

FACT SHEET:**A BRIEF HISTORY**

Cominco Ltd. Trail Operations

January 1996

**Discovery**

Gold-copper ore was discovered at nearby Red Mountain in 1890. With the prospecting and mining rush that followed, the City of Rossland was rapidly established at the base of the mountain. (A first-rate museum there tells the colourful story of the early days and includes an underground tour).

Ore was moved down to Trail Creek Landing at first by wagon. From there, it was moved downstream on the Columbia to smelters in the U.S. In 1896, an enterprising American mining man started up a small copper-gold smelter at Trail, as the landing became known. He also constructed a railroad from Rossland to Trail, then west to the Boundary country to serve the mineral industry in the Grand Forks/Greenwood area.

In 1898, Canadian Pacific bought the railroad and the smelter.

The first electrolytic refinery

In 1899, the small smelter began smelting lead-silver ores from the Slocan area near Nelson. The crude bullion was shipped south of the border. In 1901, an American inventor offered a method of refining lead by electrolysis and, early the next year, the first electrolytic lead refinery was in production at Trail. Similar refining of silver followed in the next year. The move into these metals was logical, as the Rossland copper-gold mines were reaching their peak.

In 1906, several of the Rossland mines, the Trail smelter and a small lead-silver mine in the East Kootenay joined together to form The Consolidated Mining and Smelting Company of Canada, Limited. On the company's 60th

birthday, in 1966, this cumbersome name was officially changed to Cominco Ltd. It is interesting that in 1906, Walter Aldridge, the first managing director wrote,

"This company will not be dependant on any single mine or mining district; its interests and business, besides being industrial, will be diversified to minimize the speculative element."

Whether prophecy or resolve, it was a remarkable statement because that is precisely what was achieved.

The Sullivan

The Sullivan Mine, discovered in 1892 at what is now Kimberley, B.C., was at first a failure. Its ore was too complex for the metallurgy of the day and, certainly, no one had any idea that it was one of the major deposits in the world. In 1909, Cominco acquired the idle mine and operated it by hand sorting pieces with high lead-silver values. This ore was shipped to Trail. By 1914, the Trail lead plant was the largest in the British Empire.

In 1916, Cominco developed a method of producing zinc by electrolysis, particularly for World War I needs. The company thus began to make use of the huge zinc content of the Sullivan. To ensure the large electric power requirement for the metal production of the future, Cominco obtained ownership of the West Kootenay Power and Light Company.



continued/2

A brief history/continued

Differential flotation

In 1920, Cominco engineers discovered how to separate the lead and zinc mineral in ore by a process called differential flotation - a process now in widespread use throughout the world.

At this time, the Trail-based company began to broaden its exploration activity across Canada, into the unmapped North, first by canoe, then later, by bush planes flown by company engineers. Cominco was in Africa in the 1920s.

Environmental control

The other important event of the 1920s was the start of environmental control. There was little or no control of sulphur emissions by smelters anywhere in the world until the Age of Ecology began in the 1960s. But at Trail, the heavy emissions in the narrow river valley drifted south across the border, and complaints and damage suits resulted in the need for pollution control long before it became a topic of world importance.

In 1930, Cominco constructed plants at Trail to make sulphuric acid from the smelter smoke, and to use the acid to make chemical fertilizers in other new plants. It was truly a pioneering venture. It had not been attempted before on such a scale. Also, chemical fertilizer was a relatively

unknown commodity. Cominco had to work out how to make good products and to convince farmers that these would benefit their crops. All this at the start of the Great Depression!

The Kimberley-Trail production partnership weathered the storm. Employees agreed to share work to avoid layoffs - single men worked part time.

Expanding horizons

In the period after World War II, Cominco was poised to broaden its activity in Canada and other countries. It had the expertise and resources to do so, although Kimberley and Trail would remain as the company's most important production unit.

The company, now Vancouver-based, has broadened to include widespread exploration, mining, metals, and fertilizers operation with interests in Canada, related activity in the U.S. and South America, and Sales Offices in Japan and Singapore. As one of Canada's major industrial organizations, it makes an important contribution to the country's economy.



The future

Since 1977, \$800 million has been spent on modernization projects at Trail. This period of modernization will culminate in a new lead smelter at the end of 1996.

Cominco's major shareholder is Teck Corporation, a major Canadian mining company based in Vancouver, B.C.



Tom Schwartz
Oct. 8/97

FACT SHEET:

QUICK FACTS

Cominco Ltd. Trail Operations

January 1997



Daily consumption

Zinc concentrate -	1400 tonnes (1545 tons)	Natural gas -	200,000 cu. metres (4,900 cfm)
Lead concentrate -	350 tonnes (385 tons)	Electric power -	5,280,000 kW.h (220 aMW)
Limerock -	100 tonnes (110 tons)	Water -	280,000 tonnes (43,000 gal./min.)
Silica -	27 tonnes (30 tons)	Compressed air -	1,800,000 c. metres(44,000cfm)
Coal -	175 tonnes (193 tons)	Oxygen -	235 tonnes (260 tons)
Fuels -	11,500 litres (2,500 gallons)	Plant area -	196 hectares (485 acres)

Personnel

Employment		Wages and salaries	
1991 - 2,613	1994 - 1,988	1991 - \$139,800,000	1994 - \$103,100,000
1992 - 2,148	1995 - 2,010	1992 - \$127,000,000	1995 - \$109,000,000
1993 - 1,946	1996 - 2,044	1993 - \$107,200,000	1996 - \$114,744,000

How our products are used

Zinc

- coats steel to prevent rust in cars and other steel products
- castings of car parts, faucets, toys, appliances
- zinc plus copper makes brass
- zinc oxide is used in rubber, paints, cosmetics, skin cream
- rolled zinc is used for car trim, roofing, coins



Lead

- car batteries (70% of all lead use)
- radiation protection and soundproofing
- pigments, compounds and cable sheathing
- used to contain corrosive chemicals

Silver

- photographic film, jewellery, tableware

Gold

- investment, jewellery, solar sheathing

Indium, Cadmium, Germanium

- electronic materials

Bismuth

- pharmaceuticals, alloys

Sulphur dioxide

- used in pulp mills for bleaching
- biocide in foods
- metallurgical reagent
- municipal water treatment

Sulphuric acid

- used in pulp mills
- used in fertilizer production
- car batteries

Sulphur

- sulphur dioxide, sulphuric acid
- fertilizers

Copper sulphate

- milling reagent, fungicide
- animal feeds

Copper arsenate

- wood preservative

Sodium antimonate

- fire retardant

Van Schooten
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Tom Schwartz
01.8/97

FACT SHEET:

POWER

Cominco Ltd. Trail Operations

June 1996



Cominco's hydro electric development on the **Pend d'Oreille** river has been a key factor in the growth of the company's mining, metallurgical and chemical fertilizer operations in the Kootenay districts of British Columbia.

Power from this plant is vital to the huge production complex of Trail Operations, where a large part of the output is based on electrolytic processes. An 86-mile transmission line carries power to the company's Kimberley operations.

Cominco dam

Waneta, on the **Pend d'Oreille** River

Height: 64 m

Length: 290 m

Concrete construction

Construction completed in 1954 (2 generating units), 3rd unit installed 1964, 4th unit in 1966

Unit 3 upgrade 1995

4 generating units

Rated capacity

Basic: 375,000 kW

Upgrade: 25,300 kW

Total: 400,300 kW

Generation

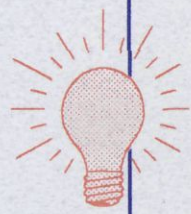
Basic: 2,469,300,000 kW.h

Upgrade: 136,700,000 kW.h

Total: 2,606,000,000 kW.h

Usage

Trail Operations:	1,942,000,000 kW.h/annum average
Kimberley Operations:	158,000,000 kW.h/annum average
Cominco Total:	2,100,000,000 kW.h/annum average
Surplus sales to W.K. Power:	144,000,000 kW.h/annum average
Surplus sold to market:	362,000,000 kW.h/annum average



Fun fact

The Waneta generators produce enough power to light a 100-watt bulb continuously in 3,000,000 homes, or replace 1,500,000 barrels of crude oil per year, or supply a city of 250,000 with power.

TRAIL OPERATIONS

Smelting and refining have been carried out at Trail since 1896. Over the years, the processes and plants have been modified many times with advances in technology. The Fertilizer Plants were built 60 years ago to solve the sulphur dioxide problem long before the term 'acid rain' was coined.

