7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.1. FLOTATION

The cost curves in this section are based on flotation operations that produce a single concentrate product. Nevertheless, for operations that produce multiple concentrate products, costs can be estimated by reapplying the curves for each product, making the appropriate input tonnage reduction before each reapplication.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a daily input tonnage (X), in metric tons of dry ore per day to the flotation section for each product. The curves are valid for operations between 40 and 95,000 mtpd, operating three shifts per day. Each flotation section consists of all rougher, scavenger, and cleaner circuits required to produce a final concentrate. The curves include all daily operating and maintenance costs associated with the conditioning of the feed, operation of the flotation machines, and the necessary pumping and launder facilities used for the passage of the pulp through the separation process. The costs reflect operations that use only mechanical, self-aerating, flotation machines, but these costs can be adjusted to account for the use of mechanical, blower-aerating machines. However, for operations that employ nonmechanical flotation machines (e.g., pneumatic or column machines), the costs cannot be accurately modified.

BASE CURVE

(L) Labor Operating Cost $(Y_{L\ SMALL}) = 9.807(X)^{0.757}$

$(Y_{L\ MEDIUM/LARGE}) = 483.344+0.026(X)$

The operating labor costs consist of the following typical range of personnel:

	Small (40 to 250 mtpd)	Medium and Large (250 to 95,000 mtpd)
Direct labor.....	95%	67%
Maintenance labor.....	5%	33%

The average base salary including burden for labor is as follows:

	Small (40 to 250 mtpd)	Medium (250 to 47,600 mtpd)	Large (47,600 to 95,000 mtpd)	Av salary per hour (base rate)
Flotation operator.....	100%	90%	25%	$16.78
Assistant flotation operator.....	-	-	21%	14.56
Reagent monitor.....	-	-	20%	13.66
Plant laborer.....	-	10%	34%	11.68

The average wage for labor is $14.44 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.832(X)^{1.000}$
The supply curve consists of 82% reagents and 18% electric power.

The reagents usage consists of

	Usage (lb/mt)	Deliverable Cost ($/lb)
Slaked Lime (Calcium Hydroxide).....	5.500	0.061
MIBC (Methyl Isobutyl Carbinol).....	0.075	0.580
Aero 343 (Sodium Isopropyl Xanthate).....	0.100	0.840
Sodium Sulfhydrate (Sodium Hydrosulfide).....	0.750	0.750

The reagent usage is based on a copper ore of average floatability and economic grade. The user must make any adjustments of reagent usage and costs for the ore under consideration.

(E) Equipment Operating Cost $(Y_{E\ SMALL}) = 4.131+0.149(X)$
$(Y_{E\ MEDIUM/LARGE}) = 66.630+0.013(X)$
The equipment operation curve for small operations consists of 81% for repair and maintenance parts and 19% for lubrication. The equipment operation curve for medium and large operations consists of 91% for repair and maintenance parts and 9% for lubrication.

ADJUSTMENT FACTORS

Reagent Consumption If reagent consumption or costs are known to be different from the base usage, the proper adjustments should be made.

Two-Product Flotation System Factor If a two-product flotation system is to be utilized, the additional labor requirements can be estimated by multiplying the labor portion of the curve by one of the following factors:

For capacities between 40 and 1,000 mtpd

Labor factor $(Y_{L\ 40\text{-}1,000}) = 1.0$

For capacities between 1,000 and 5,000 mtpd

Labor factor $(Y_{L\ 1,000\text{-}5,000}) = 0.900+0.0001(X)$
where X = ore to the flotation section, in metric tons per day.

For capacities between 5,000 and 95,000 mtpd

Labor factor $(Y_{L\ 5,000\text{-}95,000}) = 1.4$

Three-Product Flotation System Factor If a three-product flotation system is to be utilized, the additional labor requirements can be estimated by multiplying the labor portion of the curve by one of the following factors:

For capacities between 40 and 1,000 mtpd

Labor factor $(Y_{L\ 40\text{-}1,000}) = 1.0$

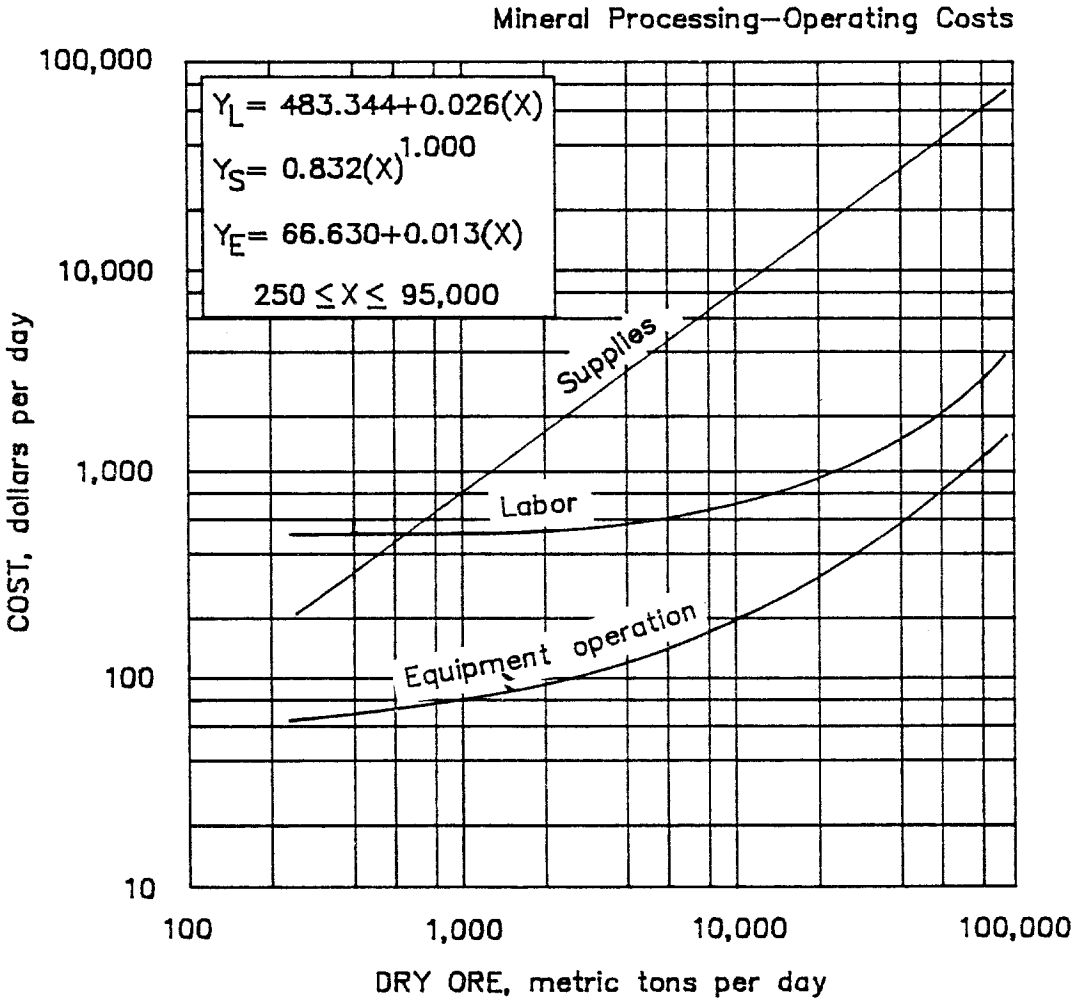
For capacities between 1,000 and 5,000 mtpd

Labor factor $(Y_{L\ 1,000\text{-}5,000}) = 0.837+0.000163(X)$
where X = ore to the flotation section, in metric tons per day.

For capacities between 5,000 and 95,000 mtpd

Labor factor $(Y_{L\ 5,000\text{-}95,000}) = 1.652$

External Blower System If the flotation machines require an external blower system for pulp aeration, the extra operating costs (labor, electric power, overhaul and repair parts, and lubrication) should be added to the applicable base curve costs.



