	14.040
7b	759.3	0.733	0.665	0.558	3.390	1.159	0.219	0.397	8.780	0.430	0.240	15.160
7c	638.0	0.708	0.789	0.834	0.998	0.719	0.235	0.392	9.430	0.396	0.269	14.480
8a	776.8	0.697	0.430	0.392	0.329	0.417	0.242	0.379	9.110	0.416	0.277	13.690
8b	841.0	0.956	0.696	0.558	0.935	0.701	0.258	0.402	8.390	0.366	0.286	15.710
8c	814.3	0.732	0.285	0.152	0.656	0.862	0.244	0.382	8.430	0.432	0.294	14.570
11a	1026.8	0.584	0.382	0.339	0.263	0.411	0.219	0.456	11.480	0.424	0.280	14.590
11b	1077.1	0.615	1.077	0.696	1.247	0.864	0.180	0.366	13.380	0.469	0.260	13.800
11c	1248.4	0.663	0.281	0.161	0.666	0.870	0.211	0.368	13.040	0.424	0.298	15.020
12a	1626.3	0.667	0.334	0.150	0.587	0.980	0.149	0.389	11.920	0.370	0.267	16.640
12b	1483.7	0.619	0.190	0.092	0.446	0.424	0.167	0.384	12.520	0.441	0.257	14.660
12c	1338.0	0.656	0.294	0.160	0.605	0.847	0.187	0.358	12.270	0.420	0.294	14.930
13a	645.5	0.752	0.327	0.440	0.463	0.632	0.181	0.340	12.890	0.272	0.227	14.730
13b	928.6	0.809	0.389	0.528	0.652	0.627	0.246	0.362	11.530	0.569	0.279	14.580
13c	1356.8	0.670	0.293	0.821	0.525	0.546	0.206	0.345	10.640	0.451	0.300	15.750

Missing values represent outliers or unsuccessful regression attempts

Test 13c smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	63.1	3.3	0.8	t/hr
Rod mill dilution		20.6		t/hr
Rod mill discharge	63.1	23.9	0.8	t/hr
Primary dilution		202.9		t/hr
Prim cyclone feed	439.1	455.8	1.2	t/hr
Prim cyclone A o/f	52.5	148.3	0.4	t/hr
Prim cyclone B o/f	52.5	148.3	0.4	t/hr
Prim cyclone A u/f	167.0	79.6	0.2	t/hr
Prim cyclone B u/f	167.0	79.6	0.2	t/hr
Pebble addition 1	2.8		0.0	t/hr
Pebble addition 2	2.3		0.0	t/hr
Peb mill 1 product	169.8	79.6	0.2	t/hr
Peb mill 2 product	169.3	79.6	0.3	t/hr
Secondary dilution		7.9		t/hr
Sec cyclone feed	105.0	304.4	0.8	t/hr
Sec cyclone o/f	67.9	234.7	0.5	t/hr
Sec cyclone u/f	37.1	69.7	0.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	14.4	4.6	6.4	45.5	29.2	0.3
Prim cyc feed	22.7	30.5	22.2	20.0	4.6	0.6
Prim cyc A o/f	59.1	38.2	2.7	0.1	0.0	1.8
Prim cyc B o/f	59.1	38.2	2.7	0.1	0.0	1.6
Prim cyc A u/f	11.3	28.1	28.3	26.3	6.0	2.2
Prim cyc B u/f	11.3	28.1	28.3	26.3	6.0	0.8
Peb mill 1 disch	11.6	15.9	13.1	9.2	0.5	10.1
Peb mill 2 disch	12.9	14.8	13.7	8.2	0.5	10.2
Sec cyc feed	59.1	38.2	2.7	0.1	0.0	1.5
Sec cyc o/f	80.2	19.6	0.1	0.1	0.0	0.1
Sec cyc u/f	20.3	72.1	7.6	0.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	78	85	%
Peb mill moist	32	32	%

Test 13b smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	60.7	3.1	1.0	t/hr
Rod mill dilution		20.1		t/hr
Rod mill discharge	60.7	23.2	1.0	t/hr
Primary dilution		197.6		t/hr
Prim cyclone feed	434.8	453.9	0.1	t/hr
Prim cyclone A o/f	51.7	147.9	0.2	t/hr
Prim cyclone B o/f	51.7	147.9	0.2	t/hr
Prim cyclone A u/f	165.6	79.1	0.2	t/hr
Prim cyclone B u/f	165.6	79.1	0.2	t/hr
Pebble addition 1	2.8		0.0	t/hr
Pebble addition 2	2.3		0.0	t/hr
Peb mill 1 product	163.4	79.1	0.2	t/hr
Peb mill 2 product	167.9	79.1	0.3	t/hr
Secondary dilution		7.9		t/hr
Sec cyclone feed	103.5	303.7	0.4	t/hr
Sec cyclone o/f	65.8	228.7	1.0	t/hr
Sec cyclone u/f	37.7	75.0	1.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	12.2	7.4	9.7	51.7	19.0	0.3
Prim cyc feed	21.7	31.5	25.4	18.4	3.0	0.8
Prim cyc A o/f	.1	40.7	4.2	0.1	0.0	2.6
Prim cyc B o/f	55.1	40.7	4.2	0.1	0.0	0.8
Prim cyc A u/f	11.2	28.6	32.0	24.1	3.9	1.2
Prim cyc B u/f	11.2	28.6	32.0	24.1	3.9	1.1
Peb mill 1 disch	10.6	16.7	14.7	7.9	0.4	10.1
Peb mill 2 disch	12.6	15.3	15.1	6.5	0.4	10.2
Sec cyc feed	55.1	40.7	4.2	0.1	0.0	1.7
Sec cyc o/f	73.4	26.4	0.2	0.1	0.0	0.5
Sec cyc u/f	23.3	65.5	11.2	0.1	0.0	0.2

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	78	85	%
Peb mill moist	32	32	%

Test 13a smoothed mass balance

Stream	Solids	Water	Adj	
Rod mill feed	48.3	2.5	1.5	t/hr
Rod mill dilution		15.8		t/hr
Rod mill discharge	48.3	18.3	1.5	t/hr
Primary dilution		190.9		t/hr
Prim cyclone feed	448.5	444.3	1.5	t/hr
Prim cyclone A o/f	48.6	138.6	0.1	t/hr
Prim cyclone B o/f	48.6	138.6	0.1	t/hr
Prim cyclone A u/f	175.6	83.5	0.8	t/hr
Prim cyclone B u/f	175.6	83.5	0.8	t/hr
Pebble addition 1	2.8		0.0	t/hr
Pebble addition 2	2.3		0.0	t/hr
Peb mill 1 product	178.3	83.5	0.7	t/hr
Peb mill 2 product	177.8	83.5	0.2	t/hr
Secondary dilution		7.8		t/hr
Sec cyclone feed	97.3	285.1	0.1	t/hr
Sec cyclone o/f	53.2	217.0	1.2	t/hr
Sec cyclone u/f	44.2	68.1	1.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700	Adj
Rod mill discharge	18.9	7.4	10.0	52.5	11.2	0.4
Prim cyc feed	22.1	30.6	27.4	18.3	1.5	0.8
Prim cyc A o/f	58.1	35.5	6.4	0.0	0.0	0.5
Prim cyc B o/f	58.1	35.5	6.4	0.0	0.0	1.0
Prim cyc A u/f	12.2	29.2	33.2	23.4	1.9	2.1
Prim cyc B u/f	12.2	29.2	33.2	23.4	1.9	1.1
Peb mill 1 disch	11.6	14.4	15.6	8.1	0.4	10.1
Peb mill 2 disch	10.6	13.5	15.9	7.8	0.4	10.1
Sec cyc feed	58.1	35.5	6.4	0.0	0.0	0.4
Sec cyc o/f	85.6	14.2	0.1	0.0	0.0	0.2
Sec cyc u/f	24.9	61.1	14.0	0.1	0.0	0.1

Check for accuracy:

	Calc	Meas	
Prim cyc o/f moist	74	74	%
Sec cyc o/f moist	80	86	%
Peb mill moist	32	32	%

Test 3c modelled mass balance

Stream	Solids	Water	
Rod mill feed	66.4	3.0	t/hr
Rod mill dilution		22.7	t/hr
Rod mill discharge	66.4	25.7	t/hr
Primary dilution		201.3	t/hr
Prim cyclone feed	463.7	413.2	t/hr
Prim cyclone A o/f	66.3	134.7	t/hr
Prim cyclone B o/f	66.3	134.7	t/hr
Prim cyclone A u/f	165.7	72.0	t/hr
Prim cyclone B u/f	165.7	72.0	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	169.0	72.0	t/hr
Peb mill 2 product	169.4	72.0	t/hr
Secondary dilution		10.3	t/hr
Sec cyclone feed	132.6	279.6	t/hr
Sec cyclone o/f	73.7	237.4	t/hr
Sec cyclone u/f	58.9	42.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.1	6.2	6.8	46.4	31.5
Prim cyc feed	23.3	24.0	29.6	17.1	6.0
Prim cyc A o/f	50.3	29.1	19.6	0.9	0.0
Prim cyc B o/f	50.3	29.1	19.6	0.9	0.0
Prim cyc A u/f	12.5	21.9	33.5	23.6	8.3
Prim cyc B u/f	12.5	21.9	33.5	23.6	8.3
Peb mill 1 disch	24.6	25.5	33.7	14.3	2.0
Peb mill 2 disch	25.5	25.6	33.3	13.7	1.9
Sec cyc feed	50.3	29.1	19.6	0.9	0.0
Sec cyc o/f	67.1	23.9	9.0	0.0	0.0
Sec cyc u/f	29.4	35.7	32.8	2.1	0.0

PCF = 588.2 m3 per hour
PCD = 1.491
PSM = 67.1 % passing 75 microns

Test 3c modelled mass balance

Stream	Solids	Water	
Rod mill feed	66.4	3.0	t/hr
Rod mill dilution		22.7	t/hr
Rod mill discharge	66.4	25.7	t/hr
Primary dilution		201.3	t/hr
Prim cyclone feed	463.7	413.2	t/hr
Prim cyclone A o/f	66.3	134.7	t/hr
Prim cyclone B o/f	66.3	134.7	t/hr
Prim cyclone A u/f	165.7	72.0	t/hr
Prim cyclone B u/f	165.7	72.0	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	169.0	72.0	t/hr
Peb mill 2 product	169.4	72.0	t/hr
Secondary dilution		10.3	t/hr
Sec cyclone feed	132.6	279.6	t/hr
Sec cyclone o/f	73.7	237.4	t/hr
Sec cyclone u/f	58.9	42.2	t/hr

Size analysis

Stream	-75	-180+75	-250+180	-1700+250	+1700
Rod mill discharge	9.1	6.2	6.8	46.4	31.5
Prim cyc feed	23.3	24.0	29.6	17.1	6.0
Prim cyc A o/f	50.3	29.1	19.6	0.9	0.0
Prim cyc B o/f	50.3	29.1	19.6	0.9	0.0
Prim cyc A u/f	12.5	21.9	33.5	23.6	8.3
Prim cyc B u/f	12.5	21.9	33.5	23.6	8.3
Peb mill 1 disch	24.6	25.5	33.7	14.3	2.0
Peb mill 2 disch	25.5	25.6	33.3	13.7	1.9
Sec cyc feed	50.3	29.1	19.6	0.9	0.0
Sec cyc o/f	67.1	23.9	9.0	0.0	0.0
Sec cyc u/f	29.4	35.7	32.8	2.1	0.0

PCF = 588.2 m3 per hour
PCD = 1.491
PSM = 67.1 % passing 75 microns

Test 3b modelled mass balance

Stream	Solids	Water	
Rod mill feed	69.6	3.0	t/hr
Rod mill dilution		23.9	t/hr
Rod mill discharge	69.6	26.9	t/hr
Primary dilution		201.1	t/hr
Prim cyclone feed	477.2	417.6	t/hr
Prim cyclone A o/f	68.4	135.0	t/hr
Prim cyclone B o/f	68.4	135.0	t/hr
Prim cyclone A u/f	170.2	73.8	t/hr
Prim cyclone B u/f	170.2	73.8	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	173.5	73.8	t/hr
Peb mill 2 product	173.9	73.8	t/hr
Secondary dilution		10.2	t/hr
Sec cyclone feed	136.8	280.3	t/hr
Sec cyclone o/f	76.6	238.3	t/hr
Sec cyclone u/f	60.2	42.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.5	5.8	6.4	45.1	34.2
Prim cyc feed	23.4	23.2	29.1	17.6	6.7
Prim cyc A o/f	50.4	28.5	19.9	1.1	0.0
Prim cyc B o/f	50.4	28.5	19.9	1.1	0.0
Prim cyc A u/f	12.5	21.0	32.8	24.3	9.4
Prim cyc B u/f	12.5	21.0	32.8	24.3	9.4
Peb mill 1 disch	25.0	24.6	33.0	14.9	2.4
Peb mill 2 disch	25.0	24.7	32.7	14.5	2.3
Sec cyc feed	50.4	28.5	19.9	1.1	0.0
Sec cyc o/f	67.1	23.6	9.3	0.0	0.0
Sec cyc u/f	29.3	34.8	33.5	2.5	0.0

PCF = 597.7 m3 pc" hour
PCD = 1.497
PSM = 67.1 % passing 75 microns

Test 3a modelled mass balance

Stream	Solids	Water	
Rod mill feed	70.5	3.0	t/hr
Rod mill dilution		24.3	t/hr
Rod mill discharge	70.5	27.3	t/hr
Primary dilution		195.9	t/hr
Prim cyclone feed	476.8	412.7	t/hr
Prim cyclone A o/f	68.7	132.3	t/hr
Prim cyclone B o/f	68.7	132.3	t/hr
Prim cyclone A u/f	169.5	74.0	t/hr
Prim cyclone B u/f	169.5	74.0	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	172.8	74.0	t/hr
Peb mill 2 product	173.2	74.0	t/hr
Secondary dilution		11.4	t/hr
Sec cyclone feed	137.4	275.9	t/hr
Sec cyclone o/f	77.2	234.4	t/hr
Sec cyclone u/f	60.3	41.5	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.3	5.7	6.3	44.7	35.0
Prim cy. feed	23.0	23.0	29.2	17.8	6.9
Prim cyc A o/f	49.5	28.7	20.5	1.2	0.0
Prim cyc B o/f	49.5	28.7	20.5	1.2	0.0
Prim cyc A u/f	12.2	20.8	32.8	24.5	9.8
Prim cyc B u/f	12.2	20.8	32.8	24.5	9.8
Peb mill 1 disch	24.7	24.5	33.2	15.1	2.5
Peb mill 2 disch	25.4	24.6	32.9	14.7	2.4
Sec cyc feed	49.5	28.7	20.5	1.2	0.0
Sec cyc o/f	66.1	24.1	9.8	0.0	0.0
Sec cyc u/f	28.3	34.7	34.2	2.7	0.0

PCF = 592.6 m3 per hour
PCD = 1.501
PSM = 66.1 % passing 75 microns

Test 2a modelled mass balance

Stream	Solids	Water	
Rod mill feed	62.2	3.0	t/hr
Rod mill dilution		21.1	t/hr
Rod mill discharge	62.2	24.1	t/hr
Primary dilution		280.6	t/hr
Prim cyclone feed	484.1	495.3	t/hr
Prim cyclone A o/f	64.1	178.9	t/hr
Prim cyclone B o/f	64.1	178.9	t/hr
Prim cyclone A u/f	178.1	68.8	t/hr
Prim cyclone B u/f	178.1	68.8	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	180.7	68.8	t/hr
Peb mill 2 product	180.4	68.8	t/hr
Secondary dilution		20.8	t/hr
Sec cyclone feed	128.3	378.5	t/hr
Sec cyclone o/f	67.4	325.6	t/hr
Sec cyclone u/f	60.9	52.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.1	6.8	7.4	48.2	27.5
Prim cyc feed	30.4	24.9	24.1	15.6	5.0
Prim cyc A o/f	64.9	24.7	10.3	0.2	0.0
Prim cyc B o/f	64.9	24.7	10.3	0.2	0.0
Prim cyc A u/f	18.0	24.9	29.2	21.2	6.8
Prim cyc B u/f	18.0	24.9	29.2	21.2	6.8
Peb mill 1 disch	31.2	26.4	28.0	12.6	1.9
Peb mill 2 disch	31.0	26.4	28.0	12.6	1.9
Sec cyc feed	64.9	24.7	10.3	0.2	0.0
Sec cyc o/f	81.2	15.8	2.9	0.0	0.0
Sec cyc u/f	46.7	34.5	18.4	0.3	0.0

