

7.1. MINERAL PROCESSING---OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.1. ACID LEACHING
BERYLLIUM ORE

The operating cost curves for beryllium ore include the operation and maintenance of the leaching circuit from the ore to the leaching circuit through the discharge of the leached ore. The total daily operating cost is the sum of three separate cost curves for labor, supplies, and equipment operation at a daily feed rate (X) in metric tons of ore per day. The curves are valid for operations between 85 and 560 mtpd, operating three shifts per day.

BASE CURVE

(L) Labor Operating Cost $Y_L = 7.348(X)^{0.427}$

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

Direct labor.....	95%
Maintenance labor.....	5%

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

		Av salary per hour (base rate)
Mill operator.....	66%	\$16.78
Mill helper.....	26%	13.66
Mill laborer.....	8%	11.68

The average wage for labor is \$15.64 per worker-hour (including burden and average shift differential). ~

(S) Supply Operating Cost $(Y_S) = 26.070(X)^{0.976}$

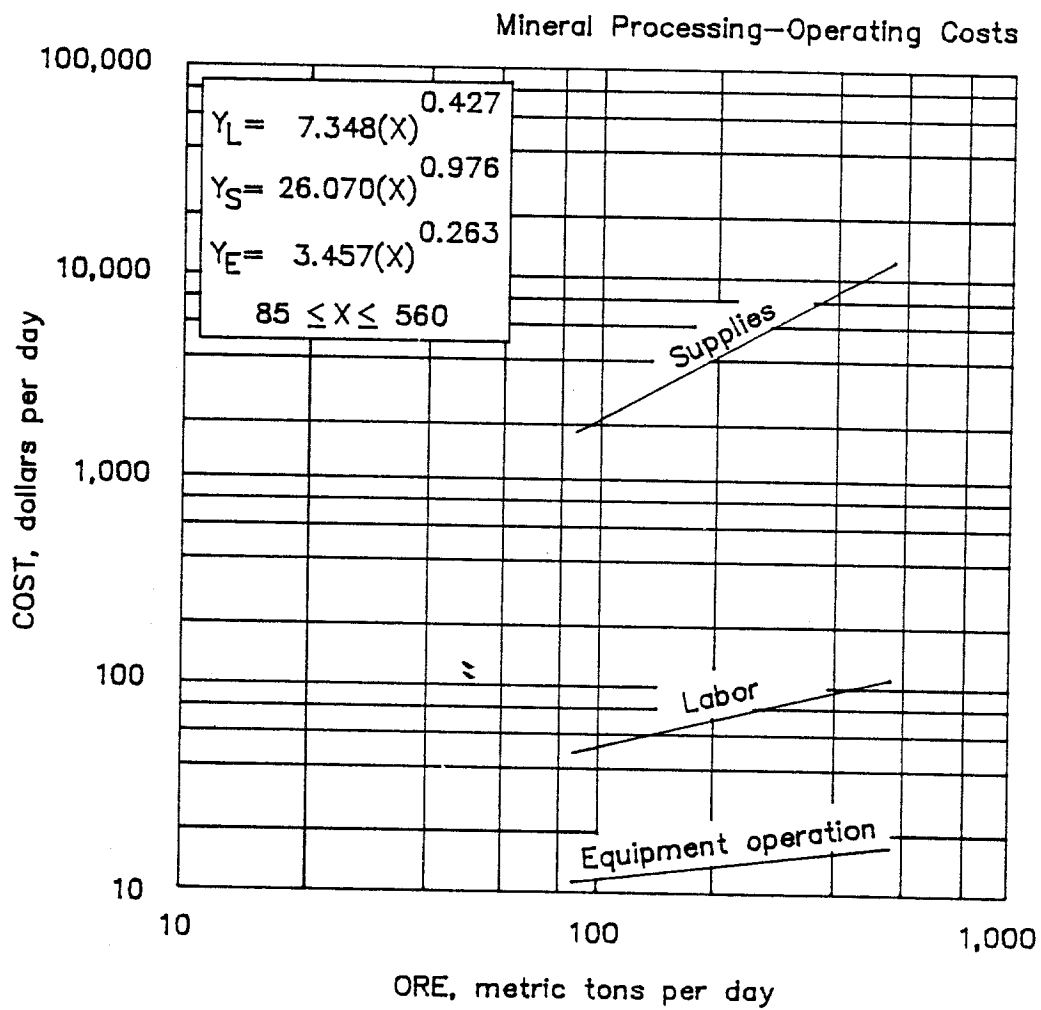
The supply cost consists of 86.5% sulfuric acid, 11.6% natural gas, and 1.9% electric power.

(E) Equipment Operating Cost $Y_E = 3.457(X)^{0.263}$

The equipment operating curve consists of 100% for repair parts and materials. The curve includes an allowance for the replacement of items such as motors, pump parts, gears, and drive belts associated with the leaching circuit.

ADJUSTMENT FACTOR

Shift Factor The base curves are based on a three-shift-per-day leaching operation. Beryllium leaching operations would probably operate on continuous basis to maintain a steady feed to the subsequent separation circuit. No adjustment factor for a oneor two-shift operation is recommended for acid leaching of beryllium ores.



7.1.5.1.1. Acid leaching
BERYLLIUM ORE

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.2. ACID LEACHING
CARBONATE

The operating cost curves for leaching carbonates in concentrates include the operation and maintenance of the leaching circuit from the concentrate to the leaching circuit through the discharge of the leached concentrate. The total daily operating cost is the sum of three separate cost curves for labor, supplies, and equipment operation at a daily feed rate (X) in metric tons of concentrate per day. The curves are valid for operations between 4 and 1,700 mtpd, operating three shifts per day.

BASE CURVE

The base curves for leaching carbonates in concentrates were assumed at 5% carbonate (as CO₂).

(L) Labor Operating Cost $(Y_L) = 5.100(X)^{0.470}$

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

Direct labor.....	78%
Maintenance labor.....	22%

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

		Av salary per hour (base rate)
Control room operator.....	8%	\$17.23
Mill operator.....	50%	16.78
Mill helper.....	32%	13.66
Mill laborer.....	10%	11.68

The average wage for labor is \$15.69 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 4.974(X)^{0.966}$

The supply cost consists of 93.3% sulfuric acid and 6.7% electric power.

(E) Equipment Operating Cost $(Y_E) = 0.622(X)^{0.441}$

The equipment operation curve consists 100% for repair parts and materials. The curve includes an allowance for the replacement of items such as gears, pump parts, motors, and drive belts associated with the leaching circuit.