7.1.3.1. Flotation

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.2.1. GRAVITY SEPARATION
JIGS

The equations of this section can be used to estimate jig operating costs for the separation of heavy-ore minerals from waste. The equations are most applicable to barite, gold placer, diamond, and chromite processing operations. The base curves are not applicable to dredge operations; see section 3.2.2.4, (IC 9142). Also, the curves do not cover costs for jigs used in closed-circuit grinding; for this type of operation, use section 7.1.3.2.2.

Costs are derived for operation of a complete jig system based on the input tonnage to the jig circuit. This includes all equipment directly associated with the jig circuit, such as trommel or vibrating screens, pumps, surgebins, piping, and the jig units.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the feed rate (X), in metric tons of ore per day. The curves are valid for operations between 400 and 10,000 mtpd, operating three shifts per day. The curves include all daily operating and maintenance costs associated directly with the jig circuits.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 76.038(X)^{0.340}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	60%
Maintenance labor.....	40%

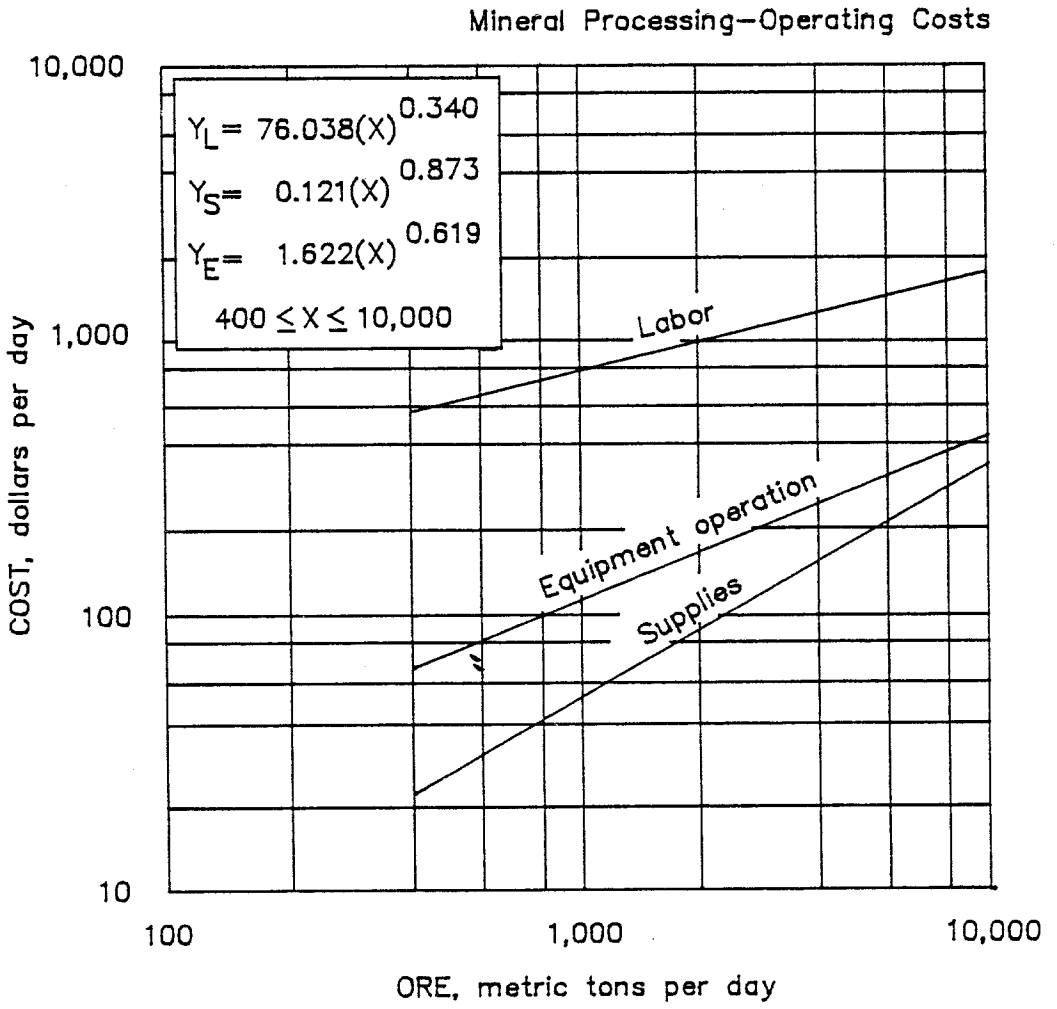
The average base salary including burden for labor is as follows:

	Small (400 to 5,000 mtpd)	Large (5,000 to 10,000 mtpd)	Av salary per hour (base rate)
Jig operator.....	86%	43%	$16.78
Mill operator.....	-	22%	16.78
Mill helper.....	14%	35%	13.66

The average wage for labor is $15.88 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.121(X)^{0.873}$
The supply cost consists of 98% electric power and 2% lubricants.

(E) Equipment Operating Cost $(Y_E) = 1.622(X)^{0.619}$
The equipment operation curve consists of 98% for repair parts and 2% for lubrication. The curve includes allowances for the replacement of motors, screen cloths, hoses, and repair parts for pumps, jigs, and all other pieces of equipment directly associated with the jig circuits.



7.1.3.2.1. Gravity separation
JIGS

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.2.2. GRAVITY SEPARATION
JIGS IN CLOSED-CIRCUIT GRINDING

These curves cover the costs of using one jig to recover small amounts of unusually coarse or fine-free minerals from the grinding mill discharge. This is an accessory process used prior to other forms of treatment, such as flotation or cyanidation, where coarse material or large particles would not be recovered. Jigs in closed-circuit grinding are most commonly employed in small flotation and cyanidation plants that beneficiate ores of gold, lead-silver-zinc, or fluorspar. Do not use this section to estimate costs for entire circuits of jigs that process large tonnages of ore (see section 7.1.3.2.1.).

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the feed rate (X), in metric tons of ore per day to the jig circuit. The curves are valid for operations between 25 and 700 mtpd, operating three shifts per day. The curves include all daily operating and maintenance costs for jigs, screens, and pumps used in closed-circuit grinding.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 56.562(X)^{0.158}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	52%
Maintenance labor.....	48%

The average base salary including burden for labor is as follows:

	%	Av salary per hour (base rate)
Mill laborers.....	100%	$14.19

The average wage for labor is $15.33 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 5.319(X)^{0.055}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_E) = 35.529e^{0.0002(X)}$
The equipment operation curve consists of 94% for repair parts and 6% for lubrication. The curve includes allowances for the replacement of motors, screen cloths, and repair parts for pumps, jigs, and all other pieces of equipment directly associated with this type of system.

