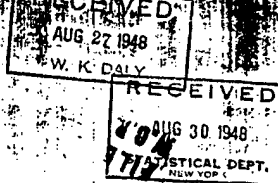


ANACONDA COPPER MINING COMPANY

SLAG TREATING PLANT

REPORT ON AUDIT OF SLAG TREATING PLANT - EAST HELENA, MONTANA

MONTH OF MAY 1948



Audit of the Slag Treating Plant, East Helena, Montana, embraces examination of records for the month of May, 1948, as outlined in "Books and Records Checked." No observations were made of May 31, 1948, inventories.

Audit included review of records pertaining to receipt and purchase of hot and cold slag from the American Smelting and Refining Company, shipments of baghouse fume to Great Falls Electrolytic Zinc Plant and other consignees, and compilation and valuation of baghouse fume inventories.

The report includes data on the physical and accounting features of the receipts of slag, and shipments and inventories of baghouse fume. The report is divided as follows:

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E. C. Jacobson, Metallurgical Auditor

July 15th, 1948

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ANACONDA COPPER MINING COMPANY
SLAG TREATING PLANT - EAST HELENA, MONTANA
MONTH OF MAY 1948

SYNOPSIS OF PLANT OPERATION

The following synopsis of the East Helena Slag Treating Plant is from an article entitled "Tuning off Zinc from Lead Slag at East Helena" written by Mr. Alexander Lalet, former superintendent of the plant. The article appeared in the Engineering and Mining Journal for August 24, 1929. Revisions in data to allow for changes made at the plant since original installation have been incorporated in the synopsis. Detailed synopses of Mr. E. M. Baldwin, Superintendent, was used in supplying the revisions.

Experiments in recovering waste zinc from lead-furnace slags were begun late in 1926 at Tootle, Utah. The first work was done in a copper converter, and in fact the furnace now used may be described as a non-tipping converter.

The design of a suitable plant for East Helena, Montana was begun in June 1927, and plant was blown in on December 3, 1927. This plant now consists, in the first place, of a water-jacketed furnace 8' x 21' in area having a charge hole at one end, into which the liquid slag from the American Smelting and Refining Company's lead furnaces, running 12 to 15% zinc is poured. In addition to the liquid slag and accompanying skulls, some cold slag is also treated. The cold slag is taken from a dump accumulated prior to construction of the Slag Treating Plant.

At the other end of the furnace is a tap hole which discharges the slag, freed of most of the zinc, into 30-ton pots. The bottom of the furnace is made of water-cooled steel pipes and about 4 inches above these plates are the tuyeres. Therefore, the working bottom of the furnace is a layer of chilled slag. The sides of the furnace consist of ordinary water jackets, made rather stronger than in the usual copper or lead blast furnace. This is necessary because the action within the furnace is extremely violent, the turbulence much more resembling that found in a converter than in the peaceable and quiet lead or copper furnace.

The tuyeres are 40 in number, 20 being on each side, are four inches in diameter, and each tuyere is provided with a one inch coal pipe, through which coal is fed into the blast air immediately before it enters the furnace. The charge hole and charge floor are 15 feet above the furnace bottom. Above the charge hole is a rectangular canopy of water jackets which confines the gases so that they may be conducted into the dust-collecting system. Then comes a horizontal flue of water jackets 8 x 8 feet and 34 feet long. This flue is provided with a large opening through which air is admitted to burn the metallic vapors to zinc oxide, also burning the excess coal dust and carbon monoxide.

The rest of the plant is more or less conventional, consisting of the usual system of cooling tubes to bring the temperature of the gases down so that they will not burn the bags. First comes a water cooled downtake; then a brick flue branching into two parallel 8 foot steel flues each 366 feet long; then upright U-tubes presenting a cooling surface of about 36,000 square feet. The U-tubes effect about 45% of the cooling before fume reaches the baghouse. They are 32 in number, 37 inches in diameter, and each is 57 feet high. The system is arranged so that eight tubes are connected in parallel.