The Trail smelter was originally built to process materials from local mines. Now, concentrates are purchased from many other parts of the world, though mines in B.C., Washington State, Idaho, Montana, Colorado and Alaska remain important to us. The rock dug up in these mines is ground into fine powder so the metal-bearing particles can be separated and concentrated. Over 700,000 tonnes of these concentrates are processed at Trail every year.

In the past 15 years, Cominco Ltd. has demonstrated its commitment to the Trail operations by investing almost \$1 billion in the operation. Today, the complex consists of 22 individual plants, which, if they were to be replaced today, would cost the company about \$3 billion.

The facility employs about 2,000 people who produce a wide range of products representing a large part of the periodic table: zinc, lead, silver, gold, indium, cadmium, germanium, bismuth, liquid sulphur dioxide, sulphuric acid, elemental sulphur, ammonium sulphate, copper sulphate, copper arsenate and sodium antimonate.

The high-recovery efficiency of Trail Operations and low-cost electricity are essential to offset the high cost of transporting materials to and from Trail.

*Cominco
Aug 97*

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COMINCO LTD.

TRAIL METALLURGICAL OPERATIONS

A TECHNICAL DESCRIPTION

OF THE

MAIN PRODUCTION PROCESSES

August 1997

TRAIL OPERATIONS

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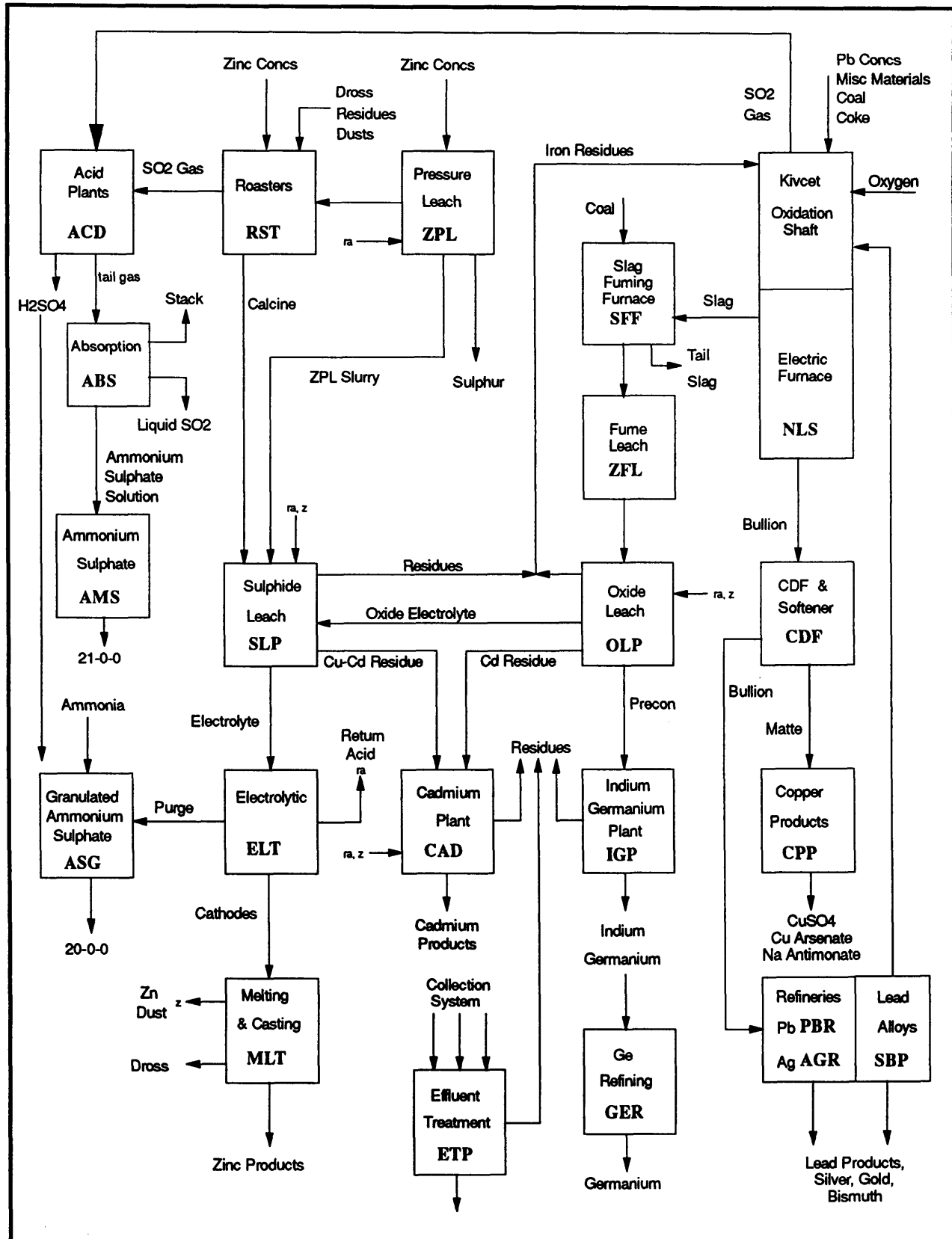
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Cominco Operations at Trail



ZINC OPERATIONS

ROASTING AND SULPHUR RECOVERY

The roasters currently treat about 1,400 t/d of zinc concentrates. Over half of the total concentrate treated originates from the Red Dog Mine in Alaska. During the summer, concentrate is shipped from Alaska to Vancouver where it is loaded into rail cars and hauled inland, transferred to trucks, and delivered to Trail. The remainder of the roaster feed is made up of Sullivan concentrate, various custom concentrates, and recycles from Pressure Leach and the Zinc Melting Plant. These arrive either by rail car or by truck. Typical analyses of the major components of the zinc concentrates are shown below.

	<u>Zinc</u>	<u>Lead</u>	<u>Iron</u>
Red Dog	55.0%	3.2%	4.4%
Sullivan	51.0%	5.2%	9.5%
Customs	52.0%	3.0%	8.0%

Each of the three roasters has two feed bins allowing greater control over the composition of the feed by ratioing Red Dog to a mix of the other concentrates and recycles. Each of the two Lurgi fluid bed roasters has a bed area of 84 m², and operates continually except for an annual shutdown period. The third roaster, a suspension or flash roaster, operates on a part-time basis, depending on the need.

In the Lurgi roaster circuit, 10% to 30% of the calcine reports to bed overflow, with the remaining calcine collected in the dry-gas cooling and cleaning system. This system includes boilers, cyclones and electrostatic precipitators. All calcine is fed to an integrated air-classification/ball mill grinding circuit with fine calcine going to the roaster product bin. The calcine is transferred pneumatically to the two 3,000-t silos at the Leaching Plant. Further gas cleaning and cooling is accomplished with venturi scrubbers and packed cooling towers to yield a water-saturated gas stream at 40°C.

The gas flow rate at this stage is approximately 3,600 m³/minute after the addition of Kivcet gas. The gas, containing about 8% SO₂, then passes through a series of primary and secondary mist treaters. These treaters will remove any acid mist that formed during the cooling of the gas stream. Finally, the gas stream is scrubbed of mercury by a Boliden-Norzinc mercury removal process, involving HgCl precipitation before going to one of three single-stage contact acid plants. The acid plants are all Monsanto design, ranging in capacity from 410 t/d to 820 t/d. These plants convert 95% of the SO₂ in the gas stream to a marketable sulphuric acid product. The SO₂ remaining in the Acid Plants' tail gas is removed by an ammonia scrubbing process that virtually eliminates the SO₂ in the gas. The scrubbed gas then passes through a Brinks plume eliminator and is discharged to the atmosphere through a 125-m stack.

The ammonia scrubbing system produces an ammonium bisulphite product that is acidified with sulphuric acid to produce ammonium sulphate solution and 100% SO₂. The ammonium sulphate is pumped to the Trail Fertilizer Operations, and the SO₂ is dried, compressed, condensed and sold as liquid SO₂.

ZINC PRESSURE LEACHING

The Pressure Leach Plant at Trail was the first commercial application of direct leaching of zinc concentrates when the first autoclave came on line in 1981. The original autoclave was replaced by a larger autoclave in 1997. The plant has the capacity to treat 25% of the total Zinc Plant concentrate input; a mixture of Sullivan and Red Dog concentrates is being treated until the Sullivan mine shuts down. In the process, zinc concentrate is reground in a ball mill circuit and mixed with return acid and oxygen in a five-compartment autoclave at 150°C and 1,400 kPa. The elemental sulphur is separated from the product leach slurry by flotation, melted, and hot filtered to produce a high-quality elemental sulphur that is marketed. The zinc sulphate leach solution and plumbojarosite leach residue are pumped to the Sulphide Leaching Plant for further processing.

