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Process Design Criteria

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Sheet	Revisions							Sheet	Revisions						
	00	01	02	03	04	05			00	01	02	03	04	05	
1	X							31	X						
2	X							32	X	X					
3	X							33	X						
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5	X							35	X						
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7	X							37	X						
8	X	X	X					38	X						
9	X	X						39	X						
10	X	X						40	X						
11	X	X						41	X						
12	X	X						42	X	X					
13	X							43							
14	X	X						44							
15	X	X						45							
16	X	X						46							
17	X	X						47							
18	X	X						48							
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27	X							57							
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1. INTRODUCTION

A copper company has intended to construction a new phase copper and molybdenum concentrator plant (as a copper concentrate by product. The report detailed below will serve as the process design criteria for two different phase.

“Nominal” and “Design” capacity of the project is equal to indicate 4680 dmtph and 5400 dmtph fresh ore feed conditions respectively (2340 dtph and 2700 dtph for each phase). The plant is “Designed” to accommodate the “Maximum” conditions.

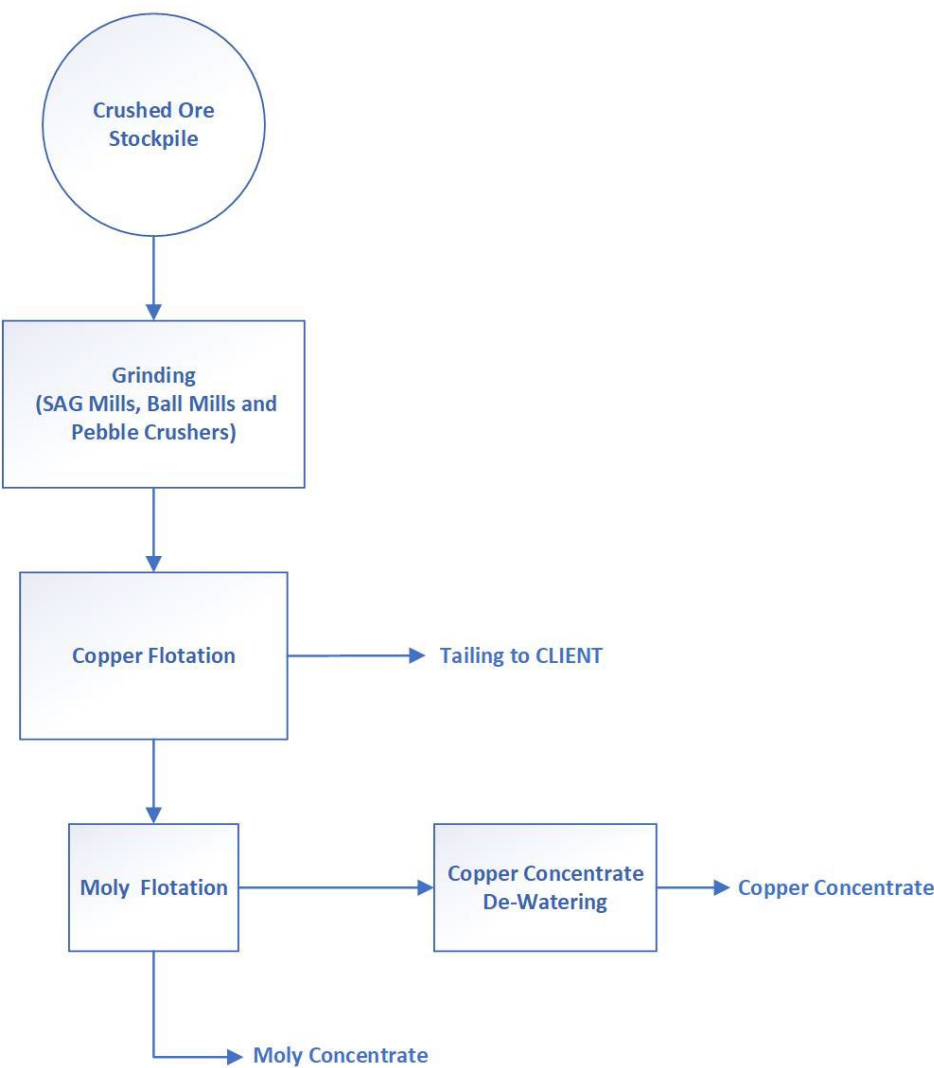


Figure 1. Simplified Block Flow Diagram

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2. DATA SOURCES

Process design criteria mentioned in this document are based on data sources which are referenced in below table:

Table 1. List of data sources

Source Code	Document Title	Rev	Date
A	Process Design Criteria (Basic engineering Package)	N / A	N / A
B	Calculated values	N / A	N / A
C	To be Finalized by Vendor	N / A	N / A

3. GENERAL PRODUCTION DATA

A brief summary of the expected production data for plant is given in table 2 below:

Table 2. General Production Data

Description	Units	Value	SOURCE
Stockpile Area (up to SAG Mill)			
Stock Pile Live Capacity	h	24	A
Stock Pile Live Capacity (common with plant other phase)	ton	130000	A
Process Plant (from SAG Mill Feed Stockpile)			
Plant Operating Times			
Calendar days per year	d	365	-
Working Days per Year	d	320	A
Working Hours per Year	h	7680	A
Shifts per Day	#	3	A
Hours per Shift	#	8	A
Plant Availability	%	(320/365=) 88	A
Production Data			
Nominal Ore Feed Rate per phase (Dry Basis)	DMTPH	2340	A
Maximum Ore Feed Rate per phase (Dry Basis)	DMTPH	2700	A

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4. ORE CHARACTERISTICS

The feed ore to plant will be supplied from the Mine pit. Material characteristics of ore body are given in table 3:

Table 3. Feed to Concentrate Plant

Description	Unit	Value	SOURCE
Copper Head Grade	%(m/m)	0.44	A
Mo Head Grade	ppm	180	A
Estimated Copper Oxides in Feed Ore	%(m/m)	0.0	A
Ore Feed Moisture	%(m/m)	6	A
Ore Specific Gravity	-	2.8	A
Ore Bulk Density	t/m ³	1.80	A
Bond Ball Mill Work index	Kwh/t	14.3	A
Bond Crusher Work Index	Kwh/t	18.1	A

5. STOCKPILE AND MILL FEED SYSTEM

Table 4. Stockpile

Description	Unit	Value	SOURCE
Quantity	#	1	A
Location (indoors/ outdoors)	-	outdoors	A
Stockpile Shape	-	Conical	A
Ore Bulk Density	t/m ³	1.80	A
Height	m	53.424	B
Diameter	m	115	B
Angle of repose	°	38	A
Material P80	mm	150	A
Material Top size	mm	250	A
Moisture Content	%	6	A
Required Accessing tunnel	Qty	2 (One for each Phase)	A
Reclaim Angle	°	70	A

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6. APRON FEEDERS AND FEED CONVEYORS

Table 5. Apron feeder

Description	Unit	Value	SOURCE
Number of Rows (Withdrawal Conveyors)	#	2 (One for each Phase)	A
Total Quantity	#	12	A
Number of Feeders per Transfer Conveyor	#	6	A
Arrangement	-	3 Duty; 3 Standby per Row	A
Location (indoors/ outdoors)	-	Indoors (-25 to 40°C)	C
Apron Feeder Type	-	Heavy Duty Apron Feeder	A
Apron Feeder Model	-	WFL	C
Motor Size	kW	WFL	C
Material Handled	-	Crushed Copper Ore	A
Material P80	mm	150	A
Material Top size	mm	250	A
Angle of Repose	°	38	A
Reclaim Angle	°	70	A
Moisture Content	%	6	A
Bulk Density	t/m ³	1.8	A
Nominal Ore Feed Rate (Dry Basis)	DMTPH	780	A
Maximum Capacity Ore Feed Rate (Dry Basis)	DMTPH	900	A

Table 6. SAG Mill Feed Conveyor

02

Description	Unit	Value	SOURCE
Quantity	#	2 (1 for each phase)	A
Location (indoors/ outdoors)	#	outdoors	A
Material Handled	-	Crushed Copper Ore	A
Material P80	mm	150	A
Material Top size	mm	250	A
Angle of Repose	°	38	A
Surcharge Angle	°	20	B
Moisture Content	%	6	A
Bulk Density	t/m ³	1.8	A
Nominal Ore Feed Rate per phase (Dry Basis)	DMTPH	2815	A
Maximum Capacity Ore Feed Rate per phase (Dry Basis)	DMTPH	3248	A

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7. GRINDING CIRCUIT

Grinding Circuit consist of two SAG mills, four Ball Mills and eight Hydro cyclone clusters. Twelve (12) apron feeders (6 duty, 6 standby) under the stockpile transfer ore onto two conveyor which discharge the feed ore into two SAG mills. The SAG mills discharge is screened on vibrating screens. Oversize is transferred to four pebble crusher and the crushed product is fed back into the SAG mills. For each phase, the undersize from the SAG mill screen collects in a mill discharge sump.

For particle size classification, each of two mills discharge sump is equipped to four parallel lines. Each line consists one centrifuge slurry pump and one hydro cyclone cluster. Two of these four lines are for Duty purpose and two of them are Standby.

The underflow from each duty cyclone cluster reports separately to the one ball mill (four ball mills working in parallel) and the ball mills discharge are returning to the related mill discharge sumps. The overflow from each phase hydro cyclone clusters is transferred to the related receiving tank in their flotation circuits.

