

- g. The 30-J suspension jet piercing machine was at the property during the year. A time study was run on the drilling, the results recorded and a report written at the completion of its testing.
- h. The annual report maps for 1956 were made.
- i. The 1958 stripping program was calculated and the necessary maps to accompany this proposal were prepared.
- j. The ore tonnage above the 1560 bench was calculated and the necessary roads to efficiently remove the ore were calculated.

#### DIKES

- a. The 1524 contour of the tailings pond was surveyed. From this information, the volume of the area which is available for tailings disposal was calculated. This was done to determine the life of the tailings pond and at what time in the future must the dikes be raised to accommodate more tailings.
- b. A route was surveyed for a 6" pipe line to dikes 2, 3, 4 and 5. This is to be used to pump thickened tailings to these dikes in an effort to seal off the present seepage through these dikes. The engineering work was then done in conjunction with the laying of the pipe.
- c. Water levels, tailings samples and weir readings were taken monthly at various locations in the tailings system.

#### GENERAL

- a. A survey was made and plans drawn for the expansion of the track system serving the pocket and stockpile area.
- b. Slope and grade stakes were set for the expansion of the stockpile area.
- c. The regular and regrind stockpiles were surveyed and the volumes calculated.
- d. Lines and elevations were run and maps made of the surface and ledge profiles in the area of the proposed plant expansion.
- e. Some layout was done on the stockpiling of various materials to accommodate any plant expansion.

#### 8. TILDEN MINE - Allen H. Heikkinen, Mining Engineer

A summary of the engineering activities at the Tilden Mine during 1957 is as follows:

- a. Planning and supervision of primary drilling and blasting

- b. Pit surveying and mapping and computing ore reserves and stripping estimates
- c. General Mine supervision

F. MISCELLANEOUS ACTIVITIES

1. ORE ESTIMATES

The following table shows a comparison of the tonnages as reported to the Michigan State Tax Commission:

TABLE XI

<u>Mine</u>	<u>Tons</u>	
	<u>As of 8/31/56</u>	<u>As of 8/31/57</u>
Athens	573,822	401,560
Bunker Hill	4,291,522	5,350,071
Cambria-Jackson	182,901	268,526
Cliffs Shaft	1,125,468	1,077,977
Maas	3,283,970	2,113,094
Pioneer & Arctic	2,089,500	1,423,106
Mather,		
"A" Shaft	7,698,313	7,305,597
"B" Shaft	<u>14,170,902</u>	<u>14,222,340</u>
Total Developed Ore	33,416,398	32,162,271
<u>Undeveloped Reserves</u>		
Section 3, 47-27	<u>302,378</u>	<u>302,378</u>
Grand Total All Ores	33,718,776	32,464,649

2. STOCKPILES

Estimates of the ore in stock were made by the Mining Engineering Department at the Bunker Hill and Cliffs Shaft Mines and the Mather Mine, "A" and "B" Shafts.

The following table shows the comparison of the ore in stock on November 1, 1956 and November 1, 1957:



TABLE XII

<u>Mine</u>	<u>November 1, 1956</u>	<u>November 1, 1957</u>
Bunker Hill	146,059	183,294
Cambria-Jackson	18,684	679
Cliffs Shaft		
Lump	32,197	59,333
#2 Crushed		2,759
Humboldt	28,820	118,427
Lloyd	112,801	111,356
Maas	1,405	121,366
Mather,		
"A" Shaft	160,150	80,731
"B" Shaft	113,372	144,671
Ohio	11,535	0
Republic	157,659	145,867
Pelletizing Plant	3,115	8,291
Tilden	<u>57,866</u>	<u>69,263</u>
Totals	843,663	1,046,037

3. SHAFT GAUGING

The runners in the various operating shafts were gauged on the dates shown on the following table:

TABLE XIII

<u>Mine</u>	<u>Date</u>
Bunker Hill	October 12th
Cambria-Jackson	March 30th September 21st
Cliffs Shaft (counterweight runners)	January 25th July 12th August 24th
Maas	June 27th

<u>Mine</u>	<u>Date</u>
Mather,	
"A" Shaft	April 14th September 21st
"B" Shaft	April 14th September 15th

#### 4. SUBSIDENCE

During the year, the Subsidence Committee was reorganized. Each underground mine with an actual or potential subsidence problem organized a sub-committee. A Range Subsidence Committee, consisting of the Manager of Michigan Mines, Manager of Ore Development, Chief Geologist, District Geologist, Director of Safety, Chief Mining Engineer, District Mining Engineer and all of the underground superintendents, was organized. The purpose of the smaller mine committees under the new program was the consideration of the immediate problems of each individual mine. The Range Committee was to function on a larger basis, correlating the findings of the mine committees, conducting investigations on a range-wide basis, investigating any new techniques which might be employed in subsidence work and to consider anything else related to subsidence which would not fall within the scope of the mine committees. One meeting of the Range Subsidence Committee was held in 1957 and was attended by the Chief Mining Engineer and District Mining Engineer. The Mather Mine, "A" and "B" Shafts' Committee met on a regular basis throughout the year.

The existing iron pin subsidence grids in connection with the Maas--Pioneer & Arctic, Negaunee--Athens--Bunker Hill workings were checked twice during the year. Elevations for each pin were established and checked for indications of movement. In addition, all cracks or openings and the edge of the caves were surveyed and mapped. No major indications of movement or advances of caves were found. Subsidence activities were expressed generally on surface by widening of existing cracks and displacement between the sides of the cracks rather than by the existence of new cracks. The one exception to this was the extension of the cracking to the West side of Mitchell Avenue by the Maas cave.

The iron pin grid at the Cambria-Jackson Mine was extended to cover the rock dump which had been established out over old workings. The purpose of this extension is to determine whether or not any further movement will take place in a filled cave. A new grid system was established over the area South of the Mather Mine, "B" Shaft which is expected to cave first. Advantage was taken of the abandoned roads and railroad rights of way in the area. Pins were set in concrete at 200' intervals.

The extension of the Cambria grid and the location of the new Mather Mine, "B" Shaft grid is shown colored in red on Figure 1.



MAP OF SURFACE  
LIMITS OF UNDERGROUND WORKINGS

"B" SHAFT  
MATHER MINE  
SECTION 1, T. 47 N., R. 27 W.

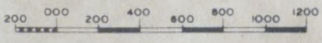


FIGURE 1  
MINING ENGINEERING DEPARTMENT  
ANNUAL REPORT  
1957

Cambria & Mather Mine, "B" Shaft  
Subsidence Grids



Figure 2 shows colored in red a portion of Mill Street in the City of Negaunee. This portion of the street was abandoned by action of the City Council because it was located over the expected subsidence from Mather Mine, "B" Shaft.

In the City of Negaunee after the necessary legal steps were taken, that portion of Mitchell Avenue lying between Main Street and the alley between Case and Peck Streets, Lots 6 to 13, inclusive, in Block 36 and Lot 5 of Block 35 of the Pioneer Iron Company's Plat in the City of Negaunee were abandoned and vacated. This area is shown in red on Figure 3.

5. TOWNSITE CREW - LeRoy Hosking, Engineer

a. EAGLE MILLS PELLETIZING PLANT

During the year, a number of projects required engineering assistance, such as, establishing center lines, grades, locations, etc. The following are some of the major projects with which the Townsite Crew was associated:

1. Completion of the ore thawing building
2. Installation of an overhead crane
3. Installation of gas lines
4. Checking of grate machine
5. Layout and grading in the stockpile area
6. Installation of a ball mill
7. Installation of a thickener
8. Alignment of conveyors

Preliminary surveys were run, plans and estimates were made and construction work was supervised for the construction of two settling basins.

The stockpile survey was made and an estimate of the pellets in stockpile was calculated.

All installations were surveyed and the locations recorded on a permanent map.

b. EAGLE MILLS ORE IMPROVEMENT PLANT

During the year a number of projects required engineering assistance, such as, establishing center lines, grades, locations, etc. The following are some of the major projects with which the Townsite Crew was associated:



JUNEE MINE CO.