ADJUSTMENT FACTORS

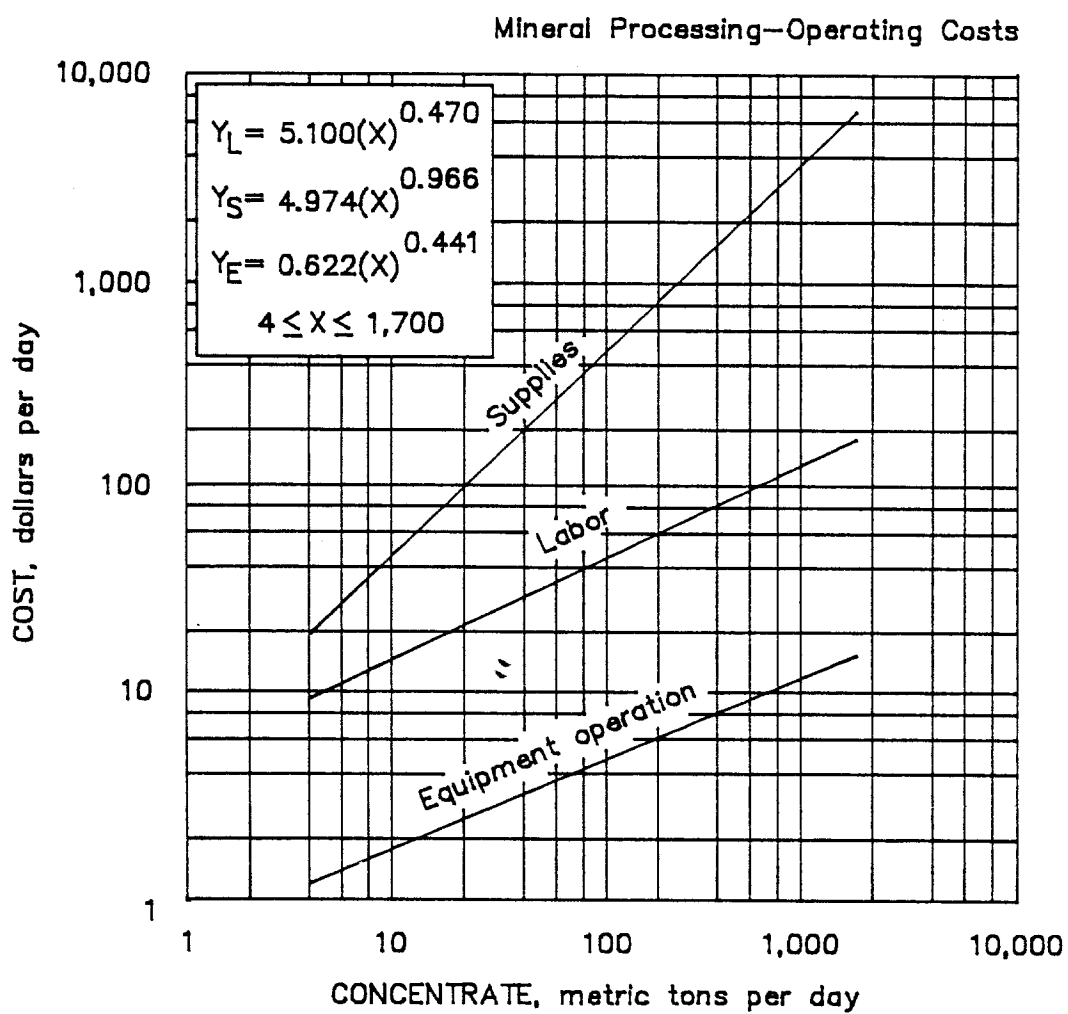
Percent Carbonate Factor The curves are based on a carbonate content (as CO₂) of 5% in the concentrate. To adjust the base curve for different levels of carbonate content, multiply the cost obtained from the supply curve by the following factor:

Supply factor $(F_S) = 0.195(C) + 0.0257$
where C = carbonate as CO_3 in the concentrate, expressed as percent.

Leach Time Factor The curves are based on a leaching time of 4 h. To adjust the base curve for different leach times, multiply the costs obtained from the curves by the following factors:

Supply factor $(F_S) = 0.007(T) + 0.972$

Equipment operation factor $(F_E) = 0.370(T)^{0.717}$
where T = actual leach time, in hours.



7.1.5.1.2. Acid leaching
CARBONATE

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.3. ACID LEACHING
COPPER ORE

The operating cost curves for copper ore include the operation and maintenance of the leaching circuit from the ore to the leaching circuit through the discharge of the leached ore. The total daily operating cost is the sum of three separate cost curves for labor, supplies, and equipment operation at a daily feed rate (X), in metric tons of ore per day. The curves are valid for operations between 3,000 and 10,500 mtpd, operating three shifts per day.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 0.189(X)^{0.762}$

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

Direct labor.....	95%
Maintenance labor.....	5%

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

		Av slaary per hour (base rate)
Control room operator.....	29%	\$17.23
Mill operator.....	46%	16.78
Mill helper.....	17%	13.66
Mill laborer.....	8%	11.68

The average wage for labor is \$16.07 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 7.977(X)^{0.998}$

The supply operating costs consist of 99.2% sulfuric acid and 0.8% electricity.

(E) Equipment Operating Cost $(Y_E) = 0.007(X)^{0.999}$

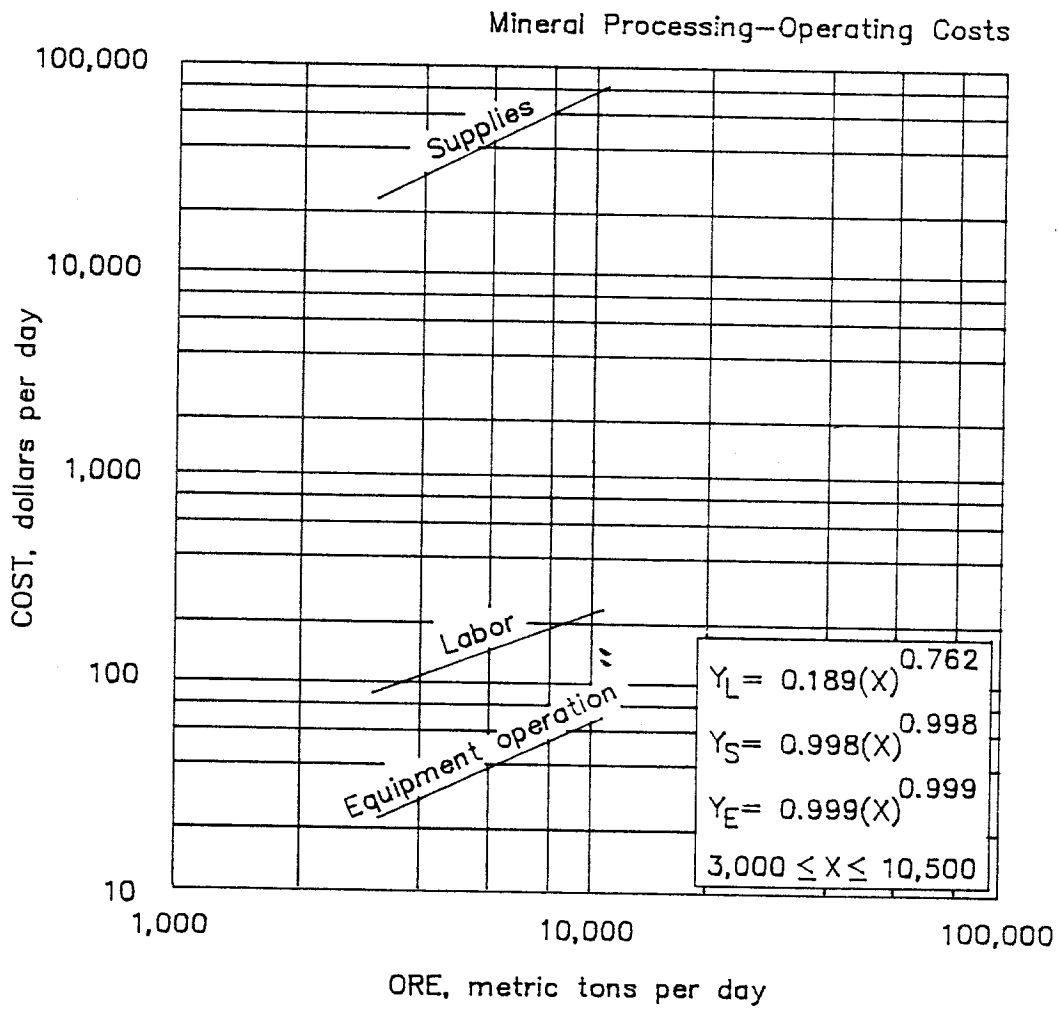
The equipment operation curve consists of 100% for repair parts and materials. The curve includes an allowance for the replacement of items such as motors, pump parts, gears, and drive belts associated with the acid leaching circuit.