PCF = 678.0 m3 per hour
PCD = 1.445
PSM = 81.2 % passing 75 microns

Test 2b modelled mass balance

Stream	Solids	Water	
Rod mill feed	74.0	3.0	t/hr
Rod mill dilution		25.6	t/hr
Rod mill discharge	74.0	28.6	t/hr
Primary dilution		276.8	t/hr
Prim cyclone feed	541.6	509.4	t/hr
Prim cyclone A o/f	72.7	178.4	t/hr
Prim cyclone B o/f	72.7	178.4	t/hr
Prim cyclone A u/f	197.9	76.2	t/hr
Prim cyclone B u/f	197.9	76.2	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	200.5	76.2	t/hr
Peb mill 2 product	200.2	76.2	t/hr
Secondary dilution		21.2	t/hr
Sec cyclone feed	145.4	378.1	t/hr
Sec cyclone o/f	78.5	326.5	t/hr
Sec cyclone u/f	66.9	51.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.7	5.3	5.9	43.3	37.7
Prim cyc feed	29.7	20.6	23.0	18.2	8.5
Prim cyc A o/f	64.4	22.8	12.3	0.5	0.0
Prim cyc B o/f	64.4	22.8	12.3	0.5	0.0
Prim cyc A u/f	17.0	19.9	27.0	24.6	11.5
Prim cyc B u/f	17.0	19.9	27.0	24.6	11.5
Peb mill 1 disch	32.6	21.6	28.9	15.7	4.2
Peb mill 2 disch	29.7	21.6	26.8	17.1	4.8
Sec cyc feed	64.4	22.8	12.3	0.5	0.0
Sec cyc o/f	80.7	15.4	3.9	0.0	0.0
Sec cyc u/f	45.3	31.6	22.1	1.0	0.0

PCF = 713.8 m3 per hour
PCD = 1.472
PSM = 80.7 % passing 75 microns

Test 2a modelled mass balance

Stream	Solids	Water	
Rod mill feed	66.0	3.0	t/hr
Rod mill dilution		22.5	t/hr
Rod mill discharge	66.0	25.5	t/hr
Primary dilution		270.1	t/hr
Prim cyclone feed	507.0	495.6	t/hr
Prim cyclone A o/f	69.5	175.2	t/hr
Prim cyclone B o/f	69.5	175.2	t/hr
Prim cyclone A u/f	183.8	72.5	t/hr
Prim cyclone B u/f	183.8	72.5	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	186.4	72.5	t/hr
Peb mill 2 product	186.1	72.5	t/hr
Secondary dilution		64.5	t/hr
Sec cyclone feed	139.0	414.9	t/hr
Sec cyclone o/f	70.5	360.1	t/hr
Sec cyclone u/f	68.5	54.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.2	6.3	6.9	46.6	31.1
Prim cyc feed	30.5	23.7	23.8	16.1	5.9
Prim cyc A o/f	64.0	24.5	11.3	0.3	0.0
Prim cyc B o/f	64.0	24.5	11.3	0.3	0.0
Prim cyc A u/f	17.8	23.4	28.5	22.1	8.1
Prim cyc B u/f	17.8	23.4	28.5	22.1	8.1
Peb mill 1 disch	31.7	25.0	27.4	13.4	2.5
Peb mill 2 disch	31.0	25.0	27.6	13.8	2.6
Sec cyc feed	64.0	24.5	11.3	0.3	0.0
Sec cyc o/f	81.4	15.5	3.1	0.0	0.0
Sec cyc u/f	46.1	33.7	19.7	0.6	0.0

PCF = 686.9 m3 per hour
PCD = 1.460
PSM = 81.4 % passing 75 microns

Test 2a modelled mass balance

Stream	Solids	Water	
Rod mill feed	66.0	3.0	t/hr
Rod mill dilution		22.5	t/hr
Rod mill discharge	66.0	25.5	t/hr
Primary dilution		270.1	t/hr
Prim cyclone feed	507.0	495.6	t/hr
Prim cyclone A o/f	69.5	175.2	t/hr
Prim cyclone B o/f	69.5	175.2	t/hr
Prim cyclone A u/f	183.8	72.5	t/hr
Prim cyclone B u/f	183.8	72.5	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	186.4	72.5	t/hr
Peb mill 2 product	186.1	72.5	t/hr
Secondary dilution		64.5	t/hr
Sec cyclone feed	139.0	414.9	t/hr
Sec cyclone o/f	70.5	360.1	t/hr
Sec cyclone u/f	68.5	54.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.2	6.3	6.9	46.6	31.1
Prim cyc feed	30.5	23.7	23.8	16.1	5.9
Prim cyc A o/f	64.0	24.5	11.3	0.3	0.0
Prim cyc B o/f	64.0	24.5	11.3	0.3	0.0
Prim cyc A u/f	17.8	23.4	28.5	22.1	8.1
Prim cyc B u/f	17.8	23.4	28.5	22.1	8.1
Peb mill 1 disch	31.7	25.0	27.4	13.4	2.5
Peb mill 2 disch	31.0	25.0	27.6	13.8	2.6
Sec cyc feed	64.0	24.5	11.3	0.3	0.0
Sec cyc o/f	81.4	15.5	3.1	0.0	0.0
Sec cyc u/f	46.1	33.7	19.7	0.6	0.0

PCF = 686.9 m3 per hour
PCD = 1.460
PSM = 81.4 % passing 75 microns

Test 1c modelled mass balance

Stream	Solids	Water	
Rod mill feed	66.2	3.0	t/hr
Rod mill dilution		22.6	t/hr
Rod mill discharge	66.2	25.6	t/hr
Primary dilution		287.2	t/hr
Prim cyclone feed	500.5	505.4	t/hr
Prim cyclone A o/f	65.7	182.4	t/hr
Prim cyclone B o/f	65.7	182.4	t/hr
Prim cyclone A u/f	184.4	70.3	t/hr
Prim cyclone B u/f	184.4	70.3	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	187.0	70.3	t/hr
Peb mill 2 product	186.7	70.3	t/hr
Secondary dilution		3.7	t/hr
Sec cyclone feed	131.3	368.5	t/hr
Sec cyclone o/f	70.7	316.5	t/hr
Sec cyclone u/f	60.6	52.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.1	6.2	6.8	46.5	31.3
Prim cyc feed	30.5	23.5	23.6	16.4	6.1
Prim cyc A o/f	65.6	23.8	10.4	0.2	0.0
Prim cyc B o/f	65.6	23.8	10.4	0.2	0.0
Prim cyc A u/f	17.9	23.4	28.3	22.1	8.2
Prim cyc B u/f	17.9	23.4	28.3	22.1	8.2
Peb mill 1 disch	31.9	24.9	27.2	13.5	2.5
Peb mill 2 disch	31.2	24.9	27.5	13.8	2.6
Sec cyc feed	65.6	23.8	10.4	0.2	0.0
Sec cyc o/f	81.4	15.5	3.1	0.0	0.0
Sec cyc u/f	47.2	33.6	18.9	0.4	0.0

PCF = 694.3 m3 per hour
PCD = 1.449
PSM = 81.4 % passing 75 microns

Test 1b modelled mass balance

Stream	Solids	Water	
Rod mill feed	66.1	3.0	t/hr
Rod mill dilution		22.6	t/hr
Rod mill discharge	66.1	25.6	t/hr
Primary dilution		286.6	t/hr
Prim cyclone feed	500.0	504.7	t/hr
Prim cyclone A o/f	65.7	182.0	t/hr
Prim cyclone B o/f	65.7	182.0	t/hr
Prim cyclone A u/f	184.2	70.3	t/hr
Prim cyclone B u/f	184.2	70.3	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	186.8	70.3	t/hr
Peb mill 2 product	186.5	70.3	t/hr
Secondary dilution		4.3	t/hr
Sec cyclone feed	131.4	368.4	t/hr
Sec cyclone o/f	70.8	316.4	t/hr
Sec cyclone u/f	60.6	52.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.2	6.2	6.8	46.5	31.2
Prim cyc feed	30.4	23.6	23.6	16.4	6.0
Prim cyc A o/f	68.5	23.9	10.4	0.2	0.0
Prim cyc B o/f	68.5	23.9	10.4	0.2	0.0
Prim cyc A u/f	17.9	23.5	28.3	22.1	8.2
Prim cyc B u/f	17.9	23.5	28.3	22.1	8.2
Peb mill 1 disch	31.9	25.0	27.2	13.4	2.5
Peb mill 2 disch	31.1	25.0	27.5	13.8	2.6
Sec cyc feed	68.5	23.9	10.4	0.2	0.0
Sec cyc o/f	81.3	15.6	3.1	0.0	0.0
Sec cyc u/f	47.0	33.7	18.9	0.4	0.0

PCF = 693.4 m3 per hour
PCD = 1.449
PSM = 81.3 % passing 75 microns

APPENDIX I Simulated mass balances

Test 1a modelled mass balance

Stream	Solids	Water	
Rod mill feed	49.1	3.0	t/hr
Rod mill dilution		16.0	t/hr
Rod mill discharge	49.1	19.0	t/hr
Primary dilution		281.3	t/hr
Prim cyclone feed	419.3	473.8	t/hr
Prim cyclone A o/f	52.7	176.6	t/hr
Prim cyclone B o/f	52.7	176.6	t/hr
Prim cyclone A u/f	157.1	60.3	t/hr
Prim cyclone B u/f	157.1	60.3	t/hr
Pebble addition 1	2.6		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	159.7	60.3	t/hr
Peb mill 2 product	159.4	60.3	t/hr
Secondary dilution		4.4	t/hr
Sec cyclone feed	105.3	357.5	t/hr
Sec cyclone o/f	54.2	304.7	t/hr
Sec cyclone u/f	51.2	52.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	16.2	10.3	10.5	51.2	11.8
Prim cyc feed	29.8	30.5	25.1	12.8	1.8
Prim cyc A o/f	64.5	27.3	8.2	0.0	0.0
Prim cyc B o/f	64.5	27.3	8.2	0.0	0.0
Prim cyc A u/f	18.2	31.5	30.9	17.1	2.4
Prim cyc B u/f	18.2	31.5	30.9	17.1	2.4
Peb mill 1 disch	28.7	32.3	29.2	9.2	0.5
Peb mill 2 disch	29.7	32.4	28.8	8.7	0.5
Sec cyc feed	64.5	27.3	8.2	0.0	0.0
Sec cyc o/f	81.0	16.9	2.2	0.0	0.0
Sec cyc u/f	47.1	38.3	14.5	0.1	0.0

PCF = 632.0 m3 per hour
PCD = 1.413
PSM = 81.0 % passing 75 microns

```
{
          }
{=========================================================================
==========}
Overlay Procedure QCRodMill(Var stm      : Stms;
                                point    : ToUnit;
                                type_num : UniTypes);

 Var
  feedpt,
  prodpt        : ToR4;

  feedh2o,
  prodh2o       : ToR6;

  rmf,d50,sl    : Real;
  i             : integer;
  fr,cum        : Array[sizrange] of Real ;

 Begin
  feedpt:=SolidSelect(stm[point^.inout[2]]) ;
  prodpt:=SolidSelect(stm[point^.inout[4]]) ;

  feedh2o:=LixivSelect(stm[point^.inout[2]]) ;
  prodh2o:=LixivSelect(stm[point^.inout[4]]) ;

  prodpt^.tonnes:=feedpt^.tonnes;
  prodh2o^.flow:=feedh2o^.flow;
  rmf:=feedpt^.tonnes*3.6;
  if rmf<40 then d50:=300 else
  d50:=43.94*rmf-1499;
  sl:=0.799;

  With system Do
     Begin
      For i:=1 To ndc Do
      Begin
          if i= 1 then cum[i]:= 1 else
          cum[i] := 1-exp(-(pow(size_class[i-1]*1e6/d50,sl)));
      End;
      For i:=ndc downto 1 do begin
          if i=ndc then fr[i]:=cum[i] else
          fr[i]:=cum[i]-cum[i+1];
      end;
      for i:= 1 to ndc do
SolidPut(i,1,1,1,1,prodpt,fr[i]*feedpt^.tonnes);
     end;
  End;
```

Test 7c modelled mass balance

Stream	Solids	Water	
Rod mill feed	50.3	3.0	t/hr
Rod mill dilution		16.5	t/hr
Rod mill discharge	50.3	19.5	t/hr
Primary dilution		156.8	t/hr
Prim cyclone feed	387.1	390.6	t/hr
Prim cyclone A o/f	53.5	108.1	t/hr
Prim cyclone B o/f	53.5	108.1	t/hr
Prim cyclone A u/f	1 3.2	87.2	t/hr
Prim cyclone B u/f	140.2	87.2	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	145.7	87.2	t/hr
Peb mill 2 product	143.6	87.2	t/hr
Secondary dilution		25.1	t/hr
Sec cyclone feed	106.9	241.4	t/hr
Sec cyclone o/f	59.4	201.5	t/hr
Sec cyclone u/f	47.5	39.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.3	9.8	10.1	51.4	13.4
Prim cyc feed	23.9	37.5	32.0	14.5	2.1
Prim cyc A o/f	48.7	30.7	19.7	0.9	0.0
Prim cyc B o/f	48.7	30.7	19.7	0.9	0.0
Prim cyc A u/f	14.5	26.2	36.7	19.7	2.9
Prim cyc B u/f	14.5	26.2	36.7	19.7	2.9
Peb mill 1 disch	24.6	28.5	35.8	10.6	0.5
Peb mill 2 disch	24.9	29.4	35.6	9.7	0.4
Sec cyc feed	48.7	30.7	19.7	0.9	0.0
Sec cyc o/f	65.3	25.5	9.2	0.0	0.0
Sec cyc u/f	27.9	37.2	32.9	2.0	0.0

PCF = 536.7 m3 per hour
PCD = 1.449
PSM = 65.3 % passing 75 microns

Test 7b modelled mass balance

Stream	Solids	Water	
Rod mill feed	54.6	3.0	t/hr
Rod mill dilution		18.1	t/hr
Rod mill discharge	54.6	21.1	t/hr
Primary dilution		158.1	t/hr
Prim cyclone feed	408.4	400.3	t/hr
Prim cyclone A o/f	56.6	109.5	t/hr
Prim cyclone B o/f	56.6	109.5	t/hr
Prim cyclone A u/f	147.5	90.6	t/hr
Prim cyclone B u/f	147.5	90.6	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	153.0	90.6	t/hr
Peb mill 2 product	150.9	90.6	t/hr
Secondary dilution		27.2	t/hr
Sec cyclone feed	113.2	246.2	t/hr
Sec cyclone o/f	63.2	206.2	t/hr
Sec cyclone u/f	50.0	40.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.8	8.4	8.9	50.8	19.0
Prim cyc feed	23.9	26.2	31.3	15.5	3.1
Prim cyc A o/f	48.7	30.0	20.2	1.1	0.0
Prim cyc B o/f	48.7	30.0	20.2	1.1	0.0
Prim cyc A u/f	14.4	24.8	35.5	21.0	4.3
Prim cyc B u/f	14.4	24.8	35.5	21.0	4.3
Peb mill 1 disch	25.2	27.4	35.0	11.6	0.8
Peb mill 2 disch	25.4	28.1	34.8	10.9	0.7
Sec cyc feed	48.7	30.0	20.2	1.1	0.0
Sec cyc o/f	65.3	25.1	9.5	0.0	0.0
Sec cyc u/f	27.7	36.2	33.6	2.5	0.0