Details of the process design criteria for the major equipment is given in the tables below:

7.1 SAG MILL

Process design criteria to be used for the design of the SAG mill are given in table 7 below:

Table 7. SAG Mill Process Design Criteria

Description	Unit	Value	SOURCE
Total Quantity	#	2 Operation & 0 Standby (1 for each phase)	A
Location (indoors/ outdoors)	-	Indoors	A
Type	-	SAG	A
Discharge Type	-	Grate	A
Motor Power	Kw	2*9000	C
Diameter inside shell	m	11	A
Flange-to-flange length	m	VTs	C
Effective Grinding length	m	6.1	A
Feed material			
Ore Type	-	Copper Ore	A
Ore Specific Gravity	t/m ³	2.8	A
Liquid Density	t/m ³	1	A
Feed Material top size (F100)	mm	250	A
Feed F80	mm	150	A
Bond Ball Mill Work Index	Kwh/t	14.3	A
Operating Condition			
Type of Grinding (Wet / Dry)	-	Wet	A
Open / Closed Circuit	-	Closed (Pebble recirculation)	A
Nominal Fresh Solids feed rate	DMTPH	2340	A
Maximum Fresh Solids Feed rate	DMTPH	2700	A

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Solids Content of Fresh Feed	%(m/m)	94	A
Solids Content of Mill Discharge	%(m/m)	65.3	A
Maximum Pebble Circulating Load (as a fraction of SAG mill fresh solids feed rate)	%	20	A
Mill Discharge Slurry Density	t/m ³	1.72	A
Feed Temperature	°C	-25 to 40	A
Mill Slurry Temperature	°C	5 to 60	A
Discharge top size, P100 (with pebble ports)	mm	70	A
Product P80 (vibrating screen undersize)	mm	2	A
Grinding media			
Grinding Media Type	-	Balls	A
Grinding media diameter	mm	125	A
Grinding media material	-	Forged steel	A
Grinding media hardness	-	Rockwell "C" 58 - 65	A
Maximum ball filling	%(v/v)	15	A
Maximum Total Filling	%(v/v)	35	C

7.2 PEBBLE CRUSHER AND VIBRATING FEEDER

Details of the process design criteria for the pebble cone crusher which crushes the SAG mill vibrating screens oversize are given in table 8 below:

Table 8. Pebble Crusher Process Design Criteria

Description	Unit	Value	SOURCE
Quantity	#	4 (Two for each phase)	A
Location (indoors/ outdoors)	-	In enclosed structure, but design for outdoors	A
Arrangement	-	Parallel	C
Crusher Type	-	Cone Crusher	A
Model	-	-	
Motor Size	Kw	1 × 315	C
Feed material			
Feed Rate as % of SAG Mill Fresh Solids feed rate	%	20	A
Ore Type	-	Copper Ore	A
Ore Specific Gravity	-	2.8	A
Liquid Density	t/m ³	1	
Bulk Density	t/m ³	1.8	A
Bond Crusher Work Index	Kwh/t	18.1	A
Feed Top size (F100)	mm	70	A
Feed F80	mm	30	A
Bond Abrasion Index	g	VTS	A
Operating conditions			
Nominal Fresh Solids feed rate	DMTPH	234	A
Maximum Fresh Solids Feed rate	DMTPH	270	A
Total Nominal Fresh Solids feed rate (each phase)	DMTPH	468	A
Total Maximum Fresh Solids Feed rate (each phase)	DMTPH	540	A

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Solids Content of Feed	%(m/m)	90	A
Product P80	mm	15	A

Table 9. Vibrating Feeder Process Design Criteria

Description	Unit	Value	SOURCE
Quantity	#	4 Operation & 0 Standby (2 for each phase)	A
Location (indoors/ outdoors)	-	outdoors	A
Arrangement	-	Parallel	A
Application Description	-	Pebble Crusher Feeder	A
Model	-		
Size (LxWxH)	m	2.5 × 0.8 × 0.23	C
Motor Size	Kw	2.2	C
Feed material			
Feed Rate as % of SAG Mill Fresh Solids feed rate	%	20	A
Ore Type	-	Copper Ore	A
Ore Specific Gravity	-	2.8	A
Liquid Density	t/m ³	1	A
Angle of Repose	°	35	A
Bulk Density	t/m ³	1.8	A
Feed Top size (F100)	mm	70	A
Operating conditions			
Nominal Fresh Solids feed rate	DMTPH	234	A
Maximum Fresh Solids Feed rate	DMTPH	270	A
Total Nominal Fresh Solids feed rate (each phase)	DMTPH	468	A
Total Maximum Fresh Solids Feed rate (each phase)	DMTPH	540	A
Solids Content of Feed	%(m/m)	90	A
Mounting Method		Base Mounted	C

7.3 BALL MILL

The process design criteria used for the ball mills in operation are given in table 10 below:

Table 10. Ball Mill Process Design Criteria

Description	Unit	Value	SOURCE
Quantity	#	4 Operational 0 Standby (2 for each phase)	A
Location (indoors/ outdoors)	-	Indoors	A
Type	-	Ball Mill	A

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Discharge type	-	Overflow	A
Diameter inside shell	m	7.92	C
Flange-to-flange length	m	12.5	C
Effective grinding length	m	12.19	C
Motor Power	kW	2 x 9000	C
Feed material			
Ore Type		Copper Ore	A
Ore Specific Gravity	-	2.8	A
Liquid Density	t/m ³	1	A
Bond Ball Mill Work Index	kWh/t	14.3	A
Feed top size (F100)	mm	12.7	A
Feed F80	microns	650	A
Operating Conditions			
Type of Grinding (wet / dry)	-	Wet	A
Open / Closed Circuit	-	Closed (with Cyclone)	A
Nominal Fresh Solids Feed rate per mill	DMTPH	1174.21	A
Maximum Fresh Solids Feed rate per mill	DMTPH	1354.86	A
Solids Content of Undiluted Mill Feed	%(m/m)	70.66	A
Solids Content of Mill Discharge	%(m/m)	64.54	A
Product P80 (cyclone overflow)	μm	90	A
Circulating Load	%	300	A
Maximum Feed Temperature	°C	70	A
Grinding Media Type	-	Ball	A
Grinding media diameter	mm	75	A
Grinding media material	-	Forged steel	A
Grinding media hardness	-	Typica 58 – 62 RC	A
Maximum total filling (% by volume)	%(v/v)	35-40	A
Maximum ball filling (% by volume)	%(v/v)	35	A

7.4 VIBRATING SCREEN

The process design criteria used for the SAG mills discharge vibrating screens that separates oversize to pebble crusher is given in table 11 below:

Table 11. Process Design Criteria for Vibrating Screen

Description	Unit	Value	SOURCE
Quantity	#	4 (One operational and One Standby for each phase)	A
Location (indoors/ outdoors)	-	Indoors	A
Screen Size (L x W)	m	8.54 × 7.27	C
Motor Size	kW	90	C
Feed material			
Ore Type	-	SAG Mill Discharge	A
Ore Specific Gravity	-	2.8	A
Liquid Density	t/m ³	1	A
Ore Bulk Density	t/m ³	1.80	A
Feed size F100	mm	70	A
Feed size F80	mm	2	A
Operating Conditions			

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Type of screening (wet / dry)	-	Wet	A
Nominal solids feed rate	tph	2815.02	A
Maximum solids feed rate	tph	3248.09	A
Solids content in feed slurry	%(m/m)	65.3	A
Feed slurry density	t/m ³	1.72	A
Maximum Feed slurry temperature	°C	5 to 60	A
Minimum required screening efficiency	%	95	A
Screen aperture	mm	12.7×25.4	A
Washing System	-	Spray Water	A

7.5 HYDROCYCLONE CLUSTER

The process design criteria used for the eight (8) hydro cyclone cluster classifying SAG and ball mill discharges are given in table 12 below:

Table 12. Hydro cyclone Design Criteria

Description	Units	Value	SOURCE
Quantity of cyclone clusters	set	8 (Two operation and Two standby for each phase)	A
Location (indoors/ outdoors)	-	Indoor	A
Quantity of cyclones in each cluster	#	10 (8 operation and 2 standby)	C
Ball mill circulating load (%)	%	300	A
Ore Type	-	Copper Ore	A
Ore Specific Gravity	-	2.8	A
Liquid Density	t/m ³	1	A
Operating Pressure	kPa	150 (100 to 200)	C
Feed			
Nominal solids feed rate per cluster	tph	4694.04	A
Maximum solids feed rate per cluster	tph	5416.19	A
Solid's content	%(m/m)	55	A
Slurry density	t/m ³	1.55	A
Nominal slurry flow rate per cluster	m ³ /h	5517.02	A
Maximum slurry flow rate per cluster	m ³ /h	6365.78	A
Feed slurry temperature	°C	5 to 60	A
Feed F100	mm	12.7	A
Feed F80	microns	800 - 1100	A
Overflow			
Nominal solids flow rate per cluster	tph	1173.51	A
Maximum solids flow rate per cluster	tph	1354.05	A
Solid content	%(m/m)	33	A
Slurry density	t/m ³	1.27	A
Nominal slurry flow rate per cluster	m ³ /h	2801.69	A
Maximum slurry flow rate per cluster	m ³ /h	3232.72	A
P100	μm	150	A
P80	μm	90	A
Underflow			

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Nominal solids flow rate per cluster	tph	3520.53	A
Maximum solids flow rate per cluster	tph	4062.14	A
Solid content	%(m/m)	70.71	A
Slurry density	t/m ³	1.83	A
Nominal slurry flow rate per cluster	m ³ /h	2715.33	A
Maximum slurry flow rate per cluster	m ³ /h	3133.07	A
Cyclone Cut-size, d50	µm	116	C

8. FLOTATION CIRCUIT

The flotation circuit is used to affect the mechanical separation of value copper minerals (predominantly chalcopyrite) from the rest of the ore. The circuit makes use of one (1) rougher and three (3) cleaner stages with (4) cleaner-scavenger stages to produce a concentrate at the best possible grade and overall recovery. As mentioned above, Plant includes 2 phase and each phase has an independent and similar flotation circuit which a brief summary of this flotation circuit is given as follows:

Overflow from the hydro-cyclone clusters in the grinding circuit are combined and flows into a receiving tank and then passed to a conditioning tank prior to the rougher cells. From there the slurry is flows to the feed box of rougher cells by gravity. There are One (1) rougher bank which consisting of twelve (12) of 320 m³ roughing flotation cells. The tailings from the rougher flotation bank are fed to a tailing receiving tank by gravity. The overflow (concentrate) from the rougher cells is combined and fed into the regrind Ball Mill discharge sump. It is possible for the concentrate off the first and second rougher cells to by-pass the regrind section and be pumped to the first cleaners receiving tanks.