ADJUSTMENT FACTORS

Shift Factor The base curves are based on a three-shift-per-day operation. Copper leaching operations would probably operate on a continuous basis to maintain a steady flow rate to the subsequent countercurrent decantation (CCD) thickening circuit. No adjustment factor for a oneor two-shift operation is recommended for acid leaching of copper ores.

Sulfuric Acid Consumption Factor The base curve is based on an acid consumption rate of 220 lb of sulfuric acid per metric ton of copper ore leached. For consumption rates other than 220 lb, multiply the cost obtained from the supply curve by the following factor:

Supply factor $(F_S) = 0.0045(X) + 0.010$
where X = actual consumption rate of sulfuric acid, in pounds per metric ton of copper ore leached.



7.1.5.1.3. Acid leaching
COPPER ORE

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.4. ACID LEACHING
PYROCHLORE

The operating cost curves for pyrochlore concentrates include the operation and maintenance of the leaching circuit from the concentrate to the leaching circuit through the discharge of the leached concentrate. The total daily operating cost is the sum of three separate cost curves for labor, supplies, and equipment operation at a daily feed rate (X) in metric tons of concentrate per day. The curves are valid for operations between 4 and 170 mtpd, operating three shifts per day.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 5.118(X)^{0.654}$

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

Direct labor.....	90%
Maintenance labor.....	10%

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

		Av salary per hour (base rate)
Mill operator.....	47%	\$16.78
Mill helper.....	53%	13.66

The average wage for labor is \$15.32 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) \cong 17.656(X)^{0.990}$

The supply cost consists of 93.7% hydrochloric acid, 4.6% filter aid, and 1.7% electric power.

(E) Equipment Operating Cost $(Y_E) = 2.877(X)^{0.494}$

The equipment operation curve consists of 100% for repair parts and materials. The curve includes an allowance for the replacement of items such as motors, pump parts, gears, filter cloth, and drive belts associated with the leaching circuit.

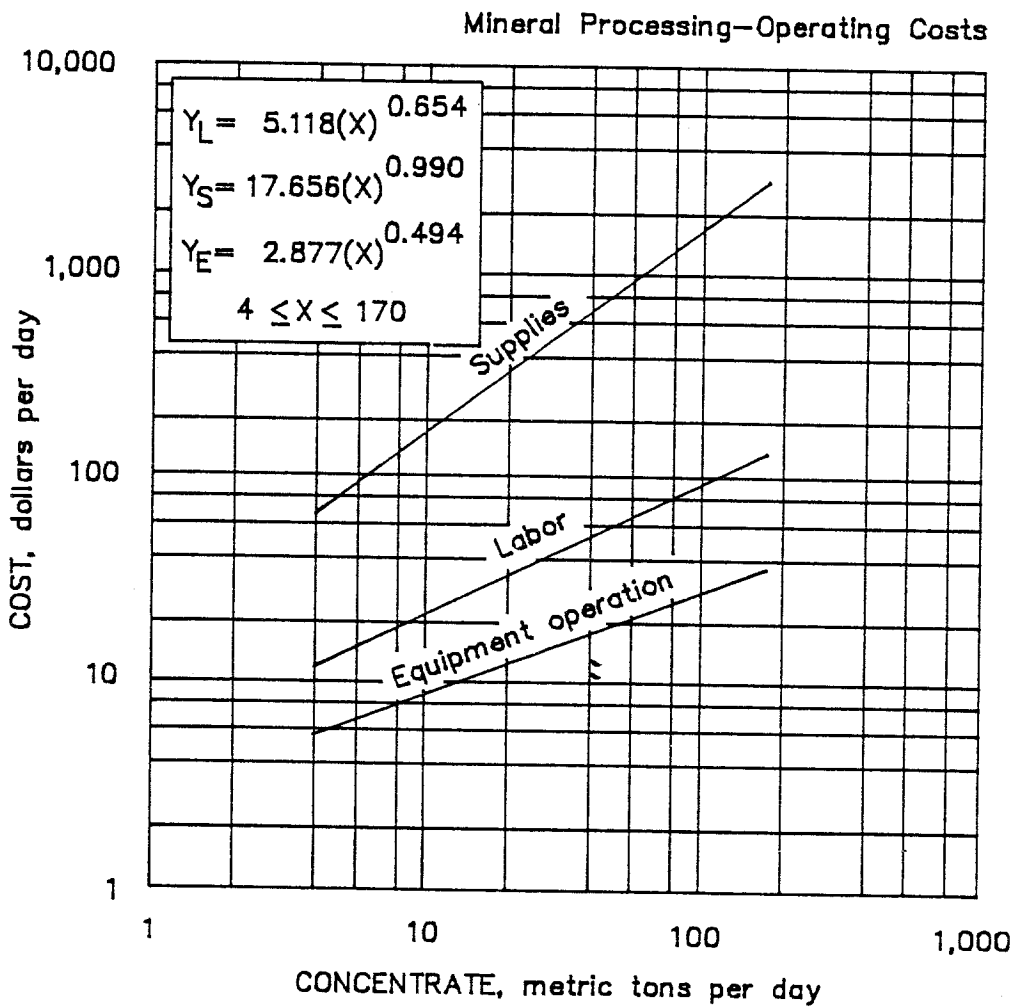
ADJUSTMENT FACTORS

Number of Leaching Stages The curve is based on a two-stage pyrochlore leaching operation. To adjust for a one-stage pyrochlore leach circuit, the costs obtained from the curves should be multiplied by the following factors:

Labor factor $(F_L) = 3.55$

Supply factor $(F_S) = 0.19$

Equipment operation factor $(F_E) = 0.49$



7.1.5.1.4. Acid leaching
PYROCHLORE

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.5. LEACHING
CARBON-IN-PULP

The operational cost curves pertain to carbon-in-pulp (CIP) processing of "lower grade" ores containing approximately 0.09 to 0.7 tr oz of gold per short ton (3 to 24 g of gold per metric ton), 1 troy ounce of silver or gold plus silver per ton (34 g/mt). The section includes all daily operating and maintenance costs for the successive unit processes of conventional slurry thickening of 80% minus 200-mesh ground ore; cyanide agitation leaching; wood-chip and trash screening; adsorption of precious metals by activated coconut carbon in five adsorption stages for gold recovery (six to eight for silver); countercurrent carbon transfer; screening for separation of charcoal from pulp; hot caustic-cyanide stripping of carbon at atmospheric pressure, or a higher pressures with or without the use of alcohol; carbon acid washing and regeneration by heating and quenching; electrowinning on steelwool cathodes; carbon column scavenger recovery from bleed streams and tailing return water used in the process; and bullion refining and casting facilities, including slag processing. Cyanide is not regenerated from the barren solution in the process, and comminution and tailings disposal costs are not included.