Finally comes the baghouse in which are hung 576 woolen bags 18 inches in diameter and 54½ feet high. Gases are drawn from the furnace and U-tubes and forced through the bags by a fan 7½ feet in diameter. The fume drops into hoppers which discharge into gondola cars for shipment to the electrolytic refinery at Great Falls. The entire plant is unique in shape, being 40 feet wide and 1,000 feet long.

After crushing the coal in a Raymond mill it is fed into the furnace by four machines, of which one is allotted to each quarter of the furnace, an extra one being provided as a spare. Each machine handles ten tuyeres. There is a bin in each machine which holds 1½ hours supply of coal, and at the bottom is a chamber with a screw delivering coal direct to the furnace through about 20 feet of connecting pipe.

The slag, to the amount of about 600 tons a day, comes in pots holding 8½ tons, and about 11 pots make a charge. Sometimes, when the slag supply is not sufficient, skulls are added. The time of blowing a charge runs from 100 to 160 minutes, and the depth of the liquid bath in the furnace is about 3½ feet above tuyeres. From 17 to 20 per cent of coal is used, and there must be a slight excess of unburned coal; the amount fed depends on the condition and nature of the slag received. Extraction of zinc ordinarily runs from 85 to 90 per cent. It is easy, by continued blowing, to bring up the extraction to 95 or 96 per cent, but it does not pay. Besides the zinc, any lead left in the slag is also recovered.

At the end of the furnace opposite to the charge spout, there are two tapping notches with a launder leading from each notch, which are of sufficient size to tap out and discard 58 tons of de-zincized slag in 10 minutes. The discarded slag is emptied from the furnace into two 30 ton tilting slag pots which carry the slag to the waste dump over a standard gauge track.

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ANACONDA COPPER MINING COMPANY
SLAG TREATING PLANT - EAST HELENA, MONTANA

CONTRACT

CONTRACT WITH AMERICAN SMELTING AND REFINING COMPANY

The contract has a duration of ten years from January 1, 1941. It provides for purchase of molten slag from current operations of the American Smelting and Refining Company and also dump slag from prior operations. Purchase of current slag is limited to a maximum of 400 tons per day and dump slag to a maximum of 250 tons per day, although the Anaconda Company may at its option purchase and receive any such current slag as may be produced in excess of 400 tons per day.

According to the contract the purchase price of either current or dump slag shall be the highest net amount payable under any one of three schedules (a), (b) or (c) and shall not be less than 10¢ per ton. The purchase price is to be computed on basis of zinc assay and Engineering and Journal price for Prime Western Zinc for the calendar month of delivery. Provisions in all schedules include payment adjustments for increases or decreases in zinc assay and quotation. In addition to these adjustments schedules (a) for both current and dump slag also have provisions for price deductions due to increases in average labor rate and price of coal.

During May, 1948, the purchase price of both slags was based on schedule (c). For informative purposes the contract provisions for purchase of current slag under this schedule are here summarized:

When the assay of zinc is 10% and the applicable zinc quotation is 6¢ per pound the base price payable shall be 22¢ per ton adjusted as follows:

- (1) Add 20¢ per ton for each 1% that the zinc assay shall be in excess of 10%, fractions in proportion.
- (2) Deduct 20¢ per ton for each 1% that the zinc assay shall be less than 10%, fractions in proportion.
- (3) Deduct 9/32¢ (.28125¢) for each pound of zinc contained in the slag for each 1% that the applicable zinc quotation shall be less than 6¢ per pound, fractions in proportion.
- (4) Add 9/32¢ (.28125¢) for each pound of zinc contained in the slag for each 1% that the applicable zinc quotation shall be in excess of 6¢ per pound up to and including 7.5¢ per pound, fractions in proportion, and add 13/32¢ (.40625¢) for each pound of zinc contained in the slag for each 1% that the applicable zinc quotation shall be in excess of 7.5¢ per pound, fractions in proportion.