Slurry is pumped from the regrind mill discharge sump to cyclone clusters (One duty and One standby) where the underflow goes to a ball mill, intended to further polish and liberate copper bearing minerals, with the discharge from the regrind ball mill fed to the regrind mill discharge sump. Lime is added into the underflow launders to regulate slurry pH for cleaner stages. Overflow from the cyclone cluster is fed into a small receiving tank, the overflow from which is then fed via gravity into the first of seven (7) flotation vessels. The first three (3) 200 m³ in volume of these cells act as cleaners and the last four (4) 200 m³ in volume as cleaner scavengers. Concentrate from the cleaner cells is pumped to the re-cleaner cells and the concentrate from the cleaner scavenger cells is fed to the regrind mill discharge sump. The tailings from the cleaner scavenger and rougher cells are combined in receiving tailing tank and transferred out of flotation plant by pipe line.

The re-cleaner cells consist of five (5) of 20 m³ conventional mechanical flotation cells. Tailings from the re-cleaner cells is re-circulated to the cleaner cells, whilst the re-cleaner concentrate is fed into the re-re-cleaner cells which consist of three (3) off 20 m³ conventional mechanically agitated flotation cells connected in series with the re-cleaner cells. Tailings from the re-re-cleaner cells is re-circulated to the re-cleaner cells. The re-re-cleaner concentrate is the Molybdenum flotation plant feed. Concentrate from the final copper cleaner cells is fed to the Mo-Cu concentrate thickener for dewatering and feeding to Mo plant. Also, re-cleaner concentrate can be by-passed and considered as the final concentrate.

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8.1 ROUGHER FLOTATION CIRCUIT

Table 13. Rougher Flotation Design Criteria

Description	Unit	Value	SOURCE
Location (indoors/ outdoors)		Indoors	
Rougher Flotation			
Cell type	Type	Cylindrical	
Cell size	m3	320	A
Number of cells, installed	#	24 (12 each phase)	A
Number of banks, installed	#	2 (One each phase)	A
Number of cells per bank	#	12	A
Aeration factor	%	85	A
Unit recovery (nominal)	%	92.27	A
Unit recovery (maximum)	%	92.27	A
Overall rougher mass pull (nominal)	%	14	A
Overall rougher mass pull (maximum)	%	14	A
Residence time (nominal)	min	35	A
Residence time (maximum)	min	30.33	A
Flotation Feed			
Feed slurry density	t/m3	1.27	A
Solids federate per bank (nominal)	tph	2347.02	A
Solids Federate per bank (maximum)	tph	2708.01	A
Copper feed rate per bank (nominal)	tph	10.33	A
Copper feed rate per bank (maximum)	tph	11.92	A
Copper grade	%(m/m)	0.44	A
Solids content	%(m/m)	33	A
Flotation pH	pH	11.5	A
Slurry density	t/m3	1.27	A
Slurry flow rate per bank (nominal)	m3/h	5603.38	A
Slurry flow rate per bank (maximum)	m3/h	6465.43	A
Flotation Concentrate			
Concentrate destination		Regrind sump	A
Solid flowrate per bank (nominal)	tph	328.58	A
Solid flowrate per bank (maximum)	tph	379.13	A
Copper flowrate per bank (nominal)	tph	9.53	A
Copper flowrate per bank (maximum)	tph	11	A
Slurry flow rate per bank (nominal)	m3/h	1103.1	A
Slurry flow rate per bank (maximum)	m3/h	1272.8	A
Concentrate froth factor	-	2	A
Copper grade (nominal)	%(m/m)	2.9	A
Copper grade (maximum)	%(m/m)	2.9	A
Slurry density	t/m3	1.19	A
Solids Content	%(m/m)	25	A
Total Launder water addition rate	m3/h	300	A
Flotation Tailing			
Tailing destination		Final tailings	
Solids Content (nominal)	%(m/m)	32.95	A
Solids Content (maximum)	%(m/m)	32.95	A

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Solid's flowrate per bank (nominal)	tph	2018.44	A
Solid's flowrate per bank (maximum)	tph	2328.96	A
Copper flowrate per bank (nominal)	tph	0.8	A
Copper flowrate per bank (maximum)	tph	0.92	A
Copper grade (nominal)	%(m/m)	0.04	A
Copper grade (maximum)	%(m/m)	0.04	A
Slurry density	t/m3	1.27	A
Flotation tailing slurry flow rate per bank (nominal)	m3/h	4828.28	A
Flotation tailing slurry flow rate per bank (maximum)	m3/h	5571.09	A
Tailings froth factor		1.2	A

8.2 FLOTATION REGRIND CIRCUIT

Table 14. Flotation Regrind Mill Design Criteria

Description	Unit	Value	SOURCE
Quantity	#	2 (One Each phase)	
Location (indoors/ outdoors)		Indoors	
Flotation Regrind Mill			
Type		Ball mill	A
Mill Size (L x D)	m	10.5 x 5.2	
Motor Size	kW	4500	A
Bond work index	kWh/t	14.3	A
Feed particle, F80	µm	90	A
Product particle size, P80	µm	38	A
Total feed rate, solids to mill (nominal)	tph	1057.75	A
Total feed rate, solids to mill (maximum)	tph	1220.48	A
Discharge Slurry flow rate (nominal)	m3/h	926.05	A
Discharge Slurry flow rate (maximum)	m3/h	1068.52	A
Copper feed rate (nominal)	tph	31.13	A
Copper feed rate (maximum)	tph	35.92	A
Copper grade (nominal)	%(m/m)	2.94	A
Copper grade (maximum)	%(m/m)	2.94	A
Slurry density	t/m3	1.74	A
Recirculating load	%	300	A
Mill Solids Content	%(m/m)	65 - 70	A
Grinding ball diameter	mm		

Table 15. Regrind Cyclone Cluster Design Criteria

Description	Unit	Value	SOURCE
Location (indoors/outdoors)		Indoors	A
Quantity of Cyclone's clusters		4 (One operation and One standby for each phase)	A
Quantity of Cyclones per cyclone	#	WFL	C
Cyclone Size (Model)	mm	150	A
Ball mill circulating load	%	300	A
Ore Type		Copper Ore	
Ore Specific Gravity (nominal)		2.9	A
Ore Specific Gravity (maximum)		2.9	A

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Liquid Density	t/m3	1	A
Operating Pressure	kPa	WFL	C
Feed			
Solid's content	%(m/m)	40 – 45	A
Slurry density	t/m3	1.35 – 1.4	A
Feed slurry flow rate (nominal)	m3/h	2374.38	A
Feed slurry flow rate (maximum)	m3/h	2739.66	A
Solids flowrate to cyclone cluster (nominal)	tph	1411.03	A
Solids flowrate to cyclone cluster (maximum)	tph	1628.11	A
Cyclone feed F100	µm	150	A
Cyclone feed F80	µm	90	A
Feed slurry temperature	°C	5 to 60	A
Overflow			
Overflow slurry solids particle size, P80	µm	38	A
Overflow slurry percent solids	%(m/m)	20 - 25	A
Slurry density	t/m3	1.15 – 1.2	A
Overflow slurry flow rate (nominal)	m3/h	1452.3	A
Overflow slurry flow rate (maximum)	m3/h	1675.73	A
Overflow solids flow rate (nominal)	tph	352.58	A
Overflow solids flow rate (maximum)	tph	406.83	A
Underflow			
Underflow slurry percent solids	%(m/m)	65 –70	A
Slurry density	t/m3	1.74	A
Underflow slurry flow rate (nominal)	m3/h	921.82	A
Underflow slurry flow rate (maximum)	m3/h	1063.64	A
Underflow solids flow rate (nominal)	tph	1057.75	A
Underflow solids flow rate (maximum)	tph	1220.48	A
Cyclone cut-size, d50	µm	WFL	A

8.3 CLEANER FLOTATION CIRCUIT

Table 16. Cleaner Flotation Design Criteria

Description	Unit	Value	SOURCE
Location (indoors/ outdoors)		Indoors	
Cleaner Flotation			
Cell Type		Cylindrical	C
Cell size	m3	200	A
Number of cells installed	#	6 (3 each phase)	A
Number banks	#	2 (One each phase)	A
Active volume	m3	607	A
Aeration factor	%	85	A
Unit recovery (nominal)	%	90	A
Unit recovery (maximum)	%	90	A
Residence time (nominal)	min	18	A
Residence time (maximum)	min	15.6	A
Cleaner Feed			
Solids feed rate per bank (nominal)	tph	377.99	A
Solids feed rate per bank (maximum)	tph	435.33	A