PCF = 554.4 m3 per hour
PCD = 1.459
PSM = 65.3 % passing 75 microns

Test 7a modelled mass balance

Stream	Solids	Water	
Rod mill feed	51.9	3.0	t/hr
Rod mill dilution		17.1	t/hr
Rod mill discharge	51.9	20.1	t/hr
Primary dilution		154.9	t/hr
Prim cyclone feed	397.3	393.5	t/hr
Prim cyclone A o/f	55.5	107.8	t/hr
Prim cyclone B o/f	55.5	107.8	t/hr
Prim cyclone A u/f	143.1	89.0	t/hr
Prim cyclone B u/f	143.1	89.0	t/hr
Pebble addition 1	5.5		c/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	148.6	89.0	t/hr
Peb mill 2 product	146.5	89.0	t/hr
Secondary dilution		36.6	t/hr
Sec cyclone feed	111.1	252.3	t/hr
Sec cyclone o/f	60.8	211.7	t/hr
Sec cyclone u/f	50.2	40.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	14.2	9.2	9.7	51.3	15.6
Prim cyc feed	24.0	27.0	31.7	14.8	2.5
Prim cyc A o/f	48.6	30.5	19.9	1.0	0.0
Prim cyc B o/f	48.6	30.5	19.9	1.0	0.0
Prim cyc A u/f	14.5	25.7	36.1	20.2	3.4
Prim cyc B u/f	14.5	25.7	36.1	20.2	3.4
Peb mill 1 disch	24.9	28.1	35.4	11.0	0.6
Peb mill 2 disch	25.2	28.9	35.2	10.2	0.6
Sec cyc feed	48.6	30.5	19.9	1.0	0.0
Sec cyc o/f	65.6	25.2	9.1	0.0	0.0
Sec cyc u/f	27.9	36.8	33.0	2.2	0.0

PCF = 543.4 m3 per hour
PCD = 1.455
PSM = 65.6 % passing 75 microns

Test 6c modelled mass balance

Stream	Solids	Water	
Rod mill feed	56.4	3.0	t/hr
Rod mill dilution		18.8	t/hr
Rod mill discharge	56.4	21.8	t/hr
Primary dilution		174.1	t/hr
Prim cyclone feed	435.3	429.7	t/hr
Prim cyclone A o/f	60.6	120.0	t/hr
Prim cyclone B o/f	60.6	120.0	t/hr
Prim cyclone A u/f	156.9	94.8	t/hr
Prim cyclone B u/f	156.9	94.8	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	162.4	94.8	t/hr
Peb mill 2 product	160.3	94.8	t/hr
Secondary dilution		52.2	t/hr
Sec cyclone feed	122.3	292.2	t/hr
Sec cyclone o/f	65.1	248.0	t/hr
Sec cyclone u/f	56.1	44.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.0	8.0	8.5	50.3	21.1
Prim cyc feed	26.4	26.2	28.7	15.2	3.5
Prim cyc A o/f	52.8	28.8	17.4	1.0	0.0
Prim cyc B o/f	52.8	28.8	17.4	1.0	0.0
Prim cyc A u/f	16.2	25.2	33.0	20.7	4.8
Prim cyc B u/f	16.2	25.2	33.0	20.7	4.8
Peb mill 1 disch	27.9	27.4	32.1	11.6	1.1
Peb mill 2 disch	28.0	27.9	32.0	11.1	1.0
Sec cyc feed	52.8	28.8	17.4	1.0	0.0
Sec cyc o/f	70.5	22.5	7.1	0.0	0.0
Sec cyc u/f	32.3	36.2	29.4	2.1	0.0

PCF = 594.0 m3 per hour
PCD = 1.456
P8M = 70.5 % passing 75 microns

Test 6b modelled mass balance

Stream	Solids	Water	
Rod mill feed	47.0	3.0	t/hr
Rod mill dilution		15.2	t/hr
Rod mill discharge	47.0	18.2	t/hr
Primary dilution		172.6	t/hr
Prim cyclone feed	397.2	415.9	t/hr
Prim cyclone A o/f	55.6	119.0	t/hr
Prim cyclone B o/f	55.6	119.0	t/hr
Prim cyclone A u/f	143.0	88.9	t/hr
Prim cyclone B u/f	143.0	88.9	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	148.5	88.9	t/hr
Peb mill 2 product	146.4	88.9	t/hr
Secondary dilution		81.2	t/hr
Sec cyclone feed	111.1	319.3	t/hr
Sec cyclone o/f	55.9	271.9	t/hr
Sec cyclone u/f	55.3	47.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.0	11.2	11.3	50.4	9.0
Prim cyc feed	27.3	29.9	29.0	12.5	1.3
Prim cyc A o/f	53.3	30.6	15.5	0.5	0.0
Prim cyc B o/f	53.3	30.6	15.5	0.5	0.0
Prim cyc A u/f	17.1	29.5	34.3	17.2	1.8
Prim cyc B u/f	17.1	29.5	34.3	17.2	1.8
Peb mill 1 disch	27.4	30.8	32.5	9.0	0.3
Peb mill 2 disch	27.6	31.5	32.3	8.3	0.3
Sec cyc feed	53.3	30.6	15.5	0.5	0.0
Sec cyc o/f	72.3	22.4	5.4	0.0	0.0
Sec cyc u/f	34.1	39.0	25.8	1.1	0.0

PCF = 565.8 m3 per hour
PCD = 1.437
PSM = 72.3 % passing 75 microns

Test 6a modelled mass balance

Stream	Solids	Water	
Rod mill feed	47.4	3.0	t/hr
Rod mill dilution		15.3	t/hr
Rod mill discharge	47.4	18.3	t/hr
Primary dilution		172.0	t/hr
Prim cyclone feed	396.0	414.2	t/hr
Prim cyclone A o/f	55.3	118.4	t/hr
Prim cyclone B o/f	55.3	118.4	t/hr
Prim cyclone A u/f	142.9	88.7	t/hr
Prim cyclone B u/f	142.9	88.7	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	148.4	88.7	t/hr
Peb mill 2 product	146.3	88.7	t/hr
Secondary dilution		70.7	t/hr
Sec cyclone feed	110.6	307.6	t/hr
Sec cyclone o/f	56.6	261.2	t/hr
Sec cyclone u/f	54.0	46.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	17.6	11.0	11.2	50.6	9.5
Prim cyc feed	27.0	29.6	29.2	12.8	1.4
Prim cyc A o/f	53.1	30.6	15.8	0.5	0.0
Prim cyc B o/f	53.1	30.6	15.8	0.5	0.0
Prim cyc A u/f	17.0	29.2	34.4	17.5	1.9
Prim cyc B u/f	17.0	29.2	34.4	17.5	1.9
Peb mill 1 disch	27.2	30.6	32.8	9.1	0.4
Peb mill 2 disch	27.5	31.3	32.5	8.5	0.3
Sec cyc feed	53.1	30.6	15.8	0.5	0.0
Sec cyc o/f	71.7	22.6	5.6	0.0	0.0
Sec cyc u/f	33.7	38.9	26.3	1.1	0.0

PCP = 563.6 m3 per hour
PCD = 1.437
PSM = 71.7 % passing 75 microns

Test 5c modelled mass balance

Stream	Solids	Water	
Rod mill feed	73.6	3.0	t/hr
Rod mill dilution		25.5	t/hr
Rod mill discharge	73.6	28.5	t/hr
Primary dilution		177.4	t/hr
Prim cyclone feed	476.7	395.3	t/hr
Prim cyclone A o/f	70.0	122.4	t/hr
Prim cyclone B o/f	70.0	122.4	t/hr
Prim cyclone A u/f	168.3	75.2	t/hr
Prim cyclone B u/f	168.3	75.2	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	171.6	75.2	t/hr
Peb mill 2 product	172.0	75.2	t/hr
Secondary dilution		9.2	t/hr
Sec cyclone feed	140.0	254.0	t/hr
Sec cyclone o/f	80.4	215.0	t/hr
Sec cyclone u/f	59.6	39.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.8	5.4	6.0	43.5	37.4
Prim cyc feed	21.5	22.0	30.2	18.6	7.7
Prim cyc A o/f	46.3	28.6	23.3	1.8	0.0
Prim cyc B o/f	46.3	28.6	23.3	1.8	0.0
Prim cyc A u/f	11.1	19.2	33.1	25.6	10.9
Prim cyc B u/f	11.1	19.2	33.1	25.6	10.9
Peb mill 1 disch	23.4	23.5	34.2	16.1	2.8
Peb mill 2 disch	24.3	23.7	33.9	15.6	2.6
Sec cyc feed	46.3	28.6	23.3	1.8	0.0
Sec cyc o/f	62.2	25.3	12.5	0.1	0.0
Sec cyc u/f	24.9	33.0	38.0	4.1	0.0

PCF = 575.2 m3 per hour
PCD = 1.516
PSM = 62.2 % passing 75 microns

Test 5b modelled mass balance

Stream	Solids	Water	
Rod mill feed	71.5	3.0	t/hr
Rod mill dilution		24.7	t/hr
Rod mill discharge	71.5	27.7	t/hr
Primary dilution		172.3	t/hr
Prim cyclone feed	464.2	386.1	t/hr
Prim cyclone A o/f	68.3	119.1	t/hr
Prim cyclone B o/f	68.3	119.1	t/hr
Prim cyclone A u/f	163.7	73.9	t/hr
Prim cyclone B u/f	163.7	73.9	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	167.0	73.9	t/hr
Peb mill 2 product	167.4	73.9	t/hr
Secondary dilution		9.1	t/hr
Sec cyclone feed	136.5	247.4	t/hr
Sec cyclone o/f	78.2	208.9	t/hr
Sec cyclone u/f	58.3	38.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.1	5.6	6.2	44.3	35.8
Prim cyc feed	20.8	22.4	31.1	18.5	7.2
Prim cyc A o/f	44.9	29.2	24.1	1.8	0.0
Prim cyc B o/f	44.9	29.2	24.1	1.8	0.0
Prim cyc A u/f	10.7	19.6	34.1	25.4	10.2
Prim cyc B u/f	10.7	19.6	34.1	25.4	10.2
Peb mill 1 disch	22.5	23.9	35.3	15.8	2.4
Peb mill 2 disch	23.6	24.1	34.9	15.1	2.3
Sec cyc feed	44.9	29.2	24.1	1.8	0.0
Sec cyc o/f	60.7	26.1	13.1	0.1	0.0
Sec cyc u/f	23.7	33.3	38.8	4.1	0.0

PCF = 561.3 m3 per hour
PCD = 1.515
PSM = 60.7 % passing 75 microns

Test 5a modelled mass balance

Stream	Solids	Water	
Rod mill feed	65.6	3.0	t/hr
Rod mill dilution		22.4	t/hr
Rod mill discharge	65.6	25.4	t/hr
Primary dilution		178.9	t/hr
Prim cyclone feed	447.2	386.7	t/hr
Prim cyclone A o/f	65.2	122.0	t/hr
Prim cyclone B o/f	65.2	122.0	t/hr
Prim cyclone A u/f	158.4	71.3	t/hr
Prim cyclone B u/f	158.4	71.3	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	161.7	71.3	t/hr
Peb mill 2 product	162.1	71.3	t/hr
Secondary dilution		14.0	t/hr
Sec cyclone feed	130.4	258.1	t/hr
Sec cyclone o/f	72.6	218.3	t/hr
Sec cyclone u/f	57.8	39.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.3	6.3	6.9	46.7	30.8
Prim cyc feed	21.2	23.9	31.7	17.5	5.8
Prim cyc A o/f	45.8	30.1	22.8	1.3	0.0
Prim cyc B o/f	45.8	30.1	22.8	1.3	0.0
Prim cyc A u/f	11.1	21.3	35.3	24.1	8.2
Prim cyc B u/f	11.1	21.3	35.3	24.1	8.2
Peb mill 1 disch	22.3	25.3	36.0	14.5	1.8
Peb mill 2 disch	23.6	25.6	35.5	13.7	1.7
Sec cyc feed	45.8	30.1	22.8	1.3	0.0
Sec cyc o/f	62.3	26.1	11.5	0.0	0.0
Sec cyc u/f	25.0	35.0	37.0	2.9	0.0

PCF = 555.5 m3 per hour
PCD = 1.501
PSM = 62.3 % passing 75 microns

Test 4c modelled mass balance

Stream	Solids	Water	
Rod mill feed	72.0	3.0	t/hr
Rod mill dilution		24.9	t/hr
Rod mill discharge	72.0	27.9	t/hr
Primary dilution		214.5	t/hr
Prim cyclone feed	495.9	436.7	t/hr
Prim cyclone A o/f	70.7	143.1	t/hr
Prim cyclone B o/f	70.7	143.1	t/hr
Prim cyclone A u/f	177.3	75.3	t/hr
Prim cyclone B u/f	177.3	75.3	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	180.6	75.3	t/hr
Peb mill 2 product	181.0	75.3	t/hr
Secondary dilution		12.3	t/hr
Sec cyclone feed	141.5	298.5	t/hr
Sec cyclone o/f	79.2	254.8	t/hr
Sec cyclone u/f	62.2	43.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.1	5.5	6.1	44.1	36.2
Prim cyc feed	25.0	22.5	27.4	17.8	7.4
Prim cyc A o/f	53.7	27.1	18.1	1.0	0.0
Prim cyc B o/f	53.7	27.1	18.1	1.0	0.0
Prim cyc A u/f	13.5	20.6	31.2	24.5	10.3
Prim cyc B u/f	13.5	20.6	31.2	24.5	10.3
Peb mill 1 disch	26.9	23.9	31.1	15.2	2.9
Peb mill 2 disch	27.1	23.8	31.0	15.2	2.9
Sec cyc feed	53.7	27.1	18.1	1.0	0.0
Sec cyc o/f	70.4	21.6	8.0	0.0	0.0
Sec cyc u/f	32.5	34.2	31.1	2.2	0.0

PCF = 623.8 m3 per hour
PCD = 1.495
PSM = 70.4 % passing 75 microns

Test 4b modelled mass balance

Stream	Solids	Water	
Rod mill feed	76.5	3.0	t/hr
Rod mill dilution		26.6	t/hr
Rod mill discharge	76.5	29.6	t/hr
Primary dilution		217.6	t/hr
Prim cyclone feed	518.3	446.8	t/hr
Prim cyclone A o/f	73.8	145.6	t/hr
Prim cyclone B o/f	73.8	145.6	t/hr
Prim cyclone A u/f	185.4	77.9	t/hr
Prim cyclone B u/f	185.4	77.9	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	188.7	77.9	t/hr
Peb mill 2 product	189.1	77.9	t/hr
Secondary dilution		10.8	t/hr
Sec cyclone feed	147.6	301.9	t/hr
Sec cyclone o/f	83.7	258.1	t/hr
Sec cyclone u/f	64.0	43.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.4	5.1	5.7	42.3	39.5
Prim cyc feed	25.4	21.0	26.4	18.6	8.6
Prim cyc A o/f	54.7	25.9	18.2	1.2	0.0
Prim cyc B o/f	54.7	25.9	18.2	1.2	0.0
Prim cyc A u/f	13.6	19.1	29.8	25.5	12.0
Prim cyc B u/f	13.6	19.1	29.8	25.5	12.0
Peb mill 1 disch	28.0	22.4	29.7	16.2	3.7
Peb mill 2 disch	27.4	22.2	29.9	16.6	3.9
Sec cyc feed	54.7	25.9	18.2	1.2	0.0
Sec cyc o/f	71.2	20.7	8.1	0.0	0.0
Sec cyc u/f	33.1	32.8	31.4	2.7	0.0