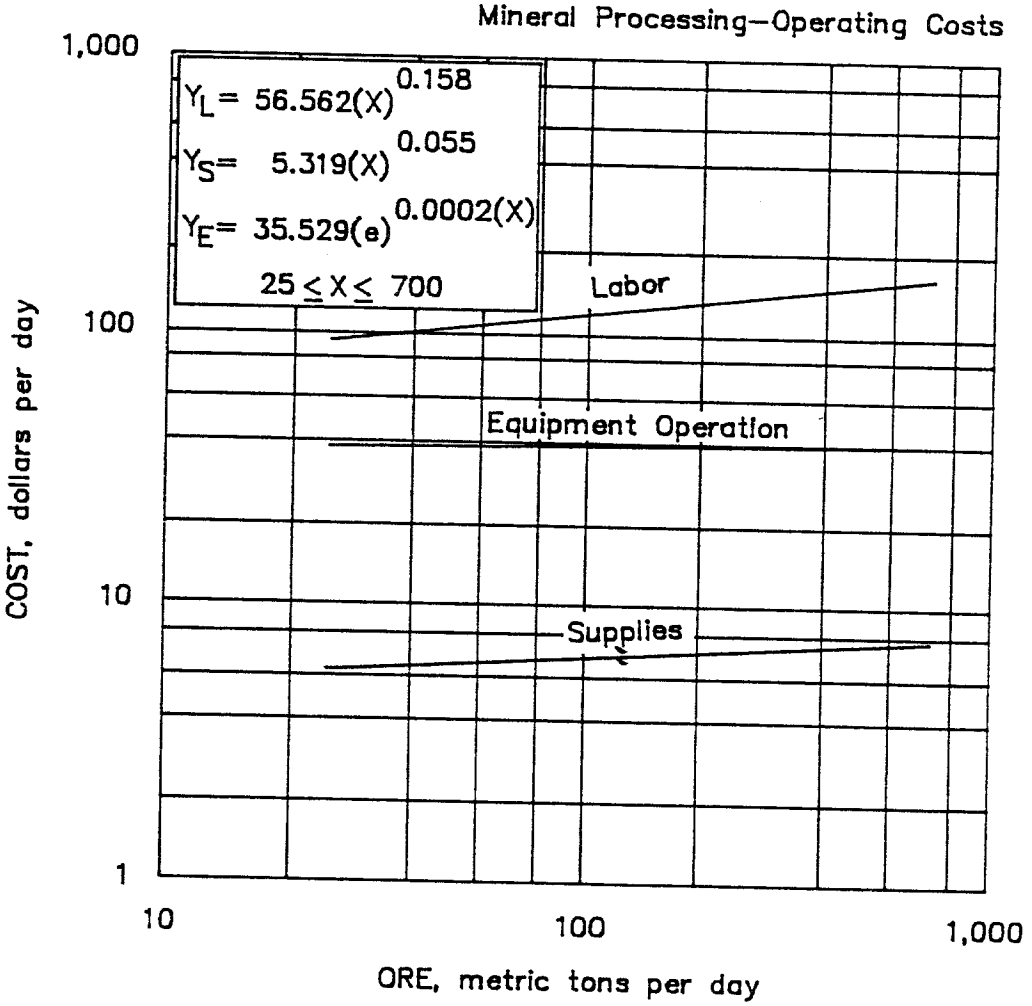
ADJUSTMENT FACTORS

Screen Factors The curves include costs for screens; however, in many instances screens are not employed with this type jig usage. If screens are not used, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 0.84$

Supply factor $(F_S) = 0.000146(X)+0.496$
where X = material to the jig circuit, in metric tons per day.

Equipment operation factor $(F_E) = 0.26$



7.1.3.2.2. Gravity separation
JIGS IN CLOSED—CIRCUIT GRINDING

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.2.3. GRAVITY SEPARATION
REICHERT CONES

The operating cost curve covers costs associated with the operation of a Reichert cone circuit to recover heavy minerals. The Reichert cone circuit includes rougher, scavenger, cleaner, and recleaner cones. The Reichert cone circuit can process ores containing 0.1% to 5.0% heavy minerals and yield a product containing a minimum of 80% heavy minerals. The feed for the Reichert circuit is assumed to be 100% minus 10 mesh at a slurry density of 60% solids by weight.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity rate (X), in mt ore feed per day. The curves are valid for operations between 2,900 and 52,440 mtpd, operating one shift per day.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 0.393(X)^{0.712}$
The operating labor costs consist of the following typical range of personnel:

	Small (2,900 to 30,000 mtpd)	Large (30,000 to 52,440 mtpd)
Direct Labor	80%	79%
Maintenance Labor	20%	21%

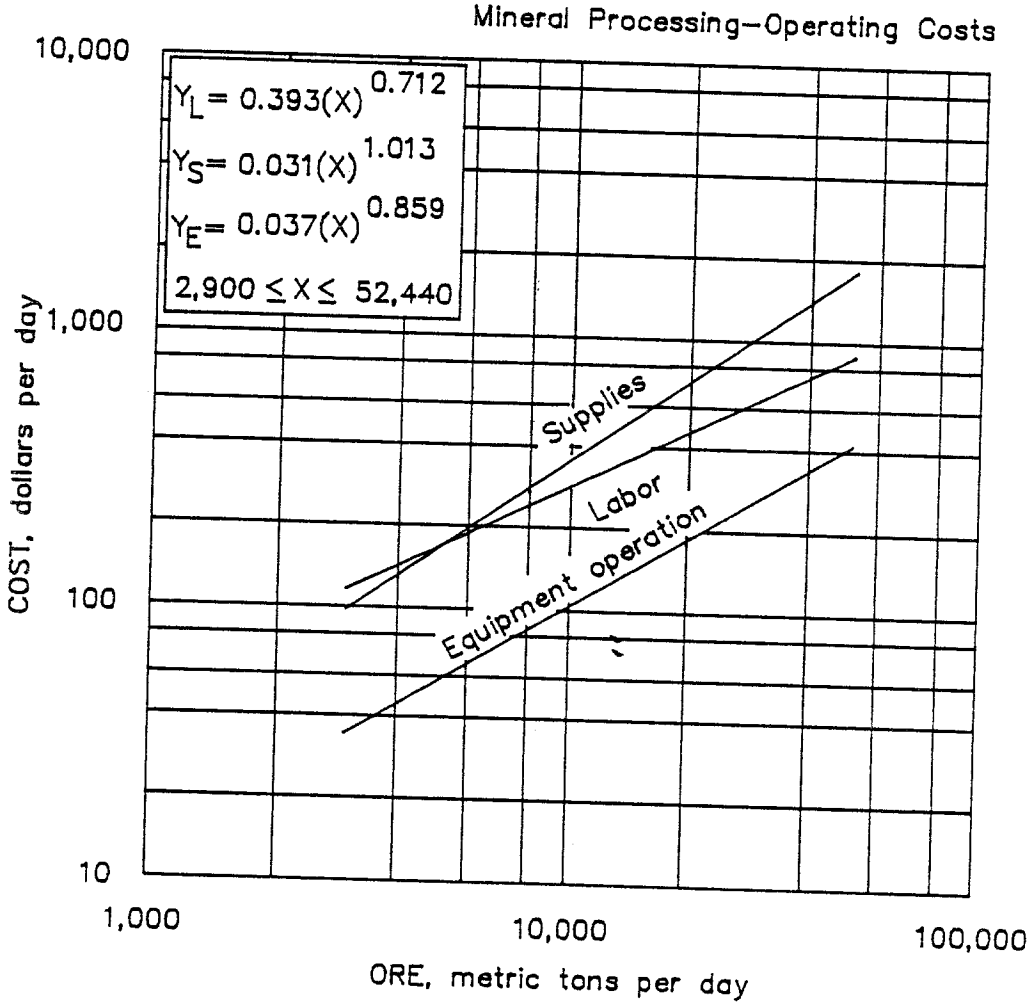
The average base salary including burden for labor is as follows:

	Small (2,900 to 30,000 mtpd)	Large (30,000 to 52,440 mtpd)	Av salary per hour (base rate)
Mill operator	81%	71%	$16.78
Mill helper	-	18%	13.66
Mill laborer	19%	11%	11.68

The average wage for labor is $15.25 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.031(X)^{1.013}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_E) = 0.037(X)^{0.859}$
The equipment operating curve consists of 100% for equipment and repair parts and materials. The curve includes allowance for the maintenance and repair of motors, pumps, and cones and all other pieces of equipment directly associated with the gravity separation circuit using Reichert cones.



7.1.3.2.3. Gravity separation
REICHERT CONES

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.2.4. GRAVITY SEPARATION
SLUICING

The operating cost curve covers costs associated with the operation of a sluicing circuit to process gravels containing gold or heavy minerals. The feed for the sluicing operation is a slurry that has been prepared by screening with either a vibrating or trommel screen, or by hydraulic mining. The cost associated with washing, screening, and water distribution is not contained in the operating cost estimates for sluicing. The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity rate (X), in metric tons of feed material per day. The curves are valid for operations between 160 and 3,320 mtpd, operating three shifts per day.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 2.165(X)^{0.490}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	83%
Maintenance labor.....	17%

The average base salary including burden for labor is as follows:

		Av salary per hour (base rate)
Sluice operator.....	100%	$17.11

The average wage for labor is $17.11 per worker-hour (including burden and average shift differential).