The curves are not applicable to conventional cyanide agitation leaching with Merrill-Crowe precipitation; preagglomeration of ores; carbon-in-leach; preoxidation of carbonaceous or graphitic ores; carbon-in-column; autoclave or pressure leaching; amalgamation; high-intensity leaching circuitry; vat, heap or dump leaching; or leaching with lixiviants other than cyanide, such as thiourea, thiosulfate, or aqueous chlorine.

BASE CURVES

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 determined on a dry basis. The curves are valid for operations between 300 and 2,200 mtpd of dry circuit feed, operating three shifts per day.

$$(L) \text{ Labor Operating Cost } (Y_L) = 14.002(X)^{0.617}$$

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

Direct labor.....	87%
Maintenance labor.....	13%

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

		Av salary per hour (base rate)
Control room operator.....	45%	\$17.56
Mill operator.....	44%	17.11
Helpe.....	11%	13.66

The average wage for labor is \$16.81 per worker-hour (including burden and average shift differential).

- (S) Supply Operating Cost $(Y_S) = 1.376(X) + 929.089$
 The supply cost consists of 52% electric power, 48% reagents. Operating cost for supplies includes the reagents and power required for all thickening, leaching, filtering, carbon handling and treatment, carbon scavenging units, and bullion casting facilities.
- (E) Equipment Operating Cost $(Y_E) = 3.901(X) + 0.571$
 The equipment operation curve consists of 91% for repair parts and 9% for lubrication.

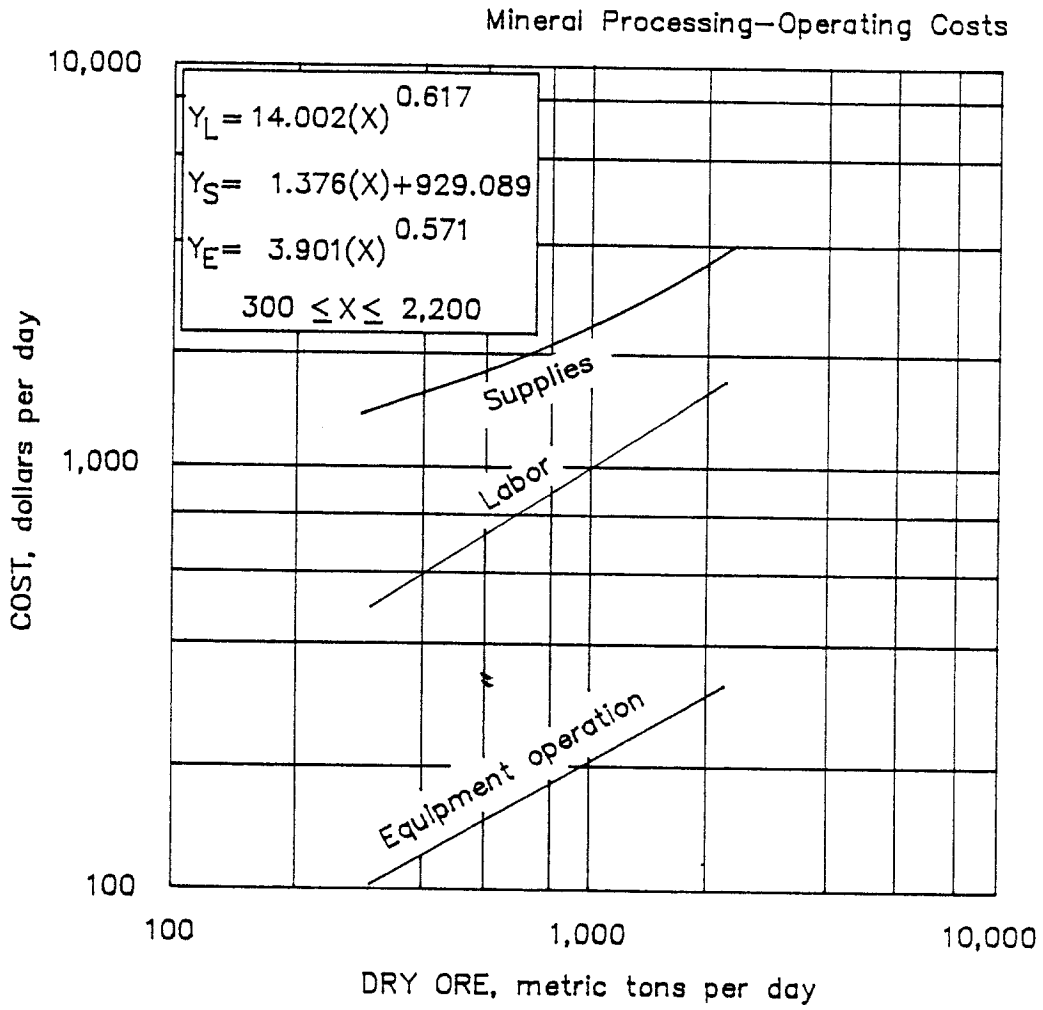
ADJUSTMENT FACTORS

Water Adjustment The hydrometallurgical nature of the leach process requires large quantities of fresh and/or recycled water. The operating costs in this section do not include water costs or costs associated with reclamation of water from tailings ponds. An average requirement of 2.05 m³ of water per metric ton of ore can be assumed for this process with up to 35% of the requirement being provided through reclamation (section 6.1.4.5.).

Carbonaceous or Graphitic Ores Factor If carbonaceous or graphitic ores are processed, multiply the the costs obtained from the supply curve by the following factor:

$$\text{Supply factor } (F_S) = 2.6$$

This adjustment accounts for the added cost of chlorine (\$206/mt) and soda ash (\$110/mt) required for oxidation.



7.1.5.1.5. Leaching
CARBON-IN-PULP

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.6. LEACHING
COPPER DUMP

Trickle-spraying leaching is the dump leaching methodology applicable for copper ore containing at least 5% pyrite (which generates most of the acid used for maintaining pH). Dump liquors are assumed to range between 0.8 and 2.0 g copper per liter. Dumps are assumed built on the existing topography with no liners being used. A leach time of 6 months is assumed, with 2 months following being allowed for dump "resting" before leaching is resumed.