MARQUETTE COUNTY, MICHIGAN

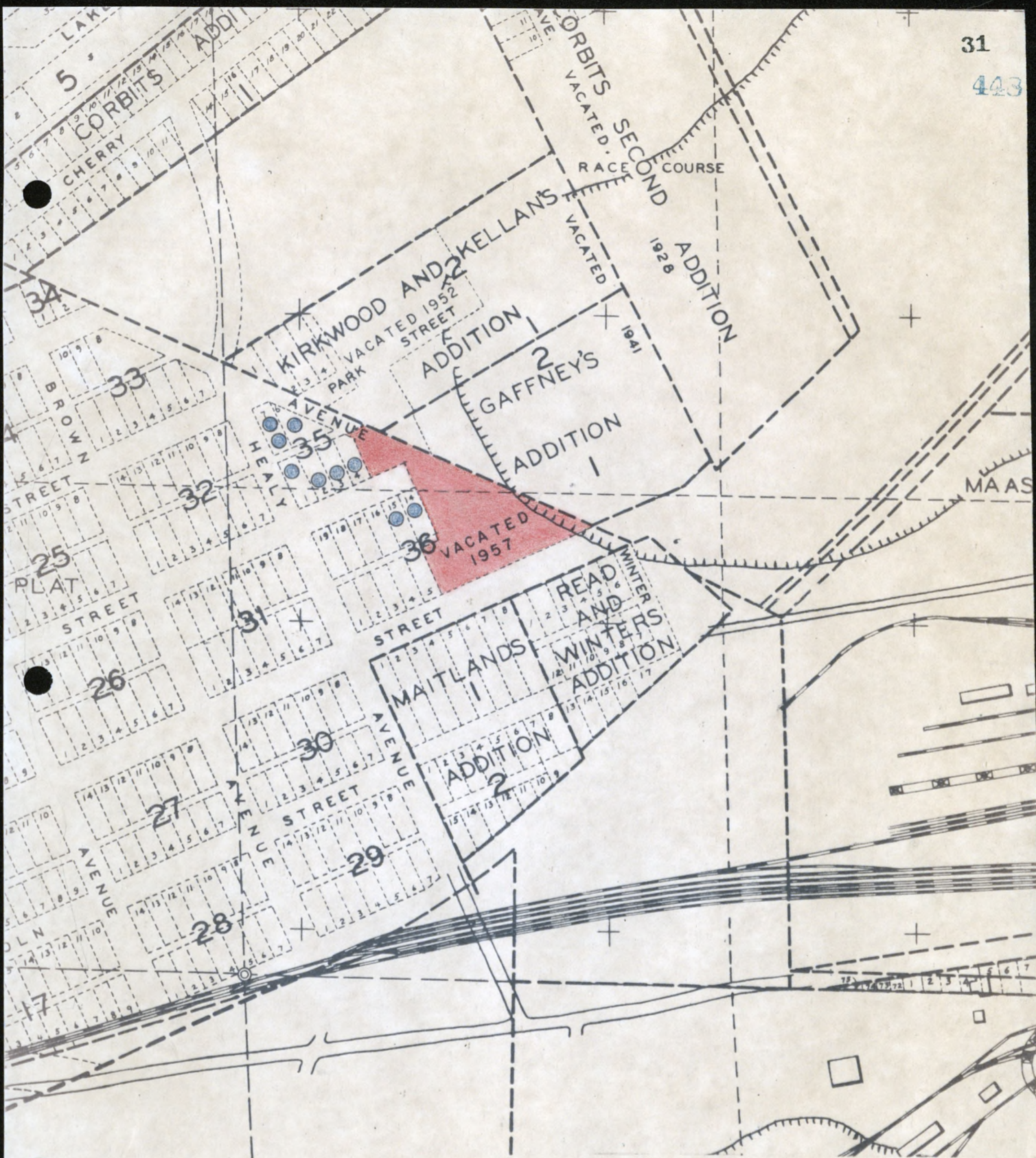
# SECTION 1, T.47N., R.27 W. MATHER MINE, "B" SHAFT SURFACE



**FIGURE 2**  
**MINING ENGINEERING DEPARTMENT**  
**ANNUAL REPORT**  
**1957**

Section 1, 47-27  
 Portion of Mill Street Abandoned





BUNKER HILL

FIGURE 3  
 MINING ENGINEERING DEPARTMENT  
 ANNUAL REPORT  
 1957

Negaunee House Moving &  
 Area Vacated 1957



1. Construction of crusher building
2. Construction of pump house
3. Construction of dikes
4. Construction of air lines
5. Layout and grading in the stocking area
6. Installation of conveyors
7. Installation of sewage disposal
8. Layout and grading of parking area and roads
9. Construction of tailings line
10. Construction of discharge line

Cross-sections were made and new base lines run throughout the whole general area.

All installations at both of the above plants were surveyed and posted on a permanent record map.

c. CITY OF NEGAUNEE

During 1957, several areas were considered for platting. Continuing mining, particularly from the Maas--Pioneer & Arctic properties, is creating a need for the clearance of the surface of portions of the platted area in Negaunee. In order to accommodate the houses which have to be moved, additional areas will have to be developed. Among the areas considered were the following:

1. The Collins Property, lying East and South of the Lakeview School, was remapped and subdivided on paper. With this as a basis, estimates were made of the improvement costs. No action was taken toward acquiring the Collins Property and nothing further was done.
2. The Maas Mine surface, East of the Cliffs Fourth Addition to the City of Negaunee, was also platted on paper and the improvement costs estimated. Negotiations have been initiated toward purchasing an undivided one-half interest in the surface from the Maas heirs. The Cleveland-Cliffs Iron Company already owns the other undivided half interest.

Plans were completed for the improvements in the Cliffs Fourth Addition. A portion of the improvements were contracted for and installed prior to the house moving activities. The Fourth Addition improvements made necessary the installation of approximately 1360' of 24" storm sewer which was connected to the present city system.

A new 6" cast iron water main was installed by the City on Lincoln Street from Healy Avenue East to the Bunker Hill Mine boundary where a new metering device was placed and from which point the mine installed a new main to the point of use.

Iron pins were concreted on the line run through the East Negaunee cave for the proposed County Road 480 relocation and levels run for subsidence checks. A profile was also run over the entire line.

A study was made of changes necessary in the Negaunee sanitary and storm sewer systems which would have to be made on the basis of the Bunker Hill mining program, and these costs estimated for the long-range Capital Expenditure Forecast of the Bunker Hill Mine.

Periodic checks were made of subsidence in the Ann Street and Mitchell Avenue areas which resulted in the closing to traffic and official abandonment of a portion of Mitchell Avenue.

On Ann Street, it was necessary to reverse the flow of the sanitary sewer system from the Athens Mine, East, to remedy the continued pipe breakage in the subsidence area. This was done under contract with The Cleveland-Cliffs Iron Company doing the engineering work.

Because of the fall of the water elevation in Teal Lake, a study was made of the records of lake elevations together with pumping and rainfall records for several years back. The possibility of diverting water from the well pumps South of Mather Mine, "B" Shaft was investigated, but after approval by mining officials, the City apparently lost interest.

After investigation of several sites for a water tank, the original site was finally approved by the City. Maps and descriptions were prepared for leasing the site to the City.

As a result of the cancellation of a flowage permit by the Barasa family, several possible methods of handling the Bunker Hill discharge water were studied and estimates made. A final decision on this will be made, based on the results of further negotiations with the Barasas.

Based on the certainty that a road relocation would be more economical than an overhead crossing over County Road 492, a preliminary survey was made from East of the L. S. & I. overhead crossing to a junction with US-41 in the Rifle Range Area. A center line profile was run and the job estimated before approaching the Negaunee City officials for an opinion. Working plans on this are practically completed and are filed pending further action on the railroad relocation.

For the C. & N. W.--D. S. S. & A. relocation, several sets of maps were prepared, depending on conditions at the time.

The L. S. & I. right of way through Negaunee was checked for space to accommodate the additional parallel tracks.



The Barasa family's rejection of an offer for the right of way resulted in a tentative relocation and estimate for the change, together with a reestimate for the whole project.

A study was also made of additional items within the proposed right of way which The Cleveland-Cliffs Iron Company would be responsible for, but which were not included in the railroads' estimate.

Engineering work on the Michigan Gas & Electric Company's gas main relocation was done and maps and descriptions prepared along with construction staking and maps and applications for various permits.

Relocation of the gas storage tank was also contracted for together with the preparation of the new site and facilities.

d. HUMBOLDT MINE

At the Humboldt Mine, boundary surveys were made, elevation control run within the property and base lines and cross-sections run in anticipation of the expansion program.

e. REPUBLIC

For the new village of Republic, the Plat of the First Addition was prepared and registered. Working drawings for the grading and improvements, together with contract specifications, were completed and the job contracted. On completion, all monuments were placed and improvements surveyed and posted. Arrangements for electric service were made by The Cleveland-Cliffs Iron Company, due to the Republic Township's inability to meet the financial requirements.

At the conclusion of the year's house moving activities, all buildings were surveyed and posted, along with the location of the new State Highway and the Marquette County Road Commission's property adjoining the plat.

The West side of the original plat was regraded to improve drainage and an independent storm sewer line was installed from the South side of the original plat, East to the East side of M-95.

Some preliminary work was done in search for a location for the Smith gas station and restaurant now located where it will be by-passed by the new highway.

f. MISCELLANEOUS

Miscellaneous jobs included:

1. Survey control at Cascade East End
2. Mather Mine, "B" Shaft subsidence
3. Goose Lake lands

4. Relocation of Palms Gas Plant in Negaunee
5. Topographic survey and mapping of proposed site for new Republic School
6. Topographic survey and mapping of C. L. Phelps Junior High School
7. Location of Eighth Addition Grade School lot
8. Profiles of Eighth Addition lots
9. Ski Hill profile
10. Miller's News Stand subsidence check
11. Mapping and levels in the Greenwood Area between the Escanaba and Carp Rivers' drainage system
12. Aerial photo control
13. Cliffs Shaft Mine stockpile survey
14. Attending public hearing on Marquette Harbor
15. Attending public hearing, City of Negaunee
16. Attending Negaunee City Council Meetings
17. Attending Republic Township Board Meetings
18. City of Negaunee warehouse and storage yard problems
19. Ishpeming City water difficulties in the vicinity of the Holt residence
20. Miscellaneous survey and level work for the house moving program
21. Preparation of various exhibits and descriptions of deeds, leases, etc.

6. FIELD ENGINEERING CREW - Frank A. Koski, Engineer

a. ISHPEMING DISTRICT

Because the Michigan Gas & Electric Company's gas main between Ishpeming and Negaunee was located in the area of anticipated subsidence from the Mather Mine, "B" Shaft's workings, it was necessary for the Michigan Gas to relocate their main. The Field Engineering Crew provided the necessary engineering control in locating the new route, preparing profiles and mapping the completed relocation.