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Copper feed rate per bank (nominal)	tph	12	A
Copper feed rate per bank (maximum)	tph	13.85	A
Flotation pH	pH	12.5	A
Copper grade (nominal)	%(m/m)	3.18	A
Copper grade (maximum)	%(m/m)	3.18	A
Solid's content	%(m/m)	19.35	A
Slurry density	t/m3	1.15	A
Slurry flow rate per bank (nominal)	m3/h	1698.71	A
Slurry flow rate per bank (maximum)	m3/h	1946.20	A
Cleaner Concentrate			
Solid's content	%(m/m)	17	A
Solid's flowrate per bank (nominal)	tph	65.45	A
Solid's flowrate per bank (maximum)	tph	75.72	A
Copper feed rate per bank (nominal)	tpd	10.8	A
Copper feed rate per bank (maximum)	tph	12.46	A
Copper grade (nominal)	%(m/m)	16.5	A
Copper grade (maximum)	%(m/m)	16.5	A
Total Launder water addition rate	m3/h	74	A
Slurry density	t/m3	1.14	A
Total slurry flow rate per bank (nominal)	m3/h	337.26	A
Total slurry flow rate per bank (maximum)	m3/h	389.15	A
Concentrate froth factor	%	2.5	A
Cleaner Tailings			
Tailing destination		Cleaner Scavengers	
Solid's content (nominal)	%(m/m)	18-20	A
Solid's content (maximum)	%(m/m)	18-20	A
Solid's flowrate per bank (nominal)	tph	311.83	A
Solid's flowrate per bank (maximum)	tph	359.81	A
Copper flowrate per bank (nominal)	tph	0.84	A
Copper flowrate per bank (maximum)	tph	0.97	A
Copper grade (nominal)	%(m/m)	0.38	A
Copper grade (maximum)	%(m/m)	0.44	A
Slurry density	t/m3	1.17	A
Slurry flow rate per bank (nominal)	m3/h	1449.83	A
Slurry flow rate per bank (maximum)	m3/h	1672.87	A
Tailings froth factor	%	1.2	A

Table 17. Cleaner Scavenger Flotation Design Criteria

Description	Unit	Value	SOURCE
Location (indoors/ outdoors)		Indoors	A
Cleaner Scavenger Flotation			
Cell Type		Cylindrical	A
Cell size	m3	200	A
Number of cells, installed	#	8 (4 each phase)	A
Number of banks	#	2 (One each phase)	A
Active volume	m3	815	A
Aeration factor	%	85	A

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Unit recovery (nominal)	%	70	A
Unit recovery (maximum)	%	70	A
Residence time (nominal)	min	29	A
Residence time (maximum)	min	26	A
Cleaner Scavenger Feed			
Solid's content (nominal)	%(m/m)	18-20	A
Solid's content (maximum)	%(m/m)	18-20	A
Solids feed rate per bank (nominal)	tph	311.83	A
Solids feed rate per bank (maximum)	tph	359.81	A
Copper feed rate per bank (nominal)	tph	0.84	A
Copper feed rate per bank (maximum)	tph	0.97	A
Flotation pH	pH	11.5	A
Copper grade (nominal)	%(m/m)	0.38	A
Copper grade (maximum)	%(m/m)	0.44	A
Slurry density	t/m3	1.17	A
Slurry flow rate per bank (nominal)	m3/h	1449.83	A
Slurry flow rate per bank (maximum)	m3/h	1672.87	A
Cleaner Scavenger Concentrate			
Concentrate destination		Regrind sump	
Solid's content	%(m/m)	20	A
Solid's flowrate per bank (nominal)	tph	24	A
Solid's flowrate per bank (maximum)	tph	27.69	A
Copper flowrate per bank (nominal)	tph	0.84	A
Copper flowrate per bank (maximum)	tph	0.97	A
Copper grade (nominal)	%(m/m)	3.5	A
Copper grade (maximum)	%(m/m)	3.5	A
Total Launder water addition rate (nominal)	m3/h	33	A
Slurry density	t/m3	1.17	A
Slurry flow rate per bank (nominal)	m3/h	103.74	A
Slurry flow rate per bank (maximum)	m3/h	119.7	A
Concentrate froth factor	%	2	A
Cleaner Scavenger Tailing			
Tailing destination	-	Final tails	A
Copper grade (nominal)	%(m/m)	0.13	A
Copper grade (maximum)	%(m/m)	0.13	A
Solid's content	%(m/m)	18.51	A
Solid's flowrate per bank (nominal)	tph	287.83	A
Solid's flowrate per bank (maximum)	tph	332.11	A
Copper flowrate per bank (nominal)	tph	0.36	A
Copper flowrate per bank (maximum)	tph	0.42	A
Slurry density	t/m3	1.13	A
Slurry flow rate per bank (nominal)	m3/h	1370.18	A
Slurry flow rate per bank (maximum)	m3/h	1550.20	A
Tailings froth factor	%	1.2	A

8.4 RE-CLEANER AND RE-RE-CLEANER FLOTATION CIRCUIT

Table 18. Re-Cleaner Flotation Design Criteria

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Description	Unit	Value	SOURCE
Location (indoors/ outdoors)		Indoors	
Re-Cleaner Flotation			
Cell Type		Cylindrical	C
Cell size	m3	20	A
Number of cells installed	#	10 (5 each phase)	A
Number banks	#	2 (One each phase)	A
Aeration factor	%	85	A
Active volume	m ³	102	A
Unit recovery (nominal)	%	87	A
Unit recovery (maximum)	%	87	A
Residence time (nominal)	min	11	A
Residence time (maximum)	min	9.5	A
Re-Cleaner Feed			
Solid's content (nominal)	%(m/m)	14.95	A
Solid's content (maximum)	%(m/m)	14.95	A
Solid's flowrate per bank (nominal)	tph	79.28	A
Solid's flowrate per bank (maximum)	tph	91.48	A
Copper flowrate per bank (nominal)	tph	12.55	A
Copper flowrate per bank (maximum)	tph	14.48	A
Flotation pH	pH	12.5	A
Copper grade	%(m/m)	15.83	A
Slurry density	t/m3	1.12	A
Slurry flow rate per bank (nominal)	m3/h	472.95	A
Slurry flow rate per bank (maximum)	m3/h	545.71	A
Re-Cleaner Concentrate			
Concentrate destination		Re-Re- Cleaners	A
Solid's content	%(m/m)	18	A
Solid's flowrate per bank (nominal)	tph	54.58	A
Solid's flowrate per bank (maximum)	tph	62.97	A
Copper flowrate per bank (nominal)	tph	10.92	A
Copper flowrate per bank (maximum)	tph	12.59	A
Copper grade (nominal)	%(m/m)	20	A
Copper grade (maximum)	%(m/m)	20	A
Total Launder water addition rate	m3/h	40	A
Slurry density	t/m3	1.13	A
Slurry flow rate per bank (nominal)	m3/h	262.8	A
Slurry flow rate per bank (maximum)	m3/h	303.23	A
Concentrate froth factor	%	3	A
Re-Cleaner Tailings			
Tailing destination		Cleaners	A
Solid's content (nominal)	%(m/m)	9.11	A
Solid's content (maximum)	%(m/m)	9.11	A
Solid's flowrate per bank (nominal)	tph	24.7	A
Solid's flowrate per bank (maximum)	tph	28.5	A
Copper flowrate per bank (nominal)	tph	1.63	A
Copper flowrate per bank (maximum)	tph	1.88	A

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Copper grade (nominal)	%(m/m)	6.6	A
Copper grade (maximum)	%(m/m)	6.6	A
Slurry density	t/m3	1.12	A
Slurry flow rate per bank (nominal)	m3/h	254.54	A
Slurry flow rate per bank (maximum)	m3/h	293.7	A
Tailings froth factor	%	1.2	A

Table 19. Re-Re-Cleaner Flotation Design Criteria

Description	Unit	Value	SOURCE
Location (indoors/ outdoors)		Indoors	A
Re-Re-Cleaner Flotation			
Cell Type		Cylindrical	C
Cell size	m3	20	A
Number of cells installed	#	6 (3 each phase)	A
Number banks	#	2 (One each phase)	A
Aeration factor	%	85	A
Active volume	m3	61.84	A
Unit recovery (nominal)	%	84	A
Unit recovery (maximum)	%	84	A
Residence time (nominal)	min	12	A
Residence time (maximum)	min	10.4	A
Re-Re-Cleaner Feed			
Solid's flowrate per bank (nominal)	tph	54.58	A
Solid's flowrate per bank (maximum)	tph	62.97	A
Copper flowrate per bank (nominal)	tph	10.92	A
Copper flowrate per bank (maximum)	tph	12.59	A
Flotation pH	pH	12.5	A
Copper grade (nominal)	%(m/m)	20	A
Copper grade (maximum)	%(m/m)	20	A
Solid's content (nominal)	%(m/m)	18	A
Solid's content (maximum)	%(m/m)	18	A
Slurry density	t/m3	1.13	A
Slurry flow rate per bank (nominal)	m3/h	262.8	A
Slurry flow rate per bank (maximum)	m3/h	303.23	A
Re-Re-Cleaner Concentrate			
Concentrate destination		Cu-Mo Thickeners	
Solid's content	%(m/m)	20	A
Slurry density per bank (nominal)	t/m3	1.18	A
Slurry density per bank (maximum)	t/m3	1.18	A
Solid's flowrate (nominal)	tph	40.75	A
Solid flowrate per bank (maximum)	tph	47.02	A
Copper flowrate per bank (nominal)	tph	9.17	A
Copper flowrate per bank (maximum)	tph	10.58	A
Copper grade (nominal)	%(m/m)	22.50	A
Copper grade (maximum)	%(m/m)	22.50	A

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Total Launder water addition rate	m3/hr	44	A
Slurry flow rate per bank (nominal)	m3/hr	173.19	A
Slurry flow rate per bank (maximum)	m3/hr	199.83	A
Concentrate froth factor	%	3	A
Re-Re-Cleaner Tailings			
Tailing destination		Re-Cleaners	A
Solid's content (nominal)	%(m/m)	9.51	A
Solid's content (maximum)	%(m/m)	9.51	A
Solid's flowrate per bank (nominal)	tph	13.83	A
Solid's flowrate per bank (maximum)	tph	15.95	A
Copper flowrate per bank (nominal)	tph	1.75	A
Copper flowrate per bank (maximum)	tph	2.2	A
Copper grade (nominal)	%(m/m)	12.63	A
Copper grade (maximum)	%(m/m)	13	A
Slurry flow rate per bank (nominal)	m3/h	135.69	A
Slurry flow rate per bank (maximum)	m3/h	149.49	A
Tailing froth factor	%	1.2	A

9. UTILITIES

9.1 GLAND SEAL WATER QUALITY REQUIRED

The requirements for cooling water to heat exchangers on mill oil cooling systems and to frequency inverter cooling are given in table below.