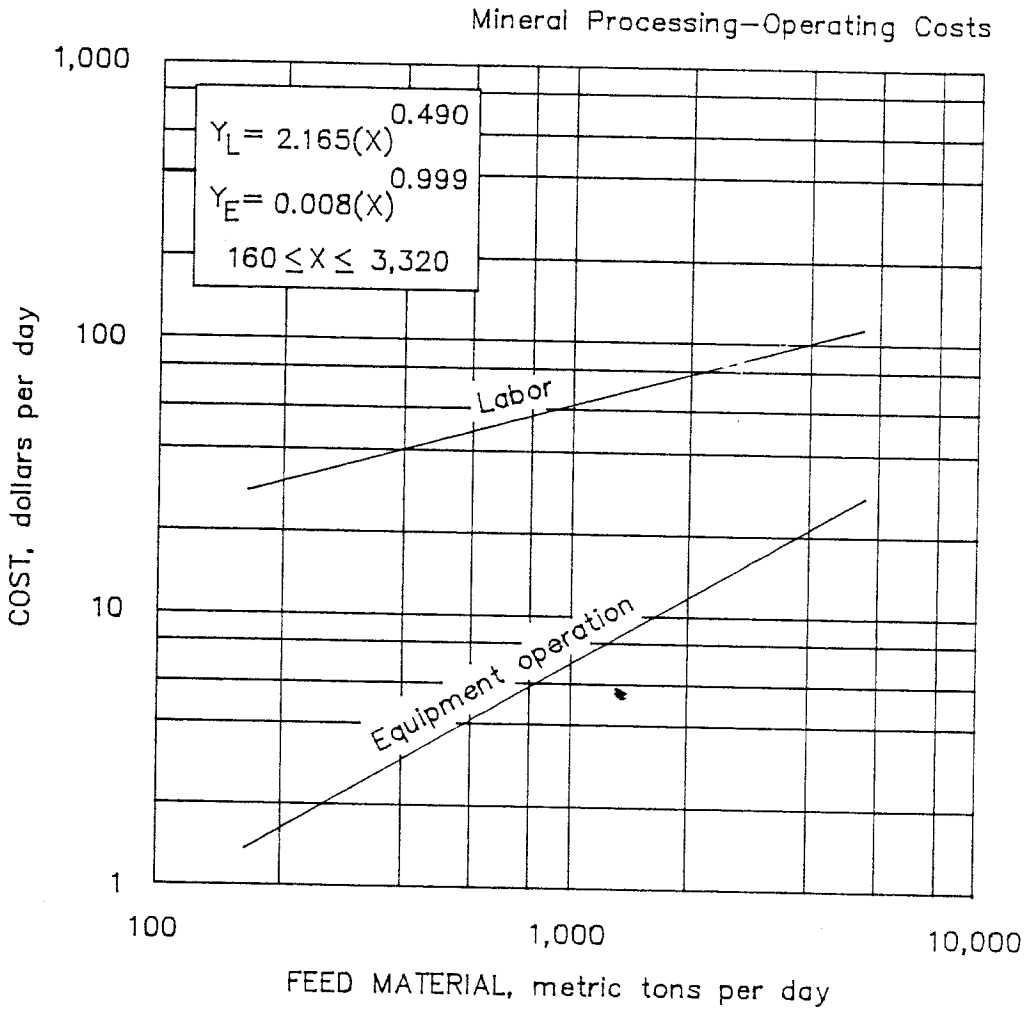
(E) Equipment Operating Cost $(Y_E) = 0.008(X)^{0.999}$
The equipment operation curve consists of 100% for equipment and repair parts and materials. The curve includes allowance for the replacement of riffles and rugs and all other pieces of equipment directly associated with the sluicing circuit.

ADJUSTMENT FACTOR

Gravel Size Factor The base curve is predicated upon processing minus 1/4-in gravel. The labor and equipment operating costs must be adjusted for differences in gravel size. Multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 0.796(R)^{-0.110}$

Equipment operation factor $(F_E) = 2.118(R)^{0.361}$
where R = radius of the topsize gravel, in inches.



7.1.3.2.4. Gravity separation
SLUCING

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.2.5. GRAVITY SEPARATION
SPIRALS

These curves cover the cost of separating heavy minerals from waste by the use of vertical spirals. Costs are derived for a complete system based on the input tonnage. This includes all equipment directly associated with the spiral circuits such as screens, pumps, slurry distributors, pipes, hoses, feed and discharge boxes, and the spiral units. Water usage for the curves is estimated at 0.63 m^3/mt of feed material. The equations do not cover costs for dewatering, scrubbing, drying, or for gravity separation by methods other than vertical spiraling. To account for these processes, the appropriate sections of this manual can be used.

In beach sand processing, the feed slurry is commonly dewatered prior to spiral concentrating. If this is the case, use the tailings thickening section (7.1.4.1.2.) of the manual.

This section is based on heavy mineral beach-sand operations located in the southeastern United States. Cost estimates for systems designed by other manufacturers, or used for processing other commodities, may be less accurate.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity rate (X), in metric tons ore feed per day. The curves are valid for operations between 100 and 25,000 mtpd, operating three shifts per day. The curves include all daily operating and maintenance costs associated directly with spiral concentration.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 18.456(X)^{0.438}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	44%
Maintenance labor.....	56%

The average base salary including burden for labor is as follows:

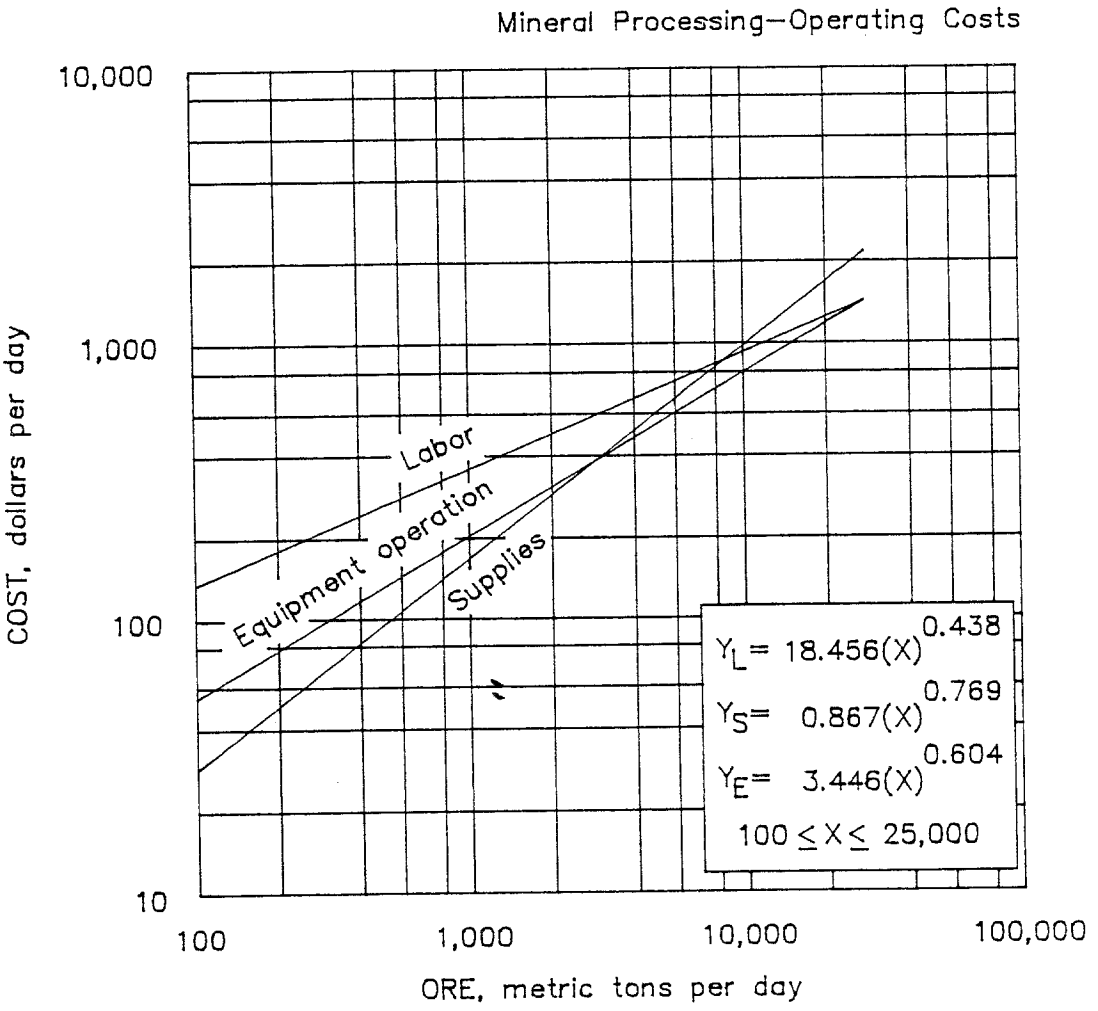
		Av salary per hour (base rate)
Plant utility person.....	100%	$14.56