On Cliffs Shaft Mine surface in Section 4, 47-27, the necessary control was established for an experimental induced polarization survey.

b. OGDEN--SCHOOLHOUSE LAKE AREA

The necessary control was established in Section 24, 47-27, for an experimental induced polarization survey.

Tentative diamond drill hole locations were staked, and the actual locations surveyed and mapped for the diamond drilling program conducted in this area.

c. NEGAUNEE DISTRICT

In the Cambria-Jackson, Maas--Pioneer & Arctic and Athens--Bunker Hill Areas in the City of Negaunee, subsidence surveys were run and the resulting data posted on the maps.

A new, subsidence control grid was established for the Mather Mine, "B" Shaft.

The fence, which had been constructed around the anticipated subsidence area at Mather Mine, "B" Shaft, was located and mapped.

d. CASCADE DISTRICT

A grid to assist in the location of a program of diamond drill holes to test for depth of ledge in the Cascade East End Area was established. Upon completion of the drilling program, the actual locations of the drill holes were surveyed and mapped.

The necessary engineering control was provided for the Isabella diamond drilling program in Section 32, 47-26.

e. EAGLE MILLS DISTRICT

The Field Engineering Crew assisted with many of the projects which have been mentioned at the Pelletizing and Ore Improvement Plants. In addition to those projects already mentioned, engineering control was provided for the Ore Improvement Plant's tailings basin. After construction of the dikes, all of the borrow pits were cross-sectioned and estimates of the amount of borrow material removed were calculated.

f. MISCELLANEOUS

Assistance was given at the Humboldt, Ohio and Tilden Mines in the general pit surveys and the mapping of the progress of mining.

Preliminary reconnaissance surveys were run in the Greenwood Area, compiling data on the difference in elevations between the Escanaba and Carp Rivers. The possibility of diverting water from the Escanaba River to the Carp River was being investigated by the Electric Power Department.

G. HOUSE MOVING ACTIVITIES - Donald W. Carlson

1. REPUBLIC

During the year, twenty-one houses and one church were moved from the Park City--West Republic Area and six houses were moved from the South side of School Street in the village of Iron City, commonly known as Republic. Of the twenty-seven houses, all but two were moved to the new Plat of Republic or the First Addition to the Plat of Republic. The other two houses were moved to locations outside of the new plat. The church was moved to the Plat of Republic. Agreements were executed covering the tearing down of eight houses in Park City and one on School Street. All of the house moving was done under contract by Schuette Brothers, moving firm from Wausau, Wisconsin. The above house moving expenditures were authorized by E&A MI-18 and during 1957, \$141,324.09 was expended under this E&A. Indicated in red on Figures 4 and 4A are the houses which were moved in 1957.

2. NEGAUNEE

Mining in the Maas--Pioneer & Arctic Properties is progressing Westwardly which necessitated the program of house moving in the City of Negaunee. The Cliffs Fourth Addition to the City of Negaunee had been prepared to receive the houses in this program. Plans were made to move twenty-one houses during 1957 but complications in the Republic house moving program delayed the Negaunee program. Schuette Brothers were the movers under contract to move the Negaunee houses. During 1957, nine houses were actually moved, eight of which were taken to the Fourth Addition and one to the Second Addition. One house was sold to be torn down. This moving program was authorized under E&A CC-918 and \$51,265.95 was expended in 1957 under this E&A. Indicated in blue on Figure 3 are the houses which were moved in 1957.

H. MICHIGAN AD VALOREM TAXES - Donald W. Carlson

The appointment of Ralph E. Magnuson, Jr., as Chief Mining Engineer brought the responsibility for the Ad Valorem Taxes into the Mining Engineering Department. This move consolidated the making of estimates of ore reserves for mine valuations, the preparation of the tax lists, the recording of valuations on non-mining properties, the requesting of checks and the paying of taxes due. The normal sequence of events from the establishment of valuations through to the payment of taxes is exemplified by the activities during the year 1957. The mine valuations were calculated by Harry J. Hardenberg, State Mine Appraiser, and are submitted by him to the local assessors by February 15th. The conference between the Mine Appraiser and Company representatives was held in Lansing on January 17th. At this conference, an opportunity is afforded the mining company to discuss the mine valuations before they are reported to the local assessors. Any data which will have an effect or should be reflected in the calculations of the mine valuations are discussed. It is sometimes possible to get the Appraiser to make changes in his tentative valuations. During the early part of March, the local Boards of Review in each city and township hold public meetings to





FIGURE 4  
 MINING ENGINEERING DEPARTMENT  
 ANNUAL REPORT  
 1957

Republic House Moving





FIGURE 4A  
 MINING ENGINEERING DEPARTMENT  
 ANNUAL REPORT  
 1957

Republic House Moving



permit the taxpayers an opportunity to view the assessment rolls. At this time, the valuations of non-mining properties are established. If necessary, it is possible to protest valuations which have been established by the local assessors. In 1957, no protests were made as in all instances, valuations were carried forward from 1956. The meetings of the Boards of Review in the following cities and townships were attended by Company representatives:

TABLE XIV

<u>Assessing District</u>	<u>Date</u>	<u>Name of Representative</u>
Ely Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Champion Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Humboldt Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Forsyth Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Richmond Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Sands Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Tilden Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson Robert G. Fountain
Ishpeming Township	3/5/57	Ralph E. Magnuson, Jr. Donald W. Carlson
City of Ishpeming	3/7/57	Ralph E. Magnuson, Jr. Donald W. Carlson
Marquette Township	3/11/57	Robert G. Fountain
Negaunee Township	3/11/57	Robert G. Fountain
Michigamme Township	3/11/57	Robert G. Fountain
Republic Township	3/11/57	Robert G. Fountain
Spurr Township	3/11/57	Robert G. Fountain

<u>Assessing District</u>	<u>Date</u>	<u>Name of Representative</u>
Crystal Falls Township	3/11/57	Ralph E. Magnuson, Jr. Donald W. Carlson
Iron River Township	3/11/57	Ralph E. Magnuson, Jr. Donald W. Carlson
City of Negaunee	3/12/57	Robert G. Fountain Donald W. Carlson
City of Iron River	3/25/57	Ralph E. Magnuson, Jr. Donald W. Carlson
City of Marquette	3/25/57	Robert G. Fountain
Village of Mineral Hills	3/29/57	By Mail

Representatives of the Land Department attended the Board of Review meetings in the following townships to check the rolls for the Mining Department:

TABLE XV

AuTrain Township

Limestone Township

The properties in the townships which lie beyond the iron-formation are Electric Power Department's lands and power installations.

In October, the County Board of Supervisors holds an annual meeting at which time the budgets for the county, township and school districts within the county are established. These budgets along with the valuations which have been established will provide the mill rate. Thus, the valuations and mill rates in the various cities and townships are determined.

With the above information and the tax list, tax receipts are prepared for each city and township. These tax receipts are delivered or mailed to the various treasurers who fill in the valuation for each description, the mill rate and the tax due. After the completed tax receipts have been returned, the information is checked against the data obtained from the Board of Review rolls as to valuations, the mill rates are checked against the County Board of Supervisors' report on mill rates and the estimate of tax due is checked. Next, a request is prepared and submitted to Cleveland for the necessary checks to cover the taxes which are due. Michigan Ad Valorem Taxes are due and payable as of December 10th and a penalty is imposed after January 10th. The requests for checks are submitted early enough to permit the checks to be received in Ishpeming near the end of the year. All checks are delivered during the first week of January. The tax receipts are stamped paid by the various treasurers at the time that the checks are delivered. The following table is a tabulation showing the 1957 valuations as compared to the 1956 valuations:



TABLE XVI

<u>Mine</u>	<u>Valuation</u>	
	<u>1957</u>	<u>1956</u>
Cliffs Shaft	\$ 5,130,000	\$ 5,500,000
Cambria-Jackson	590,000	730,000
Mather Mine,		
"A" Shaft	8,800,000	8,390,000
"B" Shaft	9,695,000	8,305,000
Maas (Including Pioneer & Arctic)	3,075,000	3,125,000
Athens	880,000	1,085,000
Bunker Hill	2,930,000	2,670,000
Humboldt	1,573,000	1,592,000
Ohio	355,000	283,000
Republic	1,760,000	1,140,000
Tilden	285,000	215,000
Pelletizing Plant	1,090,000	510,000
Ore Improvement Plant	<u>110,000</u>	<u>0</u>
Totals	\$36,273,000	\$33,545,000

The next tabulation shows the amounts requested to pay the taxes as of January 9, 1958:

TABLE XVII

<u>Assessing District</u>	1957			1956		
	<u>Valuation</u>	<u>Taxes</u>	<u>% of Total</u>	<u>Valuation</u>	<u>Taxes</u>	<u>% of Total</u>
City of Ishpeming	\$15,169,050	\$687,916.47	61.78	\$15,169,050	\$618,897.24	62.28
City of Negaunee	17,510,795	742,807.92	69.72	16,199,910	679,019.71	69.37
City of Marquette	238,510	10,353.38	1.044	238,510	9,082.46	1.085
Champion Township	44,780	1,175.92	1.875	44,545	1,124.75	1.743
Ely Township	18,750	587.09	.529	18,750	530.25	.53
Forsyth Township	191,140	6,177.65	11.99	191,165	5,927.56	12.07
Humboldt Township	1,580,050	41,093.15	78.93	1,596,800	32,255.36	79.37
Ishpeming Township	152,735	4,118.90	10.79	492,535	10,645.72	29.72
Marquette Township	609,665	14,162.52	31.96	609,665	13,854.64	32.49
Michigamme Township	21,050	792.00	2.008	21,050	788.79	2.019
Negaunee Township	1,926,146	48,635.34	73.82	1,236,335	31,841.90	62.05
Republic Township	1,822,300	46,013.09	63.11	1,187,075	29,973.67	52.41
Richmond Township	76,955	2,331.73	9.2	254,205	6,932.17	25.5
Sands Township	178,950	4,518.49	44.44	178,950	4,247.39	45.01
Tilden Township	306,115	8,069.55	11.28	236,115	6,236.17	9.106
AuTrain Township, Alger County	181,415	5,959.51		181,415	5,619.72	
Limestone Township, Alger County	10,875	336.16		10,875	322.91	
Spurr Township, Baraga County	356,200	17,998.85		283,800	13,615.31	
Crystal Falls Township, Iron County	5,600	235.20		5,450	223.45	
City of Iron River, Iron County	11,320	457.38		11,320	467.61	
Iron River Township, Iron County	6,250	168.13		181,700	4,524.35	
Village of Mineral Hills, Iron County	(6,250)	49.22		(181,250)	1,673.82	
Knight Township, Wisconsin	21,000	1,164.87		21,000	1,285.41	
Totals	\$40,439,651	\$1,645,122.52		\$38,370,220	\$1,479,090.36	



I. HOUSE ACQUISITIONS, CITY OF NEGAUNEE - Robert G. Fountain

From time to time, property is offered for sale in various parts of the City of Negaunee. Some of this property usually has no direct connection with any present surface clearing program. If the property is located within what may be a future subsidence area and if the purchase price is within reason, acquisitions are made during the year. The following acquisitions were of this nature:

TABLE XVIII

<u>House No.</u>	<u>Description</u>	<u>Purchased From</u>	<u>Purchase Price</u>	<u>Purchase Date</u>
Maas House #221	Lot 12, Block 29, Pioneer Plat	Alvina Butcher	\$6,500	5/25/57
Maas House #222	Lot 10, Block 33, Pioneer Plat	Elsworth Thiele	\$5,630	5/20/57
Maas House #223	Lot 10, Block 33, Pioneer Plat	Elsworth Thiele	\$6,270	5/20/57
Maas House #224	Lot 10, Block 33, Pioneer Plat	Elsworth Thiele	\$2,600	5/20/57
Athens House #49	Lot 3, Boyers Plat of Lot 2, Harvey's Addition	Anna Danielson	\$16,000	5/16/57
Jackson House #70	E $\frac{1}{2}$ of Lot 13, Block 4, Jackson Iron Company Addition	Gladys Wills	\$8,000	6/18/57
Jackson House #71	Lot 37, except S 33', Block 5, Jackson Iron Company Addition	John R. Kasbohm	\$12,000	6/28/57
Jackson House #72	Lot 11, Block 7, Jackson Iron Company Addition	William T. Nicholas	\$7,000	7/19/57
Jackson House #73	N 60' of Lot 14, Block 3, Jackson Iron Company Addition	Hilda Anderson	\$7,000	10/18/57



<u>House No.</u>	<u>Description</u>	<u>Purchased From</u>	<u>Purchase Price</u>	<u>Purchase Date</u>
Negaunee District Misc. Block 4, House #13	N 70', Lot 13, Pioneer Plat	Arthur LaCroix	\$9,000	9/5/57
Negaunee District Misc. E 4½', House #14	Lot 29, except W 1' and Iron Plat	James Miller	\$6,000	12/15/57

Respectfully submitted,

*Ralph E. Magnuson, Jr.*

Ralph E. Magnuson, Jr.  
Chief Mining Engineer

REM:jcj

2-24-58

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WASHINGTON FIELD  
MINE CONTENT



RESEARCH LABORATORY  
ANNUAL REPORT - YEAR 1957

The Annual Report for 1957 is subdivided into six main sections. These sections are reported separately and are related to different phases of work conducted by the Metallurgical Department. The sections are as follows: (1) General Information, (2) Pyrolysis and Agglomeration, (3) Research and Development and Flotation Projects, (4) Microscopy Section, (5) FluoSolids Reactor Pilot Plant, and (6) Sampling Studies.

The Annual Report for the Research Laboratory highlights various projects worked on during the year. This report does not include any specific test data, conclusions, or recommendations reached by completing any specific investigation. The projects that could be considered minor in nature are not included in the Annual Report; however, in most cases have been referred to in the Monthly Reports.

PART I

GENERAL INFORMATION

DISTRIBUTION OF CHARGES:

Listed below is a tabulation for the last seven years showing the Laboratory staff and total hours as reported on the Cost Sheets. The staff was enlarged during 1957 as a result of the personnel required for the twenty-four hour day, seven days a week operation of the MOC Pilot Plant and the increased work load at the Laboratory.

<u>Year</u>	<u>Staff</u>		<u>Total Hours</u>
	<u>Engineers</u>	<u>Technicians</u>	
1957	13	30	98,205
1956	13	26	68,888
1955	10	17	55,275
1954	8	15	50,982
1953	8	18	66,005
1952	6	13	47,958
1951	6	11	31,369

The number of hours spent on each specific project is tabulated below. It is interesting to note the percentages of time that were spent on specific projects.



Summary of Time Distribution  
Research Laboratory Only Excluding MOC Pilot Plant  
1957

<u>Project</u>	<u>Hours</u>	<u>% of Total Time</u>
MOC Flowsheet Development	16,550	28.2
Agglomeration Research	14,713	25.1
Plant Control Samples Humboldt, Republic, Eagle Mills	9,757	16.6
Operating U.G. Mines - Cliffs Group Studies, etc.	6,694	11.4
Drill Core Testing	4,186	7.1
Outside Explorations, Land Offers, etc.	2,519	4.3
Flotation Study	2,448	4.2
Research and Study	963	1.6
Special Studies	878	1.5
<b>Total</b>	<b>58,708</b>	<b>100.0</b>

TIME DISTRIBUTION - YEAR 1957

<u>Account</u>	<u>Hours</u>	<u>Account</u>	<u>Hours</u>
Bunker-Hill	931	Land Offer 3667	8
Cambria-Jackson	337		23
Cliffs Shaft	428		78
Maas	354		23
Mather "A"	1193		25
Mather "B"	1371	BSM Claim	2
Tilden	40	Project #15 - Benoit Lake	33
Ohio	375	Project #17 - Canada	1045
Humboldt	3165	Flotation Study	2448
Athens	8	Agglomeration Research	12113
Ore Improvement Plant	1657	Research & Study	963
Republic	3681	Microscopy Section	130
Pellet Plant	2911	Special Jubilee	100
MOC Plant	13550	Special Tilden	134
Sharon Steel Co. Tests	646	Special Richmond	78
Outside Exploration 1136	211	Special Empire	228
1136C	30	Experiments & Investigations - MINCO	5616
1148C	33	Accounts Receivable	31
1193	28	Cascade - MI-24	331
1208	28	Empire - MI-17 - (17 Holes)	693
1216	23	Osier - CC-781	9
Land Offer 3204C	36	Lake Shaft - CC-729 - (1 Hole)	4
3201C	402	CC-739 - (1 Hole)	4
3120	2	New Richmond - CC-879 - (14 Holes)	346
2792	3	Tilden - CC-859 - (17 Holes)	1038
3218C	10	Cascade - CC-825 - (8 Holes)	427
3226C	8	Belleview - CC-879 - (6 Holes)	125
3228C	9	Isabella - CC-867 (5 Holes)	452
3244	21	Ogden - CC-868 - (4 Holes)	187
3245	7	Cliffs Shaft - CC-770	13
3582	2	Cliffs Drive - CC-868E	17
3634	31	Ore Improvement Plant - CC-801	66
3643	25	- CC-801-D13	89
3646	252		
3649	2	<b>Total Hours - 1957</b>	<b>58,708</b>
3651	9		
3652	10	<b>Operating MOC Plant-Total</b>	<b>39,497</b>

Chemical Charges:

The following is the distribution of chemical charges made by the Chemical Laboratory during 1957. The total number of determinations for 1957 is roughly 7,000 higher than the analyses made in 1956. This increase is chiefly due to the operation of the MOC Pilot Plant which required control analyses for each shift.

The distribution of the analytical work to various properties and projects presents a good overall picture of the various projects investigated at the Laboratory.

TOTAL NUMBER OF DETERMINATIONS ANALYZED IN 1957 FROM RESEARCH LABORATORY SAMPLES

<u>Account</u>	<u>Analyses</u>	<u>Account</u>	<u>Analyses</u>
Maas Mine	334	E&A CC-739	30
Bunker-Hill Mine	149	770	105
Cliffs Shaft Mine	42	781	7
Mather Mine "A" Shaft	463	813	1335
Mather Mine "B" Shaft	271	814	465
Cambria-Jackson Mine	49	825	509
Humboldt Mine	1678	859	198
Republic Mine	555	867	755
Ohio Mine	377	868	213
Cliffs Group Study	1062	868E	145
MOC Operating Plant	6803	879	234
MOC-A	134	Outside Exploration 1136	8
MOC-B Humboldt	2142	1193	18
MOC-B Republic	7238	1208	41
Pellet Plant, Eagle Mills	160	Land Offer 3120	16
Marquette Iron Mining Co.-E	42	3190	11
F	14	3201	2
H	971	3201C	231
I	287	3202	5
H-Lurgi	100	3204C	54
17	467	3218	8
17E	443	3218C	25
Ore Improvement Plant	1050	3226C	9
Agglomeration Research	2	3228C	10
Agglomeration Research - F	4	3244	30
N	990	3245	50
Q	131	3587	16
S	42	3615	4
W	44	3643	59
X	206	3646	48
Flotation Study C	247	3649	10
Project 17	711	3651	9
Experiments & Investigations	178	3652	29
E&A NM-117	79	3668	34
NM-128	282	3701	42
CC-659	36	3710	5
734	277		
		Grand Total	32,830



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The following analyses were made:

Iron	20,799	Loss	52
Phosphorus	535	Magnesia	88
Silica	5,457	Gain	12
Alumina	109	Chromium	17
Manganese	85	Nickel	9
Sulphur	512	Hardness in Water	4
Ferrous Iron	4,789	Solids in Water	16
Metallic Iron	25	Chlorine	2
Zirconium	2	Cobalt	6
Titanium	203	Vanadium	6
Lime	101		
Copper	1	Total	32,830

#### Metallurgical Reports and Memoranda:

The metallurgical reports and memoranda issued by the Metallurgical Department during 1957 are listed below. It is difficult to use this list as an index of the project emphasis. One report may represent only hours of time while another may cover an investigation that took several months to complete.