BASE CURVES

The operating costs include forming the dumps (exclusive of mining and truck haulage); ripping and/or berm building; introduction of leach solution by spraying for percolation through the dump; collection of the resulting pregnant liquors; approximately 3,000-m transfer to the solvent extraction plant pregnant liquor pond; and return of the barren solution to the dump from the makeup tank. The spraying method involves the use of perforated plastic pipes for which assembly, movement, and maintenance are included in the costs. Solvent extraction and electrowinning or cementation are not included.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the production rate (X), in liters of leach solution per minute. The curves are valid for operations between 3,000 and 12,000 L/min, recirculating three shifts per day.

$$(L) \text{ Labor Operating Cost } (Y_L) = 11.371(X)^{0.353}$$

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

Direct labor.....	80%
Maintenance labor.....	20%

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

	Small (3,000 to 7,500 L/min)	Large (7,500 to 12,000 L/min)	Av salary per hour (base rate)
Pond operator.....	6%	11%	\$15.44
Pumpman.....	31%	53%	23.46
Dozer operator.....	63%	36%	16.33

The average wage for labor is \$18.55 per worker-hour (including burden and average shift differential).

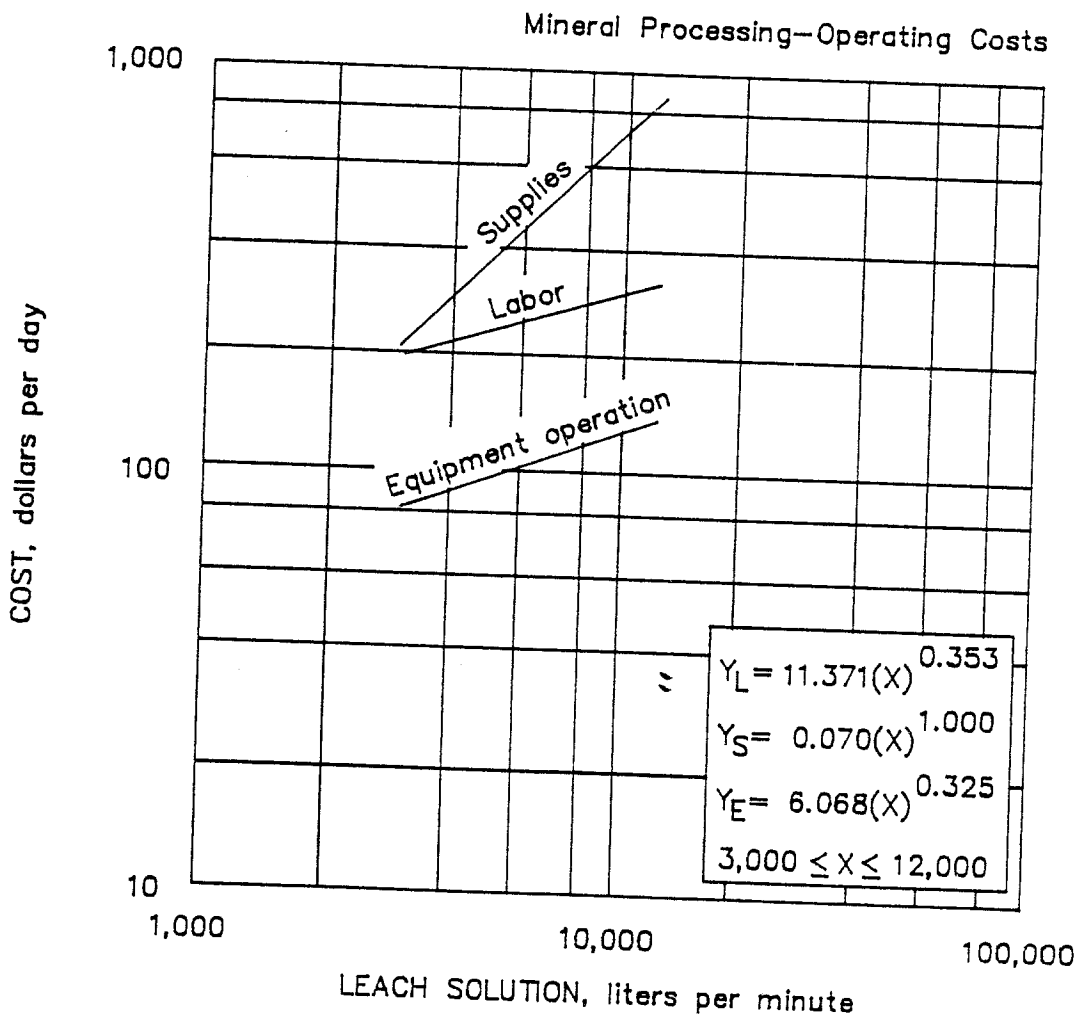
Maintenance and repair are performed by the dump crew. Labor is assigned only to the day shift.

(S) Supply Operating Cost $(Y_S) = 0.070(X)^{1.000}$

The supply cost consists of 56% electric power, 38% reagents (sulfuric acid), and 6% miscellaneous, which includes replacement pipes and couplings.

(E) Equipment Operating Cost $(Y_E) = 6.068(X)^{0.325}$

The equipment operation curve consists of 60% for parts, 33% for fuel, and 7% for lubrication for pumps, motors, vehicles, and tires.



7.1.5.1.6. Leaching
COPPER DUMP

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.7. LEACHING

CONVENTIONAL CYANIDE LEACHING WITH MERRILL-CROWE PRECIPITATION

The operational cost curves pertain to conventional cyanide leaching of "higher grade" ores containing greater than 0.7 tr oz of gold or gold plus silver per short ton (24 g/mt) or 1 tr oz of silver per short ton (34 g/mt) and small operations including leaching of flotation and/or gravity concentrates. The section includes all daily operating and maintenance costs for the successive unit processes necessary for cyanide agitation leaching of 80% minus 200-mesh ground ore; dewatering by countercurrent decantation or filtration or a filter-wash-repulp circuit to produce a clear liquor and barren solids; pregnant solution holding; pregnant solution final pressure clarification; liquor vacuum deaeration; Merrill-Crowe zinc precipitation; precious metal filtration; carbon column scavenger recovery from bleed streams and tailings return water; acid pretreatment of precipitates; and bullion refining and casting facilities. Comminution and tailings disposal costs are not included.

The curves cannot be utilized for carbon-in-pulp; preagglomeration of ores; carbon-in-leach; preoxidation of carbonaceous or graphitic ores; carbon-in-column; vat, heap, or dump leaching; autoclave or pressure leaching; amalgamation; highintensity leaching circuitry; or leaching with lixivants other than cyanide, such as with thiourea, thiosulfate, or aqueous chlorine.

BASE CURVES

The total daily operating cost is the sum of the labor, supplies, and equipment operation cost curves, each of which is based on the feed rate (X), in metric tons ore per day determined on a dry basis. The curves are valid for operations between 5 and 2,800 mtpd of circuit feed, operating 3 shifts per day.