The average wage for labor is $14.89 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.867(X)^{0.769}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_E) = 3.446(X)^{0.604}$

The equipment operation curve consists of 98% for repair parts and 2% for lubrication. The curve includes allowances for the replacement of motors, pump parts, screen cloths, spiral liners, hoses, and repair parts for all pieces of equipment directly associated with the spiral circuits.



7.1.3.2.5. Gravity separation
SPIRALS

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.2.6. GRAVITY SEPARATION TABLES

These curves cover the use of shaking tables and pumps in the concentration by gravity of ground (or finely crushed) ores or concentrates of copper, gold, lead, potash, tungsten, tin, zinc, or graphite. Average washwater requirements are 2.2 m^3/mt of ore. This section covers the total daily cost of rougher tables only. If the handbook user desires to re-table or clean the product or middlings from this circuit, the curves should be entered again with a reduced feed. Typical ratios of circuit feed between rougher and cleaner tabling sections are 3:1 or 4:1. The efficiency (and cost) of a tabling operation is not dependent on the absolute specific gravity of the material being concentrated, but on the difference in specific gravity between the valuable mineral and the gangue being fed to the tables, as well as on the particle size of the feed.

BASE CURVE

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the feed rate (X), in metric tons ore per day. The curves are valid for operations between 10 and 4,000 mtpd, operating three shifts per day. The curves include all daily operating and maintenance costs associated with tabling.

(L) Labor Operating Cost $(Y_L) = 3.493(X)^{0.681}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	83%
Maintenance labor.....	17%

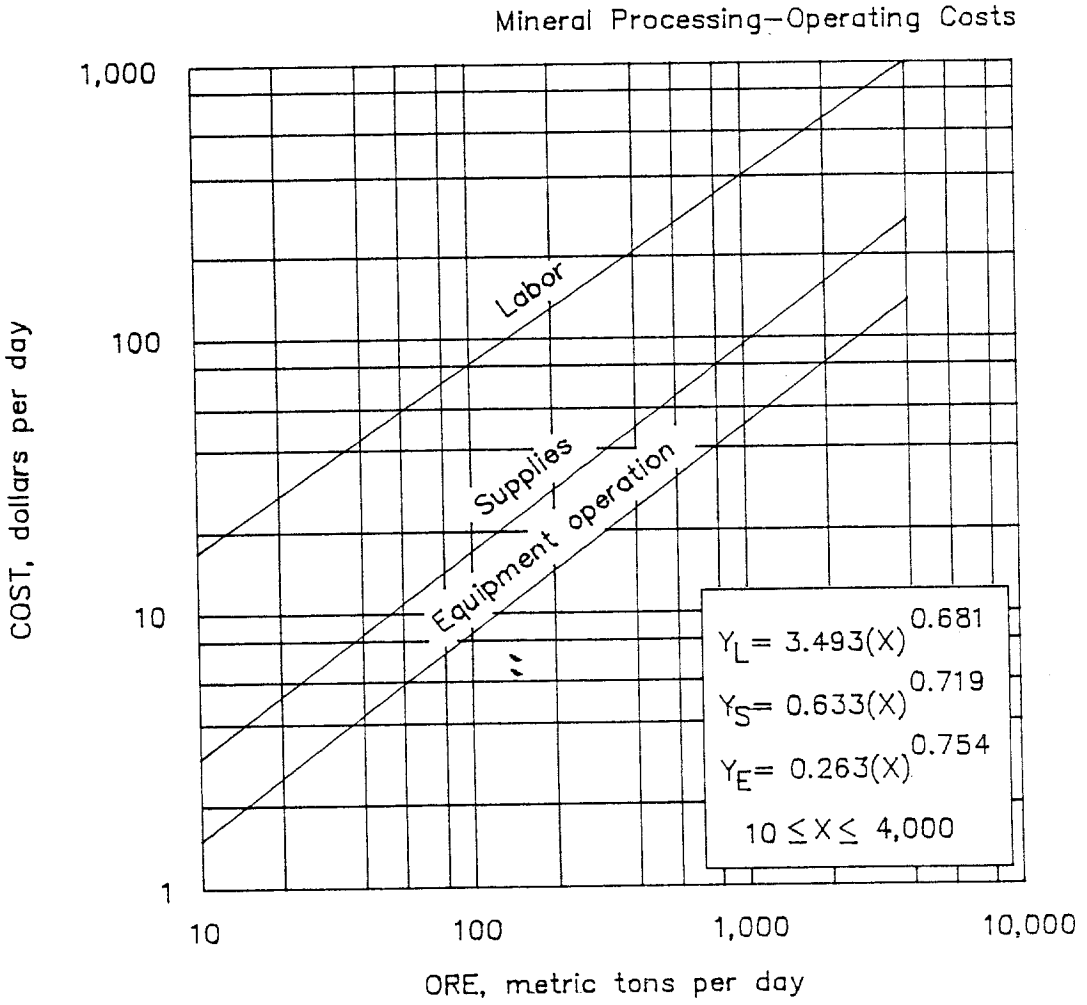
The average base salary including burden for labor is as follows:

		Av salary per hour (base rate)
Floorwalkers.....	100%	$16.22

The average wage for labor is $16.22 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.633(X)^{0.719}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_E) = 0.263(X)^{0.754}$
The equipment operation curve covers the daily operating cost for all tables and pumps, includes allowances for parts replacemnt and maintenance, and consists of 78% for repair parts and 22% for lubrication.



7.1.3.2.6. Gravity separation
TABLES

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.3. HEAVY-MEDIA SEPARATION

These curves cover the cost of separating ore minerals from waste after crushing. Each time the curve is entered, operation of a complete system is costed, including screens, demagnetizing coils, densifiers, pumps, conveyors, magnetic separators, and heavy-media equipment. The cost curves are for low-slime conditions and do not include thickeners. If thickeners are needed within the circuit, use section 7.1.4.1.1. to obtain thickening costs. The curves are representative only for dynamic cone or drum heavy-media systems and do not include Dyna Whirlpool or static systems.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity (X), in metric tons of feed per day. The curves are valid for operations between 400 and 10,000 mtpd, operating three shifts per day. The curves include all daily operating and maintenance costs associated directly with heavy-media separation.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 80.029(X)^{0.310}$

The operating labor costs consist of the following typical range of personnel:

Direct labor.....	62%
Maintenance labor.....	38%

The average base salary including burden for labor is as follows:

	Small (400 to 5,200 mtpd)	Large (5,200 to 10,000 mtpd)	Average salary per hour (base rate)
Control room operator.....	-	56%	$17.23
General laborer.....	-	44%	13.66
Utility person.....	100%	-	14.56

The average wage for labor is $16.10 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.540(X)^{1.000}$

The supply costs consist of 81% media (ferrosilicon) and 19% electric power. Media consumption is estimated at 0.75 kg/mt of ore feed.