Excluding short term service projects which sometimes are reported in letter form to management, all work completed at the Laboratory is covered in a report or memorandum.

#### METALLURGICAL REPORTS - YEAR 1957

<u>Report No.</u>	<u>Subject</u>
192 (Supplement)	Standard MOC Tests - 1956 Surface Samples
193	Ohio Mine Concentrating Plant Operation - 1956 Season
194 & Geology Report 19	The Mineralogical and Metallurgical Characteristics of Sample No. Mx-444S, A St. Lawrence River Sand Sample from Natashquan, Canada
195 & Geology Report 20	The Transformation of Iron Minerals in Relation to the Percentage of Iron Recovery in Sample Mx-489, An MOC Product from North Star Holman Ore, Minn.
196	Microscopic Examination of a Republic Crude Sample and Its MOC Product Obtained by the Traveling Grate MOC Process
197	Results of Standard MOC-Magnetic Concentration Tests on Richmond Area DDH's 45, 46, and 49 thru 54, Section 27, 47-26
198	Results of Standard MOC-Magnetic Concentration Tests on Richmond Area DDH Nos. 55, 56, 57, and 58, Section 27, 47-26
199	Results of Davis Magnetic Tube Tests on Composites from DDH Nos. 1 and 2A of the Osier Area, Section 18, T43N-R21W
200 (Supplement)	1956 Ohio Mine Ore Structure Study
201	Cliffs Group Quality Improvement Study
202	Results of Standard MOC-Magnetic Concentration Tests on Composites from Tilden District DDH Nos. 59, 60, Section 26; 4, 5, 6, 7, Section 25; 1 Section 22; T47N-R27W
203	Laboratory Investigation of Iron Ore Pellets from the Malnberget Operation
204	MOC-Magnetic Concentrate Tests - Holes 2 and 3, Section 22, Tilden District
205	Microscopic Examination of Various Products by Direct Reduction Fluidizing Method
206	Results of Standard MOC-Magnetic Concentration Tests on Composites from Tilden District-DDH No. 25, Section 27, T47N-R27W

Continued - - -



<u>Report No.</u>	<u>Subject</u>
207	Results of Standard MOC-Magnetic Concentration Tests on Composites from Cascade District DDH Nos. 47,48, and 59, Section 27, 47-26
208	Results of Standard Magnetic Concentration Tests on Composites from Empire Area Drill Holes 20-28, Section 19, 47-26
209	Summary Report - Albabel Area
210	Demonstrations of Sintering Techniques to Produce Open Hearth Sinter on a Traveling Grate Using the Updraft Principle
211	Results of Standard MOC-Magnetic Concentration Tests on Composites from Tilden District DDH Nos. 26 & 27, Section 27, T47N-R27W
212	Results of Standard MOC-Magnetic Concentration Tests on Composites from Isabella District, DDH Nos. 1, 2, & 3, Section 32, T47N-R26W
213	Results of Standard Magnetic Concentration Tests on Composites from Empire Area Drill Holes 23, 29-34, Section 19, T47N-R26W
214	MOC Reactor Pilot Plant Test 11A - Treatment of Republic Rougher Concentrate from Crude Having Average Response to Flotation

METALLURGICAL MEMORANDA - YEAR 1957

<u>Memo No.</u>	<u>Subject</u>
453	Standard MOC Tests, Richmond Exploration, DDH Nos. 51 and 52, Section 27, 47-26
454	Check Sampling - Eagle Mills Republic Pellets Repose Angles
455	Laboratory Balling Tests Using Reground Returns and Republic Concentrates with Sodium Carbonate as a Possible Chemical Reagent to Neutralize the Calcium Hydroxide in the Returns
456	Standard MOC Tests, Richmond Exploration, DDH No. 53, Section 27, 47-26
457	Land Offer 3218C, MxC-747, -956, -957, and -958
458	Land Offer 3201C, Natashquan Auger Drill Samples, Mx-444
459	Land Offer 3202, MxC-919
460	Undeslimed Flotation Testing at Republic Mill
461	Outside Exploration 1193, Mx-1920
461A	Land Offer 3652, Mx-1579
462	Microscopic Examination of Flotation Concentrates, Ungava Bay Ore, Outside Exploration 1136
463	Undeslimed Flotation Testing at Republic, Progress Report
464 (Supplements)	Complete Analyses, Flotation and Magnetic Concentrates
465	A Preliminary Laboratory Examination of Klockner-Humboldt-Deutz Briquettes
466	Concentration Test on Republic MOC Calcine at the Mines Experiment Station
467	Undeslimed Flotation Testing at Republic
468	High Tension Separation Tests at Carpc Research and Engineering
469	High Tension Separation Tests on Undeslimed Republic Ore
470	Land Offer 3646, Mx-1683, -1684, -1685
471	Standard MOC Tests, Cascade Exploration, DDH Nos. 38 & 42
472 (Supplement)	Land Offer 3226C, MxC-748
473 & Geology Report 21	Microscopic Examination of Beach Sand Samples from Crescent City, California - Land Offer 3646
474	Magnetic Concentration Tests on Lurgi Kiln MOC Products
475 (Supplement)	Land Offer 3228C, MxC-1400
476 (Supplement)	B.M.S. Claim, Mx-1921



<u>Memo No.</u>	<u>Subject</u>
477	Microscopic Examination of Lurgi Kiln Discharge Products
478	Richmond Group Hole R-5 Albanel Area
479	The Addition of Ammonia, Sodium, or Calcium Base Sulfite Liquor (Lignosol) to Specular Hematite Green Pellets in an Attempt to Increase the Wet and Dry Strengths
480	Moisture Segregation, Artificial Magnetite Concentrates
481	Quality Control Tests of Magnetite Pellets from MalMBERGET, Sweden
482	Visit to the Mines Experiment Station at the University of Minnesota to Discuss Future Shaft Furnace Pelletizing Tests and Updraft Sintering Tests
483	Check Sampling - Eagle Mills Stockpile Sampling
484	The Effect of the Size Analysis of Republic Concentrate on the Wet and Dry Strengths of Green Pellets
485	Results of Metallurgical Testing on Drill Core Composite Mx-4LOB, Rock DDH No. 1, Section 31, 43-22
486	Review of Various Additives as Possible Binders for Green Pellets made from Republic Concentrate
487 & Geology Report 22	Microscopic Examination of Sample No. Mx-1866 - Specular hematite-martite-chert from Black Hill, South Dakota
488	Quality Control Tests of Fired Pellets made from Republic Concentrate at Lurgi in Frankfurt, Germany
489	Land Offer 3683, Mx-1866
490	Land Offer 3668, Mx-2042 thru Mx-2045, Mx-500 thru -502
491	Outside Exploration 1209, Mx-2046, -2047, -503
492	Land Offer 3651, Mx-1682
493	The Effect of Desliming and/or Reagentizing High Grade Republic Ore on the Wet and Dry Strength Properties of Green Pellets
494	Results of Concentration Tests on a High Magnetite Humboldt Ore
494A	Trip Report - Ontario Research Foundation
495	Standard MOC Tests on Drill Hole 59, Section 27, 47-26, Cascade Area
496	Observation of Pelletizing and Shaft Furnace Pellet Hardening Tests at Minnesota Mines Experiment Station - Treating Republic (R-70) MOC Concentrate, Reground and Re-concentrated
497	Quality Control Tests on Fired Pellets from the Allis-Chalmers Grate Machine - Rotary Kiln Pelletizing Process
498	Trip to Meadville, Pennsylvania to meet with Westinghouse Electric's Industrial Heating Division and Study the Various Reducing Atmosphere Producers made by them - Exogas, Endogas, Monogas, Cooled-Exogas, etc. - July 5, 1957
499	Davis Magnetic Tube Test Checks - Albanel Drill Core
500	Metallurgical Tests on Republic Crude and Humboldt Rougher Concentrate Samples sent to Lurgi
501	Mineralographic Examination of Pellets made by the new Allis-Chalmers Process
502	Trip to the Mines Experiment Station at the University of Minnesota to Observe Shaft Furnace Pelletizing Tests on Artificial Magnetite Concentrate
503	High Tension Test Work - Meeting with Mr. Dyrenforth, July 16, 1957
504	The Effect of Adding Underground Fines at the Balling Slimes in Coarse Republic Flotation Concentrate rather than Re-grinding the Concentrate
505	Observing Ore Boat Loading, "Pioneer"
506	Quality Control Tests on Jones & Laughlin's Benson Magnetite Pellets Produced in an ACL Process Pilot Plant
507	Land Offer 3204-C, MxC-1370 thru -1375
508 & Geology Report 23	Microscopic Examination of Titaniferous Magnetite Samples from Benoit Lake Area, Canada