OXIDE FUME LEACHING

The Fume Leach Plant started operation in late 1982. Zinc oxide fume from the Lead Smelter slag fuming furnaces is leached with sodium carbonate to remove chlorine and fluorine. The leach slurry is pumped from the Fume Leach Plant to the Fume Filtration Plant and filtered and washed using Lasta filters.

The washed filter cake is repulped with residue filtrates and pumped to the Oxide Leaching Plant for completion of the leaching operation. Acid and neutral stages of fume leaching are done in pachuca tanks. The very high impurity content of the oxide fume requires the addition of approximately 2.5 g/L of ferric iron to the acid leach pachucas. Precipitation of ferric hydroxide in the neutral pachucas precipitates a major portion of germanium, arsenic, and antimony from solution. Iron purification may be carried out in one or two stages. The precipitated ferric hydroxide separates from solution in thickeners.

The acid thickener underflow is neutralized using oxide fume slurry; pressure filtered (Kelly or Perrin filters); and washed. A second filtration stage, with residue wash using a pressure filter, reduces water-soluble zinc in the residue. The residue is pumped to the Lead Smelter for further processing.

The solution derived from neutral leaching is purified with zinc dust in a single stage at about 50°C. The partially purified solution product is pumped to the Sulphide Leaching Plant as feed for further processing. The purification residue, rich in cadmium, is pumped to the Cadmium Plant.

INDIUM AND GERMANIUM PRODUCTION

Indium and germanium are recovered from a concentrate made in the first stage of neutralization in the oxide-fume leach plant. The resulting indium sponge and sodium germanate are refined to make indium metal and a variety of high-grade germanium products, principally GeO₂.

LEACHING AND SOLUTION PURIFICATION

The Sulphide Leaching Plant has three input streams:

- roaster calcine, 1,200 t/d, producing 600 t/d of zinc in solution
- pressure leach slurry, containing 250 t/d of zinc in solution
- oxide fume leaching solution, containing 90 t/d of zinc in solution

The function of the plant is to acid leach zinc from the calcine input and to purify the combined solution from this and the other two input streams.

The zinc calcine is acid leached in three 200-m³ and four 100-m³ tanks operating in series. The first tank is controlled to a 1.6 pH. In the remaining tanks, the pH is increased to 3.8 by adding a neutral calcine slurry and then gradually reduced to pH 3.2. Continuous pH monitoring is facilitated by submerged pH cells in each tank. The oxide and pressure leach streams are added to the first mix tank, along with neutral thickener underflow (NTU) and acid leach residue filtrate.

After leaching, the acid leach slurry is discharged to four 24-m thickeners. Underflow from these thickeners is subsequently filtered and washed in two stages using American disc filters. The washed residue is pumped to the Lead Smelter for final filtering on Lasta presses. The filtrate is returned to the Zinc Plant and the Lasta cake is processed in the Lead Smelter.

Acid-thickener overflow solution is neutralized with pre-slurried calcine and agitated through a series of four neutral mix tanks. After neutral thickening, the NTU solids are recycled to the acid leach.

Clear neutral thickener overflow flows continuously through three stages of zinc-dust purification. Fresh zinc dust is added to each stage to precipitate impurities. The first stage operates at 60°C to remove cadmium, copper, and thallium, while the last two stages operate at 73°C with added copper and antimony to remove cobalt and small amounts of thallium and nickel. Pressure filters remove the precipitated impurities after each stage. The filter cake from the first stage is sent to the Cadmium Plant for cadmium recovery. The cakes from the other stages are reprocessed to recover unused zinc and then sent to the Lead Smelter.

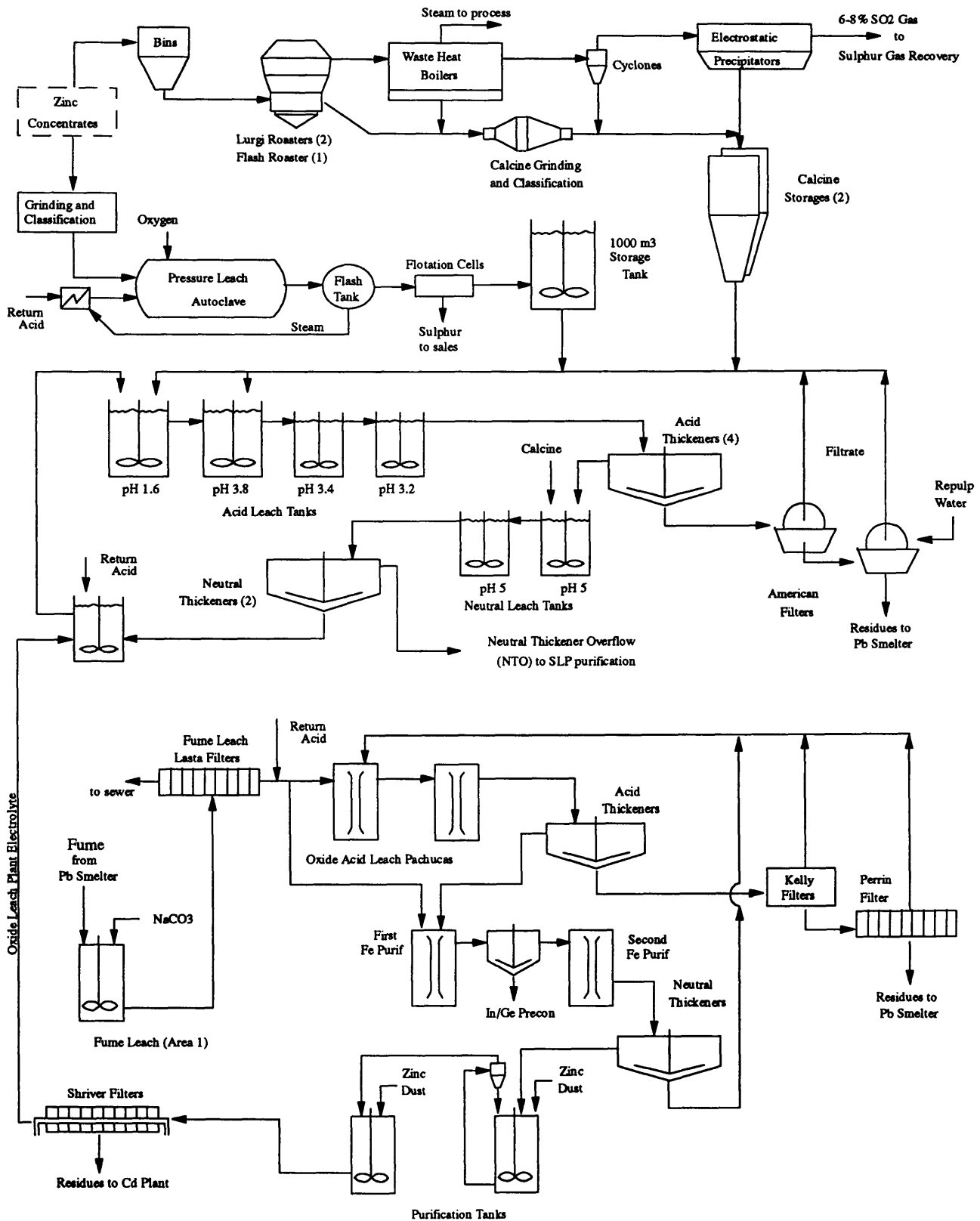
Solution analysis before and after purification is as follows:

	<u>Zn g/L</u>	<u>Cd mg/L</u>	<u>Cu mg/L</u>	<u>Co mg/L</u>	<u>Ge mg/L</u>	<u>Sb mg/L</u>	<u>Tl mg/L</u>
Before	155	300	60	15	0.1	0.2	10
After	157	<0.3	<0.1	<0.3	<0.02	<0.02	<0.3

Purified zinc sulphate solution is cooled in forced-draft atmospheric cooling towers to 25°C to evaporate water and to crystallize gypsum. Gypsum is removed in a 24-m clarifying thickener. The clear clarifier overflow is then sent to the Electrolytic Plant.