Table 20. Specification of Minimum Water Quality for Gland Seal Water

Parameter	Unit	Value	Source
Temperature	°C	35	A
pH	-	7-8,5	A
Carbonate hardness	°dH	3-8	A
Free carbon dioxide	mg/l	8-15	A
Associated carbon dioxide	mg/l	8-15	A
Aggressive carbon dioxide	mg/l	0	A
Sulfides	mg/l	ZERO	A
Oxygen	mg/l	<10	A
Chloride ions	mg/l	<50	A
Sulphate ion	mg/l	<250	A
CSB	mg/l	<7	A
Ammonia	mg/l	<5	A
Iron	mg/l	<0.2	A
Manganese	mg/l	<0.2	A
Conductivity	S/cm	200-2200	A
Residue on evaporation	mg/l	<500	A
Nitrates and nitriles	mg/l	<10	A

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Potassium permanganate consumption	mg/l	<25	A
Suspended matter	mg/l	<3	A

9.2 COOLING MAKE-UP WATER QUALITY REQUIRED

Typical cooling water units will come with a built-in capability for purification of make-up water to the suitable quality for cooling purposes. It is recommended that water of potable or gland seal water quality be provided as make-up water to these units. The exact quantities of make-up water for cooling water purposes will be provided by cooling system vendor. Cooling water quantities are given below, bearing in mind that the cooling system will be operated in closed circuit and make-up water quantities will be substantially lower than volumes indicated below.

Table 21. Equipment Cooling Water requirements (per phase)

Equipment	Unit	Value	Source
SAG Mill Main Bearing Lube Cooling Water			
Required Flow-rate	m3/h	25	A
Max water temperature	°C	25	A
SAG Mill Main Motor Lube Cooling Water			
Number of Motors	#	2	A
Required Flow-rate per motor	m3/h	0.3	A
Max water temperature	°C	25	A
Ball Mill #1 Main Bearing Lube Cooling Water			
Required Flow-rate per Mill	m3/h	25	A
Max water temperature	°C	25	A
Ball Mill #1 Main Motor Lube Cooling Water			
Number of Motors per Mill	#	2	A
Required Flow-rate per Mill Motor	m3/h	1.2	A
Max water temperature	°C	25	A
Ball Mill #2 Main Bearing Lube Cooling Water			
Required Flow-rate per Mill	m3/h	25	A
Max water temperature	°C	25	A
Ball Mill #2 Main Motor Lube Cooling Water			
Number of Motors per Mill	#	2	A
Required Flow-rate per Mill Motor	m3/h	1.2	A
Max water temperature	°C	25	A
Pebble Crusher#1 Hydraulic Circuit Cooling Water			
Required Flow-Rate	m3/h	15	A
Max water temperature	°C	25	A
Pebble Crusher#2 Hydraulic Circuit Cooling Water			
Required Flow-Rate	m3/h	15	A
Max water temperature	°C	25	A
Regrind Ball Mill Main Bearing Lube Cooling Water			
Required Flow-rate per Mill	m3/h	20	A
Max water temperature	°C	25	A
Regrind Ball Mill Main Motor Lube Cooling Water			
Number of Motors per Mill	#	1	A

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Required Flow-rate per Mill Motor	m3/h	20	A
Max water temperature	°C	25	A
XRF Analyzer Cooling Water			
Required Flow-rate per Mill	m3/h	1.5	A
Max water temperature	°C	25	A
Maximum Temperature of Water Exiting Mill Heat Exchangers	°C	31	A

9.3 CU PLANT REAGENT

Table 22. Copper Reagent list

Type	Dosage	Source
Copper Flotation Reagents		
Collector type – Flomin C4132 (NOMINAL-DESIGN)	25 - 50 g/t ore	A
Collector type – SIPX (NOMINAL-DESIGN)	20-50 g/t ore	A
Collector type – C2430 (NOMINAL-DESIGN)	20-50 g/t ore	A
Frother type– MIBC (NOMINAL-DESIGN)	20-50 g/t ore	A
Frother type– F742 (NOMINAL-DESIGN)	20-50 g/t ore	A
Fuel oil	40-50 g/t ore	A
Mo-Cu Dewatering Reagents		
Flocculant to Mo-Cu conc thickener	0g/t	A
Cu Dewatering Reagents		
Flocculant to Cu conc thickener (Undiluted)	10 g/t	A
Grinding Circuit Reagents		
Lime Addition	3000 g/t	A
Quick Lime addition to SAG mill	2000 g/t	A
Milk of Lime to Primary Cyclone Underflow	500 g/t	A
Milk of Lime to Regrind Cyclone Underflow	500 g/t	A

- Dosage of reagent is based on fresh ore to SAG mill
- Activity of quick lime is about 70%.

9.4 LIME

Lime added to plant is considered 3 kg per ton (based on SAG Mill fresh feed). Lime is added in two ways: A- 70% as quick lime (with 70% activity) and B-30% as milk of lime. More detail as the following tables (Table 23 and 24).

A: Quick Lime:

Table 23. Quick Lime Design Criteria

Description	Unit	Value	SOURCE
Quick lime Area			
Storage Live Capacity of Quick lime	h	4	A
Storage Live Capacity of Quick lime Based on Design rate of Quick lime	ton	14.4	A
The quantity of Hopper		4 (2 for each phase)	A
The live volume of each hopper	m ³	42.5	A
Process Plant (Quick Lime Area)			
Plant Operating Times			

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Calendar days per year	d	365	A
Working Days per Year	d	320	A
Working Hours per Year	h	7680	A
Shifts per Day	#	3	A
Hours per Shift	#	8	A
Plant Availability	%	88	A
Calendar days per year	d	365	A

Table 24. Weight Feeder

Description	Units	Value	SOURCE
Total Quantity	#	4 (2 for each phase)	A
Number of Feeders per Transfer Conveyor	#	2	A
Arrangement		1 Duty; 1 Standby for each phase	A
Location (indoors/ outdoors)		indoors	A
Weigh Feeder Type	-	-	C
Weigh Feeder Model	-	-	C
Motor Size	-	-	C
Material Handled	-	Quick Lime	C
Quick Lime Activity	%	70	A
Moisture Content	%	7	A
Bulk Density	t/m3	1	A
Nominal Feed Rate (Dry Basis)	DMTPH	7.02	A
Maximum Capacity (Dry Basis)	DMTPH	8.1	A

B: Hydrated Lime

For Hydrated lime storage 4 silos considered based on 7 days storage. The lime capacity of each bin is 260 m³. Dry plant air will be used for transferring Hydrated lime from bulk to lime storage silos. More details as the following tables (Tables 25 and 26).

Table 25. Hydrated Lime Design Criteria

Description	Units	Value	SOURCE
Hydrated lime Area			
Storage Live Capacity of Hydrated Lime	m ³	1040	A
Storage Live Capacity of Hydrated Lime based on days storage	day	7	A
The quantity of Bin	-	4	A
The live volume of each bin	m ³	260	A
Aeration System for each Bin	-	Considered	A
Process Plant (Hydrated Lime Area)			
Plant Operating Times			
Calendar days per year	d	365	A
Working Days per Year	d	320	A
Working Hours per Year	h	7680	A
Shifts per Day	#	3	A
Hours per Shift	#	8	A
Plant Availability	%	88	A

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Table 26. Hydrated Lime Plant Spec

Description	Units	Value	SOURCE
Number of Rows (Feeding by Screw Feder)	#	4 per	A
Arrangement	-	1 Duty; 3 Standby	A
Location (indoors/ outdoors)	-	indoors	A
Screw Feeder Type	-	WFL	C
Screw Feeder Model	-	WFL	C
Motor Size	-	-	C
Material Handled	-	Hydrated Lime	A
Bulk Density	t/ m ³	1	A
Required Air Flow Rate	N m ³ /min	60	A
Nominal Feed Rate (Dry Basis)	DMTPH	4.212	A
Maximum Capacity (Dry Basis)	DMTPH	4.86	A
Conditioning Tank with Agitator	-	2	A
Live Capacity of Conditioning Tank	m ³	10	A
Storage Tank with Agitator	m ³	170	A
Required Solidity	%	15	A
Required Raw Water in Nominal Feed Rate	m ³ /h	23.87	A
Required Raw Water in Design Feed Rate	m ³ /h	27.54	A
Transferred milk of lime by Centrifuge Pumps			
The quantity of required pumps	-	2 (1+1)	A
The total flow rate of each pump (Nominal Flow Rate)	m ³ /h	93.6	A
The total flow rate of each pump (Design Flow Rate)	m ³ /h	108	A

10. MOLYBDENUM PLANT

10.1 INTRODUCTION

Molybdenite (MoS₂) is a significant by-product mineral that occurs with the Copper minerals in the ore deposit. Since molybdenite is a sulphide mineral, it usually floats along with the Copper sulphide minerals and becomes part of the Cu-Mo concentrate. The most economical method for its separation from copper is by means of differential flotation. This is the purpose of the Molybdenum Plant.