Weighing of slag is to be done by the Anaconda Company. Sampling of current slag is to be done by the American Smelting and Refining Company at point of discharge from its furnaces to slag pots. The Anaconda Company is to sample all dump slag upon arrival at the plant. In each case three samples are to be prepared, one for use of each company and one for umpire purposes. Each sample is to represent no more than one day's delivery. Splitting limit on zinc is .4%. Providing agreement within this limit is not effected, the use of an umpire is provided for. Of the three assays then reported, the middle assay is to govern. Payments for slag are required on or before the 15th day of the month following receipt of slag.

The above briefly notes the pertinent provisions of the contract and is not intended to be all-inclusive. For further data refer to contract of January 1, 1941, and amendment effective July 1, 1943.

ACCOUNTING PROCEDURES

Complete accounting records are prepared for cost of operating the Slag Treating Plant and for determination of metallurgical statistics. The East Helena Office submits the necessary information to the Great Falls Office where entries are prepared and entered upon the books of the Great Falls Reduction Department, and metallurgical statements are prepared showing costs, treatment, production and losses. As presently constituted the metallurgical reports are relatively simple. As the operation consists of only one plant, no complications result in determining treatment, production and losses. Only one material, slag, is treated, and only one material, fume, is produced. Since receipts consist of slag treated, there are no treatment inventories. However, the inventories of fume must be determined, and this is the major inventory problem. Detailed information follows in this report relative to inventory determination.

Because the plant is a one unit operation the problem of inventory valuation is simple, no in process inventories existing to require conversion to original material equivalents as is done on the copper, zinc and manganese plants. The fume inventory is valued on a last-in, first-out basis on pounds of zinc content. Total cost of slag purchased, and total cost of treatment are divided by pounds zinc produced to arrive at respective purchase and treatment costs per pound zinc. Any increment to prior inventory is thus priced at this current cost, any reduction in inventory subtracted at last cost remaining in inventory.

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ANACONDA COPPER MINING COMPANY
SLAG TREATING PLANT - EAST HELENA, MONTANA

ACCOUNTING PROCEDURE (Continued)

In accordance with practice in use for other transfers of material from one plant to another, the fume is transferred from East Helena to the Great Falls Electrolytic Zinc Plant at cost. After having determined the inventory valuations, the cost of sales is arrived at. The cost as so determined is then prorated to allocate a portion to local sales, proper portion being applicable to shipments to Great Falls. To show this transaction a bookkeeping entry is recorded on the Great Falls books debiting "Fume Transferred from Slag Treating Plant" and crediting "Fume Transferred to Great Falls."

RECEIVED SECTION

RECEIPTS

Hot and Cold Slag

Hot and cold slag is purchased from the American Smelting and Refining Company under contract dated January 1, 1941. The contract provides for receipt of molten slag directly from the furnaces of that company and also cold slag from a dump accumulated prior to the construction of the Slag Treating Plant.

The molten slag is poured into ladles or pots at the American Smelting and Refining Company's smelter and transported to the Slag Treating Plant by rail. Prior to entering the furnace building the cars pass over a weighing scale. No scale tickets are printed by this scale, the scalesman obtaining the weight and recording the same by longhand to a Scalesman's Report. Weights are recorded in even 100 pounds, and cars are weighed both light and heavy. During the interval between loading of the slag and weighing, some cooling takes place which forms "skulls" around the pots. These skulls are usually jarred loose and also enter the furnace. However, if the skulls are not desired as feed, weight is obtained and deduction made from the weight of molten slag. The skulls so diverted are hauled to the dump. Slag from the dump also enters the plant over the same weighing scale and weighing procedure is the same. However, only cold slag treated is considered received, and memorandum is kept showing inventory of cold slag on hand.

Samples of molten and cold slag are obtained and assayed both by the American Smelting and Refining Company and the Anaconda Copper Mining Company. According to the contract the splitting limit is .4%. If the assays vary by more than this amount an umpire assay is requested. The middle assay of the three is used for settlement purposes. The settlement assays are used in computing zinc content for metallurgical reports.