PCF = 642.4 m3 per hour
PCD = 1.502
PSM = 71.2 % passing 75 microns

Test 4a modelled mass balance

Stream	Solids	Water	
Rod mill feed	77.6	3.0	t/hr
Rod mill dilution		27.0	t/hr
Rod mill discharge	77.6	30.0	t/hr
Primary dilution		213.0	t/hr
Prim cyclone feed	518.6	442.6	t/hr
Prim cyclone A o/f	74.1	143.1	t/hr
Prim cyclone B o/f	74.1	143.1	t/hr
Prim cyclone A u/f	185.0	78.2	t/hr
Prim cyclone B u/f	185.0	78.2	t/hr
Pebble addition 1	3.3		t/hr
Pebble addition 2	3.7		t/hr
Peb mill 1 product	188.	6.2	t/hr
Peb mill 2 product	188	78.2	t/hr
Secondary dilution		10.7	t/hr
Sec cyclone feed	148.2	196.9	t/hr
Sec cyclone o/f	84.4	253.6	t/hr
Sec cyclone u/f	63.9	43.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.2	5.0	5.6	41.9	40.2
Prim cyc feed	25.0	20.9	26.5	18.7	8.9
Prim cyc A o/f	53.9	26.1	18.6	1.3	0.0
Prim cyc B o/f	53.9	26.1	18.6	1.3	0.0
Prim cyc A u/f	13.4	18.9	29.7	25.6	12.4
Prim cyc B u/f	13.4	18.9	29.7	25.6	12.4
Peb mill 1 disch	27.7	22.3	29.8	16.4	3.8
Peb mill 2 disch	27.1	22.1	30.0	16.8	4.0
Sec cyc feed	53.9	26.1	18.6	1.3	0.0
Sec cyc o/f	70.4	21.1	8.5	0.0	0.0
Sec cyc u/f	32.3	32.7	32.0	3.0	0.0

PCF = 638.3 m3 per hour
PCD = 1.506
PSM = 70.4 % passing 75 microns

Test 13b modelled mass balance

Stream	Solids	Water	
Rod mill feed	59.7	3.0	t/hr
Rod mill dilution		20.1	t/hr
Rod mill discharge	59.7	23.1	t/hr
Primary dilution		197.6	t/hr
Prim cyclone feed	429.5	395.6	t/hr
Prim cyclone A o/f	60.0	131.1	t/hr
Prim cyclone B o/f	60.0	131.1	t/hr
Prim cyclone A u/f	154.6	66.6	t/hr
Prim cyclone B u/f	154.6	66.6	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	157.4	66.6	t/hr
Peb mill 2 product	156.9	66.6	t/hr
Secondary dilution		7.9	t/hr
Sec cyclone feed	120.1	270.2	t/hr
Sec cyclone o/f	64.7	228.5	t/hr
Sec cyclone u/f	55.4	41.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.9	7.3	7.9	49.2	24.9
Prim cyc feed	21.5	26.3	31.5	16.3	4.4
Prim cyc A o/f	47.3	31.9	20.1	0.7	0.0
Prim cyc B o/f	47.3	31.9	20.1	0.7	0.0
Prim cyc A u/f	11.5	24.2	35.9	22.3	6.1
Prim cyc B u/f	11.5	24.2	35.9	22.3	6.1
Peb mill 1 disch	22.0	27.6	36.0	13.0	1.3
Peb mill 2 disch	23.0	28.0	35.5	12.3	1.2
Sec cyc feed	47.3	31.9	20.1	0.7	0.0
Sec cyc o/f	64.5	26.4	9.1	0.0	0.0
Sec cyc u/f	27.2	38.3	33.0	1.5	0.0

PCF = 557.7 m3 per hour
PCD = 1.480
PSM = 64.5 % passing 75 microns

Test 13a modelled mass balance

Stream	Solids	Water	
Rod mill feed	46.8	3.0	t/hr
Rod mill dilution		15.1	t/hr
Rod mill discharge	46.8	18.1	t/hr
Primary dilution		190.9	t/hr
Prim cyclone feed	366.0	368.0	t/hr
Prim cyclone A o/f	50.0	125.5	t/hr
Prim cyclone B o/f	50.0	125.5	t/hr
Prim cyclone A u/f	133.1	58.6	t/hr
Prim cyclone B u/f	133.1	58.6	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	135.9	58.6	t/hr
Peb mi l 2 product	135.4	58.6	t/hr
Secondary dilution		7.8	t/hr
Sec cyclone feed	100.0	258.7	t/hr
Sec cyclone o/f	52.1	216.9	t/hr
Sec cyclone u/f	47.9	41.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.2	11.3	11.4	50.3	8.7
Prim cyc feed	21.0	30.7	33.7	13.3	1.3
Prim cyc A o/f	46.5	34.9	18.3	0.3	0.0
Prim cyc B o/f	46.5	34.9	18.3	0.3	0.0
Prim cyc A u/f	11.4	29.1	39.5	18.2	1.8
Prim cyc B u/f	11.4	29.1	39.5	18.2	1.8
Peb mill 1 disch	19.8	31.7	38.5	9.7	0.3
Peb mill 2 disch	20.9	32.3	37.8	8.7	0.3
Sec cyc feed	46.5	34.9	18.3	0.3	0.0
Sec cyc o/f	64.2	28.1	7.7	0.0	0.0
Sec cyc u/f	27.2	42.2	29.9	0.6	0.0

PCF = 506.1 m3 per hour
PCD = 1.450
PSM = 64.2 % passing 75 microns

Test 12c modelled mass balance

Stream	Solids	Water	
Rod mill feed	64.5	3.0	t/hr
Rod mill dilution		22.0	t/hr
Rod mill discharge	64.5	25.0	t/hr
Primary dilution		189.2	t/hr
Prim cyclone feed	445.4	393.3	t/hr
Prim cyclone A o/f	63.6	127.3	t/hr
Prim cyclone B o/f	63.6	127.3	t/hr
Prim cyclone A u/f	159.3	69.4	t/hr
Prim cyclone B u/f	159.3	69.4	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	162.1	69.4	t/hr
Peb mill 2 product	161.6	69.4	t/hr
Secondary dilution		8.2	t/hr
Sec cyclone feed	127.1	262.9	t/hr
Sec cyclone o/f	69.9	222.4	t/hr
Sec cyclone u/f	57.2	40.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.5	6.5	7.1	47.2	29.7
Prim cyc feed	21.1	24.6	31.5	17.2	5.5
Prim cyc A o/f	46.2	30.8	21.9	1.1	0.0
Prim cyc B o/f	46.2	30.8	21.9	1.1	0.0
Prim cyc A u/f	11.1	22.1	35.4	23.7	7.7
Prim cyc B u/f	11.1	22.1	35.4	23.7	7.7
Peb mill 1 disch	22.2	26.0	35.8	14.2	1.8
Peb mill 2 disch	23.0	26.4	35.5	13.5	1.6
Sec cyc feed	46.2	30.8	21.9	1.1	0.0
Sec cyc o/f	63.0	26.3	10.7	0.0	0.0
Sec cyc u/f	25.7	36.3	35.6	2.3	0.0

PCF = 561.4 m3 per hour
PCD = 1.494
PSM = 63.0 % passing 75 microns

Test 12b modelled mass balance

Stream	Solids	Water	
Rod mill feed	65.7	3.0	t/hr
Rod mill dilution		22.4	t/hr
Rod mill discharge	65.7	25.4	t/hr
Primary dilution		185.6	t/hr
Prim cyclone feed	447.5	390.7	t/hr
Prim cyclone A o/f	64.2	125.6	t/hr
Prim cyclone B o/f	64.2	125.6	t/hr
Prim cyclone A u/f	159.7	69.9	t/hr
Prim cyclone B u/f	159.7	69.9	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	162.5	69.9	t/hr
Peb mill 2 product	162.0	69.9	t/hr
Secondary dilution		8.1	t/hr
Sec cyclone feed	128.4	259.2	t/hr
Sec cyclone o/f	71.0	219.2	t/hr
Sec cyclone u/f	57.3	40.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.3	6.3	6.9	46.7	30.9
Prim cyc feed	20.9	24.3	31.6	17.5	5.8
Prim cyc A o/f	45.7	30.7	22.4	1.2	0.0
Prim cyc B o/f	45.7	30.7	22.4	1.2	0.0
Prim cyc A u/f	10.9	21.7	35.2	24.0	8.2
Prim cyc B u/f	10.9	21.7	35.2	24.0	8.2
Peb mill 1 disch	22.1	25.7	35.9	14.5	1.9
Peb mill 2 disch	22.9	26.0	35.5	13.8	1.7
Sec cyc feed	45.7	30.7	22.4	1.2	0.0
Sec cyc o/f	62.3	26.5	11.2	0.0	0.0
Sec cyc u/f	25.2	35.8	36.4	2.6	0.0

PCF = 559.6 m3 per hour
PCD = 1.498
PSH = 62.3 % passing 75 microns

Test 12a modelled mass balance

Stream	Solids	Water	
Rod mill feed	70.2	3.0	t/hr
Rod mill dilution		24.2	t/hr
Rod mill discharge	70.2	27.2	t/hr
Primary dilution		179.1	t/hr
Prim cyclone feed	461.0	369.3	t/hr
Prim cyclone A o/f	66.8	122.6	t/hr
Prim cyclone B o/f	66.8	122.6	t/hr
Prim cyclone A u/f	163.6	72.0	t/hr
Prim cyclone B u/f	163.6	72.0	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	166.4	72.0	t/hr
Peb mill 2 product	165.9	72.0	t/hr
Secondary dilution		8.5	t/hr
Sec cyclone feed	133.6	253.7	t/hr
Sec cyclone o/f	75.1	214.6	t/hr
Sec cyclone u/f	58.6	39.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.4	5.7	6.3	44.8	34.7
Prim cyc feed	20.5	23.1	31.2	18.2	6.9
Prim cyc A o/f	44.8	30.0	23.6	1.6	0.0
Prim cyc B o/f	44.8	30.0	23.6	1.6	0.0
Prim cyc A u/f	10.6	20.3	34.4	25.0	9.7
Prim cyc B u/f	10.6	20.3	34.4	25.0	9.7
Peb mill 1 disch	22.1	24.6	35.1	15.5	2.3
Peb mill 2 disch	22.8	24.9	35.2	14.9	2.2
Sec cyc feed	44.8	30.0	23.6	1.6	0.0
Sec cyc o/f	61.0	26.6	12.4	0.1	0.0
Sec cyc u/f	24.0	34.5	38.0	3.5	0.0

PCF = 363.3 m3 per hour
PCD = 1.510
PSM = 61.0 % passing 75 microns

Test 12a modelled mass balance

Stream	Solids	Water	
Rod mill feed	70.2	3.0	t/hr
Rod mill dilution		24.2	t/hr
Rod mill discharge	70.2	27.2	t/hr
Primary dilution		179.1	t/hr
Prim cyclone feed	461.0	389.3	t/hr
Prim cyclone A o/f	66.8	122.6	t/hr
Prim cyclone B o/f	66.8	122.6	t/hr
Prim cyclone A u/f	163.6	72.0	t/hr
Prim cyclone B u/f	163.6	72.0	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	166.4	72.0	t/hr
Peb mill 2 product	165.9	72.0	t/hr
Secondary dilution		8.5	t/hr
Sec cyclone feed	133.6	253.7	t/hr
Sec cyclone o/f	75.1	214.6	t/hr
Sec cyclone u/f	58.6	39.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	8.4	5.7	6.3	44.8	34.7
Prim cyc feed	20.5	23.1	31.2	18.2	6.9
Prim cyc A o/f	44.8	30.0	23.6	1.6	0.0
Prim cyc B o/f	44.8	30.0	23.6	1.6	0.0
Prim cyc A u/f	10.6	20.3	34.4	25.0	9.7
Prim cyc B u/f	10.6	20.3	34.4	25.0	9.7
Peb mill 1 disch	22.1	24.6	35.4	15.5	2.3
Peb mill 2 disch	22.8	24.9	35.2	14.9	2.2
Sec cyc feed	44.8	30.0	23.6	1.6	0.0
Sec cyc o/f	61.0	26.6	12.4	0.1	0.0
Sec cyc u/f	24.0	34.5	38.0	3.5	0.0

PCF = 563.3 m3 per hour
PCD = 1,510
PSM = 61.0 % passing 75 microns

Test 11c modelled mass balance

Stream	Solids	Water	
Rod mill feed	59.5	3.0	t/hr
Rod mill dilution		20.0	t/hr
Rod mill discharge	59.5	23.0	t/hr
Primary dilution		172.3	t/hr
Prim cyclone feed	415.6	367.5	t/hr
Prim cyclone A o/f	59.9	117.3	t/hr
Prim cyclone B o/f	59.9	117.3	t/hr
Prim cyclone A u/f	147.9	66.5	t/hr
Prim cyclone B u/f	147.9	66.5	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	150.7	66.5	t/hr
Peb mill 2 product	150.2	66.5	t/hr
Secondary dilution		14.6	t/hr
Sec cyclone feed	119.9	249.1	t/hr
Sec cyclone o/f	64.8	210.0	t/hr
Sec cyclone u/f	55.1	39.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.9	7.3	7.9	49.2	24.7
Prim cyc feed	19.4	25.5	34.0	16.8	4.4
Prim cyc A o/f	42.5	32.3	24.1	1.1	0.0
Prim cyc B o/f	42.5	32.3	24.1	1.1	0.0
Prim cyc A u/f	10.1	22.7	37.9	23.2	6.1
Prim cyc B u/f	10.1	22.7	37.9	23.2	6.1
Peb mill 1 disch	19.9	26.7	38.6	13.5	1.2
Peb mill 2 disch	21.0	27.3	38.1	12.6	1.1
Sec cyc feed	42.5	32.3	24.1	1.1	0.0
Sec cyc o/f	59.2	28.5	12.2	0.0	0.0
Sec cyc u/f	22.7	36.7	38.1	2.4	0.0

PCF = 524.3 m3 per hour
PCD = 1.494
PSM = 59.2 % passing 75 microns

Test 11b modelled mass balance

Stream	Solids	Water	
Rod mill feed	63.6	3.0	t/hr
Rod mill dilution		21.6	t/hr
Rod mill discharge	63.6	24.6	t/hr
Primary dilution		176.0	t/hr
Prim cyclone feed	433.1	376.6	t/hr
Prim cyclone A o/f	62.4	119.7	t/hr
Prim cyclone B o/f	62.4	119.7	t/hr
Prim cyclone A u/f	154.2	68.6	t/hr
Prim cyclone B u/f	154.2	68.6	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	157.0	68.6	t/hr
Peb mill 2 product	156.5	68.6	t/hr
Secondary dilution		8.6	t/hr
Sec cyclone feed	124.8	248.1	t/hr
Sec cyclone o/f	68.9	209.2	t/hr
Sec cyclone u/f	56.0	38.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.8	6.6	7.2	47.6	28.9
Prim cyc feed	19.8	24.5	33.0	17.4	5.3
Prim cyc A o/f	43.3	31.3	24.1	1.3	0.0
Prim cyc B o/f	43.3	31.3	24.1	1.3	0.0
Prim cyc A u/f	10.2	21.7	36.7	23.9	7.5
Prim cyc B u/f	10.2	21.7	36.7	23.9	7.5
Peb mill 1 disch	20.7	25.9	37.5	14.3	1.6
Peb mill 2 disch	21.7	26.3	37.1	13.4	1.4
Sec cyc feed	43.3	31.3	24.1	1.3	0.0
Sec cyc o/f	59.7	27.7	12.5	0.0	0.0
Sec cyc u/f	23.1	35.7	38.4	2.8	0.0

PCF = 540.0 m3 per hour
PCD = 1.499
PSM = 59.7 % passing 75 microns

Test 11a modelled mass balance

Stream	Solids	Water	
Rod mill feed	74.7	3.0	t/hr
Rod mill dilution		25.9	t/hr
Rod mill discharge	74.7	28.9	t/hr
Primary dilution		180.7	t/hr
Prim cyclone feed	480.1	397.5	t/hr
Prim cyclone A o/f	69.9	124.4	t/hr
Prim cyclone B o/f	69.9	124.4	t/hr
Prim cyclone A u/f	170.1	74.3	t/hr
Prim cyclone B u/f	170.1	74.3	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	172.9	74.3	t/hr
Peb mill 2 product	172.4	74.3	t/hr
Secondary dilution		8.2	t/hr
Sec cyclone feed	139.7	256.9	t/hr
Sec cyclone o/f	79.6	217.7	t/hr
Sec cyclone u/f	60.2	39.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	7.6	5.3	5.9	43.0	38.2
Prim cyc feed	21.1	22.0	30.1	18.8	8.0
Prim cyc A o/f	45.9	28.9	23.4	1.8	0.0
Prim cyc B o/f	45.9	28.9	23.4	1.8	0.0
Prim cyc A u/f	10.8	19.2	32.9	25.8	11.3
Prim cyc B u/f	10.8	19.2	32.9	25.8	11.3
Peb mill 1 disch	23.2	23.6	34.1	16.3	2.9
Peb mill 2 disch	23.5	23.8	34.0	15.9	2.8
Sec cyc feed	45.9	28.9	23.4	1.8	0.0
Sec cyc o/f	61.9	28.6	12.4	0.1	0.0
Sec cyc u/f	24.7	33.4	37.9	4.1	0.0