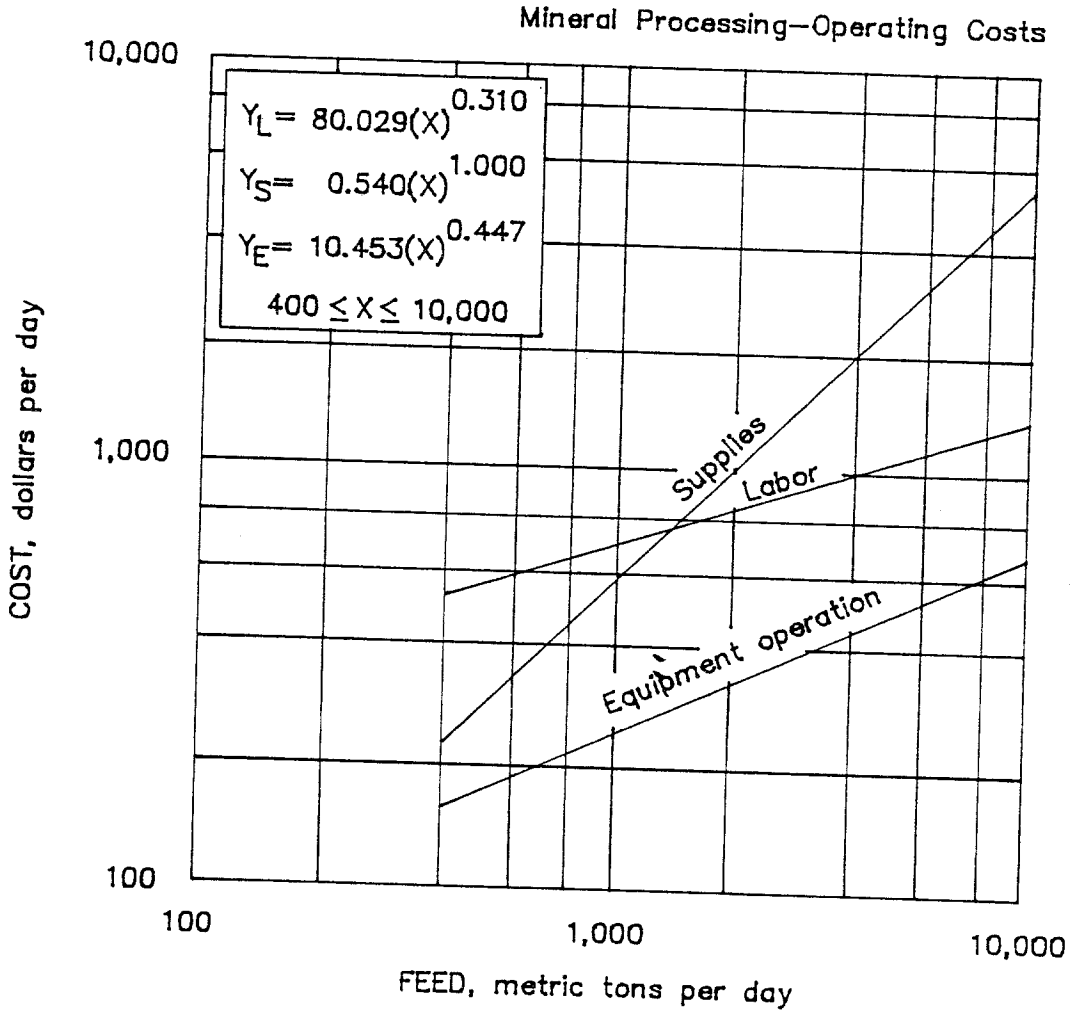
(E) Equipment Operating Cost $(Y_E) = 10.453(X)^{0.447}$

The equipment operation curve consists of 99% for repair parts and 1% for lubrication. The curve includes allowances for the replacement of motors, screen cloths, conveyor belts, and repair parts for all pieces of equipment directly associated with the heavy-media circuitry.

ADJUSTMENT FACTOR

Magnetite Factor If magnetite is used for the media (magnetite is primarily used in coal processing) multiply the cost obtained from the curves by the following factor:

Magnetite factor $(F_M) = 0.2$



7.1.3.3. Heavy—media separation

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.4.1. MAGNETIC SEPARATION

The curves cover the operation of magnetic separators, slurry pumps, and screens directly associated with the separating units. Each time the curve is entered, a complete magnetic separation system is costed, based on the tonnage input. This includes all equipment necessary for complete magnetic concentration of the input tonnage, but does not include costs for dewatering, desliming, or grinding and regrinding. If these processes are to be included in the circuit, the user should consult the appropriate sections of this manual. This section is based on large taconite operations that use low-intensity wet magnetic separation. For smaller operations, or operations using other types of magnetic separation, the curves will have limited accuracy.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) having a capacity rate (X), in metric tons of feed material per day. The curves are valid for operations between 2,000 and 100,000 mtpd, operating three shifts per day. The curves include all daily operating and maintenance costs associated directly with magnetic separation, such as screening and pumping.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 5.985(X)^{0.496}$
The operating labor costs consist of the following typical range of personnel:

	Small (2,000 to 10,000 mtpd)	Large (10,000 to 100,000 mtpd)
Direct labor	81%	61%
Maintenance labor	19%	39%

The average base salary including burden for labor is as follows:

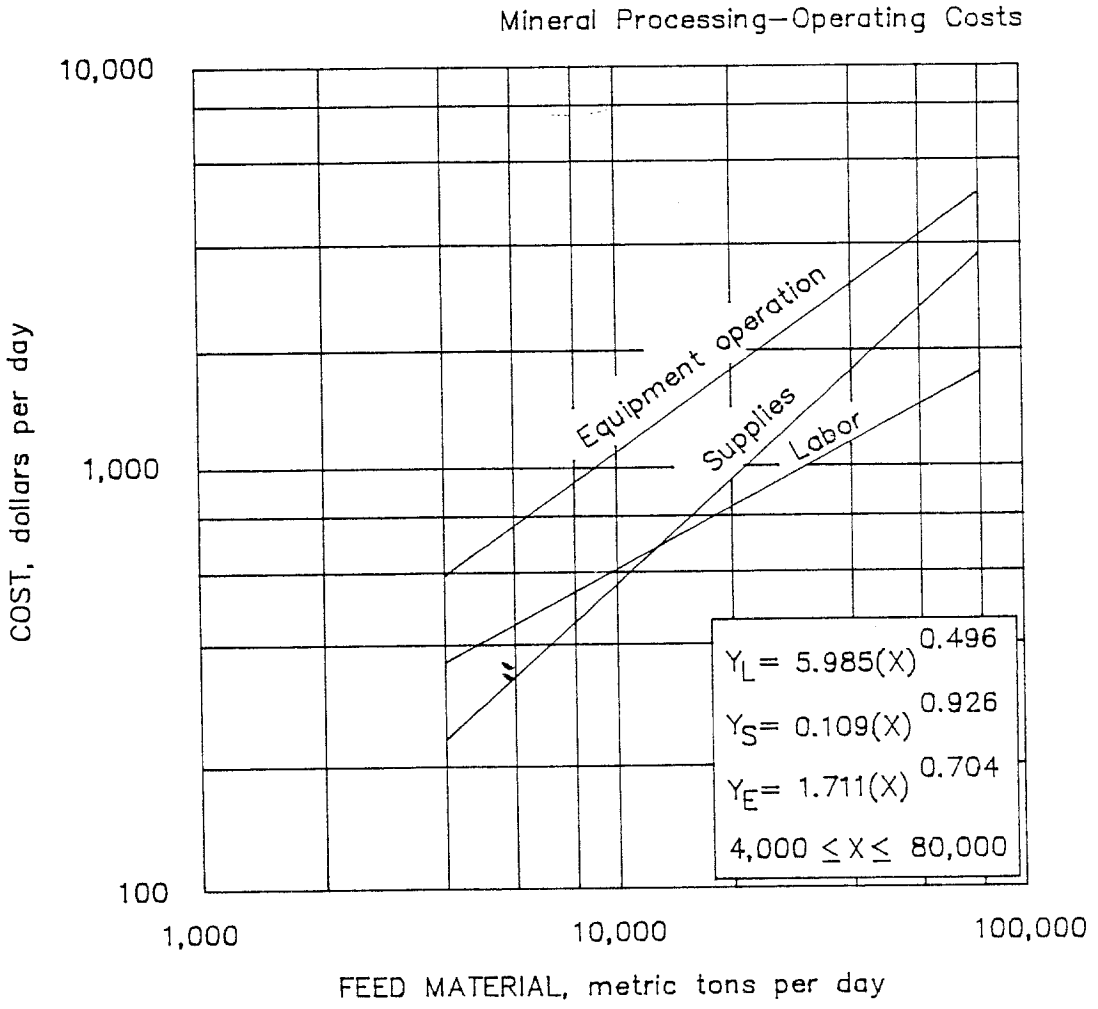
	Small (2,000 to 10,000 mtpd)	Large (10,000 to 100,000 mtpd)	Av salary per hour (base rate)
Control room operator	-	46%	$17.56
General laborer	100%	54%	13.99

Operating labor costs average $15.34 per worker-hour and include burden and shift differentials.