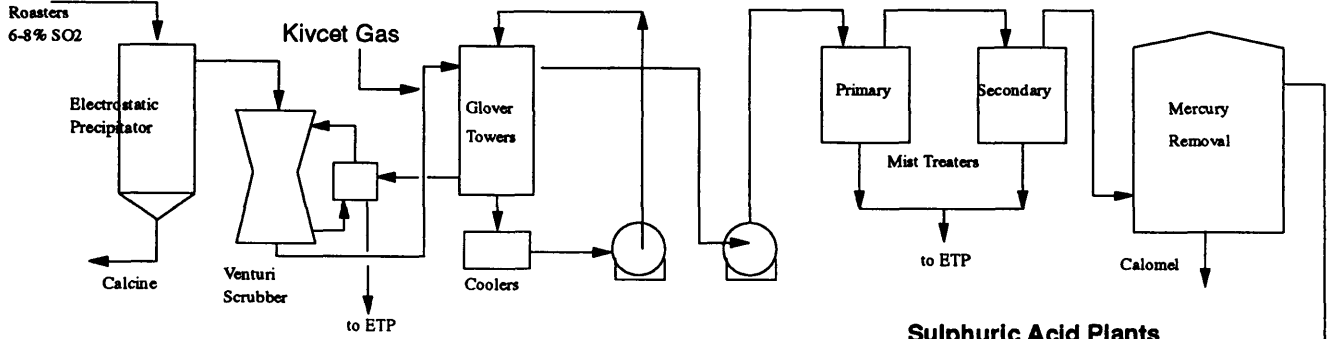
Zinc Operations Roasting and Leaching Plants



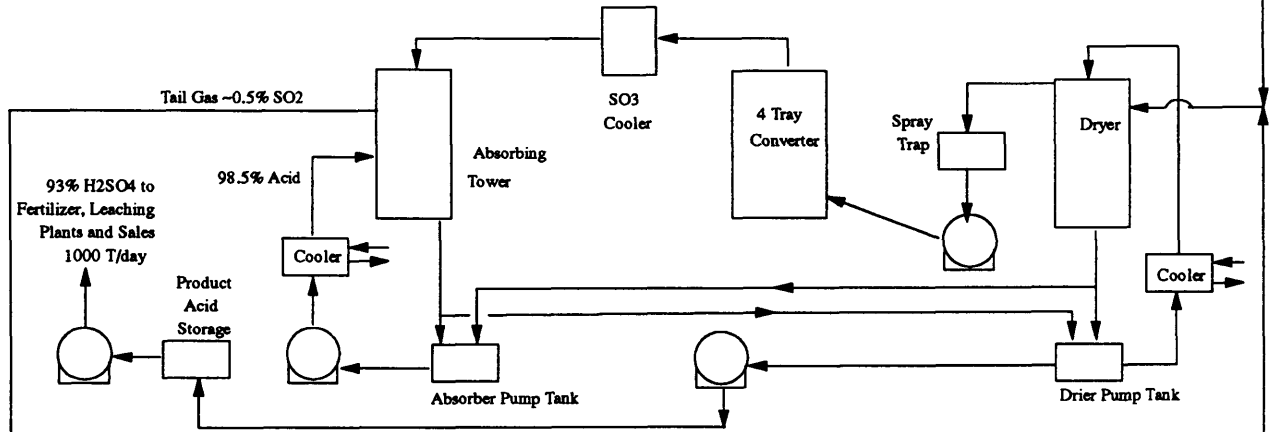


Zinc Operations Acid and Absorption Plants

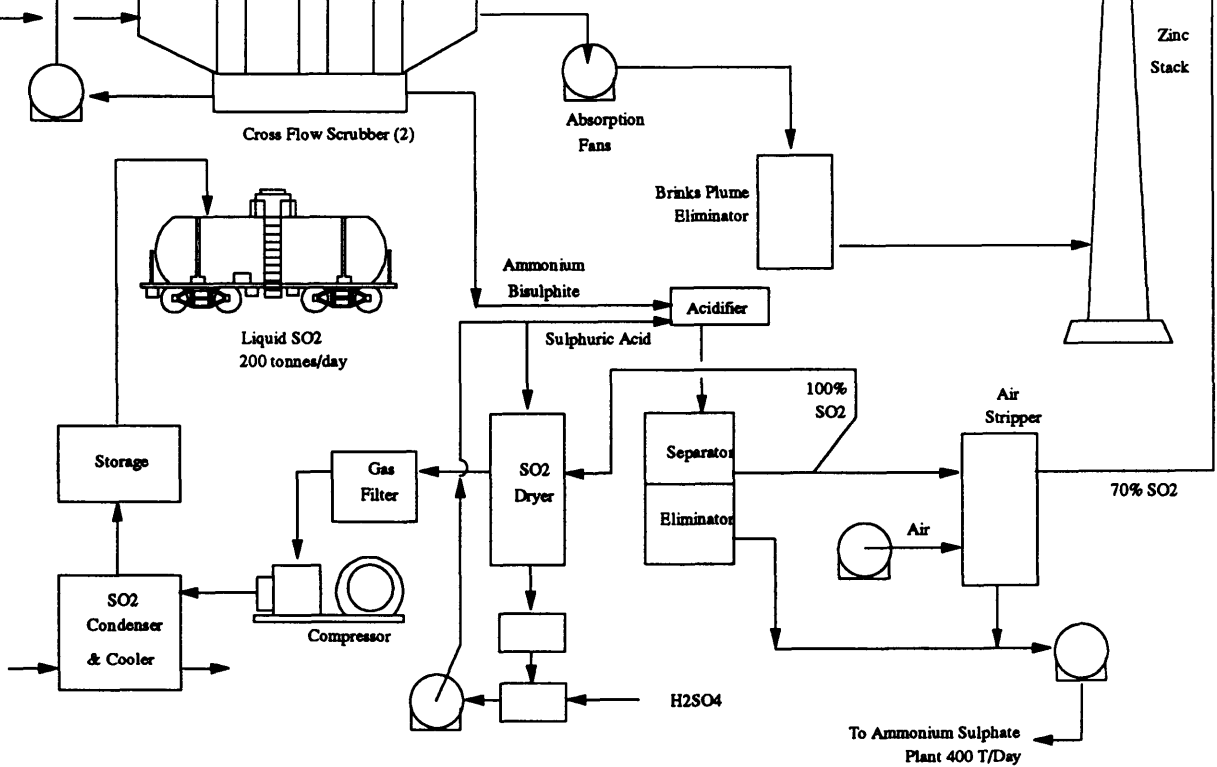
Roaster Gas Cleaning



Sulphuric Acid Plants



Zinc Absorption Plant



CADMIUM PRODUCTION

Cadmium is recovered from the filter cake obtained in the first stage of zinc-dust purification. The cake is leached with acid in two stages. In the first stage, mild acid is used to dissolve the zinc. In the second stage, stronger acid is used to dissolve the cadmium and remaining impurities, except copper, which is filtered out and sent to the Lead Smelter. Cadmium is then re-precipitated as prills using zinc dust. The prills are separated in a filter, briquetted, then distilled in furnaces to produce 99.999% cadmium metal. Spent solutions from the leaches are returned to the Sulphide Leaching Plant.

ZINC ELECTROWINNING

The cell house contains 548 cells arranged in two sections of 132 cells and two with 142 cells. Each section has its own rectifier with a capacity of 66,000 amps at 450 volts. Each cell contains 50 cathodes and 51 anodes, with a cathode deposition area of 3m² each, resulting in a current density of 440 A/m². Zinc is electrodeposited on the aluminum cathodes and oxygen is evolved from the lead anodes. The cells are of fibreglass-lined concrete construction.

The cell feed solution contains 55 g/L zinc and 160 g/L H₂SO₄ at about 30°C. The cells are fed by gravity from a head tank at about 3 L/s. Cell overflow, containing 52 g/L zinc and 165 g/L H₂SO₄ at about 35°C, is fed to atmospheric cooling towers to remove the heat of electrolysis. Following cooling, sufficient zinc sulphate solution is added to restore the zinc tenor to 55 g/L before recycle through the cells. Zinc is electrodeposited for 72 hours before being stripped.