PCF = 578.7 m3 per hour
PCD = 1.517
PSM = 61.9 % passing 75 microns

Test 8c modelled mass balance

Stream	Solids	Water	
Rod mill feed	59.7	3.0	t/hr
Rod mill dilution		20.1	t/hr
Rod mill discharge	59.7	23.1	t/hr
Primary dilution		173.2	t/hr
Prim cyclone feed	435.2	425.7	t/hr
Prim cyclone A o/f	59.3	118.2	t/hr
Prim cyclone B o/f	59.3	118.2	t/hr
Prim cyclone A u/f	158.2	94.5	t/hr
Prim cyclone B u/f	158.2	94.5	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	163.7	94.5	t/hr
Peb mill 2 product	161.6	94.5	t/hr
Secondary dilution		11.4	t/hr
Sec cyclone feed	118.5	247.8	t/hr
Sec cyclone o/f	68.3	207.5	t/hr
Sec cyclone u/f	50.2	40.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.9	7.3	7.9	49.2	24.9
Prim cyc feed	25.2	24.8	29.3	16.2	4.4
Prim cyc A o/f	51.8	28.4	18.7	1.1	0.0
Prim cyc B o/f	51.8	28.4	18.7	1.1	0.0
Prim cyc A u/f	15.2	23.6	33.3	21.9	6.0
Prim cyc B u/f	15.2	23.6	33.3	21.9	6.0
Peb mill 1 disch	27.1	26.2	32.9	12.6	1.3
Peb mill 2 disch	27.2	26.8	32.8	12.0	1.2
Sec cyc feed	51.8	28.4	18.7	1.1	0.0
Sec cyc o/f	67.6	23.5	8.9	0.0	0.0
Sec cyc u/f	30.1	35.2	32.1	2.6	0.0

PCF = 589.9 m3 per hour
PCD = 1.459
PSM = 67.6 % passing 75 microns

Test 8b modelled mass balance

Stream	Solids	Water	
Rod mill feed	55.4	3.0	t/hr
Rod mill dilution		18.4	t/hr
Rod mill discharge	55.4	21.4	t/hr
Primary dilution		171.5	t/hr
Prim cyclone feed	414.9	415.7	t/hr
Prim cyclone A o/f	56.1	116.5	t/hr
Prim cyclone B o/f	56.1	116.5	t/hr
Prim cyclone A u/f	151.2	91.3	t/hr
Prim cyclone B u/f	151.2	91.3	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	156.7	91.3	t/hr
Peb mill 2 product	154.6	91.3	t/hr
Secondary dilution		11.3	t/hr
Sec cyclone feed	112.3	244.3	t/hr
Sec cyclone o/f	64.0	204.1	t/hr
Sec cyclone u/f	48.3	40.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	12.5	8.2	8.7	50.6	20.0
Prim cyc feed	24.9	26.1	30.2	15.5	3.3
Prim cyc A o/f	51.1	29.4	18.6	0.9	0.0
Prim cyc B o/f	51.1	29.4	18.6	0.9	0.0
Prim cyc A u/f	15.1	24.9	34.5	20.9	4.6
Prim cyc B u/f	15.1	24.9	34.5	20.9	4.6
Peb mill 1 disch	26.2	27.4	33.8	11.6	0.9
Peb mill 2 disch	26.4	28.1	33.7	11.0	0.8
Sec cyc feed	51.1	29.4	19.6	0.9	0.0
Sec cyc o/f	67.2	24.2	8.6	0.0	0.0
Sec cyc u/f	29.8	36.3	31.7	2.2	0.0

PCF = 572.3 m3 per hour
PCD = 1.451
PSM = 67.2 % passing 75 microns

Test 8a modelled mass balance

Stream	Solids	Water	
Rod mill feed	52.9	3.0	t/hr
Rod mill dilution		17.5	t/hr
Rod mill discharge	52.9	20.5	t/hr
Primary dilution		172.9	t/hr
Prim cyclone feed	404.7	413.1	t/hr
Prim cyclone A o/f	54.5	116.8	t/hr
Prim cyclone B o/f	54.5	116.8	t/hr
Prim cyclone A u/f	147.8	89.7	t/hr
Prim cyclone B u/f	147.8	89.7	t/hr
Pebble addition 1	5.5		t/hr
Pebble addition 2	3.4		t/hr
Peb mill 1 product	153.3	89.7	t/hr
Peb mill 2 product	151.2	89.7	t/hr
Secondary dilution		10.8	t/hr
Sec cyclone feed	108.9	244.4	t/hr
Sec cyclone o/f	61.7	204.1	t/hr
Sec cyclone u/f	47.2	40.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	13.7	8.9	9.4	51.2	16.8
Prim cyc feed	25.0	26.9	30.4	14.9	2.7
Prim cyc A o/f	51.3	29.8	18.1	0.8	0.0
Prim cyc B o/f	51.3	29.8	18.1	0.8	0.0
Prim cyc A u/f	15.2	25.9	35.0	20.1	3.7
Prim cyc B u/f	15.2	25.9	35.0	20.1	3.7
Peb mill 1 disch	26.0	28.2	34.1	11.0	0.7
Peb mill 2 disch	26.3	28.9	33.9	10.3	0.6
Sec cyc feed	51.3	29.8	18.1	0.8	0.0
Sec cyc o/f	67.4	24.3	8.2	0.0	0.0
Sec cyc u/f	30.1	37.1	31.0	1.8	0.0

PCF = 565.8 m3 per hour
PCD = 1.445
PSM = 67.4 % passing 75 microns

Test 62 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.0	3.0	t/hr
Rod mill dilution		10.6	t/hr
Rod mill discharge	35.0	13.6	t/hr
Primary dilution		233.5	t/hr
Prim cyclone feed	335.4	435.4	t/hr
Prim cyclone A o/f	39.3	147.9	t/hr
Prim cyclone B o/f	39.3	147.9	t/hr
Prim cyclone A u/f	128.4	69.7	t/hr
Prim cyclone B u/f	128.4	69.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.4	69.7	t/hr
Peb mill 2 product	131.4	69.7	t/hr
Secondary dilution		0.0	t/hr
Sec cyclone feed	78.6	295.9	t/hr
Sec cyclone o/f	41.0	247.0	t/hr
Sec cyclone u/f	37.6	48.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.0	36.5	25.0	8.2	0.2
Prim cyc A o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc B o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc A u/f	19.9	38.6	30.5	10.7	0.3
Prim cyc B u/f	19.9	38.6	30.5	10.7	0.3
Peb mill 1 disch	27.4	38.5	28.6	5.4	0.0
Peb mill 2 disch	28.7	38.5	27.9	4.8	0.0
Sec cyc feed	63.1	29.7	7.1	0.0	0.0
Sec cyc o/f	79.4	18.7	1.9	0.0	0.0
Sec cyc u/f	45.4	41.8	12.8	0.0	0.0

PCF = 562.0 m3 per hour
PCD = 1.372
PSM = 79.4 % passing 75 microns

Test 61 optimized mass balance

Stream	Solids	Water	
Rod mill feed	43.9	3.0	t/hr
Rod mill dilution		14.0	t/hr
Rod mill discharge	43.9	17.0	t/hr
Primary dilution		215.3	t/hr
Prim cyclone feed	398.3	450.9	t/hr
Prim cyclone A o/f	53.8	144.6	t/hr
Prim cyclone B o/f	53.8	144.6	t/hr
Prim cyclone A u/f	145.4	80.8	t/hr
Prim cyclone B u/f	145.4	80.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	148.4	80.8	t/hr
Peb mill 2 product	148.4	80.8	t/hr
Secondary dilution		122.5	t/hr
Sec cyclone feed	107.6	411.6	t/hr
Sec cyclone o/f	49.9	354.7	t/hr
Sec cyclone u/f	57.7	56.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	22.0	13.1	12.7	47.2	4.9
Prim cyc feed	31.1	32.9	24.8	10.5	0.7
Prim cyc A o/f	60.6	29.5	9.7	0.1	0.0
Prim cyc B o/f	60.6	29.5	9.7	0.1	0.0
Prim cyc A u/f	20.2	34.2	30.4	14.3	0.9
Prim cyc B u/f	20.2	34.2	30.4	14.3	0.9
Peb mill 1 disch	29.3	34.5	28.6	7.4	0.2
Peb mill 2 disch	30.6	34.5	28.0	6.8	0.2
Sec cyc feed	60.6	29.5	9.7	0.1	0.0
Sec cyc o/f	80.0	17.7	2.3	0.0	0.0
Sec cyc u/f	43.8	39.7	16.2	0.3	0.0

PCF = 601.2 m3 per hour
PCD = 1.413
PSM = 80.0 % passing 75 microns

Test 60 optimized mass balance

Stream	Solids	Water	
Rod mill feed	58.8	3.0	t/hr
Rod mill dilution		19.8	t/hr
Rod mill discharge	58.8	22.8	t/hr
Primary dilution		215.0	t/hr
Prim cyclone feed	480.2	480.4	t/hr
Prim cyclone A o/f	67.6	146.7	t/hr
Prim cyclone B o/f	67.6	146.7	t/hr
Prim cyclone A u/f	172.5	93.5	t/hr
Prim cyclone B u/f	172.5	93.5	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	175.5	93.5	t/hr
Peb mill 2 product	175.5	93.5	t/hr
Secondary dilution		135.3	t/hr
Sec cyclone feed	135.2	428.7	t/hr
Sec cyclone o/f	64.8	373.1	t/hr
Sec cyclone u/f	70.4	55.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	11.2	7.4	8.0	49.5	23.9
Prim cyc feed	31.0	25.8	24.5	14.7	4.0
Prim cyc A o/f	60.6	26.1	12.7	0.5	0.0
Prim cyc B o/f	60.6	26.1	12.7	0.5	0.0
Prim cyc A u/f	19.4	25.6	29.2	20.2	5.5
Prim cyc B u/f	19.4	25.6	29.2	20.2	5.5
Peb mill 1 disch	31.8	27.0	28.0	11.7	1.5
Peb mill 2 disch	32.2	27.0	27.9	11.5	1.4
Sec cyc feed	60.6	26.1	12.7	0.5	0.0
Sec cyc o/f	80.0	16.6	3.4	0.0	0.0
Sec cyc u/f	42.8	34.9	21.3	1.0	0.0

PCF = 661.6 m3 per hour
PCD = 1.452
PSM = 80.0 % passing 75 microns

Test 59 optimized mass balance

Stream	Solids	Water	
Rod mill feed	58.8	3.0	t/hr
Rod mill dilution		19.8	t/hr
Rod mill discharge	58.8	22.8	t/hr
Primary dilution		215.0	t/hr
Prim cyclone feed	480.2	480.4	t/hr
Prim cyclone A o/f	67.6	146.7	t/hr
Prim cyclone B o/f	67.6	146.7	t/hr
Prim cyclone A u/f	172.5	93.5	t/hr
Prim cyclone B u/f	172.5	93.5	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	175.5	93.5	t/hr
Peb mill 2 product	175.5	93.5	t/hr
Secondary dilution		135.3	t/hr
Sec cyclone feed	135.2	428.7	t/hr
Sec cyclone o/f	64.8	373.1	t/hr
Sec cyclone u/f	70.4	55.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	11.2	7.4	8.0	49.5	23.9
Prim cyc feed	31.0	25.8	24.5	14.7	4.0
Prim cyc A o/f	60.6	26.1	12.7	0.5	0.0
Prim cyc B o/f	60.6	26.1	12.7	0.5	0.0
Prim cyc A u/f	19.4	25.6	29.2	20.2	5.5
Prim cyc B u/f	19.4	25.6	29.2	20.2	5.5
Peb mill 1 disch	31.8	27.0	28.0	11.7	1.5
Peb mill 2 disch	32.2	27.0	27.9	11.5	1.4
Sec cyc feed	60.6	26.1	12.7	0.5	0.0
Sec cyc o/f	80.0	16.6	3.4	0.0	0.0
Sec cyc u/f	42.8	34.9	21.3	1.0	0.0

PCF = 661.6 m3 per hour
PCD = 1.452
PSM = 80.0 % passing 75 microns

Test 58 optimized mass balance

Stream	Solids	Water	
Rod mill feed	57.8	3.0	t/hr
Rod mill dilution		19.4	t/hr
Rod mill discharge	57.8	22.4	t/hr
Primary dilution		222.8	t/hr
Prim cyclone feed	472.0	483.2	t/hr
Prim cyclone A o/f	64.9	149.8	t/hr
Prim cyclone B o/f	64.9	149.8	t/hr
Prim cyclone A u/f	171.1	91.8	t/hr
Prim cyclone B u/f	171.1	91.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	174.1	91.8	t/hr
Peb mill 2 product	174.1	91.8	t/hr
Secondary dilution		106.8	t/hr
Sec cyclone feed	129.8	406.4	t/hr
Sec cyclone o/f	63.8	352.0	t/hr
Sec cyclone u/f	66.0	54.5	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	11.5	7.6	8.2	49.8	22.8
Prim cyc feed	31.0	26.0	24.6	14.6	3.8
Prim cyc A o/f	61.4	26.0	12.2	0.4	0.0
Prim cyc B o/f	61.4	26.0	12.2	0.4	0.0
Prim cyc A u/f	19.5	26.0	29.3	20.0	5.2
Prim cyc B u/f	19.5	26.0	29.3	20.0	5.2
Peb mill 1 disch	31.7	27.4	28.1	11.5	1.4
Peb mill 2 disch	32.2	27.4	27.9	11.2	1.3
Sec cyc feed	61.4	26.0	12.2	0.4	0.0
Sec cyc o/f	80.0	16.7	3.3	0.0	0.0
Sec cyc u/f	43.4	35.1	20.7	0.9	0.0

PCF = 661.3 m3 per hour
PCD = 1.444
PSM = 80.0 % passing 75 microns

Test 57 optimized mass balance

Stream	Solids	Water	
Rod mill feed	44.2	3.0	t/hr
Rod mill dilution		14.1	t/hr
Rod mill discharge	44.2	17.1	t/hr
Primary dilution		210.7	t/hr
Prim cyclone feed	403.1	449.4	t/hr
Prim cyclone A o/f	55.3	142.9	t/hr
Prim cyclone B o/f	55.3	142.9	t/hr
Prim cyclone A u/f	146.3	81.8	t/hr
Prim cyclone B u/f	146.3	81.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	149.3	81.8	t/hr
Peb mill 2 product	149.3	81.8	t/hr
Secondary dilution		142.3	t/hr
Sec cyclone feed	110.6	428.0	t/hr
Sec cyclone o/f	50.2	370.1	t/hr
Sec cyclone u/f	60.3	58.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	21.4	12.8	12.5	47.8	5.4
Prim cyc feed	31.0	32.7	24.9	10.6	0.7
Prim cyc A o/f	60.0	29.7	10.1	0.2	0.0
Prim cyc B o/f	60.0	29.7	10.1	0.2	0.0
Prim cyc A u/f	20.0	33.9	30.5	14.6	1.0
Prim cyc B u/f	20.0	33.9	30.5	14.6	1.0
Peb mill 1 disch	29.3	34.3	28.7	7.5	0.2
Peb mill 2 disch	30.6	34.3	28.1	6.9	0.2
Sec cyc feed	60.0	29.7	10.1	0.2	0.0
Sec cyc o/f	80.0	17.7	2.3	0.0	0.0
Sec cyc u/f	43.4	39.7	16.6	0.3	0.0