10.2 OPERATING SCHEDULE

Table 27. Mo plant operation schedule

Description	Units	First section	Second Section	Source
Calendar days per Year	d	365	365	A
Working Days per Year	d	320	320	A
Working Hours per Year	h	7680	7680	A
Shifts per Day	#	3	1	A
Hours per Shift	h	24	7	A

10.3 PLANT FEED GRADE AND CAPACITY

A brief summary of the expected production data is given in table 28 below:

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Table 28. Mo plant general production data

Description	Units	Value	Source
Mo Grade in Copper Plant Feed	ppm	180	A
Mo Grade in Mo Plant Feed	%	0.5-1	A
Final Mo concentrate grade	%	53.7	A
Mo Recovery in Cu plant	%	75	A
Mo Recovery in Mo plant	%	75	A
Nominal Feed rate	tph	81.5	A
Maximum Feed rate	tph	94.04	A
Nominal production rate	MTPD	19.11	A
Design Production rate	MTPD	22.05	A

11. MOLYBDENUM PROCESS EQUIPMENT

11.1 COPPER-MOLYBDENUM CONCENTRATE THICKENER

Final concentrate from the copper flotation circuit (from the Final Cu Cleaner stage) is fed to the Mo-Cu Concentrate thickeners outside the Molybdenum Plant. The thickener overflow transmits to the water reservoir. The underflow is pumped to the Mo rougher flotation feed tank, or can be recirculated back to the Concentrate thickener feed.

Table 29. Copper-molybdenum Concentrate Thickener

Description	Unit	Value	Source
Quantity	#	1	A
Location (indoors/ outdoors)	-	outdoor	A
Type of thickener	-	-	C
Thickener unit area required	t/m ² h	0.08	A
Thickener diameter	m	30	A
Froth suppression spray flow rate	m ³ /h	~35 (VTA)	A
Thickener Feed			
Feed slurry solids flow rate (nominal)	tph	40.75	A
Feed slurry solids flow rate (maximum)	tph	47.02	A
Feed slurry density	t/m ³	1.18	A
Solid Content	% (m/m)	20	A
Feed slurry flow rate (nominal)	m ³ /h	173.19	A
Feed slurry flow rate (maximum)	m ³ /h	199.83	A
Thickener Overflow			
Overflow destination	-	Process water tank (33-3231-14)	A
Overflow slurry density	t/m ³	1	A
Overflow slurry flow rate (nominal)	m ³ /h	192.25	A
Overflow slurry flow rate (maximum)	m ³ /h	211.06	A
Thickener Underflow			
Underflow destination		Mo rougher Feed box	A
Underflow solids density	t/m ³	4	A
Underflow slurry density	t/m ³	1.6	A
Underflow solids flow rate (nominal)	tph	40.75	A
Underflow solids flow rate (Maximum)	tph	47.02	A
Solid Content	% (m/m)	50	A

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Flocculant Addition			
Flocculant addition needed	Yes/No	No	A
Flocculant dosage	g/t	0	A

11.2 MO ROUGHER FLOTATION MACHINES

The thickened Cu-Mo concentrate is pumped to conditioner tank. the concentrate is conditioned with reagent prior to rougher flotation. The slurry is diluted with water as it overflows the conditioning tanks and flows by gravity to the rougher-flotation machines. These machines consist of two rows of eight 4 m3 cells.

Table 30. Rougher Flotation Machines Design Criteria

Description	Unit	Value	Source
Number of cell row	#	2	A
Number of cells per row	#	8	A
Flotation machine type	-	DR100	A
Number of cells per bank (each row)	#	2+3+3	A
Cell volume	m3	4	A
Number of feed box per cell bank	#	1	A
Residence time (nominal)	min	20.5	A
Residence time (Design)	min	17.77	A
Number of junction box per cell bank	#	1	A
Number of tail box per cell bank	#	1	A
Cell arrangement	-	2-3-3	A
Feed pulp source	-	Mo-Cu Thickener	A
Additional feed source	-	first cleaner tail 6.43 tph solid	A
Feed Slurry per row (Normal)	m3/h	117.34	A
Feed Slurry per row (Maximum)	m3/h	135.39	A
Feed Solid per row (normal)	t/h	43.96	A
Feed Solid per row (Maximum)	t/h	50.73	A
Feed Solid Specific Gravity	-	4	A
pH	-	10-12	A
Feed – top size	µm	75	A
Feed – d80	µm	38	A
Aeration	-	Plant Air or Nitrogen by External Blower	A
Aeration factor	%	85	A

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11.3 THICKENING (FINAL COPPER CONCENTRATE DEWATERING)

Table 31. Concentrate Thickener Design Criteria

Description	Unit	Value	Source
Quantity	#	1	A
Location (indoors/ outdoors)	-	Outdoors	A
Type of thickener	-	WFL	C
Thickener unit area required	t/m ² h	0.1	A
Thickener diameter	m	30	A
Froth suppression spray flow rate	m ³ /h	20	A
Thickener Feed			
Feed solids flow rate (nominal, 17hr/d)	tph	74.55	A
Feed solids flow rate (maximum 17hr/d)	tph	86.02	A
Feed solids flow rate (nominal, 7hr/d)	tph	95.65	A
Feed solids flow rate (maximum 7hr/d)	tph	110.36	A
Ave. Feed slurry flow rate (nominal)	m ³ /h	299.62	A
Ave. Feed slurry flow rate (maximum)	m ³ /h	345.58	A
Thickener Overflow			
Overflow destination	-	Process water tank (33-3231-14)	A
Overflow density	t/m ³	1	A
Overflow flow rate (nominal)	m ³ /h	315.22	A
Overflow flow rate (maximum)	m ³ /h	356.95	A
Overflow solids concentration	ppm	-	C
Thickener Underflow			
Underflow destination	-	Filter press feed tank	A
Underflow solids density (nominal)	t/m ³	4	A
Underflow solids density (maximum)	t/m ³	4	A
Underflow solids flow rate (nominal)	tph	80.7	A
Underflow solids flow rate (maximum)	tph	93.12	A
Underflow slurry flowrate (nominal)	m ³ /h	63.63	A
Underflow slurry flowrate (maximum)	m ³ /h	73.42	A
Underflow % solids	%	65	A
Flocculant Addition			
Flocculant addition needed	Yes/No	Yes	A
Flocculant dosage	g/t	10	A

11.4 FILTRATION (FINAL COPPER CONCENTRATE DEWATERING)

Underflow from the Cu Concentrate Thickener is fed to an agitated feed tank. From the feed tank it is pumped to the Filter presses (6 filter presses in parallel, 4 duty and 2 standby). The cake from the filter

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press discharges onto a series of belt conveyors and then to concentrate storage. The liquor from the Filter Press is recirculated back to the Concentrate thickener.

Table 32. Filter Press Design Criteria

Description	Unit	Value	Source
Quantity	#	6 (4 Duty; 2 Standby)	A
Location (indoors/ outdoors)	-	Indoors	A
Feed rate (nominal) (Each filter press)	tph	20.18	A
Feed rate (maximum) (Each filter press)	tph	23.28	A
Slurry feed rate (nominal) (Each filter press)	m3/h	26.97	A
Slurry feed rate (maximum) (Each filter press)	m3/h	31.09	A
Solids Content	%(m/m)	47.92	A
Filter type	-	Filter press	A
Operating pressure	bar	8	A
Plate type	Chamber/membrane	membrane	A
Plate shifting	Manual/Automatic	Automatic	A
Filter plate size	mm	2000x2000	A
Filter cake volume per plate	L	160 (VTA)	A
Filter cake thickness	mm	40-50	A
Duty	H/day	24	A
Liquor SG	-	1	A
Solids SG	-	4	A
Maximum Liquor temperature	°C	40	A
Liquor viscosity	cP	1	A
Liquor pH	pH	10-12	A
Cleaning frequency	-	-	C
Cake moisture content – nominal	%	8	A
Cake moisture content – maximum	%	10	A
Cake Wash Required	Yes/No	VTA	C
Wash time	min	VTA	C
Air blow			
Cake air blow required	Yes/No	Yes	C
Air blow time	min	-	C
Air blow pressure	bar	8	A
Total cycle time	min	~ 15	A

11.5 MO FIRST AND SECOND CLEANER FLOTATION MACHINES

The molybdenum rougher-concentrates collected in a sump and pumped to two rows first/second cleaners. Each cell rows consists of twelve 2.8 m³ cells, the last seven of which are first cleaners and the remaining five, second cleaners. The concentrates from the seven first-cleaner cells constitute the feed to the second-cleaner cells. The second-cleaner tails flow back to the feed end of the first-cleaner cells. The second-cleaner concentrates are pumped to concentrate thickener located outside the

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building. The thickener overflow is pumped along with rougher tailings to the copper concentrate thickeners. The underflow is pumped to an open circuit mill, for further grinding. The ball mill overflow is pumped to a recirculating storage tank. These tanks will be used to store the thickened second-cleaner concentrates while the second section of the plant is not in operation (two shifts per day).