(L) Labor Operating Cost $(Y_L) \approx 378.543(X)^{0.247}$

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

	Small (5 to 50 mtpd)	Large (50 to 2,800 mtpd)
Direct labor.....	80%	72%
Maintenance labor.....	20%	28%

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

	Small (5 to 50 mtpd)	Large (50 to 2,800 mtpd)	Av salary per hour (base rate)
Mill operator.....	49%	45%	\$16.78
Control room operator.....	51%	-	17.56
Helper.....	-	13	13.66
Dryer filter operator.....	-	42%	16.22

The average wage for labor for a small operation is \$17.87 per worker-hour and for a large operation is \$17.18 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 9.227(X)0.852$

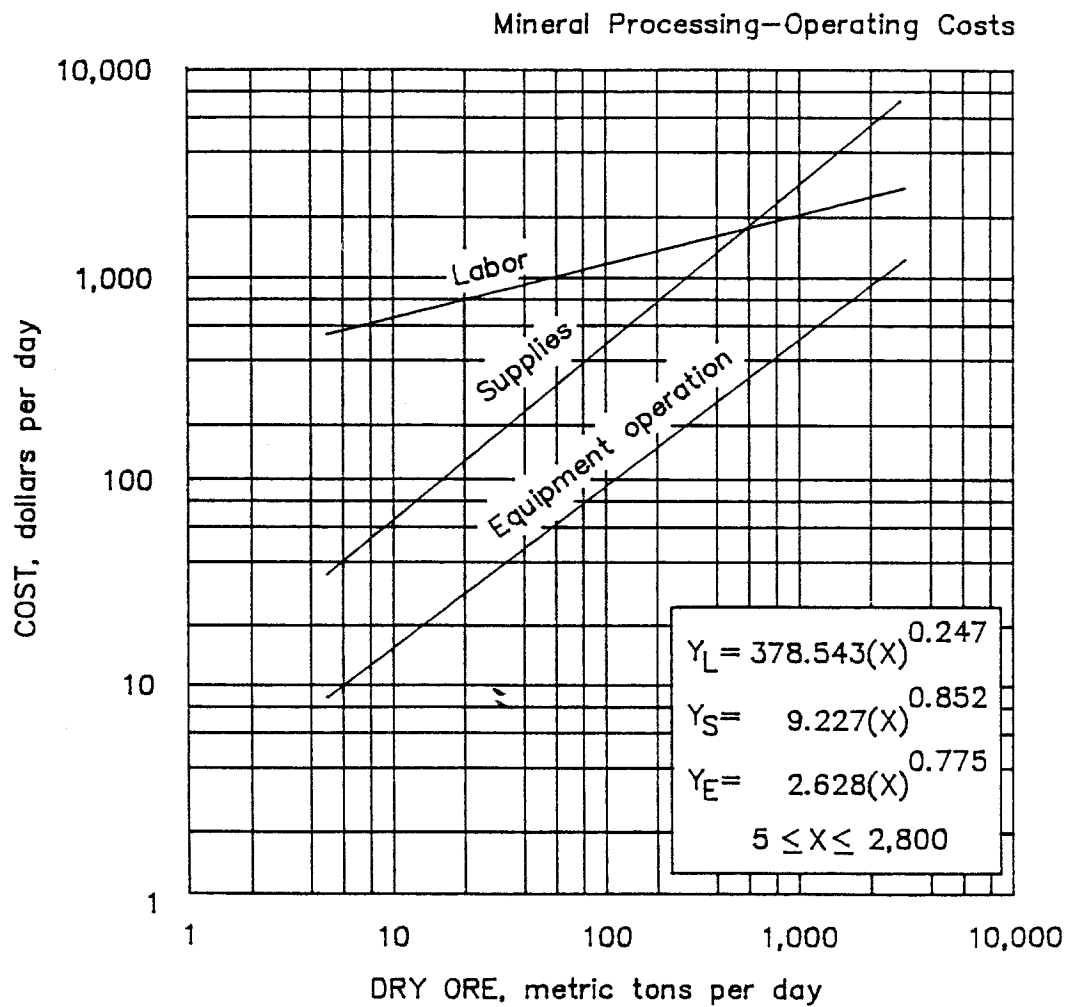
The operating cost for supplies includes the reagents and power required for all thickening, leaching, filtering, precipitation, carbon column scavenging, and bullion casting facilities. For small operations, the supply cost consists of 75% electric power and 25% reagents. For large mills, the supply cost consists of 71% to 85% reagents and 15% to 29% electric power.

(E) Equipment Operating Costs $(Y_E) = 2.628(X)0.775$

The equipment operation curve consists of 93% for repair parts and 7% for lubrication.

ADJUSTMENT FACTOR

Water Adjustment The hydrometallurgical nature of the leach process requires large quantities of fresh and/or recycled water. The base curve costs do not include water costs or costs associated with reclamation of water from tailings ponds. An average requirement of 1.13 m³ of water per metric ton of ore can be assumed for this process.



7.1.5.1.7. Leaching
 CONVENTIONAL CYANIDE LEACHING WITH
 MERRILL-CROWE PRECIPITATION

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.1.8. LEACHING
URANIUM

The operating cost curves for uranium leaching include the operation and maintenance of a uranium leaching operation from the ground slurry storage tanks following grinding through the production of uranium concentrate, yellowcake. The unit process includes leaching, solvent extraction, precipitation, and drying circuits. 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 dry ore per day. The curves are valid for operations between 770 and 6,300 mtpd, operating three shifts per day.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 180.942(X)^{0.459}$

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

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

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

		Av salary per hour (base rate)
Control room operator.....	11%	\$17.56
Mill operator.....	36%	17.11
Mill helper.....	18%	13.99
Mill suboperator.....	13%	14.89
Packer-loader.....	3%	15.77
Mill laborer.....	19%	11.68

Labor costs average \$15.62 per worker-hour and include burden and shift differentials.

(S) Supply Operating Cost $(Y_S) = 36.954(X)^{0.792}$

The supply operating costs consist of the following:

	Small (770 to 2,000 mtpd)	Large (2,000 to 6,300 mtpd)
Sulfuric acid.....	38.6%	54.2%
Other reagents.....	17.8%	25.0%
Electric power.....	5.5%	4.9%
Fuel.....	38.1%	15.9%

(E) Equipment Operating Cost $(Y_E) = 20.742(X)^{0.649}$

The equipment operation curve consists of 99.6% for repair parts and materials and 0.4% for lubrication. The curve includes an allowance for the replacement of items such as motors, pump parts, gears, and drive belts associated with uranium processing circuits.