PCF = 601.5 m3 per hour
PCD = 1.417
PSM = 80.0 % passing 75 microns

Test 56 optimized mass balance

Stream	Solids	Water	
Rod mill feed	46.1	3.0	t/hr
Rod mill dilution		14.9	t/hr
Rod mill discharge	46.1	17.9	t/hr
Primary dilution		210.9	t/hr
Prim cyclone feed	416.1	454.5	t/hr
Prim cyclone A o/f	57.4	143.4	t/hr
Prim cyclone B o/f	57.4	143.4	t/hr
Prim cyclone A u/f	150.6	83.8	t/hr
Prim cyclone B u/f	150.6	83.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	153.6	83.8	t/hr
Peb mill 2 product	153.6	83.8	t/hr
Secondary dilution		147.7	t/hr
Sec cyclone feed	114.9	434.5	t/hr
Sec cyclone o/f	52.1	376.5	t/hr
Sec cyclone u/f	62.7	58.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.9	11.7	11.7	49.8	7.9
Prim cyc feed	30.9	31.6	25.0	11.5	1.1
Prim cyc A o/f	59.9	29.3	10.7	0.2	0.0
Prim cyc B o/f	59.9	29.3	10.7	0.2	0.0
Prim cyc A u/f	19.9	32.4	30.5	15.8	1.5
Prim cyc B u/f	19.9	32.4	30.5	15.8	1.5
Peb mill 1 disch	29.6	33.0	28.8	8.3	0.3
Peb mill 2 disch	30.8	33.0	28.2	7.7	0.3
Sec cyc feed	59.9	29.3	10.7	0.2	0.0
Sec cyc o/f	80.0	17.6	2.5	0.0	0.0
Sec cyc u/f	43.2	39.0	17.5	0.4	0.0

PCF = 611.5 m3 per hour
PCD = 1.424
PSM = 80.0 % passing 75 microns

Test 56 optimized mass balance

Stream	Solids	Water	
Rod mill feed	46.1	3.0	t/hr
Rod mill dilution		14.9	t/hr
Rod mill discharge	46.1	17.9	t/hr
Primary dilution		210.9	t/hr
Prim cyclone feed	416.1	454.5	t/hr
Prim cyclone A o/f	57.4	143.4	t/hr
Prim cyclone B o/f	57.4	143.4	t/hr
Prim cyclone A u/f	150.6	83.8	t/hr
Prim cyclone B u/f	150.6	83.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	153.6	83.8	t/hr
Peb mill 2 product	153.6	83.8	t/hr
Secondary dilution		147.7	t/hr
Sec cyclone feed	114.9	434.5	t/hr
Sec cyclone o/f	52.1	376.5	t/hr
Sec cyclone u/f	62.7	58.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.9	11.7	11.7	49.8	7.9
Prim cyc feed	30.9	31.6	25.0	11.5	1.1
Prim cyc A o/f	59.9	29.3	10.7	0.2	0.0
Prim cyc B o/f	59.9	29.3	10.7	0.2	0.0
Prim cyc A u/f	19.9	32.4	30.5	15.8	1.5
Prim cyc B u/f	19.9	32.4	30.5	15.8	1.5
Peb mill 1 disch	29.6	33.0	28.8	8.3	0.3
Peb mill 2 disch	30.8	33.0	28.2	7.7	0.3
Sec cyc feed	59.9	29.3	10.7	0.2	0.0
Sec cyc o/f	80.0	17.6	2.5	0.0	0.0
Sec cyc u/f	43.2	39.0	17.5	0.4	0.0

PCF = 611.5 m3 per hour
PCD = 1.424
PSM = 80.0 % passing 75 microns

Test 55 optimized mass balance

Stream	Solids	Water	
Rod mill feed	48.2	3.0	t/hr
Rod mill dilution		15.6	t/hr
Rod mill discharge	48.2	18.6	t/hr
Primary dilution		213.7	t/hr
Prim cyclone feed	427.2	460.7	t/hr
Prim cyclone A o/f	58.9	144.9	t/hr
Prim cyclone B o/f	58.9	144.9	t/hr
Prim cyclone A u/f	154.7	85.4	t/hr
Prim cyclone B u/f	154.7	85.4	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	157.7	85.4	t/hr
Peb mill 2 product	157.7	85.4	t/hr
Secondary dilution		140.9	t/hr
Sec cyclone feed	117.8	430.8	t/hr
Sec cyclone o/f	54.2	373.3	t/hr
Sec cyclone u/f	63.6	57.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	16.9	10.7	10.9	51.0	10.6
Prim cyc feed	30.9	30.4	25.0	12.2	1.5
Prim cyc A o/f	60.1	28.6	11.0	0.2	0.0
Prim cyc B o/f	60.1	28.6	11.0	0.2	0.0
Prim cyc A u/f	19.8	31.1	30.3	16.7	2.1
Prim cyc B u/f	19.8	31.1	30.3	16.7	2.1
Peb mill 1 disch	30.0	31.8	28.8	8.9	0.4
Peb mill 2 disch	31.1	31.9	28.3	8.4	0.4
Sec cyc feed	60.1	28.6	11.0	0.2	0.0
Sec cyc o/f	80.0	17.4	2.6	0.0	0.0
Sec cyc u/f	43.2	38.2	18.2	0.5	0.0

PCF = 621.9 m3 per hour
PCD = 1.428
PSM = 80.0 % passing 75 microns

Test 54 optimized mass balance

Stream	Solids	Water	
Rod mill feed	52.7	3.0	t/hr
Rod mill dilution		17.4	t/hr
Rod mill discharge	52.7	20.4	t/hr
Primary dilution		217.3	t/hr
Prim cyclone feed	470.0	471.5	t/hr
Prim cyclone A o/f	62.4	147.0	t/hr
Prim cyclone B o/f	62.2	147.0	t/hr
Prim cyclone A u/f	162.8	88.8	t/hr
Prim cyclone B u/f	162.8	88.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	165.8	88.8	t/hr
Peb mill 2 product	165.8	88.8	t/hr
Secondary dilution		129.9	t/hr
Sec cyclone feed	124.4	423.8	t/hr
Sec cyclone o/f	58.7	367.6	t/hr
Sec cyclone u/f	65.7	56.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	13.8	9.0	9.4	51.2	16.6
Prim cyc feed	30.9	28.2	24.9	13.5	2.5
Prim cyc A o/f	60.6	27.4	11.7	0.3	0.0
Prim cyc B o/f	60.6	27.4	11.7	0.3	0.0
Prim cyc A u/f	19.6	28.5	29.9	18.5	3.5
Prim cyc B u/f	19.6	28.5	29.9	18.5	3.5
Peb mill 1 disch	30.8	29.6	28.6	10.2	0.8
Peb mill 2 disch	31.7	29.6	28.2	9.8	0.8
Sec cyc feed	60.6	27.4	11.7	0.3	0.0
Sec cyc o/f	80.0	17.1	2.9	0.0	0.0
Sec cyc u/f	43.2	36.7	19.5	0.6	0.0

PCF = 641.3 m3 per hour
PCD = 1.437
PSM = 80.0 % passing 75 microns

APPENDIX J

Simulated mass balances for optimization

Test 53 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.0	3.0	t/hr
Rod mill dilution		10.6	t/hr
Rod mill discharge	35.0	13.6	t/hr
Primary dilution		233.5	t/hr
Prim cyclone feed	335.4	435.4	t/hr
Prim cyclone A o/f	39.3	147.9	t/hr
Prim cyclone B o/f	39.3	147.9	t/hr
Prim cyclone A u/f	128.4	69.7	t/hr
Prim cyclone B u/f	128.4	69.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.4	69.7	t/hr
Peb mill 2 product	131.4	69.7	t/hr
Secondary dilution		0.0	t/hr
Sec cyclone feed	78.6	295.9	t/hr
Sec cyclone o/f	41.0	247.0	t/hr
Sec cyclone u/f	37.6	48.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.0	36.5	25.0	8.2	0.2
Prim cyc A o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc B o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc A u/f	19.9	38.6	30.5	10.7	0.3
Prim cyc B u/f	19.9	38.6	30.5	10.7	0.3
Peb mill 1 disch	27.4	38.5	28.6	5.4	0.0
Peb mill 2 disch	28.7	38.5	27.9	4.8	0.0
Sec cyc feed	63.1	29.7	7.1	0.0	0.0
Sec cyc o/f	79.4	18.7	1.9	0.0	0.0
Sec cyc u/f	45.4	41.8	12.8	0.0	0.0

PCF = 562.0 m3 per hour
PCD = 1.372
PSM = 79.4 % passing 75 microns

Test 13c modelled mass balance

Stream	Solids	Water	
Rod mill feed	62.3	3.0	t/hr
Rod mill dilution		21.1	t/hr
Rod mill discharge	62.3	24.1	t/hr
Primary dilution		202.9	t/hr
Prim cyclone feed	443.4	405.4	t/hr
Prim cyclone A o/f	62.0	134.5	t/hr
Prim cyclone B o/f	62.0	134.5	t/hr
Prim cyclone A u/f	159.6	68.1	t/hr
Prim cyclone B u/f	159.6	68.1	t/hr
Pebble addition 1	2.8		t/hr
Pebble addition 2	2.3		t/hr
Peb mill 1 product	162.4	68.1	t/hr
Peb mill 2 product	161.9	68.1	t/hr
Secondary dilution		7.9	t/hr
Sec cyclone feed	124.1	277.0	t/hr
Sec cyclone o/f	67.2	234.8	t/hr
Sec cyclone u/f	56.9	42.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	10.1	6.8	7.4	48.1	27.6
Prim cyc feed	22.2	25.7	30.6	16.6	5.0
Prim cyc A o/f	48.6	31.1	19.6	0.7	0.0
Prim cyc B o/f	48.6	31.1	19.6	0.7	0.0
Prim cyc A u/f	11.8	23.6	34.9	22.7	6.9
Prim cyc B u/f	11.8	23.6	34.9	22.7	6.9
Peb mill 1 disch	23.0	27.0	34.9	13.5	1.6
Peb mill 2 disch	23.8	27.3	34.5	12.8	1.5
Sec cyc feed	48.6	31.1	19.6	0.7	0.0
Sec cyc o/f	65.8	25.5	8.7	0.0	0.0
Sec cyc u/f	28.3	37.7	32.4	1.6	0.0

PCF = 572.7 m3 per hour
PCD = 1.482
PSM = 65.8 % passing 75 microns

Test 70 optimized mass balance

Stream	Solids	Water	
Rod mill feed	40.0	3.0	t/hr
Rod mill dilution		12.5	t/hr
Rod mill discharge	40.0	15.5	t/hr
Primary dilution		228.3	t/hr
Prim cyclone feed	352.2	439.5	t/hr
Prim cyclone A o/f	44.1	146.8	t/hr
Prim cyclone B o/f	44.1	146.8	t/hr
Prim cyclone A u/f	132.0	73.0	t/hr
Prim cyclone B u/f	132.0	73.0	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	135.0	73.0	t/hr
Peb mill 2 product	135.0	73.0	t/hr
Secondary dilution		18.8	t/hr
Sec cyclone feed	88.2	312.3	t/hr
Sec cyclone o/f	46.0	262.6	t/hr
Sec cyclone u/f	42.2	49.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	31.0	16.6	14.6	36.7	1.1
Prim cyc feed	31.3	35.9	24.5	8.1	0.1
Prim cyc A o/f	62.9	29.5	7.5	0.0	0.0
Prim cyc B o/f	62.9	29.5	7.5	0.0	0.0
Prim cyc A u/f	20.7	38.1	30.2	10.8	0.2
Prim cyc B u/f	20.7	38.1	30.2	10.8	0.2
Peb mill 1 disch	28.5	38.0	28.1	5.4	0.0
Peb mill 2 disch	29.8	37.9	27.3	4.8	0.0
Sec cyc feed	62.9	29.5	7.5	0.0	0.0
Sec cyc o/f	79.2	18.7	2.1	0.0	0.0
Sec cyc u/f	45.1	41.3	13.5	0.1	0.0

PCF = 572.4 m3 per hour
PCD = 1.383
PSM = 79.2 % passing 75 microns

Test 67 optimized mass balance

Stream	Solids	Water	
Rod mill feed	37.9	3.0	t/hr
Rod mill dilution		11.7	t/hr
Rod mill discharge	37.9	14.7	t/hr
Primary dilution		235.9	t/hr
Prim cyclone feed	350.6	445.2	t/hr
Prim cyclone A o/f	42.4	150.4	t/hr
Prim cyclone B o/f	42.4	150.4	t/hr
Prim cyclone A u/f	132.9	72.2	t/hr
Prim cyclone B u/f	132.9	72.2	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	135.9	72.2	t/hr
Peb mill 2 product	135.9	72.2	t/hr
Secondary dilution		13.1	t/hr
Sec cyclone feed	84.8	314.0	t/hr
Sec cyclone o/f	43.9	263.7	t/hr
Sec cyclone u/f	40.9	50.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	31.0	35.7	24.5	8.5	0.2
Prim cyc A o/f	63.7	29.1	7.2	0.0	0.0
Prim cyc B o/f	63.7	29.1	7.2	0.0	0.0
Prim cyc A u/f	20.6	37.8	30.1	11.2	0.3
Prim cyc B u/f	20.6	37.8	30.1	11.2	0.3
Peb mill 1 disch	28.5	37.7	28.1	5.7	0.1
Peb mill 2 disch	29.8	37.7	27.4	5.1	0.0
Sec cyc feed	63.7	29.1	7.2	0.0	0.0
Sec cyc o/f	80.0	18.1	1.9	0.0	0.0
Sec cyc u/f	46.1	40.9	12.9	0.1	0.0

POF = 577.5 m3 per hour
POD = 1.378
PSM = 80.0 % passing 75 microns

Test 73 optimized mass balance

Stream	Solids	Water	
Rod mill feed	66.1	3.0	t/hr
Rod mill dilution		22.6	t/hr
Rod mill discharge	66.1	25.6	t/hr
Primary dilution		217.5	t/hr
Prim cyclone feed	529.7	461.5	t/hr
Prim cyclone A o/f	83.1	151.7	t/hr
Prim cyclone B o/f	83.1	151.7	t/hr
Prim cyclone A u/f	181.7	79.0	t/hr
Prim cyclone B u/f	181.7	79.0	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	184.7	79.0	t/hr
Peb mill 2 product	184.7	79.0	t/hr
Secondary dilution		237.4	t/hr
Sec cyclone feed	166.3	540.8	t/hr
Sec cyclone o/f	72.1	480.5	t/hr
Sec cyclone u/f	94.1	60.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.2	6.2	6.8	46.5	31.3
Prim cyc feed	29.7	24.5	24.6	15.6	5.6
Prim cyc A o/f	57.9	26.7	14.6	0.8	0.0
Prim cyc B o/f	57.9	26.7	14.6	0.8	0.0
Prim cyc A u/f	16.8	23.5	29.2	22.3	8.2
Prim cyc B u/f	16.8	23.5	29.2	22.3	8.2
Peb mill 1 disch	30.7	25.2	28.1	13.5	3.4
Peb mill 2 disch	30.4	25.2	28.2	13.7	2.5
Sec cyc feed	57.9	26.7	14.6	0.8	0.0
Sec cyc o/f	79.9	16.6	3.5	0.0	0.0
Sec cyc u/f	41.0	34.5	23.1	1.3	0.0

PCF = 661.4 m3 per hour
PCD = 1.499
PSM = 79.9 % passing 75 microns

'est 72 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.4	3.0	t/hr
Rod mill dilution		10.7	t/hr
Rod mill discharge	35.4	13.7	t/hr
Primary dilution		255.5	t/hr
Prim cyclone feed	338.1	422.1	t/hr
Prim cyclone A o/f	40.8	160.8	t/hr
Prim cyclone B o/f	40.8	160.8	t/hr
Prim cyclone A u/f	128.2	50.3	t/hr
Prim cyclone B u/f	128.2	50.3	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.2	50.3	t/hr
Peb mill 2 product	131.2	50.3	t/hr
Secondary dilution		0.7	t/hr
Sec cyclone feed	81.7	322.2	t/hr
Sec cyclone o/f	41.4	270.9	t/hr
Sec cyclone u/f	40.3	51.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	28.8	37.6	25.2	8.2	0.2
Prim cyc A o/f	63.3	30.5	6.2	0.0	0.0
Prim cyc B o/f	63.3	30.5	6.2	0.0	0.0
Prim cyc A u/f	17.8	39.8	31.2	10.9	0.3
Prim cyc B u/f	17.8	39.8	31.2	10.9	0.3
Peb mill 1 disch	25.5	39.7	29.2	5.5	0.0
Peb mill 2 disch	26.9	39.7	28.5	4.9	0.0
Sec cyc feed	63.3	30.5	6.2	0.0	0.0
Sec cyc o/f	79.9	18.5	1.6	0.0	0.0
Sec cyc u/f	46.2	42.7	11.0	0.0	0.0