SHIPMENT SECTION

SHIPMENTS

Baghouse Fume

Major portion of baghouse fume production is shipped to the Great Falls Electrolytic Zinc Plant, the balance going to commercial consumers. The shipments to the Electrolytic Zinc Plant are made at cost and Great Falls weights and assays are used to determine the quantity transferred. For more particulars on this transfer, reference may be made to the Electrolytic Zinc Plant audit for October, 1947.

Shipments to commercial consumers are made at East Helena weights and settlement is made on the basis of these weights, metal content being determined by comparison of sellers' and buyers' assays. During May, 1948, shipments were made to American Chemet Corporation, Chicago, Illinois, and to Eagle Picher Company, Galena, Kansas.

The essential provisions of the agreements with these companies for metallurgical accounting purposes are as follows:

- (1) American Chemet Corporation. Railroad weights at East Helena and samples taken by the Slag Treating Plant govern in making settlement. The splitting limit on zinc is .5%. Payment is at 6¢ per pound of zinc contained in fume, f.o.b., East Helena when the St. Louis price for Prime Western zinc as quoted by the Engineering and Mining Journal for week of delivery is 8.25¢ per pound. To the 6¢ an addition or deduction of .90¢ per pound of zinc is made for each 1¢ increase or decrease in the price for zinc above or below 8.25¢ per pound. In the event that assays have not been agreed upon for any car before request for an additional car, settlement will be made on the basis of 70% zinc and final settlement adjusted.

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ANACONDA COPPER MINING COMPANY

SLAG TREATING PLANT - EAST HELENA, MONTANA

SHIPMENT SECTION

SHIPMENTS (Continued)

Baghouse Fume (Continued)

- (2) Eagle Picher Company. The sales price of the fume shall be based upon its zinc and lead content. In computing this price, the average Engineering and Mining Journal quotations for St. Louis Prime Western Zinc and New York pig lead for week of delivery will be used. The fume will be delivered in bulk or in paper bags as the Buyer may from time to time elect, i.e., Seller's truckage at its East Helena, Montana, smelter. In the event the buyer should elect to take shipment of fume in bags, the cost of the fume to the Buyer shall be increased not to exceed \$10 per net ton. The buyer shall pay the actual cost to Seller of packing in bags, but Buyer must be notified in advance if packing and loading cost is to exceed \$10 per net ton. When the quoted price is 5¢ per pound, or lower, for zinc, the cost of the zinc content shall be 4¢ per pound, to which there will be added .90¢ and fractions in proportion, for each 1¢ that the quoted price is above 6.50¢ per pound. No charge will be made for the lead content until the quoted price goes above 6.50¢ per pound. For each 1¢ and fractions in proportion, that the quoted price is above 6.50¢ per pound the cost will be .90¢ per pound. Railroad weights at East Helena secured by the seller, will govern in making settlement. A sample shall be taken by the Buyer, and divided into three parts, one for the Buyer, one for the Seller and one for umpire purposes. Buyer and Seller shall exchange the results of their assays and if they are within .5% of each other as to zinc and .5% as to lead, then the averages will be used in making settlement. Where the results as to either zinc or lead, or both, are not within these limits, then the reserve sample shall be sent to an umpire assayer. Of the three assays thus available, the middle result shall be used, the cost of umpire to be paid by the party whose result differs most widely from the result of the umpire.

The above agreements expired on June 30, 1948, after which they were replaced by new contracts.

INVENTORY SECTION

INVENTORIES

Fumes in Process Throughout Plant

Total zinc content of inventory is determined by the Assistant Superintendent on an accountability basis. From known weights and assays of molten slag entering the furnace, the zinc content of feed is determined. From known zinc assays on slag discharged a percentage is arrived at indicating what portion of the original feed remains in the system. The amount remaining includes allowances for increased weight due to oxidation and for weight of lead volatilized. These statistics are calculated daily and summarized for the month. To the production as so determined, (less 1% deduction for loss) is added the first of month inventory to arrive at a total to account for. From this total is deducted the estimated shipment of fume to Great Falls, the balance being carried as inventory.