Table 33. First Cleaner Flotation Machines Design Criteria

Description	Unit	Value	Source
Number of rows	#	2	A
Number of cells per row	#	7	A
Flotation machine type	-	DR50	A
Cell volume	m3	2.8	A
Residence time (nominal)	min	21.5	A
Residence time (nominal)	min	18.63	A
Number of feed box per cell bank	#	1	A
Number of junction box per cell bank	#	1	A
Number of tail box	#	1	A
Cell arrangement	-	3-4	A
Feed pulp source	-	Rougher Concentrate	A
Additional feed source	-	Second cleaner tail	A
Feed Slurry per row (Normal)	m3/h	48.30	A
Feed Slurry per row (Maximum)	m3/h	55.73	A
Feed Solid per row (normal)	t/h	8.74	A
Feed Solid per row (Maximum)	t/h	10.08	A
Solid Specific Gravity	t/m3	4.1	A
pH	-	10-12	A
Feed – top size	µm	75	A
Feed – d80	µm	38	A
Aeration	-	Plant Air or Nitrogen by External Blower	A
Aeration factor	%	85	A

Table 34. Second Cleaner Flotation Machines Design Criteria

Description	Unit	Value	Source
Number of rows	#	2	A
Number of cells per row	#	5	A
Flotation machine type	-	DR50	A
Cell volume	m3	1.4	A
Residence time (nominal)	min	13.8	A
Residence time (nominal)	min	11.96	A

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Number of feed box per cell bank	#	1	A
Number of junction box per cell bank	#	0	A
Number of tail box	#	1	A
Cell arrangement	-	5	A
Feed pulp source	-	First cleaner Concentrate	A
Feed Slurry per row (Normal)	m ³ /h	51.05	A
Feed Slurry per row (Maximum)	m ³ /h	58.9	A
Feed Solid per row (normal)	t/h	5.52	A
Feed Solid per row (Maximum)	t/h	6.37	A
Solid Specific Gravity	t/m ³	4.1	A
pH	-	10-12	A
Feed – top size	μm	75	A
Feed – d80	μm	38	A
Aeration	-	Plant Air or Nitrogen by External Blower	A
Aeration factor	%	85	A

11.6 SECOND CLEANER CONCENTRATE THICKENER

The process design criteria used for Second cleaner Concentrate Thickener are given in table 34 below:

Table 35. Second cleaner Concentrate Thickener

Description	Units	Value	Source
Quantity	#	1	A
Location (indoors/ outdoors)	-	outdoor	A
Type of thickener	-	High rate	C
Thickener unit area required	t/m ² h	-	C
Thickener diameter	m	20	A
Froth suppression spray flow rate	m ³ /h	7	A
Thickener Feed			
Feed slurry solids flow rate (nominal)	tph	6.95	A
Feed slurry solids flow rate (maximum)	tph	8.02	A
Feed slurry density	t/m ³	1.07	A
Solid Content	% (m/m)	9	A
Feed slurry flow rate (nominal)	m ³ /h	71.96	A
Feed slurry flow rate (maximum)	m ³ /h	83.03	A
Thickener Overflow			
Overflow destination	-	-	C
Overflow slurry density	t/m ³	1	A
Overflow slurry flow rate (nominal)	m ³ /h	75.04	A

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Overflow slurry flow rate (maximum)	m ³ /h	86.37	A
Thickener Underflow			
Underflow destination	-	First ball mill	A
Underflow solids density	t/m ³	4.12	A
Underflow slurry density	t/m ³	1.83	A
Underflow solids flow rate (nominal)	tph	6.95	A
Underflow solids flow rate (Maximum)	tph	8.02	A
Solid Content	% (m/m)	60	A

11.7 SECOND CLEANER CONCENTRATE GRINDING

The process design criteria used for ball mill of Second cleaner Concentrate given in table 35 below:

Table 36. Second cleaner Concentrate ball mill

Description	Units	Value	Source
Quantity	#	1	A
Location (indoors/ outdoors)	-	Indoor	A
Type	-	Ball mill	A
Mill Size (model)	ft	5*8	A
Motor size	kW	-	C
Feed size distribution k80	µm	38	A
Solid Specific Gravity	t/m ³	4.12	A
Type of Grinding (wet / dry)	-	Wet	A
Open / Closed Circuit	-	Open	A
Nominal Fresh Solids Feed rate	t/h	6.95	A
Maximum Fresh Solids feed rate	t/h	8.02	A
Solids Content of Undiluted Mill Feed	% (m/m)	60	A
Solids Content of Mill Discharge	% (m/m)	60	A
Product P80	µm	25	A
Circulating Load	-	-	A
Grinding Media Type	-	ball	A
Grinding Media Material	-	CS	A
Maximum ball filling (% by volume)	%(v/v)	WFL	C
Critical speed	%	WFL	C

11.8 THIRD AND FOURTH CLEANERS

The thickened and re-grind concentrates from the storage tanks flow by gravity to third/fourth cleaners that consists of eleven 2.8 cells, the last seven of which are third cleaners and the remaining four cells are fourth cleaners. Reagent are added to the feedbox of the third cleaner and after the third cell, for flotation control. The third-cleaner tails join the rougher tailing to the copper concentrate thickeners

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and the third-cleaner concentrates are pumped to the fourth cleaners. The fourth-cleaner tails flow by gravity to the third-cleaner feed and the fourth cleaner concentrates flow to its corresponding ball mill discharge pump sump. From the concentrate sump is pumped to a cyclone cluster. cyclone cluster operates in closed circuit with one ball mill, equipped with drum feeder and trommel discharge. Ball mill will be operated at approximately 100% circulating load. The cyclone underflow returns to the ball mill at 60% solids and the over flow reports at 5% solids, to the fifth cleaner.

Table 37. Third Cleaner Flotation Machines Design Criteria

Description	Unit	Value	Source
Number of Rows	#	2	A
Number of cells per row	#	7	A
Flotation machine type	-	DR50	A
Cell volume	m3	2.8	A
Number of feed box per cell bank	#	1	A
Number of junction box per cell bank	#	1	A
Residence time (nominal)	min	7	A
Residence time (design)	min	6.07	A
Number of tail box	#	1	A
Cell arrangement	-	3-4	A
Feed pulp source	-	2nd cleaner Concentrate	A
Additional feed source	-	Fourth cleaner tail	A
Feed Slurry per row (Normal)	m3/h	218.40	A
Feed Slurry per row (Maximum)	m3/h	251.94	A
Feed Solid per row (normal)	t/h	16.25	A
Feed Solid per row (Maximum)	t/h	18.76	A
Solid Specific Gravity	t/m ³	4.12	A
pH	-	10-12	A
Feed – d100	µm	25	A
Aeration	-	Plant Air or Nitrogen by External Blower	A
Aeration factor	%	85	A

Table 38. Fourth Cleaner Flotation Machines Design Criteria

Description	Units	Value	Source
Number of Rows	#	2	A
Number of cells per row	#	4	A

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Flotation machine type	-	DR50	A
Cell volume	m3	2.8	A
Residence time (nominal)	min	3	A
Residence time (Design)	min	2.6	A
Number of feed box per cell bank	#	1	A
Number of junction box per cell bank	#	0	A
Number of tail box	#	1	A
Cell arrangement	-	4	A
Feed pulp source	-	3RD cleaner Concentrate	A
Additional feed source	-	5 TH Cleaner tails	A
Feed Slurry per row (Normal)	m3/h	198.46	A
Feed Slurry per row (Maximum)	m3/h	229	A
Feed Solid per row (normal)	t/h	11.44	A
Feed Solid per row (Maximum)	t/h	13.2	A
Solid Specific Gravity	t/m ³	4.32	A
pH	-	10-12	A
Feed – d100	µm	25	A
Aeration	-	Plant Air or Nitrogen by External Blower	A
Aeration factor	%	85	A

11.9 FOURTH CLEANER CONCENTRATE GRINDING

The process design criteria used for ball mill of fourth cleaner Concentrate given in table 39 below:

Table 39. Fourth cleaner Concentrate ball mill

Description	Units	Value	Source
Quantity	#	2	A
Location (indoors/ outdoors)	-	Indoor	A
Type	-	ball mill	A
Mill Size (model)	-	4*6 ft	A
Motor size	kW	WFL	C
Feed size distribution k80	µm	25	A
Solid Specific Gravity	t/m ³	4.32	A
Type of Grinding (wet / dry)	-	Wet	A
Open / Closed Circuit	-	close	A
Nominal Fresh Solids feed rate	t/h	7.1	A
Maximum Fresh Solids feed rate	t/h	8.19	A
Solids Content of Undiluted Mill Feed	% (m/m)	-	C
Solids Content of Mill Discharge	% (m/m)	-	C
Product size distribution k100	µm	25	A

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Circulating Load	%	100	A
Grinding Media Type	-	ball	A
Grinding Media Material	-	CS	A
Maximum ball filling (% by volume)	%(v/v)	-	C
Critical Speed	%	-	C

Table 40. Fourth cleaner Concentrate Hydro cyclone

Description	Unit	Value	Source
Location (indoors/outdoors)	-	Indoors	A
Quantity of cyclone clusters	-	2 (One for each ball mill)	A
Quantity of Cyclones (each cluster)	#	3	A
Cyclone Model	in	6	A, C
Mill circulating load	%	100	A
Ore Type	-	Mo-Cu Cons.	A
Ore Specific Gravity (nominal)	-	4.35	A
Liquid Density	t/m3	1	A
Operating Pressure	kPa	-	C
Feed			
Solids content	%(m/m)	9.4	A
Feed slurry flow rate (nominal)	m3/h	140.36	A
Feed slurry flow rate (maximum)	m3/h	161.9	A
Solids flowrate to cyclone cluster (nominal)	tph	14.19	A
Solids flowrate to cyclone cluster (maximum)	tph	16.38	A
Cyclone feed F100	µm	38	A
Feed slurry temperature	°C	5 to 60	A
Overflow			
Overflow slurry solids particle size, k100	µm	20	A
Overflow slurry percent solids	%(m/m)	5.04	A
Overflow slurry flow rate (nominal)	m3/h	135.33	A
Overflow slurry flow rate (maximum)	m3/h	156.16	A
Overflow solids flow rate (nominal)	tph	7.1	A
Overflow solids flow rate (maximum)	tph	8.19	A
Underflow			
Underflow slurry percent solids	%(m/m)	70	A
Underflow slurry flow rate (nominal)	m3/h	9.35	A
Underflow slurry flow rate (maximum)	m3/h	10.78	A
Underflow solids flow rate (nominal)	tph	7.1	A
Underflow solids flow rate (maximum)	tph	8.19	A
Cyclone cut-size, d50	µm	WFL	C

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11.10 FIFTH, SIXTH, SEVENTH CLEANERS

The fifth/sixth/seventh cleaners consist of a rows of four 2.8 m3 cells and six 1.4 m3 self-induced air cells equipped with froth paddles. The initial four 2.8 m3 cells are fifth cleaners, the next four 1.4 m3 cells are the sixth cleaners, and the last two 1.4 m3 cells are the seventh cleaners. Reagents are added to the head of the fifth cleaners, for flotation control. The fifth-cleaner tails are pumped to the fourth-cleaner feed and the fifth-cleaner concentrate is pumped to the sixth-cleaner feedbox. The sixth-cleaner tailings flow by gravity to join the fifth-cleaner feed. The sixth-cleaner concentrates are pumped to the seventh cleaner. This is the final stage of flotation. The seventh cleaner tails flow by gravity to the sixth-cleaner feed.