<u>Memo No.</u>	<u>Subject</u>
509	Magnetic Concentration Tests on Humboldt Mill Composites for June
510	Concentration Test Results on Composites from Albabel Area
511	Results of Concentration Tests on Mill Samples from the Humboldt Rougher Flotation Test Run and on a Sample of the Rougher Concentrate Stockpile
512	A Laboratory Examination of a Sample from Venezuela
513	Observing Ore Boat Loading, "Frontenac"
514	Preliminary Study of the Balling and Firing Characteristics of Republic Artificial Magnetite Concentrate Pellets
515	Review of Amine Flotation of Tilden MOC-Magnetite Concentrates and Outline of Future Studies
516	Microscopic Examination of Products Produced from Reactor and Laboratory Tests of the Republic Ore
517	Land Offer 3683 - Mx-1867 thru Mx-1881
518	Albabel Area Drill Core Composites
519	Land Offer 3701 - Mx-1882 & Mx-1883
520 & Geology Report 24	Preliminary Laboratory Examination of Titaniferous Samples from Project 17, Quebec Canada
521	Metallurgical Results of the Duplex MOC Process as Compared with Flotation and Standard MOC for Humboldt Ores
522	Heavy Media Bucket Tests - Maas Mine
523	Mineralographic Examination of Lurgi MOC Products Produced from the Republic Ore and Humboldt Rougher Concentrate
524 & Geology Report 25	Mineralographic Examination of Sample No. Mx-2051, Carter Iron Deposit, Montana - Land Offer 3710
525	Metallurgical Tests - Miscellaneous Sample Mx-2051
526	Land Offer 3244, MxC-786, -787, -788
527	Land Offer 3245 - Sample MxC-789, -790, -791
528	The Effect of the Quantity of Bentonite on the Wet and Dry Strength Properties of Green Pellets Produced from Republic Flotation Concentrate and Republic High Grade Crude
529	Direct Reduction - Krupp-Renn Plant at Watenstedt
530	Heavy Media Bucket Tests, Lloyd Mine Stockpile
531	Metallurgical Results of the Duplex MOC Process for Two Aggregate Samples of Humboldt Rod Mill Feed Composites
532	Metallurgical Results of the Duplex MOC Process for an Aggregate Sample of Republic Rod Mill Feed Composites
533	Preliminary Moisture Segregation Study of Artificial Magnetite Concentrate in a Bin
534	Observing Ore Boat Loading, "Pontiac"
535 (Supplement)	A Qualitative Study of the Effect of Defoaming Agents on Republic Flotation Concentrates
536	Review of Some Conditions that Effect Pelletizing of Republic Flotation Concentrates
537 & Geology Report 27	Microscopic Examination of Specimens from Ford Lake, Hopes Advanced Bay, Quebec, Canada
538	The Effect of Using Various Size Mather "B" Fines as the Balling Slimes in Green Pellets Produced from Republic Flotation Concentrate
539	A Visit to McLouth Steel Corporation
540	Observing Ore Boat Loading - "James Norris"
541	The Effect of Size Analysis on the Wet and Dry Strength Properties of Green Pellets Produced from Republic Artificial Magnetite Concentrate
542	Effect of the Flotation Reagent - Bentonite Ratio in Republic High Grade Crude on the Balling Characteristics and Wet and Dry Strength Properties of Green Pellets
543	Missouri Manganese Sample - Mx-508
544	Microscopic Examination of Lurgi Pellets Produced from the Republic Ore Concentrate
545	Mineralographic Examination of a Pellet from Atitkokan, Canada



<u>Memo No.</u>	<u>Subject</u>
546	The Microscopic Texture and Chemical Composition of the Hand Rolled Pellets Produced from the Pickands Mather's Laboratory from the Ashland Ore, Butternut, Wisconsin
547	Results of MOC Concentration Tests on Samples from Rougher Concentrate Shipments to Lurgi
548 & Geology Report 28	Mineralographic Examination of Some Drill Core Specimens from DD Hole No. 1, Section 13, Marquette County
549	Observing Ore Boat Loading - "Bruce Angus"
550	Albanel Area Samples, Project 17
551 (Supplement)	Filter Aids for Reground Republic Flotation Concentrates
552	Sub-Sieve Size Analyses on Cooler and Dust Box Products from Lurgi Kiln Test H-6 (Humboldt Rougher Concentrate)
552A (Supplement)	Balling Tests on Minus 1/4-Inch Underground Ore Sent to Allis-Chalmers for Pelletizing Tests in the ACL System
553	Observations of Tests #5 and 6 at the Mines Experiment Station, University of Minnesota, Week of November 11-16, 1957
554	Empire - Summary of Metallurgical Results on Drill Core Material
555	The Effect of Adding Ten Percent Cyclone Fines from the Ore Improvement Plant to Various Amounts of Coarse Republic Concentrate and Reground Republic Concentrate on the Strength Properties of Green Pellets
556	Updraft Pelletizing Tests Using Coke Produced from Island Creek Bituminous Coal as the Source of Fuel
557	The Quality of Fired Pellets Produced from Minus 1/4-Inch Ore Improvement Plant Fines in the Allis-Chalmers Gate-Kiln System on November 26, 1957
558 (Supplement)	Retesting Albanel & Sandspit Area Composites, Albanel & Sandspit Claim Groups - Project #17
559	Drying and Indurating Temperatures Necessary to Agglomerate -1/4" OIP Fines by Allis-Chalmers Gate Kiln System

Sample Shipments:

Within any one year, various samples are shipped from the Laboratory to various companies and laboratories. These samples are requested for a variety of reasons. The bulk of the samples shipped, however, are for test work. Presented below is a list of the samples shipped during 1957.

<u>Date</u>	<u>Company</u>	<u>Amount &amp; Samples</u>	<u>Purpose</u>
1/3/57	Mr. F. M. Stephens, Jr. Battelle Memorial Institute Columbus, Ohio	2,400# iron ore concentrate	Direct reduction studies
1/4/57	Mr. J. F. Hunt Carpco Research & Engr. Jacksonville, Florida	320# iron ore R-71 & R-72	High tension tests
1/4/57	Mr. A. P. Kerschbaum Armco Steel Corporation Middletown, Ohio	2,400# Humboldt and Republic flotation concentrates	Direct reduction studies
1/7/57	Mr. J. F. Hunt Carpco Research & Engr. Jacksonville, Florida	2 - 5# boxes specular hematite	Pilot plant tests with high tension equipment
1/10/57	Mr. A. D. Kennedy Institute of Mineral Research Houghton, Michigan	34 - 5# boxes RH-6, 7, 8, 9, 11	Standard MOC test work

Continued - - -



<u>Date</u>	<u>Company</u>	<u>Amount &amp; Samples</u>	<u>Purpose</u>
1/15/57	Mr. E. D. Martin Inland Steel Company Hammond, Indiana	160# MOC concentrates	Research work
1/29/57	Mr. C. A. Johnson Hydrocarbon Research, Inc. Trenton, New Jersey	15# MxC-881 beach sand concentrate	Direct reduction work
1/31/57	Mr. J. L. Loring Sinclair Research Lab., Inc. Harvey, Illinois	100# flotation con- centrates	Research work in connection with oil refining processes
2/8/57	Grellinger & Rose Architects, Milwaukee, Wisconsin	2 small samples of ore	Possible use as concrete aggregate for radiation barrier
2/21/57	Mr. Jerome A. Schwartz, Chicago 13, Illinois	Approx. 100 lbs., 1 can low grade iron ore	Experimental test work
3/13/57	Mr. A. D. Kennedy, Institute of Mineral Research, Houghton, Michigan	12 - 5 lb. boxes of Richmond Samples RH12A thru L & Sample K-786	For standard MOC test work
3/15/57	Mr. Al Fry, Pennsylvania Crusher Div. Westchester, Pennsylvania	1 drum, 910 lbs. Republic Mine MOC concentrates	To test crushing frozen chunks
3/15/57	Mr. George L. Farnsworth, Chemical Corn Exchange Bank New York, New York	1 iron ore specimen	For display purposes
3/15/57	Mr. Julius Madaras, Meridan, Inc. Longview, Texas	4 drums, 3,750 lbs. gross crude Humboldt ore	For test work
3/21/57	Blackstone Corporation, Jamestown, New York	2 samples of flotation froth	For ultrasonic testing
3/21/57	Mr. Dale Bergstedt, Eimco Corporation Palatine, Illinois	1-55 gal. drum of arti- ficial magnetite concen- trates	For filtering tests
4/1/57	Dr. C. F. Fuchs Emulsol Chemical Corp. Chicago 3, Illinois	1 gal. sample of froth from Pelletizing Plant	For froth depression studies
4/1/57	Dearborn Chemical Company Chicago 9, Illinois	1 gal. sample of froth from Pelletizing Plant	Settling aids testing
4/2/57	Denver Equipment Company Denver 17, Colorado	938 lbs. of R-70 arti- ficial magnetite con- centrate	Filtering tests
4/4/57	Inland Steel, Research Laboratory, Hammond, Indiana	115 lbs. Empire magnetic concentrate	General sample for inspection
4/9/57	Angel Stone, Ltd. Hamilton, Ont., Canada	29 lbs. Maas Special	Tinting stone
4/10/57	University of Wisconsin Madison, Wisconsin	10 bags. approx. 1,000 lbs. CS intermediate ore	Possible use for radiation barrier