(S) Supply Operating Cost $(Y_S) = 0.109(X)^{0.926}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_E) = 1.711(X)^{0.704}$

The equipment operation curve consists of 98% for repair parts and 2% for lubrication for all magnetic separation equipment. The curve includes allowances for the replacement of liners, covers, motors, pump parts, gear boxes, screens, and miscellaneous repair parts.



7.1.3.4.1. Magnetic separation

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.4.2. HIGH INTENSITY MAGNETIC SEPARATION WET (WHIMS)

The operating costs for high-intensity magnetic separation are given on a metric ton per day of feed basis. The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity rate (X), in metric tons of dry feed to the magnetic separation circuit per day. The curves are valid for operations between 2,100 and 47,000 mtpd, operating three shifts per day.

BASE CURVES

The base curve is predicated on processing a hematite-bearing ore through wet high-intensity magnetic separators (WHIMS), in a single stage operation.

(L) Labor Operating Cost $(Y_{L\ WHIMS}) = 0.512(X)^{0.785}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	86%
Maintenance labor.....	14%

The average base salary including burden for labor is as follows:

		Av salary per hour (base rate)
Control room operator.....	30%	$17.56
Mill operator.....	22%	17.11
Mill helper.....	34%	13.99
Mill laborer.....	14%	11.68

The average wage for labor is $15.37 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_{S\ WHIMS}) = 0.038(X)^{1.020}$
The supply cost consists of 100% electric power.

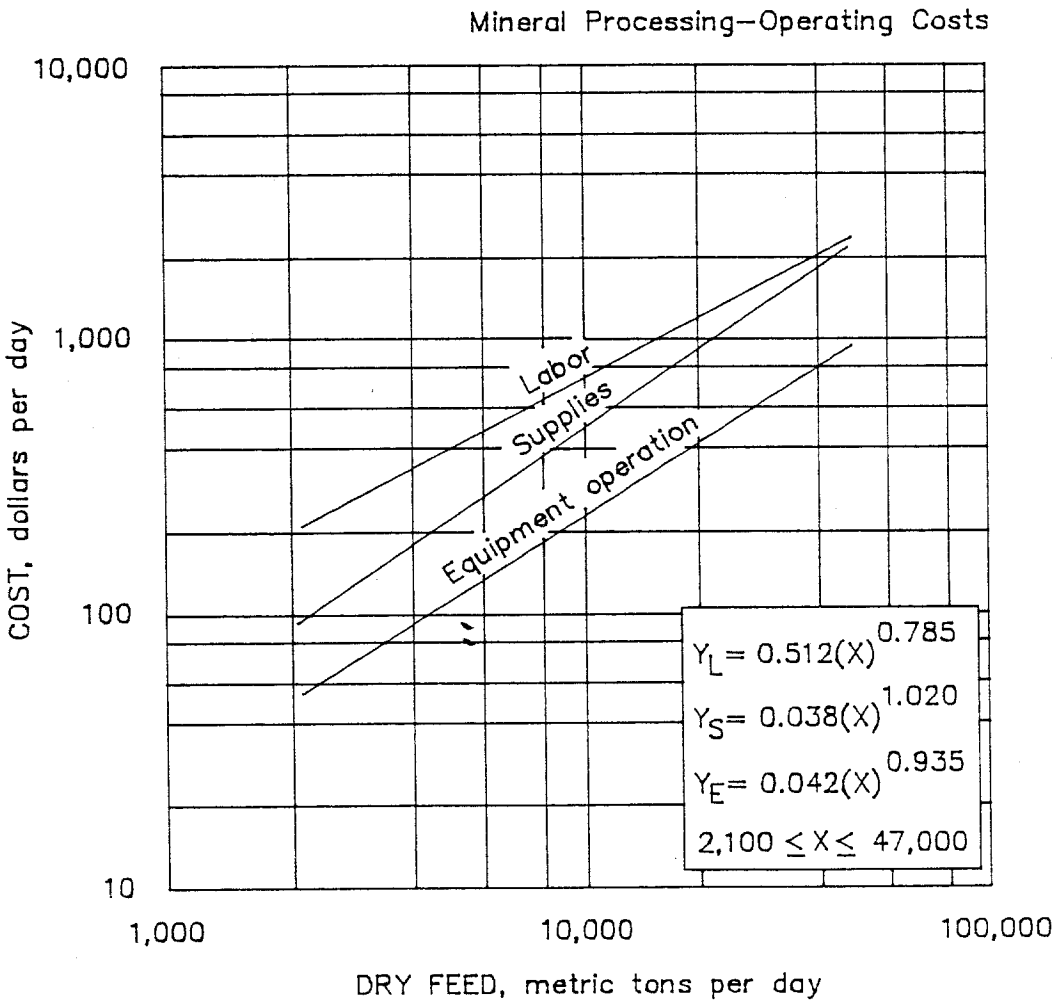
(E) Equipment Operating Cost $(Y_{E\ WHIMS}) = 0.042(X)^{0.935}$
The equipment operating cost consists of 100% for repair parts and materials.

ADJUSTMENT FACTOR

Addition of a Cleaner Stage To produce a higher quality product, a cleaner stage may be added. To adjust for a cleaner stage, multiply the supply and equipment costs obtained from the curves by the following factors:

Supply factor $(F_{S\ WHIMS}) = 1.22$

Equipment operation factor $(F_{E\ WHIMS}) = 1.14$



7.1.3.4.2. High intensity magnetic separation—wet (WHIMS)

7.1. MINERAL PROCESSING - OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.4.3. HIGH-INTENSITY MAGNETIC SEPARATION
DRY

The operating costs for high-intensity magnetic separation are given on a metric ton per day of feed basis. The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity rate (X), in metric tons of ore to the magnetic separation circuit per day. The curves are valid for operations between 80 and 900 mtpd, operating three shifts per day.

BASE CURVES

The dry high-intensity magnetic separation cost curves are based on recovering ilmenite from an ore or a concentrate.

(L) Labor Operating Cost $(Y_{L\ DRY}) = 5.333(X)^{0.654}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	86%
Maintenance labor.....	14%

The average base salary including burden for labor is as follows:

			Av salary per hour (base rate)
Control room operator.....	2%		$17.56
Mill operator.....	65%	≈	17.11
Mill laborer.....	32%		11.68

The average wage for labor is $15.68 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_{S\ DRY}) = 0.281(X)^{0.935}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_{E\ DRY}) = 0.095(X)^{0.969}$
The equipment operating cost consists of 100% for repair parts and materials.