ADJUSTMENT FACTORS

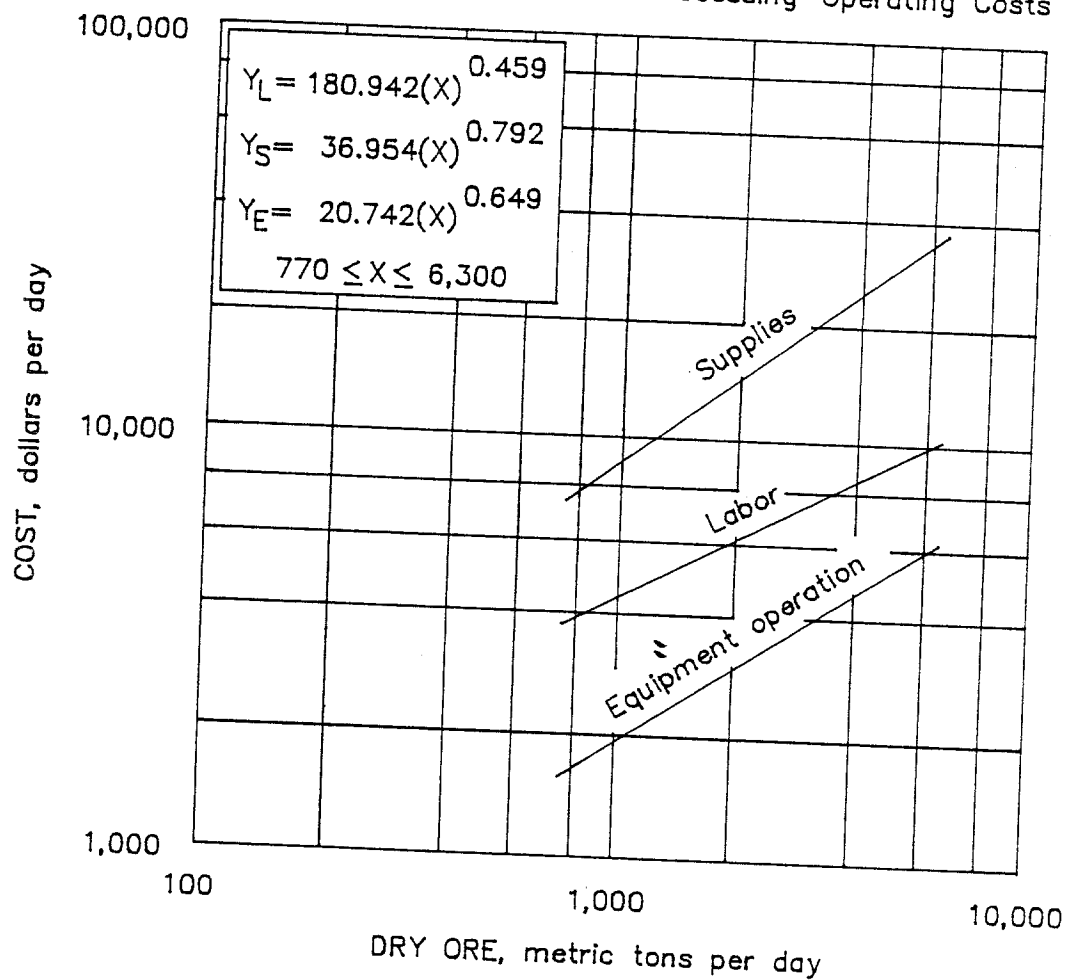
Shift Factor The curve is based on a three-shift-per-day operation. Typically, uranium leaching operations operate on a continuous basis to maintain steady flow rates between the various processing circuits. No adjustment factor for a one- or two-shift operation is recommended for this unit process.

Sulfuric Acid Consumption Factor The curve is based on a consumption rate of 100 lb of sulfuric acid per metric ton of ore. This consumption rate varies significantly between 55 and 400 lb as a function of the individual ore characteristics.

For consumption rates other than 100 lb, multiply the supply operating cost by the following factor:

Supply factor $(F_S) = 0.00530(P)+0.47$
where P = new consumption rate, in pounds.

Mineral Processing—Operating Costs



7.1.5.1.8. Leaching URANIUM

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.2.1. SOLVENT EXTRACTION
BERYLLIUM

The operating cost curves for a beryllium solvent extraction circuit include its operation and maintenance from clarified pregnant aqueous solution through the production of a pregnant strip solution. 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 liters per minute of clarified pregnant aqueous solution to the solvent extraction circuit. The curves are valid for operations between 85 and 575 L, operating three shifts per day.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 34.627(X)^{0.452}$

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

Direct labor.....	90%
Maintenance labor.....	10%

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

		Av salary per hour (base rate)
Solvent extraction operator..	74%	\$16.78
Solvent extraction helper....	19%	13.66
Laborer.....	7%	11.68

The average wage for labor is \$15.94 per worker-hour (including burden and average shift differential).²

(S) Supply Operating Cost $(Y_S) = 5.662(X)^{0.980}$

The supply operating cost consists of 81.8% reagents, 13.6% natural gas, and 4.6% electricity.

(E) Equipment Operating Cost $(Y_E) = 4.929(X)^{0.186}$

The equipment operation curve consists of 100% for repair parts and materials. The curve includes an allowance for the replacement of items such as motors, pump parts, bearings, and drive belts associated with the beryllium solvent extraction circuit.

ADJUSTMENT FACTORS

Shift Factor The base curves are based on a three-shift-per-day operation. It is desirable to operate solvent extraction circuits on a continuous basis to minimize the formation of crud and/or emulsions. The crud and/or emulsions may contain radioactive materials and would require special disposal and/or processing at an additional cost. No adjustment factor for a one or two-shift operation is recommended for beryllium solvent extraction circuits.

Number of Extraction Stages The base curves are premised on the installation of seven extraction stages. To adjust for a different number of extraction stages, multiply the supply and equipment operation costs obtained from the curves by the following factors:

$$\text{Supply factor } (F_S) = 0.958(N)^{0.022}$$

$$\text{Equipment operation factor } (F_E) = 0.527(N)^{0.329}$$

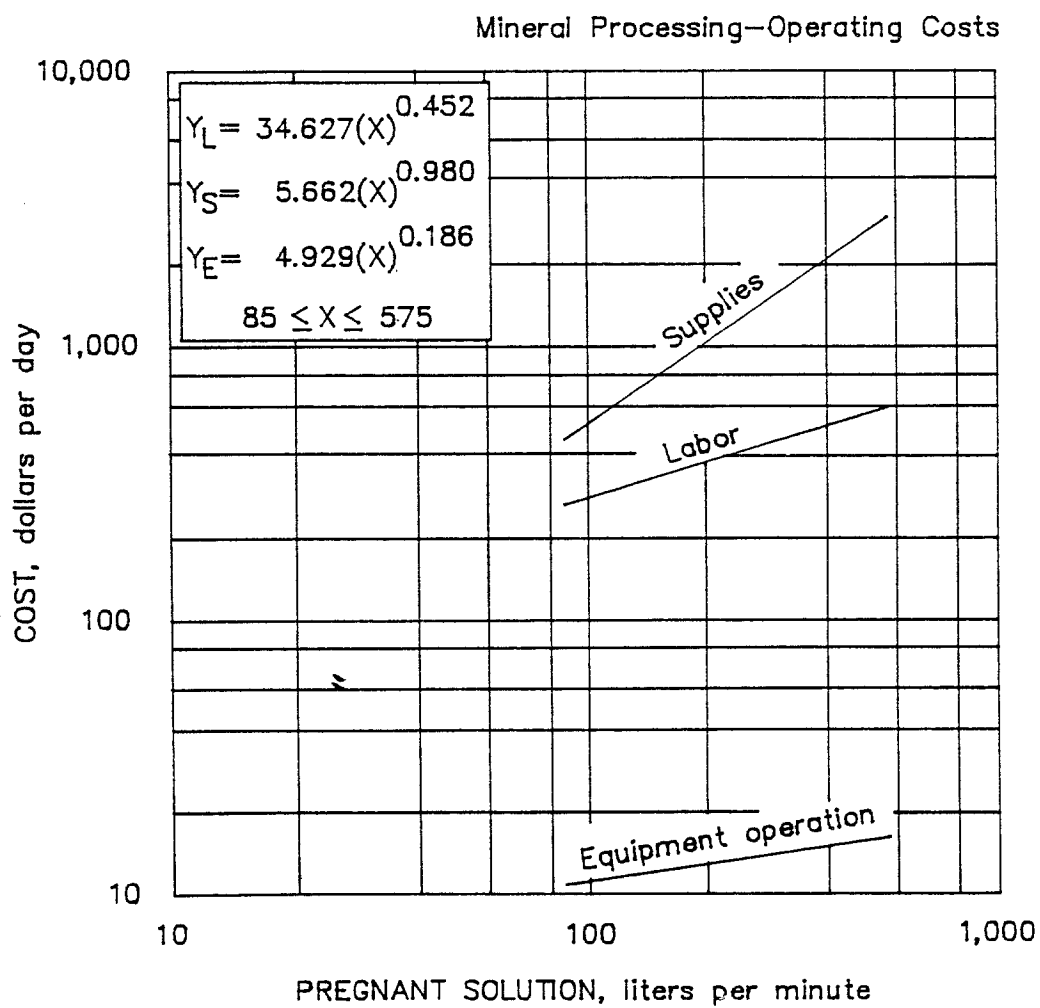
where N = number of extraction stages.