Each of the four sections has its own double-masted crane for pulling cathodes on a three-day cycle. Alternate cathodes are removed from two opposite cells in a section and transported by crane to the water wash and drip-dry cells. They are then placed on the feed conveyor of one of four stripping machines. About 9,100 cathodes are stripped of electrodeposited zinc each day. The cellhouse layout is such that any crane can feed any stripping machine. Each crane can also pull cathodes from either one of two sections. The stripped cathodes are returned to the cells and the zinc electrodeposition cycle is repeated. The same cranes are used to transport anodes to the cleaning machine for periodic cleaning and straightening. Anodes are normally cleaned every 40 days, and the cells are cleaned every four months.

ELECTROLYTIC PLANT DATA

Production capacity	290,000 tonnes/year
Immersed cathode area	3 m ²
Maximum current density	440 A/m ²
Current per contact	1,320 A
Cathodes pulled per day	9,100
Crane lifts per day to stripping machines	176

Cathodes in service	27,400
Anodes in service	27,948
Operating cells	548
Weight of zinc per cathode	95 kg
Cathode deposit time	72 h

MELTING AND CASTING

The Melting Plant has three Ajax melting furnaces for melting cathode zinc (two of 2,000 kW and one of 3,000 kW capacity), a 500 kW atomizing furnace, and a Williams Mill to treat the drosses. Off gases are cleaned in four baghouses with a capacity of 42,500 Nm³/hr each.

The casting facilities are: two Mitsui-Cominco slab casting machines, one Shepard casting machine, one Cominco-designed "C-Cast" semi-continuous "jumbo" casting unit, and two "jumbo" casting lines. The casting machines are equipped with alloying furnaces for the controlled addition of alloying elements as required. Mechanical devices include automatic skimming, automatic stacking and automatic stripping. A wide variety of alloys and shapes are produced. These include special high grade, high grade, and a number of alloys containing minor amounts of lead, aluminum, cadmium and copper, as well as a die casting alloy.

About 40% of production is cast into 25-kg slabs with the remainder cast into one-tonne jumbos of three basic shapes. One of these is Cominco's trademarked C-Cast jumbo, which is made by sawing sections from 4.6-m semi-continuous cast logs. This product is cavity-free, saves 23% on storage space and has a weight tolerance of plus or minus 1%.

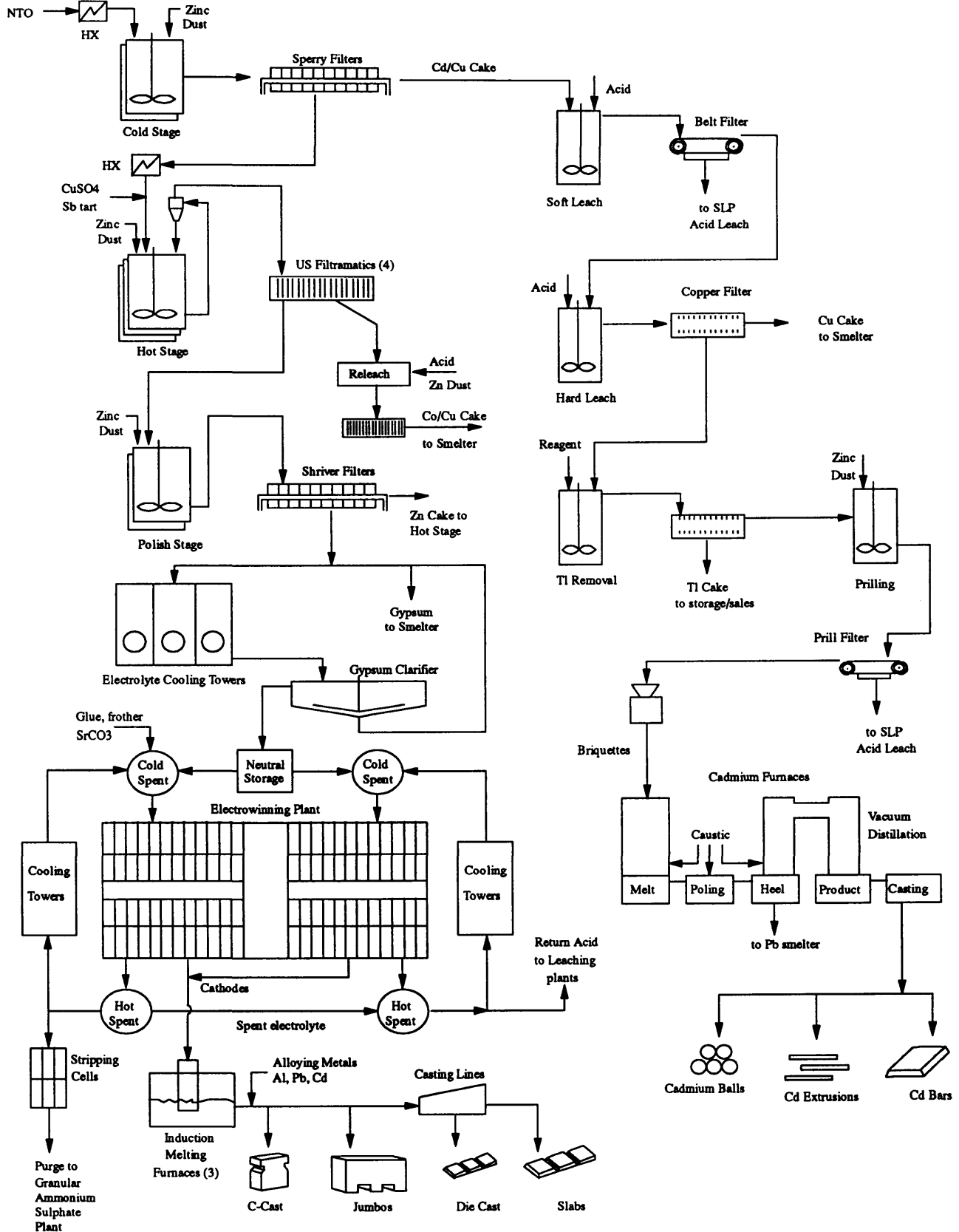
A typical assay of special high grade zinc is:

Lead	0.003% max.
Cadmium	0.001% max.
Copper	0.001% max.
Iron	0.001% max.
Zinc	99.995% max.



Zinc Operations

Electrolytic, Melting, Cadmium Plants



FERTILIZER OPERATIONS

Since the Fertilizer Operations began operating in 1930, a number of major changes have taken place. Fertilizer production expanded gradually in the 1930s with product acceptance. Construction was required during World War II to produce ordnance-grade ammonium nitrate, and this was followed by expansion to meet the heavy post-war demand for fertilizers. In more recent years, with the Company having divested its fertilizer production facilities, fertilizer manufacture at Trail has been directed mainly to the environmental objective of efficient recovery and utilization of metallurgical sulphur.

CRYSTALLINE AMMONIUM SULPHATE PLANT

The Ammonium Sulphate Plant, which came on line in 1930, receives a 40% ammonium sulphate solution pumped from Tadanac. The solution is evaporated to produce crystalline ammonium sulphate fertilizers, the grade of which is 21-0-0.

The plant capacity is approximately 425 t/d from two double effect, draft-tube-baffle crystallizers. The first unit is heated by steam and operates at atmospheric pressure and 110°C. The second unit operates at -70 kPa vacuum and 80°C. Steam evaporated from the first unit is used to heat the second unit for energy efficiency.

Control of solution flow through a fines destruction loop makes growing large crystals possible in a draft-tube-baffle crystallizer. The crystal is pumped in solution (magma) to the centrifuges where the liquid is separated. The crystal is then dried in two direct gas fired rotary dryers. Dry crystals are then screened into a 21-0-0 Regular size product and a 21-0-0 Fluid Grade smaller product.

GRANULAR AMMONIUM SULPHATE

The granular Ammonium Sulphate Plant began operation in May of 1994 and resides in the original Phosphate building built in the 1930's. Sulphuric acid from the Acid Plant, stripped electrolyte from the Electrolytic Plant, and anhydrous ammonia from Alberta are mixed to produce a Granular Ammonium Sulphate product. The grade is 20-0-0 and contains about 1% zinc and other micronutrients.

The sulphuric acid, ammonia and stripped electrolyte are combined in a pipe reactor to form an ammonium sulphate slurry. The slurry is sprayed on a rolling bed of recycle fines inside a granulator to form granules. The discharge of the granulator is dried in a direct fire rotary dryer to reduce the moisture to 0.6%. The dried granules then pass over double deck screens and are separated into three sizes; oversized, product, and fines. The oversized are pulverized, combined with the fines from the screens then fed into the granulator. The product is cooled in a rotary drum, screened, then sent to the storage plant.