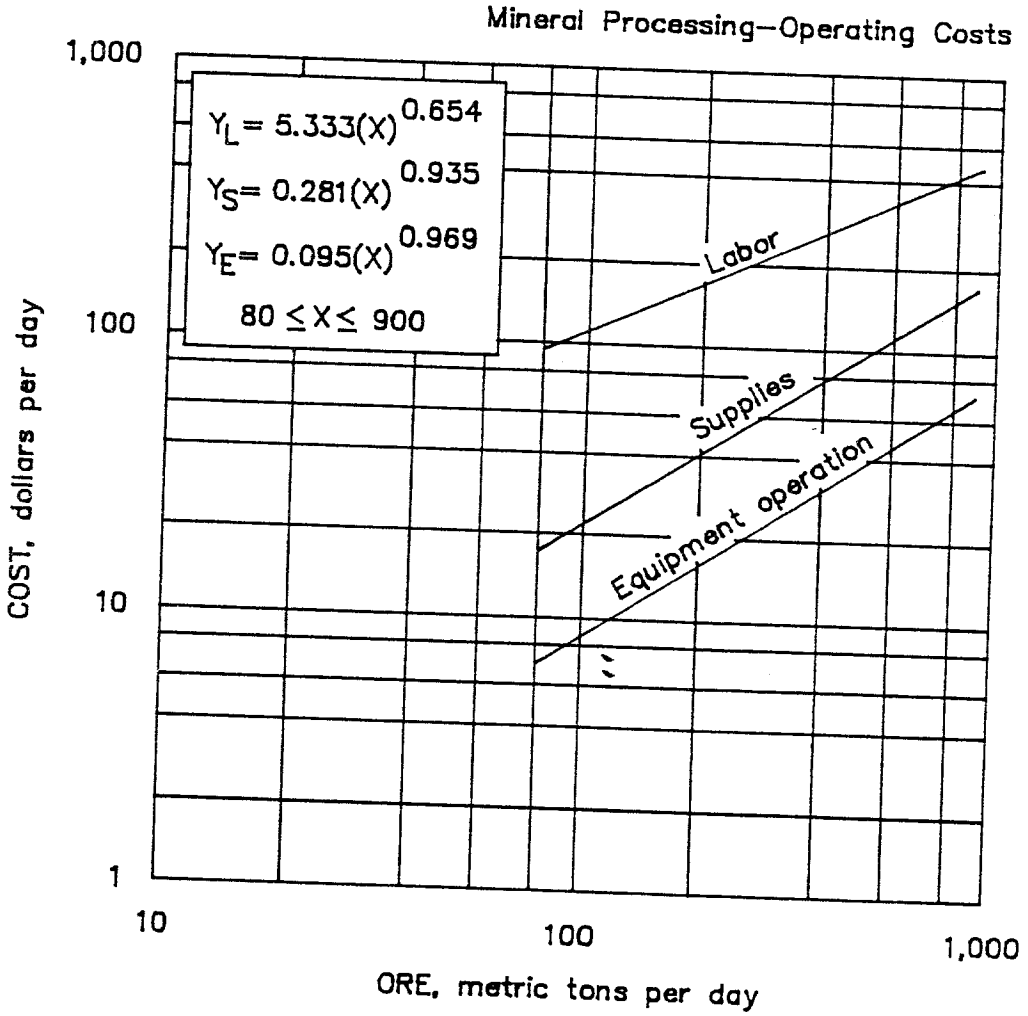
ADJUSTMENT FACTOR

Feed Rate The base curves are based on feeding a high-intensity induced roll separator at a dry feed rate of 25.8 (kg/h)/cm of roll length. The feed rate can vary from 9 to 179 (kg/h)/cm depending on the application. For strategic commodities, this range is 18 to 55 (kg/h)/cm. To adjust for different hourly feed rates, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.001(25.8/F)^{0.653}$

Supply factor $(F_S) = 1.001(25.8/F)^{0.932}$

Equipment operation factor $(F_E) = 1.001(25.8/F)^{0.967}$
where F = new hourly feed rate, in kilograms per hour per centimeter of roll length.



7.1.3.4.3. High intensity magnetic separation—dry

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.3. BENEFICIATION

7.1.3.5. PHOTOMETRIC SEPARATION

The operating cost curves for photometric separation are given on a metric ton per day basis. The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the capacity rate (X), in metric tons of feed material to the sorter plant per day. The curves are valid for operations between 925 and 7,280 mtpd, operating on a continuous basis.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 1.285(X)^{0.728}$
The operating labor costs consist of the following typical range of personnel:

Direct labor.....	96%
Maintenance labor.....	4%

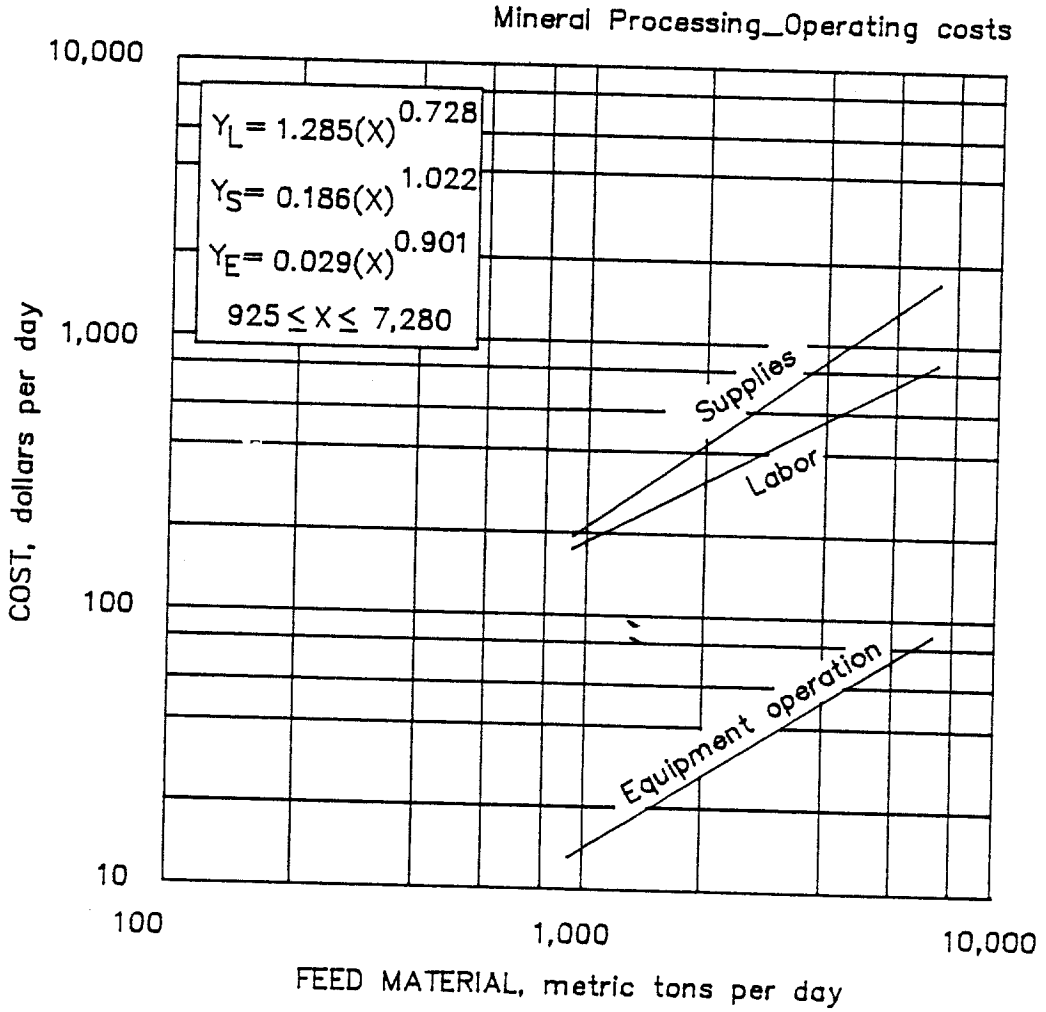
The labor costs consist of the following typical range of personnel:

		Av salary per hour (base rate)
Mill operator.....	50%	$16.78
Mill helper.....	50%	13.66

The average wage for labor is $15.28 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.186(X)^{1.022}$
The supply costs consist of 93.8% electric power. and 6.2% water.

(E) Equipment Operating Cost $(Y_E) = 0.029(X)^{0.901}$
The equipment operation curve consists of 100% for repair parts and materials.



7.1.3.5. Photometric separation