Table 41. Fifth Cleaner Flotation Machines Design Criteria

Description	Unit	Value	Source
Number of Rows	#	2	A
Number of cells per row	#	4	A
Flotation machine type	-	DR50	A
Cell volume	m3	2.8	A
Residence time (nominal)	min	3.4	A
Residence time (nominal)	min	2.95	A
Number of feed box per row	#	1	A
Number of junction box per cell bank	#	0	A
Number of tail box	#	Not required	A
Cell arrangement	-	4	A
Feed pulp source	-	Re-grinded 4th cleaner Concentrate	A
Additional feed source	-	Sixth cleaner tail	A
Feed Slurry per row (Normal)	m3/h	174.59	A
Feed Slurry per row (Maximum)	m3/h	201.45	A
Feed Solid per row (normal)	t/h	8.61	A
Feed Solid per row (Maximum)	t/h	9.93	A
Solid Specific Gravity	t/m ³	4.35	A
pH	-	10-12	A
Feed – top size	µm	25	A
Feed – d80	µm	20	A
Aeration	-	Self-Induced	A
Aeration factor	%	85	A

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Table 42. Sixth Cleaner Flotation Machines Design Criteria

Description	Units	Value	Source
Number of cell bank	#	2	A
Number of cells per row	#	4	A
Flotation machine type	-	DR5	A
Cell volume	m3	1.4	A
Residence time (nominal)	min	2.7	A
Residence time (nominal)	min	2.3	A
Number of feed box per row	#	1	A
Number of junction box per cell bank	#	0	A
Number of tail box	#	Not required	A
Cell arrangement	-	4	A
Feed pulp source	-	5th cleaner Concentrate	A
Additional feed source	-	7th Cleaner tails	A
Feed Slurry per row (Normal)	m3/h	107.58	A
Feed Slurry per row (Maximum)	m3/h	124.13	A
Feed Solid per row (normal)	t/h	5.37	A
Feed Solid per row (Maximum)	t/h	6.19	A
Solid S. G	t/m ³	4.63	A
pH	-	10-12	A
Feed – top size	mm	25	A
Feed – d80	µm	20	A
Aeration	-	Self-Induced	A
Aeration factor	%	85	A

Table 43. Seventh Cleaner Flotation Machines Design Criteria

Description	Unit	Value	Source
Number of rows	#	2	A
Number of cells per row	#	2	A
Flotation machine type	-	DR25	A
Cell volume	m3	1.4	A
Residence time (nominal)	min	1.9	A
Residence time (nominal)	min	1.7	A
Number of feed box per row	#	1	A
Number of junction box per row	#	0	A
Number of tail box	#	Not required	A
Cell arrangement	-	2	A
Feed pulp source	-	3rd cleaner Concentrate	A

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Additional feed source	-	5 TH Cleaner tails	A
Feed Slurry (Normal)	m3/h	74.08	A
Feed Slurry (Maximum)	m3/h	85.48	A
Feed Solid (normal)	t/h	3.86	A
Feed Solid (Maximum)	t/h	4.45	A
Solid Specific Gravity	t/m ³	4.63	A
pH	-	10-12	
Feed – top size	mm	25	A
Feed – d80	µm	20	A
Aeration	-	Self-Induced	A
Aeration factor	%	85	A

11.11 FINAL MO THICKENER

Table 44. Final Concentrate Thickener Design Criteria

Description	Units	Value	Source
Quantity	#	1	A
Location (indoors/ outdoors)	-	outdoor	A
Type of thickener	-	High rate	C
Thickener unit area required	t/m ² h	WFL	C
Thickener diameter	m	20	C
Froth suppression spray flow rate	m ³ /h	-	C
Filter Feed			
Feed slurry solids flow rate (nominal)	tph	2.73	A
Feed slurry solids flow rate (maximum)	tph	3.15	A
Feed slurry density	t/m ³	1.04	A
Solid Content	% (m/m)	5	A
Feed slurry flow rate (nominal)	m ³ /h	52.5	A
Feed slurry flow rate (maximum)	m ³ /h	60.57	A
Thickener Overflow			
Overflow destination	-	-	C
Overflow slurry density	t/m ³	1	A
Overflow slurry flow rate (nominal)	m ³ /h	61.34	A
Overflow slurry flow rate (maximum)	m ³ /h	69.29	A
Thickener Underflow			
Underflow destination	-	filter feed tank	F
Underflow solids density	t/m ³	4.7	F
Underflow solids flow rate (nominal)	tph	2.73	F
Underflow solids flow rate (Maximum)	tph	3.15	F
Solid Content	% (m/m)	65	F

11.12 LEACH TANKS

Table 45. Final Concentrate Leaching Design Criteria

Description	Unit	Value	Source
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Quantity	#	2 (One operation and One Standby)	A
Location (indoors/ outdoors)	-	Indoor	A
Dimension	D*h	1.8*1.8	A
Feed slurry solids flow rate (nominal) per tank	tph	2.73	A
Feed slurry solids flow rate (maximum) per tank	tph	3.15	A
Feed slurry density	t/m ³	2.05	A
Feed Solid Content	% (m/m)	65	A
Feed slurry flow rate (nominal) per tank	m ³ /h	2.05	A
Feed slurry flow rate (maximum) per tank	m ³ /h	2.37	A
Feed Specific Gravity	t/m ³	4.7	A
Agitation	-	Yes	A
Type of Agitation	-	WFL	C
Power of Agitation	kw	WFL	C

11.13 MO CONCENTRATE FILTERING, DRYING AND LOADING

The concentrate flows to the first of two press filters. The filtrates from both filters are pumped to the final molybdenum-concentrate thickener. The filtered concentrate from the filter press drops to a screw-type dryer. The dryer discharge fills either of two 15 ton capacity dry-concentrate live-bottom storage bins. The concentrate is withdrawn from the bins into a reversible screw feeder into a batch-weighting hopper. When the hopper is filled to a preset weight it stops the screw feeder and dumps the concentrate into a drum located below. This process is repeated until the drum is filled to the desired weight. Empty drums are conveyed up to the packing machine on a roller conveyor and the full drums are transported away on a second roller conveyor to be sampled, marked, sealed, weighed, and stored prior to shipment.

Table 46. Final Concentrate Filter Design Criteria

Description	Unit	Value	Source
Quantity	#	2 (One operation and One Standby)	A
Location (indoors/ outdoors)	-	Indoor	A
Type of filter	-	Filter Press	A
Filter Feed			
Feed slurry solids flow rate (nominal)	tph	2.73	A
Feed slurry solids flow rate (maximum)	tph	3.15	A
Feed slurry density	t/m ³	2.05	A
Feed Solid Content	% (m/m)	65	A
Feed slurry flow rate (nominal)	m ³ /h	2.05	A
Feed slurry flow rate (maximum)	m ³ /h	2.37	A
Feed Specific Gravity	t/m ³	4.7	A
Filtrate	m ³ /h	-	C
Filter Cake (nominal)	tph	2.73	A
Filter Cake (maximum)	tph	3.15	A
Filter cake Solid Content	% (m/m)	91	A

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Table 47. Final Concentrate Dryer Design Criteria

Description	Unit	Value	Source
Quantity	#	1	A
Location (indoors/ outdoors)	-	Indoor	A
Type of dryer	-	Single Screw	A
Feed slurry solids flow rate (nominal)	tph	2.73	A
Feed slurry solids flow rate (maximum)	tph	3.15	A
Feed Solid Content	% (m/m)	91	A
Feed Specific Gravity	t/m ³	4.7	A
Discharge solid content	% (m/m)	98.5	A
Filter Cake (nominal)	tph	2.73	A
Filter Cake (maximum)	tph	3.15	A

Table 48. Dry Concentrate storage Bin Design Criteria

Description	Unit	Value	Source
Quantity	#	2	A
Location (indoors/ outdoors)	-	Indoor	A
Type of bin	-	cylindrical section	A
Dimension	mm	WFL	
Total Capacity	t	30	A
Feed Solid Content	% (m/m)	98.5	A
Feed Specific Gravity	t/m ³	4.7	A

Table 49. Dry Concentrate packing Design Criteria

Description	Unit	Value	Source
Quantity	#	2	A
Location (indoors/ outdoors)	-	Indoor	A
Type of feeder	-	Drum packing screw feeders	A
Dimension	mm	WFL	C
Capacity	tph	1.6	A
Feed Solid Content	% (m/m)	98.5	A
Feed Specific Gravity	t/m ³	4.7	A

Table 50. Dry Concentrate packing Design Criteria

Description	Unit	Value	Source
Quantity	#	1	
Location (indoors/ outdoors)	-	Indoor	A
Type of filter	-	platform scale	A
range	lbs	0-800	A

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The following reagents will be prepared in the molybdenum reagent mixing area and pumped to flotation cells:

- 1- Ammonium Sulfide ((NH₄)₂S)
- 2- Sodium hydrosulfide (NaHS)
- 3- Sodium cyanide (NaCN)
- 4- Fuel oil
- 5- Exofoam 636

Due to the danger of fire and explosion from flammable reagents the reagent mixing area shall be partitioned off from the rest of the building and all continues – running motors therein shall be explosion proof.

Note 1. WFL: will be finalized later

Note 2. VTS: vendor to specify