PCF = 549.7 m3 per hour
PCD = 1.383
PSM = 79.9 % passing 75 microns

Test 71 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.6	3.0	t/hr
Rod mill dilution		10.8	t/hr
Rod mill discharge	35.6	13.8	t/hr
Primary dilution		246.1	t/hr
Prim cyclone feed	343.7	417.8	t/hr
Prim cyclone A o/f	43.3	157.1	t/hr
Prim cyclone B o/f	43.3	157.1	t/hr
Prim cyclone A u/f	128.6	51.8	t/hr
Prim cyclone B u/f	128.6	51.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.6	51.8	t/hr
Peb mill 2 product	131.6	51.8	t/hr
Secondary dilution		44.9	t/hr
Sec cyclone feed	86.6	359.2	t/hr
Sec cyclone o/f	41.6	304.8	t/hr
Sec cyclone u/f	45.0	54.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	28.9	37.6	25.1	8.2	0.2
Prim cyc A o/f	62.0	31.2	6.8	0.0	0.0
Prim cyc B o/f	62.0	31.2	6.8	0.0	0.0
Prim cyc A u/f	17.8	39.8	31.2	10.9	0.3
Prim cyc B u/f	17.8	39.8	31.2	10.9	0.3
Peb mill 1 disch	25.5	39.7	29.2	5.5	0.0
Peb mill 2 disch	26.9	39.7	28.5	4.9	0.0
Sec cyc feed	62.0	31.2	6.8	0.0	0.0
Sec cyc o/f	80.0	18.5	1.6	0.0	0.0
Sec cyc u/f	45.4	43.0	11.6	0.0	0.0

PCF = 547.5 m3 per hour
PCD = 1.391
PSM = 80.0 % passing 75 microns

Test 69 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.8	3.0	t/hr
Rod mill dilution		10.9	t/hr
Rod mill discharge	35.8	13.9	t/hr
Primary dilution		233.3	t/hr
Prim cyclone feed	341.7	439.1	t/hr
Prim cyclone A o/f	40.8	148.7	t/hr
Prim cyclone B o/f	40.8	148.7	t/hr
Prim cyclone A u/f	130.1	70.8	t/hr
Prim cyclone B u/f	130.1	70.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	133.1	70.8	t/hr
Peb mill 2 product	133.1	70.8	t/hr
Secondary dilution		15.0	t/hr
Sec cyclone feed	81.5	312.5	t/hr
Sec cyclone o/f	41.8	262.1	t/hr
Sec cyclone u/f	39.7	50.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.5	36.3	24.7	8.3	0.2
Prim cyc A o/f	63.4	29.5	7.1	0.0	0.0
Prim cyc B o/f	63.4	29.5	7.1	0.0	0.0
Prim cyc A u/f	20.3	38.4	30.2	10.8	0.3
Prim cyc B u/f	20.3	38.4	30.2	10.8	0.3
Peb mill 1 disch	27.9	38.3	28.3	5.5	0.0
Peb mill 2 disch	29.2	38.3	27.5	4.9	0.0
Sec cyc feed	63.4	29.5	7.1	0.0	0.0
Sec cyc o/f	79.9	18.2	1.8	0.0	0.0
Sec cyc u/f	45.9	41.4	12.6	0.1	0.0

PCF = 568.0 m3 per hour
PCD = 1.375
PSM = 79.9 % passing 75 microns

Test 68 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.0	3.0	t/hr
Rod mill dilution		10.6	t/hr
Rod mill discharge	35.0	13.6	t/hr
Primary dilution		234.0	t/hr
Prim cyclone feed	335.6	436.0	t/hr
Prim cyclone A o/f	39.3	148.2	t/hr
Prim cyclone B o/f	39.3	148.2	t/hr
Prim cyclone A u/f	128.5	69.7	t/hr
Prim cyclone B u/f	128.5	69.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.5	69.7	t/hr
Peb mill 2 product	131.5	69.7	t/hr
Secondary dilution		0.0	t/hr
Sec cyclone feed	78.7	296.4	t/hr
Sec cyclone o/f	41.0	247.5	t/hr
Sec cyclone u/f	37.6	48.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.1	36.5	25.0	8.2	0.2
Prim cyc A o/f	63.2	29.7	7.1	0.0	0.0
Prim cyc B o/f	63.2	29.7	7.1	0.0	0.0
Prim cyc A u/f	19.9	38.6	30.5	10.7	0.3
Prim cyc B u/f	19.9	38.6	30.5	10.7	0.3
Peb mill 1 disch	[illegible]5	38.5	28.6	5.4	0.0
Peb mill 2 disch	.8	38.5	27.8	4.8	0.0
Sec cyc feed	63.2	29.7	7.1	0.0	0.0
Sec cyc o/f	79.5	18.6	1.9	0.0	0.0
Sec cyc u/f	45.6	41.7	12.7	0.0	0.0

PCF = 562.6 m3 per hour
PCD = 1.371
PSM = 79.5 % passing 75 microns

Test 65 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.0	3.0	t/hr
Rod mill dilution		10.6	t/hr
Rod mill discharge	35.0	13.6	t/hr
Primary dilution		233.5	t/hr
Prim cyclone feed	335.4	435.4	t/hr
Prim cyclone A o/f	39.3	147.9	t/hr
Prim cyclone B o/f	39.3	147.9	t/hr
Prim cyclone A u/f	128.4	69.7	t/hr
Prim cyclone B u/f	128.4	69.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.4	69.7	t/hr
Peb mill 2 product	131.4	69.7	t/hr
Secondary dilution		0.0	t/hr
Sec cyclone feed	78.6	295.9	t/hr
Sec cyclone o/f	41.0	247.0	t/hr
Sec cyclone u/f	37.6	48.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.0	36.5	25.0	8.2	0.2
Prim cyc A o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc B o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc A u/f	19.9	38.6	30.5	10.7	0.3
Prim cyc B u/f	19.9	38.6	30.5	10.7	0.3
Peb mill 1 disch	27.4	38.5	28.6	5.4	0.0
Peb mill 2 disch	28.7	38.5	27.9	4.8	0.0
Sec cyc feed	63.1	29.7	7.1	0.0	0.0
Sec cyc o/f	79.4	18.7	1.9	0.0	0.0
Sec cyc u/f	45.4	41.8	12.8	0.0	0.0

PCF = 562.0 m3 per hour
PCD = 1.372
PSM = 79.4 % passing 75 microns

Test 64 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.8	3.0	t/hr
Rod mill dilution		10.9	t/hr
Rod mill discharge	35.8	13.9	t/hr
Primary dilution		233.3	t/hr
Prim cyclone feed	341.7	439.1	t/hr
Prim cyclone A o/f	40.8	148.7	t/hr
Prim cyclone B o/f	40.8	148.7	t/hr
Prim cyclone A u/f	130.1	70.8	t/hr
Prim cyclone B u/f	130.1	70.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	133.1	70.8	t/hr
Peb mill 2 product	133.1	70.8	t/hr
Secondary dilution		15.0	t/hr
Sec cyclone feed	81.5	312.5	t/hr
Sec cyclone o/f	41.8	262.1	t/hr
Sec cyclone u/f	39.7	50.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	18.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.5	36.3	24.7	8.3	0.2
Prim cyc A o/f	63.4	29.5	7.1	0.0	0.0
Prim cyc B o/f	63.4	29.5	7.1	0.0	0.0
Prim cyc A u/f	20.3	38.4	30.2	10.8	0.3
Prim cyc B u/f	20.3	38.4	30.2	10.8	0.3
Peb mill 1 disch	27.9	38.3	28.3	5.5	0.0
Peb mill 2 disch	29.2	38.3	27.5	4.9	0.0
Sec cyc feed	63.4	29.5	7.1	0.0	0.0
Sec cyc o/f	79.9	18.2	1.8	0.0	0.0
Sec cyc u/f	45.9	41.4	12.6	0.1	0.0

PCF = 568.0 m3 per hour
PCD = 1.375
PSM = 79.9 % passing 75 microns

Test 64 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.8	3.0	t/hr
Rod mill dilution		10.9	t/hr
Rod mill discharge	35.8	13.9	t/hr
Primary dilution		233.3	t/hr
Prim cyclone feed	341.7	439.1	t/hr
Prim cyclone A o/f	40.8	148.7	t/hr
Prim cyclone B o/f	40.8	148.7	t/hr
Prim cyclone A u/f	130.1	70.8	t/hr
Prim cyclone B u/f	130.1	70.8	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	133.1	70.8	t/hr
Peb mill 2 product	133.1	70.8	t/hr
Secondary dilution		15.0	t/hr
Sec cyclone feed	81.5	312.5	t/hr
Sec cyclone o/f	41.8	262.1	t/hr
Sec cyclone u/f	39.7	50.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.5	36.3	24.7	8.3	0.2
Prim cyc A o/f	63.4	29.5	7.1	0.0	0.0
Prim cyc B o/f	63.4	29.5	7.1	0.0	0.0
Prim cyc A u/f	20.3	38.4	30.2	10.8	0.3
Prim cyc B u/f	20.3	38.4	30.2	10.8	0.3
Peb mill 1 disch	27.9	38.3	28.3	5.5	0.0
Peb mill 2 disch	29.2	38.3	27.5	4.9	0.0
Sec cyc feed	63.4	29.5	7.1	0.0	0.0
Sec cyc o/f	79.9	18.2	1.8	0.0	0.0
Sec cyc u/f	45.9	41.4	12.6	0.1	0.0

PCF = 568.0 m3 per hour
POD = 1.375
PSM = 79.9 % passing 75 microns

Test 63 optimized mass balance

Stream	Solids	Water	
Rod mill feed	35.0	3.0	t/hr
Rod mill dilution		10.6	t/hr
Rod mill discharge	35.0	13.6	t/hr
Primary dilution		233.5	t/hr
Prim cyclone feed	335.4	435.4	t/hr
Prim cyclone A o/f	39.3	147.9	t/hr
Prim cyclone B o/f	39.3	147.9	t/hr
Prim cyclone A u/f	128.4	69.7	t/hr
Prim cyclone B u/f	128.4	69.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	131.4	69.7	t/hr
Peb mill 2 product	131.4	69.7	t/hr
Secondary dilution		0.0	t/hr
Sec cyclone feed	78.6	295.9	t/hr
Sec cyclone o/f	41.0	247.0	t/hr
Sec cyclone u/f	37.6	48.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.0	36.5	25.0	8.2	0.2
Prim cyc A o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc B o/f	63.1	29.7	7.1	0.0	0.0
Prim cyc A u/f	19.9	38.6	30.5	10.7	0.3
Prim cyc B u/f	19.9	38.6	30.5	10.7	0.3
Peb mill 1 disch	27.4	38.8	28.6	5.4	0.0
Peb mill 2 disch	28.7	38.5	27.9	4.8	0.0
Sec cyc feed	63.1	29.7	7.1	0.0	0.0
Sec cyc o/f	79.4	18.7	1.9	0.0	0.0
Sec cyc u/f	45.4	1.8	12.8	0.0	0.0

PCF = 562.0 m3 per hour
PCD = 1.372
PSM = 79.4 % passing 75 microns

Test 66 optimized mass balance

Stream	Solids	Water	
Rod mill feed	37.2	3.0	t/hr
Rod mill dilution		11.4	t/hr
Rod mill discharge	37.2	14.4	t/hr
Primary dilution		337.5	t/hr
Prim cyclone feed	347.1	444.9	t/hr
Prim cyclone A o/f	41.5	150.9	t/hr
Prim cyclone B o/f	41.5	150.9	t/hr
Prim cyclone A u/f	132.1	71.5	t/hr
Prim cyclone B u/f	132.1	71.5	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	135.1	71.5	t/hr
Peb mill 2 product	135.1	71.5	t/hr
Secondary dilution		7.0	t/hr
Sec cyclone feed	83.0	308.8	t/hr
Sec cyclone o/f	43.2	258.9	t/hr
Sec cyclone u/f	39.8	49.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	30.9	35.9	24.5	8.4	0.2
Prim cyc A o/f	63.9	29.0	7.0	0.0	0.0
Prim cyc B o/f	63.9	29.0	7.0	0.0	0.0
Prim cyc A u/f	20.5	38.0	30.0	11.1	0.3
Prim cyc B u/f	20.5	38.0	30.0	11.1	0.3
Peb mill 1 disch	28.4	37.9	28.1	5.6	0.0
Peb mill 2 disch	29.7	37.9	27.4	5.0	0.0
Sec cyc feed	63.9	29.0	7.0	0.0	0.0
Sec cyc o/f	80.1	18.1	1.9	0.0	0.0
Sec cyc u/f	46.4	41.0	12.6	0.1	0.0

PCF = 575.9 m3 per hour
PCD = 1.375
PSM = 80.1 % passing 75 microns

Test 82 optimized mass balance

Stream	Solids	Water	
Rod mill feed	44.0	3.0	t/hr
Rod mill dilution		14.0	t/hr
Rod mill discharge	44.0	17.0	t/hr
Primary dilution		217.6	t/hr
Prim cyclone feed	411.8	425.6	t/hr
Prim cyclone A o/f	61.5	149.5	t/hr
Prim cyclone B o/f	61.5	149.5	t/hr
Prim cyclone A u/f	144.4	63.3	t/hr
Prim cyclone B u/f	144.4	63.3	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	147.4	63.3	t/hr
Peb mill 2 product	147.4	63.3	t/hr
Secondary dilution		227.6	t/hr
Sec cyclone feed	122.9	526.7	t/hr
Sec cyclone o/f	50.0	462.3	t/hr
Sec cyclone u/f	72.9	64.4	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	21.7	13.0	12.6	47.5	5.2
Prim cyc feed	29.6	34.3	25.2	10.3	0.7
Prim cyc A o/f	57.6	31.9	10.3	0.1	0.0
Prim cyc B o/f	57.6	31.9	10.3	0.1	0.0
Prim cyc A u/f	17.7	35.3	31.5	14.6	1.0
Prim cyc B u/f	17.7	35.3	31.5	14.6	1.0
Peb mill 1 disch	27.0	35.7	29.7	7.5	0.2
Peb mill 2 disch	26.3	35.7	29.0	6.9	0.2
Sec cyc feed	57.6	31.9	10.3	0.1	0.0
Sec cyc o/f	80.0	18.0	2.0	0.0	0.0
Sec cyc u/f	42.3	41.5	16.0	0.2	0.0

PCF = 581.0 m3 per hour
PCD = 1.441
PSM = 80.0 % passing 75 microns

Test 81 optimized mass balance

Stream	Solids	Water	
Rod mill feed	53.1	3.0	t/hr
Rod mill dilution		17.6	t/hr
Rod mill discharge	53.1	20.6	t/hr
Primary dilution		220.7	t/hr
Prim cyclone feed	466.4	445.3	t/hr
Prim cyclone A o/f	71.3	152.2	t/hr
Prim cyclone B o/f	71.3	152.2	t/hr
Prim cyclone A u/f	161.9	70.4	t/hr
Prim cyclone B u/f	161.9	70.4	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	164.9	70.4	t/hr
Peb mill 2 product	164.9	70.4	t/hr
Secondary dilution		237.9	t/hr
Sec cyclone feed	142.5	542.4	t/hr
Sec cyclone o/f	59.1	479.2	t/hr
Sec cyclone u/f	83.4	63.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	13.6	8.8	9.3	51.2	17.1
Prim cyc feed	39.6	29.5	25.3	13.1	2.5
Prim cyc A o/f	57.6	29.6	12.4	0.3	0.0
Prim cyc B o/f	57.6	29.6	12.4	0.3	0.0
Prim cyc A u/f	17.2	29.4	31.0	18.7	3.7
Prim cyc B u/f	17.2	29.4	31.0	18.7	3.7
Peb mill 1 disch	28.6	30.5	29.6	10.4	0.9
Peb mill 2 disch	29.6	30.5	29.2	9.9	0.8
Sec cyc feed	57.6	29.6	12.4	0.3	0.0
Sec cyc o/f	80.0	17.4	2.6	0.0	0.0
Sec cyc u/f	41.7	38.4	19.4	0.5	0.0