Ventilation from the granulator and dryer pass through a venturi scrubber where the bulk of the particulate is removed by recirculating scrubber liquor. A secondary micromist scrubber uses air and water to remove the fine particulate. The remaining vapour exits the scrubber stack as steam to the atmosphere. The scrubber liquor is then fed back into the pipe reactor.

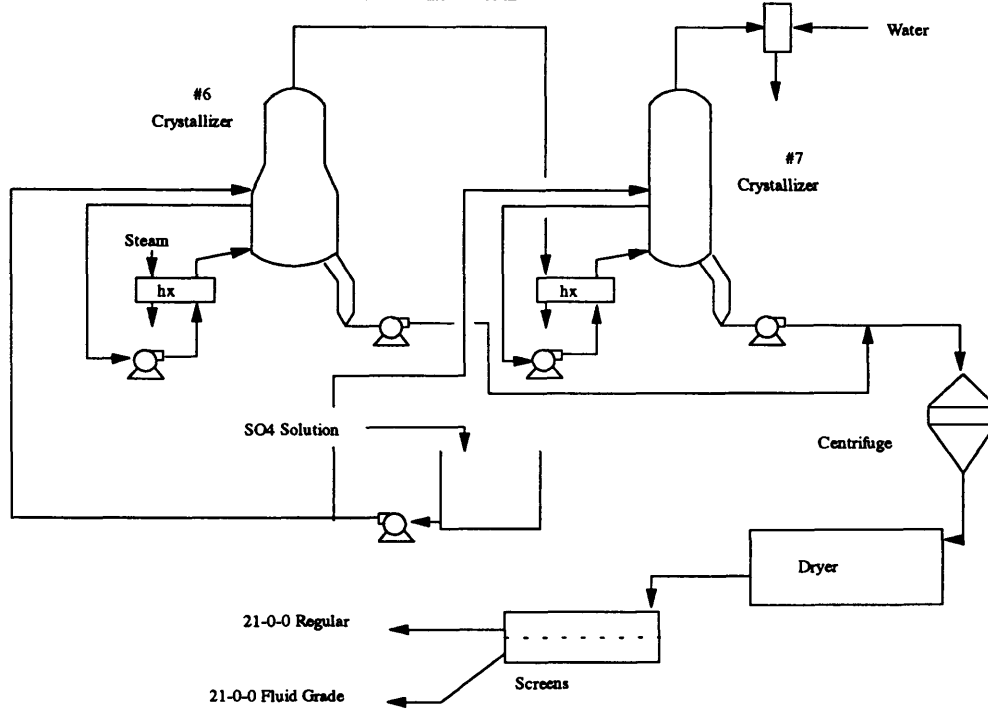
OXYGEN GAS PRODUCTION

BOC Gases operates a 1,200 t/d Oxygen Plant on-site to produce oxygen gas for use in the Kivcet furnace, the Zinc Pressure Leach autoclave, the Copper Matte Leach autoclave and in the Zinc Roasters. The Oxygen Plant also produces nitrogen gas for use in the Sulphide Leaching Plant and compressed argon for sale off-site.

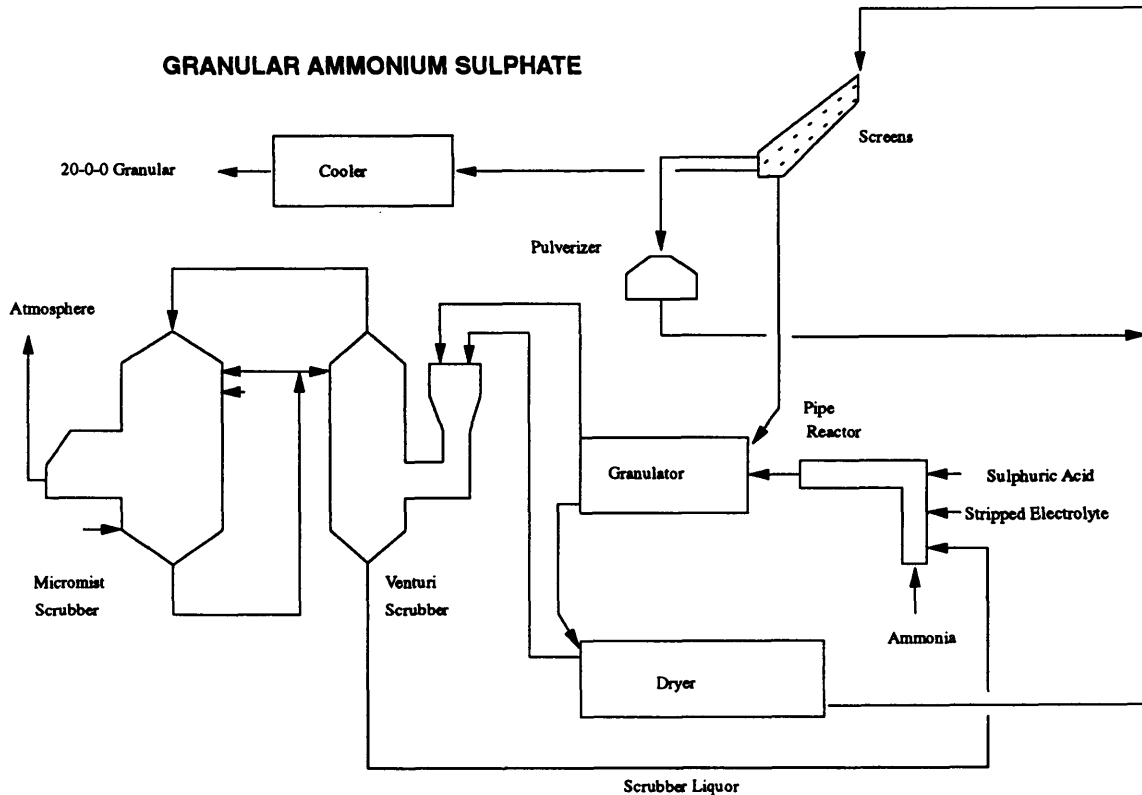


Zinc Operations Fertilizer Production

CRYSTALLINE AMMONIUM SULPHATE



GRANULAR AMMONIUM SULPHATE



LEAD OPERATIONS

The Lead Smelter is located on the site of the original Trail smelter built by F. Augustus Heinze in 1896 to smelt the copper-gold ores from the Rossland mines.

Smelting of lead ores began in 1899. Through the years, the smelting of copper ores diminished as ore supplies were depleted. Lead smelting expanded, particularly after the acquisition of the Sullivan Mine. Many technical changes have been made through the years. A major innovation was the recovery of zinc from the smelter by slag fuming, which began in 1930, with a second fuming furnace added in 1947. A Sintering Plant was commissioned in 1953, while the original brick shaft blast furnaces were replaced with water jacketed shaft furnaces in the 1940s, and modernized in 1979. The sintering - blast furnace technology was replaced by the Kivcet flash smelting process in 1997.

The Lead Refinery at Trail, which began production in 1902, was the first commercial application of an electrolytic lead refining process - the process developed by Dr. Anson G. Betts in 1901. The original installation consisted of 240 asphalt-lined wooden cells with a rated capacity of 5 t/d of lead. Expansion and process improvements over the years brought the plant to 1,002 cells and a capacity of about 460 t/d of refined lead. The Betts electrolytic process continues to be the commercial refining process of choice for producing high-purity lead from the metallurgically complex concentrates handled at the Trail Operations. Additional processes have been added for the recovery of silver, gold and bismuth, as well as alloys of antimony, arsenic and copper.

TYPICAL PRODUCTION AND ASSAYS OF LEAD OPERATION PROCESS STREAMS

	Typical Production t/d	Ag %	Zn %	Pb %	Fe %	Cu %	SiO ₂ %	CaO %	Bi %	Sb %	As %	S %
Kivcet Furnace Slag	450	-	18	3	30	0.3	21	12	-	-	-	1.4
Lead Bullion	335	.3	-	97	-	0.5	-	-	0.02	1.2	1.2	-
Fume	175	-	50	14	-	-	-	-	-	-	-	.3
Barren Slag	-	-	2.5	.1	33	.5	28	14	-	-	-	.3
Copper Matte	15	.15	-	40	-	40	-	-	-	-	1.4	14
Refined Lead	330	-	-	99.99	-	-	-	-	.002	-	-	-
Refined Silver	1.0	99.99	-	-	-	-	-	-	-	-	-	-

KIVCET FURNACE

Lead concentrates from Cominco's Sullivan Mine and custom concentrates from other sources all over the world are treated together with residues from the Zinc Operations Oxide and Sulphide Leaching plants. Silica and limerock fluxing, refinery by-products, smelter recycle materials, coal and coke make up the remainder of the feed.