<u>Date</u>	<u>Company</u>	<u>Amount &amp; Samples</u>	<u>Purpose</u>
4/10/57	Denver Equipment Company Denver 17, Colorado	12 lbs. R-70 cyclone overflow product	For hydroseparator tests
4/11/57	Emulson Corporation Chicago 3, Illinois	5 lbs. deslimed flota- tion feed	Flotation test work
4/26/57	Dorr Oliver, Inc. Oakland, California	5 gals. artificial magnetite conc. pulp	For filter tests
5/3/57	Carpco Research & Engr. Jacksonville 6, Florida	20# R-70-1, 25# R-70-2, 14# R-68	For testing with high tension separators
5/3/57	Dings Magnetic Separator Co. Milwaukee 46, Wisconsin	30 lbs. Republic ore	Testing with high in- tensity magnetic separator equipment
5/7/57	Mines Experiment Station University of Minnesota Minneapolis, Minnesota	50 tons magnetic concentrate	Pelletizing studies
5/17/57	Dorr-Oliver, Inc. Westport, Connecticut	100 lbs. rougher flota- tion concentrates	Space rate determina- tion
5/20/57	Institute of Mineral Research Houghton, Michigan	4-5# boxes Mx-1641, -1643, -1644, -1655	For standard MOC tests
5/23/57	Sharon Steel Corporation Sharon, Pennsylvania	5 lbs. of pellets	As per request of Mr. H. C. Swanson
5/24/57	Mr. J.S. Wilbur CCI Company Cleveland, Ohio	3 Specimens	For transmittal to Sharon Steel repre- sentatives
5/28/57	Lurgi Germany	15 barrels -1/4" ore prepared in Hardinge Cascade Mill-20 barrels Humboldt rougher flotation concentrates	For tests in rotary kiln
6/5/57	Institute of Mineral Research Houghton, Michigan	28-5# bags Cascade and Tilden samples	For standard MOC test work
6/6/57	Mines Experiment Station University of Minnesota Minneapolis, Minnesota	657# pulverized coal	Shaft furnace pellet- izing tests
6/26/57	Institute of Mineral Research Houghton, Michigan	41-5# boxes samples- Project 17	For standard Davis magnetic tube tests
6/28/57	Institute of Mineral Research Houghton, Michigan	32-5# boxes of Humboldt samples	For standard MOC- concentration tests
7/3/57	American Colloid Company Chicago, Illinois	130 lbs. Republic concentrate	Test work with bentonite
7/9/57	Carpco Mfg. Company, Inc. Jacksonville, Florida	35 pounds low grade iron ore	High tension separator tests
7/9/57	Mr. Russell E. Hollis 420 S. Main Street New Carlisle, Ohio	2 lbs. Republic specu- lar hematite concen- trate	Display purposes



<u>Date</u>	<u>Company</u>	<u>Amount &amp; Samples</u>	<u>Purpose</u>
7/19/57	National Lead, Research Lab Brooklyn 1, New York	296# Republic crude No. 1, 263# Republic crude No. 2, 278# Humboldt crude No. 1, 204# Humboldt Rougher Flotation concentrate	For tests with RN Process
7/23/57	Institute of Mineral Research Houghton, Michigan	100# 1957 Surface samples	For standard MOC tests
7/24/57	United Abrasive Grain Co. Quinnesec, Michigan	1-1/2# Tilden siliceous ore	To determine possible application in the tumbling of metal
7/29/57	Dorr-Oliver Westport, Connecticut	1 drum reactor product, 1 drum Republic crude	For fluidizing tests
8/5/57	Bethlehem Steel Company Lebanon, Pennsylvania	80# reground Republic concentrate	For laboratory balling tests
8/8/57	J.P. Cullen & Son Janesville, Wisconsin	100# Cliffs Shaft lump	Radioactive shielding
8/14/57	Ontario Research Foundation Toronto, Ontario, CANADA	5# artificial magnetite concentrate	For demagnetization tests
8/20/57	Mr. Breng Bjornraa 2926 W. River Rd. Minneapolis, Minnesota	60# pellets, 60# low grade specular hematite ore	Requested by Mr. G. J. Holt
8/20/57	Institute of Mineral Research Houghton, Michigan	10-5# boxes Tilden & Isabella samples	For standard MOC tests
8/23/57	Institute of Mineral Research Houghton, Michigan	7-5# boxes Tilden samples	For standard MOC tests
8/23/57	Dearborn Chemical Company Chicago 9, Illinois	20# Republic reground concentrate	Froth depression
8/30/57	Institute of Mineral Research Houghton, Michigan	200 gms H6 Kaster dust 200 gms H6 Kuhler dust	For sizing analyses
9/4/57	Allis-Chalmers Mfg. Company Carrollville, Wisconsin	20 barrels Republic MOC concentrate, 20 barrels Republic flot. concentrate Total shipment approximately 20 tons	For tests using ACL Process
9/10/57	Institute of Mineral Research Houghton, Michigan	11-5# boxes Empire samples E-202 to E-205, E-207, -209 and E-210	For MOC test work
9/11/57	MCM&T Bureau of Mines Houghton, Michigan	200# Republic concentrate, 200# artificial magnetite concentrate	For pelletizing tests
9/17/57	Dr. Roberts Dorr Company Westport, Connecticut	15# R-70 crude	For microscopic tests
9/18/57	Mr. F. C. Roberts 2636 1/2 W. Main St. Alhambra, California	69 Specimens	For standard size thin sections



<u>Date</u>	<u>Company</u>	<u>Amount &amp; Sample</u>	<u>Purpose</u>
9/20/57	National Lead Research Lab. Brooklyn 1, New York	3 bags T-185 Tilden crude ore	For direct reduction RN Process
10/11/57	Mr. A.C. Behrendsen Liberty, Missouri	100# Republic flota- tion concentrates	For bentonite studies
10/15/57	Sharon Steel Corp. Lowellville, Ohio	46 long tons Tilden crude ore	For direct reduction studies
10/23/57	Mines Experiment Station Minneapolis, Minnesota	2500# Eagle Mills products	For test work
10/24/57	Bethlehem Steel Company Bethlehem, Pennsylvania	500# Republic flota- tion concentrates	For study of various concentrates
10/24/57	Bethlehem Steel Company Bethlehem, Pennsylvania	1 bag-25# Republic flotation concentrate	For study of various concentrates
10/25/57	Linde Company Tonawanda, New York	2-100# bags pellets	Use as possible heat barrier
10/25/57	Hercules Powder Company Willmington, Delaware	1-50# bag Republic flotation concentrate	Test work relative to removing reagent film
10/25/57	The Philip Carey Mfg. Co. Lockland, Cincinnati, 15, Ohio	10# iron ore fine concentrates	For inspection and examination
10/28/57	Fried-Krupp Essen, Germany	20# Humboldt rougher flotation concentrate	For tests employing Krupp-Renn Process
10/28/57	Institute of Mineral Research Houghton, Michigan	23-5# boxes IS3A-Q, T-188A-F	For standard MOC tests
11/1/57	Allis-Chalmers Mfg. Co. Carrollville, Wisconsin	8 tons, 20 barrels Eagle Mills concentrate	For ACL Test Work
11/8/57	Allis-Chalmers Mfg. Co. Carrollville, Wisconsin	20 barrels, 20,000# Republic MOC concen- trated product	For ACL test work
11/8/57	Dorr-Oliver Inc. Westport, Connecticut	4 barrels, approx. 4000# Tilden & R-70 crude ore	For MOC test work
11/15/57	Allis-Chalmers Mfg. Co. Carrollville, Wisconsin	30 barrels, 27,000# Group No. 1 1/4" fines from Ore Improvement Plant	For ACL test work
11/21/57	Jones & Laughlin Pittsburgh, Pennsylvania	50# Republic RM Feed	For examination
11/21/57	Ramsey Engr. Co. St. Paul, Minnesota	41 lbs. R-76B	For determination of magnetite content
11/21/57	Dorr-Oliver, Inc. Westport, Connecticut	92 lbs. R-76B	To determine grind- ability in the Fluid bed
11/21/57	Battelle Memorial Institute Columbus, Ohio	50 tons artificial magnetite	For experimental reduction work
11/22/57	Shell Oil Research Lab. Wood River, Illinois	200# Republic flota- tion concentrate	For agglomeration testing