PCF = 621.3 m3 per hour
PCD = 1.467
PSM = 80.0 % passing 75 microns

Test 80 optimized mass balance

Stream	Solids	Water	
Rod mill feed	58.9	3.0	t/hr
Rod mill dilution		19.8	t/hr
Rod mill discharge	58.9	22.8	t/hr
Primary dilution		224.1	t/hr
Prim cyclone feed	492.8	455.4	t/hr
Prim cyclone A o/f	75.5	154.1	t/hr
Prim cyclone B o/f	75.5	154.1	t/hr
Prim cyclone A u/f	170.9	73.7	t/hr
Prim cyclone B u/f	170.9	73.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	173.9	73.7	t/hr
Peb mill 2 product	173.9	73.7	t/hr
Secondary dilution		219.8	t/hr
Sec cyclone feed	150.9	528.0	t/hr
Sec cyclone o/f	64.9	466.7	t/hr
Sec cyclone u/f	86.0	61.2	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	11.1	7.4	8.0	49.4	24.0
Prim cyc feed	29.7	27.1	25.0	14.3	3.9
Prim cyc A o/f	58.2	28.2	13.2	0.4	0.0
Prim cyc B o/f	58.2	28.2	13.2	0.4	0.0
Prim cyc A u/f	17.1	26.6	30.3	20.4	5.6
Prim cyc B u/f	17.1	26.6	30.3	20.4	5.6
Peb mill 1 disch	29.6	28.0	29.1	11.8	1.5
Peb mill 2 disch	30.1	28.0	28.9	11.6	1.4
Sec cyc feed	58.2	28.2	13.2	0.4	0.0
Sec cyc o/f	80.0	17.0	3.0	0.0	0.0
Sec cyc u/f	41.7	36.6	20.9	0.8	0.0

PCF = 641.4 m3 per hour
PCD = 1.478
PSM = 80.0 % passing 75 microns

Test 79 optimized mass balance

Stream	Solids	Water	
Rod mill feed	39.6	3.0	t/hr
Rod mill dilution		12.3	t/hr
Rod mill discharge	39.6	15.3	t/hr
Primary dilution		209.2	t/hr
Prim cyclone feed	361.6	464.7	t/hr
Prim cyclone A o/f	44.5	137.6	t/hr
Prim cyclone B o/f	44.5	137.6	t/hr
Prim cyclone A u/f	136.3	94.7	t/hr
Prim cyclone B u/f	136.3	94.7	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	139.3	94.7	t/hr
Peb mill 2 product	139.3	94.7	t/hr
Secondary dilution		47.9	t/hr
Sec cyclone feed	88.9	323.2	t/hr
Sec cyclone o/f	45.6	272.4	t/hr
Sec cyclone u/f	43.3	50.8	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	28.1	15.6	14.2	40.3	1.8
Prim cyc feed	32.9	34.3	24.0	8.7	0.2
Prim cyc A o/f	63.2	28.4	8.3	0.1	0.0
Prim cyc B o/f	63.2	28.4	8.3	0.1	0.0
Prim cyc A u/f	23.0	36.2	29.1	11.5	0.3
Prim cyc B u/f	23.0	36.2	29.1	11.5	0.3
Peb mill 1 disch	30.9	36.1	27.1	5.8	0.1
Peb mill ' disch	32.2	36.1	26.4	5.2	0.0
Sec cyc feed	63.2	28.4	8.3	0.1	0.0
Sec cyc o/f	80.0	17.8	2.2	0.0	0.0
Sec cyc u/f	45.5	39.6	14.8	0.2	0.0

PCF = 601.2 m3 per hour
PCD = 1.375
PSM = 80.0 % passing 75 microns

Test 78 optimized mass balance

Stream	Solids	Water	
Rod mill feed	49.8	3.0	t/hr
Rod mill dilution		16.3	t/hr
Rod mill discharge	49.8	19.3	t/hr
Primary dilution		220.3	t/hr
Prim cyclone feed	424.3	500.7	t/hr
Prim cyclone A o/f	52.7	144.7	t/hr
Prim cyclone B o/f	52.7	144.7	t/hr
Prim cyclone A u/f	159.5	105.6	t/hr
Prim cyclone B u/f	159.5	105.6	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	162.5	105.6	t/hr
Peb mill 2 produc	162.5	105.6	t/hr
Secondary dilution		38.5	t/hr
Sec cyclone feed	105.4	328.0	t/hr
Sec cyclone o/f	55.8	278.1	t/hr
Sec cyclone u/f	49.6	49.9	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	15.6	10.0	10.3	51.3	12.8
Prim cyc feed	32.4	28.2	24.4	13.1	1.9
Prim cyc A o/f	63.5	25.8	10.4	0.3	0.0
Prim cyc B o/f	63.5	25.8	10.4	0.3	0.0
Prim cyc A u/f	22.1	29.0	29.1	17.3	2.6
Prim cyc B u/f	22.1	29.0	29.1	17.3	2.6
Peb mill 1 disch	32.6	29.8	27.7	9.4	0.6
Peb mill 2 disch	33.5	29.8	27.3	8.8	0.5
Sec cyc feed	63.5	25.8	10.4	0.3	0.0
Sec cyc o/f	80.0	16.9	3.1	0.0	0.0
Sec cyc u/f	44.9	35.9	18.7	0.6	0.0

PCF = 660.8 m3 per hour
PCD = 1.400
PSM = 80.0 % passing 75 microns

Test 77 optimized mass balance

Stream	Solids	Water	
Rod mill feed	51.0	3.0	t/hr
Rod mill dilution		16.8	t/hr
Rod mill discharge	51.0	19.8	t/hr
Primary dilution		213.4	t/hr
Prim cyclone feed	433.2	498.9	t/hr
Prim cyclone A o/f	55.0	142.1	t/hr
Prim cyclone B o/f	55.0	142.1	t/hr
Prim cyclone A u/f	161.6	107.3	t/hr
Prim cyclone B u/f	161.6	107.3	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	164.6	107.3	t/hr
Peb mill 2 product	164.6	107.3	t/hr
Secondary dilution		61.6	t/hr
Sec cyclone feed	110.1	345.9	t/hr
Sec cyclone o/f	57.0	294.8	t/hr
Sec cyclone u/f	53.0	51.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	14.8	9.5	9.9	51.4	14.4
Prim cyc feed	32.3	27.7	24.4	13.3	2.2
Prim cyc A o/f	62.8	25.9	11.0	0.4	0.0
Prim cyc B o/f	62.8	25.9	11.0	0.4	0.0
Prim cyc A u/f	21.9	26.3	29.0	17.8	3.0
Prim cyc B u/f	21.9	26.3	29.0	17.8	3.0
Peb mill 1 disch	32.7	29.2	27.7	9.7	0.7
Peb mill 2 disch	33.6	29.3	27.3	9.2	0.6
Sec cyc feed	62.8	25.9	11.0	0.4	0.0
Sec cyc o/f	80.0	16.8	3.2	0.0	0.0
Sec cyc u/f	44.3	35.6	19.3	0.7	0.0

PCF = 662.4 m3 per hour
PCD = 1.407
PSM = 80.0 % passing 75 microns

Test 77 optimized mass balance

Stream	Solids	Water	
Rod mill feed	51.0	3.0	t/hr
Rod mill dilution		16.8	t/hr
Rod mill discharge	51.0	19.8	t/hr
Primary dilution		213.4	t/hr
Prim cyclone feed	433.2	498.9	t/hr
Prim cyclone A o/f	55.0	142.1	t/hr
Prim cyclone B o/f	55.0	142.1	t/hr
Prim cyclone A u/f	161.6	107.3	t/hr
Prim cyclone B u/f	161.6	107.3	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	164.6	107.3	t/hr
Peb mill 2 product	164.6	107.3	t/hr
Secondary dilution		61.6	t/hr
Sec cyclone feed	110.1	345.9	t/hr
Sec cyclone o/f	57.0	294.8	t/hr
Sec cyclone u/f	53.0	51.1	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	14.8	9.5	9.9	51.4	14.4
Prim cyc feed	32.3	27.7	24.4	13.3	2.2
Prim cyc A o/f	62.8	25.9	11.0	0.4	0.0
Prim cyc B o/f	62.8	25.9	11.0	0.4	0.0
Prim cyc A u/f	21.9	28.3	29.0	17.8	3.0
Prim cyc B u/f	21.9	28.3	29.0	17.8	3.0
Peb mill 1 disch	32.7	29.2	27.7	9.7	0.7
Peb mill 2 disch	33.6	29.3	27.3	9.2	0.6
Sec cyc feed	62.8	25.9	11.0	0.4	0.0
Sec cyc o/f	80.0	16.8	3.2	0.0	0.0
Sec cyc u/f	44.3	35.6	19.3	0.7	0.0

PCF = 662.4 m3 per hour
PCD = 1.407
PSM = 80.0 % passing 75 microns

Test 76 optimized mass balance

Stream	Solids	Water	
Rod mill feed	37.4	3.0	t/hr
Rod mill dilution		11.5	t/hr
Rod mill discharge	37.4	14.5	t/hr
Primary dilution		173.6	t/hr
Prim cyclone feed	364.7	438.4	t/hr
Prim cyclone A o/f	49.2	123.3	t/hr
Prim cyclone B o/f	49.2	123.3	t/hr
Prim cyclone A u/f	133.1	95.9	t/hr
Prim cyclone B u/f	133.1	95.9	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	136.1	95.9	t/hr
Peb mill 2 product	136.1	95.9	t/hr
Secondary dilution		174.9	t/hr
Sec cyclone feed	98.5	421.6	t/hr
Sec cyclone o/f	43.4	363.0	t/hr
Sec cyclone u/f	55.1	58.6	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	38.1	15.6	14.2	40.3	1.8
Prim cyc feed	32.2	35.3	24.1	8.1	0.2
Prim cyc A o/f	59.2	30.8	9.9	0.2	0.0
Prim cyc B o/f	59.2	30.8	9.9	0.2	0.0
Prim cyc A u/f	22.2	37.0	29.4	11.1	0.3
Prim cyc B u/f	22.2	37.0	29.4	11.1	0.3
Peb mill 1 disch	29.9	36.9	27.5	5.6	0.1
Peb mill 2 disch	31.2	36.9	26.8	5.0	0.0
Sec cyc feed	59.2	30.8	9.9	0.2	0.0
Sec cyc o/f	79.8	18.0	2.1	0.0	0.0
Sec cyc u/f	42.9	40.8	16.0	0.3	0.0

PCF = 576.0 m3 per hour
PCD = 1,394
PSM = 79.8 % passing 75 microns

Test 75 optimized mass balance

Stream	Solids	Water	
Rod mill feed	42.5	3.0	t/hr
Rod mill dilution		13.4	t/hr
Rod mill discharge	42.5	16.4	t/hr
Primary dilution		225.9	t/hr
Prim cyclone feed	375.8	484.2	t/hr
Prim cyclone A o/f	44.7	145.2	t/hr
Prim cyclone B o/f	44.7	145.2	t/hr
Prim cyclone A u/f	143.2	96.9	t/hr
Prim cyclone B u/f	143.2	96.9	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	146.2	96.9	t/hr
Peb mill 2 product	146.2	96.9	t/hr
Secondary dilution		4.2	t/hr
Sec cyclone feed	89.4	294.6	t/hr
Sec cyclone o/f	48.5	246.6	t/hr
Sec cyclone u/f	40.9	48.0	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	24.4	14.2	13.4	44.7	3.4
Prim cyc feed	32.8	32.4	24.2	10.1	0.5
Prim cyc A o/f	64.5	27.0	8.3	0.1	0.0
Prim cyc B o/f	64.5	27.0	8.3	0.1	0.0
Prim cyc A u/f	23.0	34.1	29.2	13.2	0.6
Prim cyc B u/f	23.0	34.1	29.2	13.2	0.6
Peb mill 1 disch	31.6	34.2	27.4	6.7	0.1
Peb mill 2 disch	32.8	34.2	26.7	6.1	0.1
Sec cyc feed	64.5	27.0	8.3	0.1	0.0
Sec cyc o/f	80.0	17.5	2.5	0.0	0.0
Sec cyc u/f	46.2	38.3	15.3	0.2	0.0

PCF = 626.0 m3 per hour
PCD = 1.374
PSM = 80.0 % passing 75 microns

Test 74 optimized mass balance

Stream	Solids	Water	
Rod mill feed	66.3	3.0	t/hr
Rod mill dilution		22.7	t/hr
Rod mill discharge	66.3	25.7	t/hr
Primary dilution		217.6	t/hr
Prim cyclone feed	530.8	461.9	t/hr
Prim cyclone A o/f	83.3	151.8	t/hr
Prim cyclone B o/f	83.3	151.8	t/hr
Prim cyclone A u/f	182.1	79.1	t/hr
Prim cyclone B u/f	182.1	79.1	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	185.1	79.1	t/hr
Peb mill 2 product	185.1	79.1	t/hr
Secondary dilution		237.7	t/hr
Sec cyclone feed	166.7	541.3	t/hr
Sec cyclone o/f	72.3	480.9	t/hr
Sec cyclone u/f	94.3	60.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.1	6.2	6.8	46.4	31.4
Prim cyc feed	29.8	24.4	24.6	15.6	5.7
Prim cyc A o/f	57.9	26.7	14.6	0.8	0.0
Prim cyc B o/f	57.9	26.7	14.6	0.8	0.0
Prim cyc A u/f	16.8	23.4	29.2	22.3	8.3
Prim cyc B u/f	16.8	23.4	29.2	22.3	8.3
Peb mill 1 disch	30.8	25.2	28.1	13.5	2.5
Peb mill 2 disch	30.4	25.1	28.2	13.8	2.5
Sec cyc feed	57.9	26.7	14.6	0.8	0.0
Sec cyc o/f	80.0	16.5	3.5	0.0	0.0
Sec cyc u/f	41.1	34.5	23.1	1.4	0.0

PCF = 662.2 m3 per hour
PCD = 1.499
PSM = 80.0 % passing 75 microns

Test 74 optimized mass balance

Stream	Solids	Water	
Rod mill feed	66.3	3.0	t/hr
Rod mill dilution		22.7	t/hr
Rod mill discharge	66.3	25.7	t/hr
Primary dilution		217.6	t/hr
Prim cyclone feed	530.8	461.9	t/hr
Prim cyclone A /f	83.3	151.8	t/hr
Prim cyclone B o/f	83.3	151.8	t/hr
Prim cyclone A u/f	182.1	79.1	t/hr
Prim cyclone B u/f	182.1	79.1	t/hr
Pebble addition 1	3.0		t/hr
Pebble addition 2	3.0		t/hr
Peb mill 1 product	185.1	79.1	t/hr
Peb mill 2 product	185.1	79.1	t/hr
Secondary dilution		237.7	t/hr
Sec cyclone feed	166.7	541.3	t/hr
Sec cyclone o/f	72.3	480.9	t/hr
Sec cyclone u/f	94.3	60.3	t/hr

Size analysis

Stream	-75	-150+75	-250+150	-1700+250	+1700
Rod mill discharge	9.1	6.2	6.8	46.4	31.4
Prim cyc feed	29.8	24.4	24.6	15.6	5.7
Prim cyc A o/f	57.9	26.7	14.6	0.8	0.0
Prim cyc B o/f	57.9	26.7	14.6	0.8	0.0
Prim cyc A u/f	16.8	23.4	29.2	22.3	8.3
Prim cyc B u/f	16.8	23.4	29.2	22.3	8.3
Peb mill 1 disch	30.8	25.2	28.1	13.5	2.5
Peb mill 2 disch	30.4	25.1	28.2	13.8	2.5
Sec cyc feed	57.9	26.7	14.6	0.8	0.0
Sec cyc o/f	80.0	16.5	3.5	0.0	0.0
Sec cyc u/f	41.1	34.5	23.1	1.4	0.0

PCF = 662.2 m3 per hour
PCD = 1.499
PSM = 80.0 % passing 75 microns

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