Most concentrates are received in solid-bottom gondola railway cars at the unloading facility. Cars are pipe-sampled for assaying after weighing. In the Feed Plant, the materials are proportioned according to the charge calculation, using 12 feed bins of 90-tonne capacity with variable-speed belts.

The mixed feed is dried in a 24-metre natural gas fired rotary dryer to less than 1% moisture, and then pulverized in a ball mill.

The Kivcet flash smelting process is a revolutionary concept where the smelting and reduction reactions take place in two distinct stages within the same rectangular furnace. The initial "flash" smelting of the dry feed takes place in an oxygen-fed flame burning in a reaction shaft above the molten bath of lead and slag. A layer of coke is floating on the molten bath in this section of the furnace. The second stage of the process, called the "reduction" stage, occurs in this layer of coke. In the next section of the furnace, the molten bath is heated by electrical energy.

The smelting reaction at a temperature of more than 1,350°C produces a fully oxidized melt with practically all the sulphur in the charge leaving the shaft as a gas rich in SO₂. The molten products are filtered through a bed of coke. The coke is charged via the burners, and floats on top of the slag bath. The coke reduces the lead oxide to lead. The slag passes under a partially submerged partition wall into the electric furnace. The lead bullion collects in the bottom of the furnace beneath the slag from where it can be tapped periodically for drossing.

The integral electric furnace is primarily a settler which allows lead metal dispersed in the slag to settle into the bullion. It also provides heat to maintain a reservoir of molten slag which will be tapped in batches to the slag fuming furnace. A portion of the zinc in the slag is fumed here. This fume is cooled through a boiler then filtered in a common baghouse used also for the slag fuming operation.

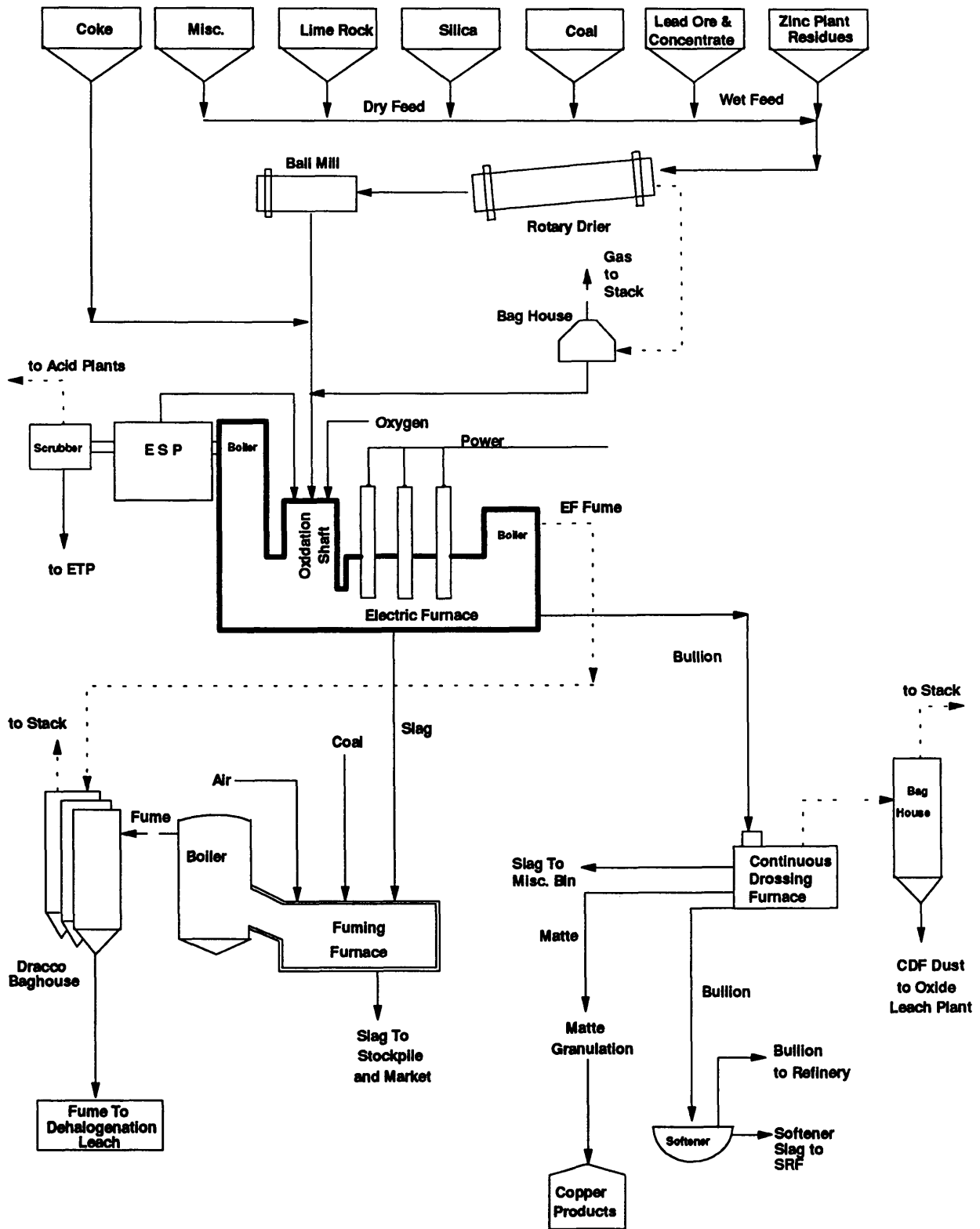
Gases from the smelting shaft are cooled in a waste heat boiler, cleaned in an electrostatic precipitator and a spray tower in preparation for sulphur recovery in the acid plants.

Slag analysis is controlled through Kivcet furnace charge adjustment to maintain ratios SiO₂/CaO = 1.7 and SiO₂/Fe = 0.75. Bullion composition is controlled by charge adjustments.

The bullion is transferred by launder to the continuous drossing furnace where it is cooled to produce a copper matte, which is tapped intermittently from the furnace. The lead is at the bottom of the furnace and is cooled by circulating it through a kettle that has water-cooled cooling coils. The



Lead Operations Kivcet and Fuming Furnaces



drossed bullion is subsequently softened by oxygen addition to remove excess arsenic and antimony before being cast into 5-tonne buttons and transported to the Refinery.

Copper matte tapped from the continuous dressing furnace is used internally for copper sulphate and copper arsenate production. Fume from this furnace containing indium is collected in an eight-compartment baghouse and processed in the Zinc Oxide Leaching plant.

SLAG FURNACE

The Kivcet furnace slag is batch-charged to a slag fuming furnace from which zinc and lead oxide are fumed using coal and air. The fume-carrying gases pass through waste heat boilers and then through a Dracco baghouse (5,000 m² of cloth) for fume recovery. The fume is collected in a bin before processing in a batch-type leaching process where soda ash and fume are slurried with water to render fluorine and chlorine soluble before being pumped to the Zinc Operations.

Barren slag from the slag fuming furnace is sold to cement producers. The excess is stockpiled.

LEAD REFINERY

Impure lead bullion from the smelter is delivered in 5-tonne button form to the Refinery where it is remelted and cast into an anode shape. Each refining cell is set with 24 anodes and 25 pure lead cathode starting sheets. Lead is corroded from the anodes and deposited on refined lead cathode starting sheets. Electrolyte containing typically 90 g/L H₂SiF₆ and 120 g/L dissolved lead circulates through the cells. Organic addition agents (lignin sulphonates and an extract of the aloes plant) are added to the electrolyte to assist in producing dense, level cathode deposits.

At the end of the five days, the cathodes and anodes are removed, and the cells are reset with new anodes and cathodes. The cathode deposits are washed and then melted in a 210-tonne capacity melting pot. The molten lead is given a final flash treatment with caustic soda to remove traces of antimony, arsenic and tin, and is then ready to be cast into ingots for sale. The bullion impurities consisting of copper, silver, gold, bismuth, antimony and arsenic are retained on the anodes in the form of a black slime. This slime is scraped from the anodes, washed and partially dried before being processed in the Silver Refinery furnaces for the contained metals. The lead remaining at the anode after five days of electrolysis amounts to about 40% of the original weight and is remelted and cast into new anodes.