The inventory as so determined is for total zinc content only. Since a portion of the inventory remains outside the flue and averages approximately 55% zinc, a further segregation is made showing total tonnages of 55% grade and 70% grade. By visual observation the foreman estimates the tonnage outside the flue system. The tonnage of fume in cars is also determined by estimate (or actual weight when available) and the zinc content is calculated. From the total zinc inventory, the pounds of zinc in cars and outside flue system are deducted to arrive at the zinc content of the fume remaining in flues and baghouse. This is in turn converted to dry tons on a 70% assay basis. The respective tonnages at 55% and 70% assays are then reported to the Great Falls Office where they are used in the computation of metallurgical statistics.

The above method of arriving at the inventory is used because the fume in the system is enclosed and impossible of visual estimation. According to Mr. R. L. Thompson, Assistant Superintendent, the method has been very satisfactory, previous cleanups having yielded fume very close in tonnage to calculated inventory.

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ANACONDA COPPER MINING COMPANY
SLAG TREATING PLANT - EAST HELENA, MONTANA

INVENTORY SECTION

INVENTORIES

Fume in Transit to Great Falls

The East Helena office reports daily to Great Falls the car numbers of fume shipped. Great Falls includes in its receipts the cars dumped at the plant. Any cars shipped from East Helena and not received at Great Falls are therefore classed as in transit inventory. Each car is sampled at Great Falls and moisture percentage determined. A composite sample is also prepared from which zinc assays are determined. Average lead and silver assays are obtained from statement of fume received at the mine plant. By application of moisture percentages and assays as thus obtained, the dry weight and metal content of the inventory is calculated.

ERRORS AND DISCREPANCIES

SETTLEMENT WITH AMERICAN SMELTING AND REFINING COMPANY FOR SLAG PURCHASED

As noted under comments on contract with the American Smelting and Refining Company the purchase price of either current or dump slag shall be the highest net amount payable under any one of three schedules (a), (b) or (c), and shall not be less than 10¢ per ton. Provisions in all schedules include payment adjustments for increases or decreases in zinc assay and quotation. In addition to these adjustments schedule (a) for both current and dump slag also provide for price deductions due to increases in average labor rate, effective July 1, 1943, by amended agreement between the companies. The average labor rates are determined by the Slag Treating Plant Office and reported to the Great Falls Metallurgical Accounting Department for use in calculating the settlement. Mr. Mark Holland, Metallurgical Accountant, noted that error had been made by East Helena in submitting the change in average rate for May, 1946. He stated that East Helena was advised and a new average rate change was recently submitted. However, up to and including May, 1946, the incorrect rate increase was used in preparation of settlement schedules (a) as provided by contract. Due to payment under schedule (c) being most beneficial to the American Smelting and Refining Company for May, 1946, regardless of use of incorrect average labor rate, no revision of settlement is required. Total cumulative wage increase per hour as used in May, 1946, was \$.4827 instead of correct amount \$.3901. Summary of prices per ton of slag as calculated for May, 1946, is as follows:

	<u>Hot Slag</u>	<u>Cold Slag</u>
Schedule (a)	\$ 6.0314	\$ 5.7180
Schedule (b)	2.1108	1.7507
Schedule (c) (Settlement basis)	7.3901	5.8743

Using corrected average wage increase:

Schedule (a)	\$ 6.0777	\$ 5.8101
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The American Smelting and Refining Company has been advised as to the average wage rate correction and has indicated that no additional payments are due under the contract.

INVENTORY VALUATIONS

Valuation of baghouse fume is on a "last-in, first-out" basis. Metallurgical reports were first prepared omitting shipment of 2,500 pounds fume to Great Falls via truck. Inventory was valued on production before correction of the error, valuation being \$18.43 higher than it would have been if calculated on corrected production data. Error is negligible.

GENERAL REMARKS AND CONCLUSION

No errors of consequence were noted in review of metallurgical accounting procedure for the Slag Treating Plant at East Helena, and no recommendations are herein made. Excellent cooperation was received from the Operating and Accounting Departments at East Helena and from the Metallurgical Accounting Department at Great Falls during course of this audit.

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