Number of Stripping Stages The base curves are premised on the installation of two stripping stages. To adjust for a different number of stripping stages, multiply the supply and equipment operation costs obtained from the curves by the following factors:

$$\text{Supply factor } (F_S) = 0.998(S)^{0.003}$$

$$\text{Equipment operation factor } (F_E) = 0.940(S)^{0.090}$$

where S = number of stripping stages.



7.1.5.2.1. Solvent extraction
BERYLLIUM

7.1. MINERAL PROCESSING--OPERATING COSTS

7.1.5. HYDROMETALLURGY

7.1.5.2.2. SOLVENT EXTRACTION
COPPER

The operating cost curves for a copper solvent extraction circuit include its operation and maintenance from clarified pregnant aqueous solution through the production of a pregnant strip solution. 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 liters per minute of clarified pregnant aqueous solution to the solvent extraction circuit. The curves are valid for operations between 8,000 and 27,000 L, operating three shifts per day.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 0.142(X)0.899$

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

Direct labor.....	74%
Maintenance labor.....	26%

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

		Av salary per hour (base rate)
Control room operator.....	4%	\$17.23
Solvent extraction operator	93%	16.78
Laborer.....	3%	11.68

The average wage for labor is \$16.69 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.277(X)0.988$

The supply operating cost consists of 89.9% reagents and 10.1% electricity.

(E) Equipment Operation Cost $(Y_E) = 0.020(X)0.935$

The equipment operation curve consists of 97.6% for repair parts and materials and 2.4% for lubrication. The curve includes an allowance for the replacement of items such as motors, pump parts, bearings, gears, piping, and drive belts associated with the copper extraction circuit.

ADJUSTMENT FACTORS

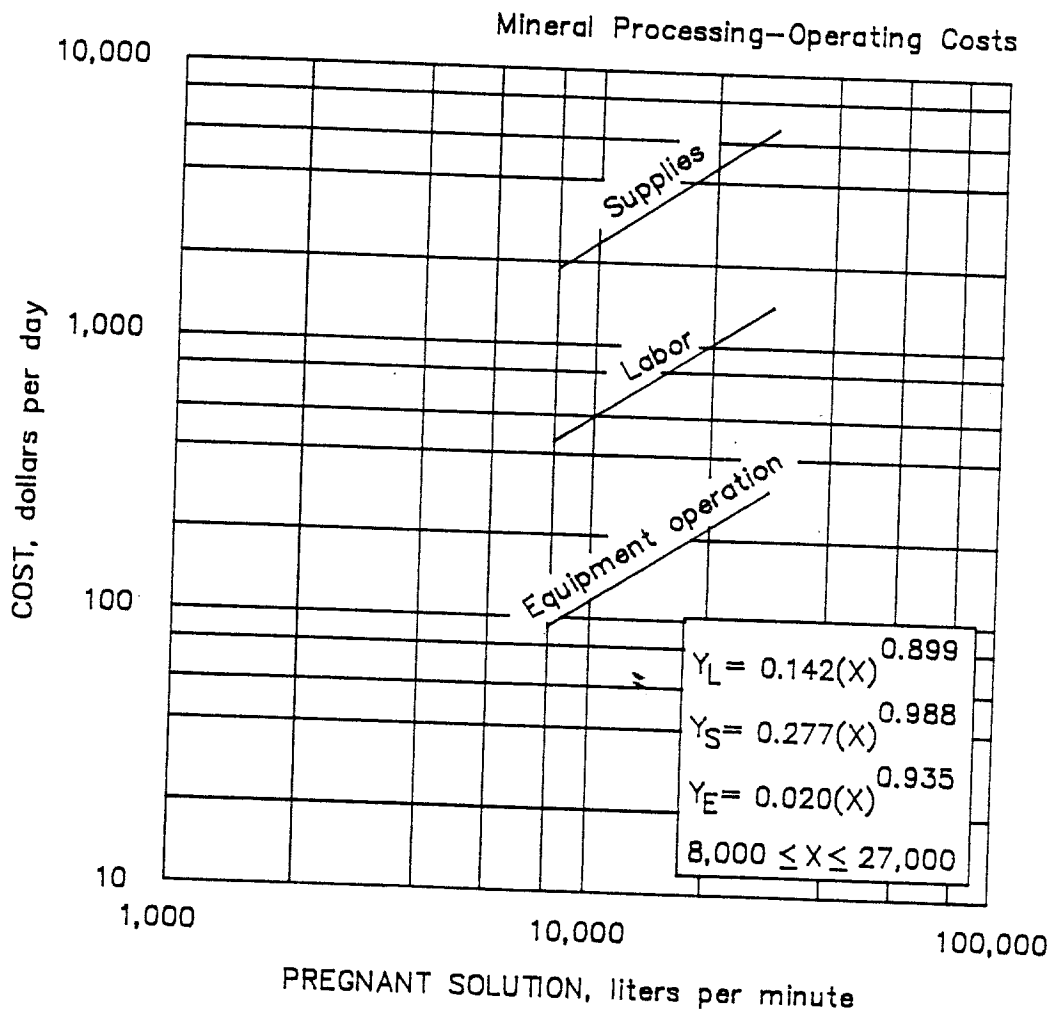
Shift Factor The base curves are based on a three-shift-per-day operation. It is desirable to operate solvent extraction circuits on a continuous basis to minimize the formation of crud and/or emulsion. The crud and/or emulsion may contain radioactive materials which would require special disposal and/or processing at an additional cost. Therefore, no adjustment factor for a one- or two-shift operation is recommended for copper solvent extraction circuits.

Number of Stages The base case is premised on a total of eight stages (four extraction and four stripping) in the solvent extraction. To adjust for a different number of stages, multiply the supply and equipment operation costs obtained from the curves by the following factors:

$$\text{Supply factor } (F_S) = 0.758(N)^{0.133}$$

$$\text{Equipment operation factor } (F_E) = 0.510(N)^{0.324}$$

where N = total number of extraction and stripping stages.



7.1.5.2.2. Solvent extraction
COPPER