SILVER REFINERY

Slime from the anodes is dried, then melted to produce a crude metal (black metal) and slag that is recycled back to the smelter.

The black metal is then transferred to a burn-down furnace where antimony and arsenic are preferentially oxidized at 750°C to 850°C. These oxides, along with dusts from the slimes melting operation, are recovered in the furnace ventilation baghouses. They are then further processed in

the Copper Products plant to produce sodium antimonate and copper arsenate. Gas from the baghouse is passed through a wetted packed-bed scrubber before venting to atmosphere.

The metal from the burn-down operation is transferred to the top blown rotary converter (TBRC) and heated to 1,000°C, where pure oxygen is used to remove the lead, bismuth and copper in the form of litharge slag. Litharge slag is reduced in a reverberatory furnace to produce a 60% bismuth-30% lead alloy. This alloy, after copper removal by drossing and silver removal by the Parks process, is treated with chlorine to produce pure bismuth metal and by-product lead chloride. The lead chloride is either sold, recycled to the Lead Smelter, or reduced to lead metal with coke and limerock.

The Dore metal from the TBRC furnace contains 99.5% silver and a small amount of gold and is cast into thin slabs that form the anodes in Thum electrorefining cells. Silver crystals formed on the cathode are removed from the silver nitrate electrolyte and, after washing, are melted into 1,000-troy ounce bars. Gold is recovered from the anode compartment as a black slime, which is washed with nitric acid to remove silver. The resulting "gold sands" are melted to produce 95% gold bullion bars.

LEAD ALLOYS PLANT

The Lead Alloys plant produces and casts alloys for sale and for use in other Trail metallurgical operations. Among the products are: calcium-tin-lead alloys, for sale and use in maintenance-free batteries; silver-lead anodes, for use in zinc electrolysis; and copper-lead, for sheet manufacture. Softener slag from the Smelter is reduced in a short rotary furnace (SRF), for production of arsenic-antimonial lead products and for subsequent recovery of metallic arsenic by vacuum distillation. Fumes from the SRF are filtered in a baghouse. The antimony-arsenic bearing dust is processed at the Copper Products plant.

COPPER PRODUCTS

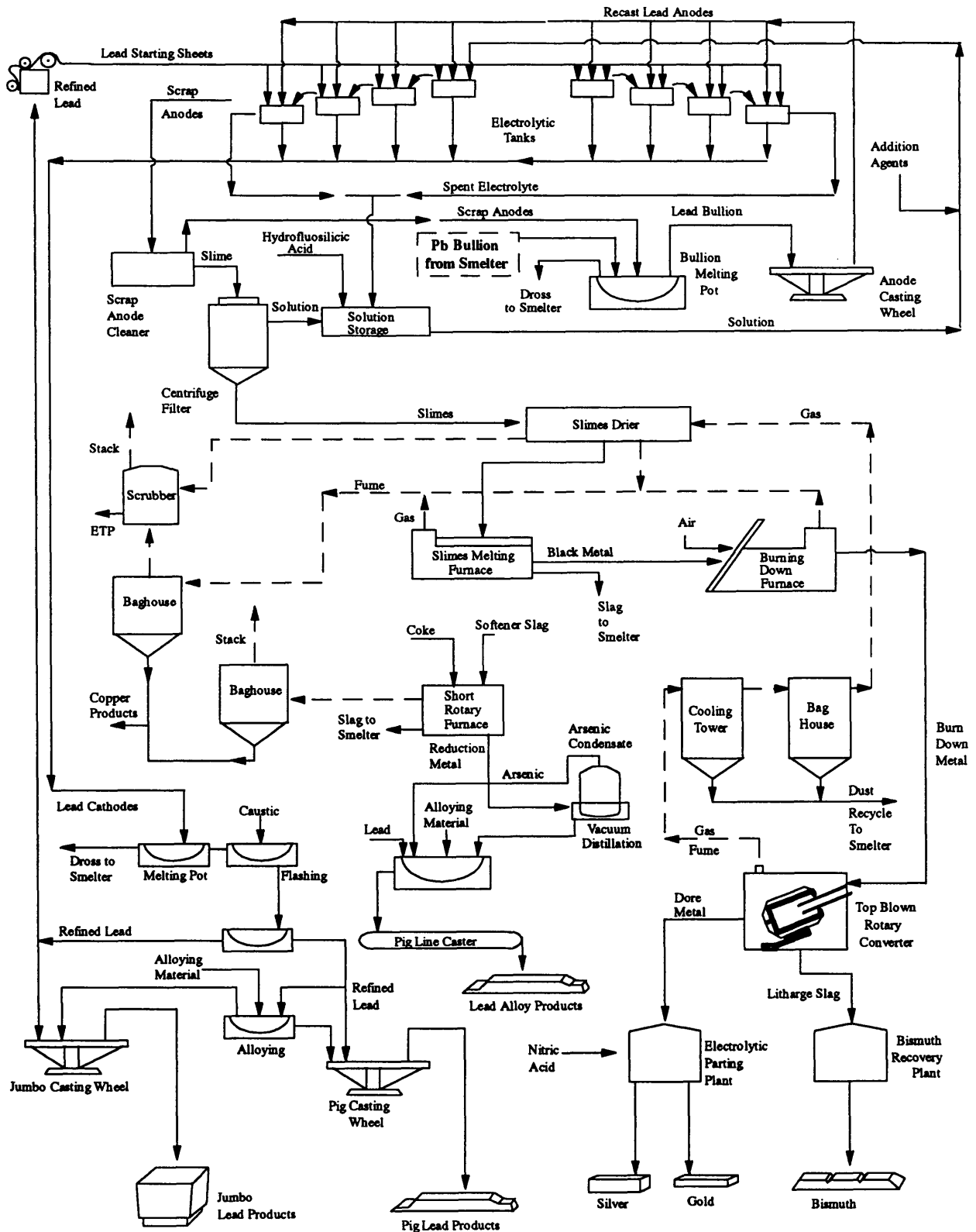
Matte from the Smelter is ground and pressure leached using pure oxygen and sulphuric acid. The resulting slurry is filtered and the solution is evaporated to produce copper sulphate crystals, which are dried and packaged for sale.

Arsenic- and antimony-bearing dusts are pressure leached using pure oxygen and caustic. A sodium antimonate product is produced by filtration and crystalline copper arsenate is made from the resulting filtrate.



Lead Operations

Refining, Casting, Specialty Metals



EFFLUENT TREATMENT PLANT

Waste water from the Lead and Zinc Operations is treated by liming in the Effluent Treatment Plant, which was commissioned in June 1981. Heavy metals are precipitated in reaction tanks and the solids separate in a 25-m thickener. Solids containing metal values, including zinc, lead and cadmium, are recycled to the Zinc Operations and the treated, high-quality effluent is discharged to the Columbia River. This plant uses Cominco-developed technology and is a major component of the environmental protection measures in place at Trail Operations.

POWER

Cominco Ltd.'s hydro electric development on the Pend d'Oreille River has been a key factor in the growth of the company's mining, metallurgical and chemical fertilizer operations in the Kootenay districts of British Columbia.

Power from this plant is vital to the huge production complex of Trail Operations, where a large part of the output is based on electrolytic processes. An 86-mile transmission line carries power to the company's Kimberley operations.

Cominco dam

Waneta dam on the Pend d'Oreille River

Height: 64 m

Length: 290 m

Concrete construction

Construction completed in 1954 (2 generating units), 3rd unit installed 1964, 4th unit in 1966

Unit 3 upgrade 1995

4 generating units

Rated capacity

Basic: 375,000 kW

Upgrade: 25,300 kW

Total: 400,300 kW

Generation

Basic: 2,469,300,000 kW.h

Upgrade: 136,700,000 kW.h

Total: 2,606,000,000 kW.h

Usage

Trail Operations: 1,942,000,000 kW.h/annum average

Kimberley Operations: 158,000,000 kW.h/annum average

Cominco Total: 2,100,000,000 kW.h/annum average

Surplus sales to W.K. Power: 144,000,000 kW.h/annum average

Surplus sold to market: 362,000,000 kW.h/annum average

Fun fact

The Waneta generators produce enough power to light a 100-watt bulb continuously in 3,000,000 homes, or replace 1,500,000 barrels of crude oil per year, or supply a city of 250,000 with power.