<u>Date</u>	<u>Company</u>	<u>Amount &amp; Samples</u>	<u>Purpose</u>
11/22/57	Battelle Memorial Institute Columbus, Ohio	10# artificial magnetite	For experimental reduction work
11/27/57	Institute of Mineral Research Houghton, Michigan	53-5# boxes Empire, Ogden, Tilden, Vulcan, and Gwinn	For standard MOC tests
12/3/57	John A. Mercier Brick Co. Dearborn, Michigan	1,000# MOC concentrates	Preliminary study for blocking process
12/3/57	Dow Chemical Company Midland, Michigan	10# Republic flotation concentrates	Studies on removal of fatty acid
12/3/57	Hanna Research Lab. A.G. McKee, Requested by	200# -1/4" Group I	Agglomeration studies
12/4/57	Institute of Mineral Research Houghton, Michigan	9-5# boxes 43 lbs. Isabella Drill Hole 4	For standard MOC tests
12/5/57	Armco Steel Corp. Middletown, Ohio	35 lbs. Brazilian ore	For examination of fines
12/6/57	Institute of Mineral Research Houghton, Michigan	188# Humboldt and Rep- ublic rod mill feed composites	For grindability test correlation study
12/6/57	Dayton Malleable Iron Co. Dayton, Ohio	1,000# concentrates	Examination of material
12/10/57	Mr. W.R. VanSlyke, CCI Taconite, Minnesota	1,070# artificial magnetite	For use as cyclone media
12/10/57	Allis-Chalmers Mfg. Co. Carrollville, Wisconsin	37,800# Republic magnetite concentrates	Tests in ACL Process
12/11/57	Tamms Industries Chicago, Illinois	Approx. 7# cyclone dust samples from Ore Improve- ment Plant	To evaluate use as paint pigment
12/19/57	Mr. M.E. Volin MCM&T	50 lbs. Republic high grade crude ore	For test work
12/20/57	Mr. T.T. Quirke, Jr. Univ. of Minnesota Minneapolis, Minnesota	1-3/4#, 21 polished specimens-Albanel & Sandspit	For microscopical work
12/23/57	Mr. M. E. Volin MCM&T Houghton, Michigan	300# pellets 150# concentrates	For test work
12/27/57	Allis-Chalmers Mfg. Co. Carrollville, Wisconsin	40 tons artificial magnetite concentrate	For 3-day agglomeration test using ACL Process
12/27/57	Allis-Chalmers Mfg. Co. Carrollville, Wisconsin	15 tons -1/4" fines from Group I Stockpile	For agglomeration tests using ACL Process



PART II

PYROLYSIS & AGGLOMERATION

OPERATION OF THE EAGLE MILLS PELLETIZING PLANT:

During the first part of the year the entire staff of the pyrometallurgical section was at the Eagle Mills Pelletizing Plant helping the operators in the start-up of the plant.

Studies were conducted at the Research Laboratory in an attempt to aid the process and operation of the Pellet Plant. The variables studied are as follows:

1. Effect of desliming during concentration on the ballability of the concentrate.
2. Effect of reagentizing the crude ore for flotation on the ballability of the concentrate.
3. Effect of the amount of flotation reagent on the strength and plasticity of wet green pellets.
4. Effect of various chemical reagents on the ballability and green strength properties of pellets produced from flotation concentrate.
  - (a) settling agents
  - (b) reagents used to neutralize the returns
  - (c) defoamers and defrothers
5. Effect of the quantity of bentonite in the balling feed on the ballability and green strength properties of pellets.
6. Effect of the flotation reagent-bentonite ratio on the strength, ballability, and plasticity of wet green pellets.
7. Effect of returns on the balling and firing phases of the updraft process.
  - (a) with limestone present in the circuit
  - (b) without limestone
8. Variables that affect balling at Eagle Mills:
  - (a) Bentonite additions - location and method of mixing
  - (b) Moisture content of balling feed
  - (c) Size consist of the reground concentrate
9. Quality of the green pellets produced from the discs at Eagle Mills.
10. Grate feeders and their effect on the green pellet bed permeability.
  - (a) breakage caused by excessive drops
  - (b) deformation of plastic pellets caused by the excessive drop



11. Addition of various amounts of underground fines to reground and/or raw concentrate to increase the ballability and green pellet strength.

- (a) size of underground fines
- (b) amount of underground fines
- (c) varying the reground-raw concentrate ratio

12. Factors affecting production at Eagle Mills:

- (a) size consist of reground concentrate
- (b) amount of returns in balling feed
- (c) amount of reagent in concentrate

13. Study the corrosion problem in the RotoClones.

- (a) determine cause of corrosion
- (b) investigate possible methods of preventing corrosion

PRELIMINARY LABORATORY MOC PELLETIZING TESTS:

Tests were conducted during the year using a high grade artificial magnetite concentrate produced from Republic crude in the FluoSolids reactor and laboratory pilot plant concentrating circuit. Balling characteristics were investigated in the laboratory's 16" diameter x 6" batch balling drum while drying and firing characteristics were investigated in the Burrell tube furnace. The variables investigated are as follows:

1. The ballability of the concentrate.
2. Effect of the size consist of the concentrate on the wet and dry strength properties of green pellets.
3. Effect of the quantity of bentonite on the green strength properties of the pellets.
4. Effect of the addition of various chemical reagents to the balling feed:
  - (a) reagents to increase the pH and as such the swelling properties of bentonite
  - (b) reagents to retard drying rates
5. Effect of the pellet diameter on drying rates.
6. Quality control tests on the green and fired pellets.
7. Reducibility tests on the finished products.

AGGLOMERATION TESTS CONDUCTED AT THE UNIVERSITY OF MINNESOTA, MINES EXPERIMENT STATION:

Shaft Furnace Pelletizing Tests:

A series of four shaft furnace pelletizing tests were conducted at the Mines Experiment Station using artificial magnetite concentrate. Difficulties were en-



countered in discharging the fired pellets evenly from the furnace and maintaining the desired indurating temperature in the furnace. These difficulties caused a poorly fired product to be produced and unfavorable results were obtained. The following investigations were conducted during and after these tests:

1. Effect of pelletizing without solid fuel
2. Effect of pelletizing with solid fuel
  - (a) Internal coal
  - (b) Surface coal
  - (c) Partially internal and partially surface coal
3. Effect of adding bentonite to the surface fuel.
4. Quality control tests on fired products from the tests.

Updraft Sintering:

A series of six tests were conducted on the traveling grate at the Mines Experiment Station using underground ore. The first two tests were practice tests to determine operating conditions and obtain returns for future tests. Complete sets of data were obtained on the four remaining tests. Variables studied during these tests were as follows:

1. Size of the underground ore
2. Effect of the Fe:SiO<sub>2</sub> ratio on sinter strength
3. Effect of the amount of fuel on the sinter strength

Quality control tests on the various size sinter products revealed a very brittle product. This type of sinter could not be sold as open hearth sinter.

AGGLOMERATION BY THE ACL GRATE-KILN SYSTEM:

During the year specular hematite flotation concentrate, artificial magnetite concentrate, and underground fines were subjected to a new and novel method of agglomerating iron ore. These materials were tested on a pilot plant unit of the Allis-Chalmers grate-kiln system, commonly known as the ACL Process. Following is a brief description of the test procedures and results for each type ore.

Specular Hematite:

Pilot plant tests were conducted on October 31st and November 7th, 1957. The concentrate used during these tests was obtained from the filter circuit at Eagle Mills. The investigations conducted before and after the tests are as follows:



1. Determine if it was feasible to agglomerate this material by this method.
2. Determine the capacity of the process.
3. Determine if pre-heated pellets would withstand drop from grate to kiln.
4. Determine the preheat and drying temperatures required.
5. Quality control tests on the grate, kiln, and cooler products.

Artificial Magnetite Concentrate:

A pilot plant test was conducted on October 29th, 1957. The concentrate used during these tests was obtained from the laboratory pilot plant concentrating circuit.

The investigations conducted before and after the test are as follows:

1. Determine if it is feasible to agglomerate this material by this method.
2. Determine the capacity of the process.
3. Determine the preheat and drying temperatures required.
4. Determine the extent of oxidation of the pellets on the grate.
5. Investigate the effect of pellet diameter.
6. Quality control tests on the grate, kiln, and cooler products.

Underground Ore Fines:

Pilot plant tests were conducted on November 26th and December 5th, 1957. The tests failed because the green pellets were more tightly compacted than previous pellets and spalled or explosively disintegrated when dried at the standard drying time and temperature for the ACL Process. Because of this failure, basic studies were undertaken at the Research Laboratory. The variables studied were as follows:

1. Determine maximum drying temperature attainable without spalling or explosive disintegration.
2. Determine maximum indurating temperature to produce a hard pellet that shows no signs of thermal decomposition.
3. Determine the time required to dry pellets at the various drying temperatures.
4. Investigate the ballability of this material and the shape disc required.
  - (a) Effect of moisture
  - (b) Effect of rerolling the green pellets



QUALITY CONTROL TESTS OF VARIOUS FIRED PELLETS:

During the year samples of concentrates and fired pellets were received from pelletizing plants throughout the world. These samples were subjected to quality control tests.

These samples were received from the following sources:

1. Shaft Furnace:

- (a) Malmberget - Sweden
- (b) Erie Mining Company - Aurora, Minnesota
- (c) Bethlehem Steel - Lebanon, Pennsylvania
- (d) Marmora

2. Grate Machine:

- (a) Eagle Mills Pelletizing Plant's first shipment to International Harvester - Wisconsin Steel Division (Updraft)
- (b) Reserve Mining Company - Silver Bay, Minnesota (Downdraft)
- (c) Lurgi - flotation concentrate pellets - (Lurgi system - pilot plant, Frankfurt, Germany)

3. ACL System:

- (a) Benson magnetite, Jones & Laughlin Steel Corporation.

STANDARD LABORATORY BALLING STUDIES:

Standard laboratory balling tests conducted during the year included the following investigations:

- 1. Binder study.
- 2. Chemical reagents to remove the flotation reagent from the concentrate.
- 3. Addition of Ore Improvement Plant fines to the flotation concentrate to increase the wet strength of green pellets.
- 4. Standard laboratory balling tests to determine the quality of the bentonite received at Eagle Mills.

MISCELLANEOUS TEST PROGRAM:

The following test programs were also conducted during the year:

- 1. Evaluate the possibility of replacing anthracite coal at Eagle Mills with coke from Island Creek Coal.
- 2. Determine moisture segregation of artificial magnetite concentrate stored 100 hours in a 25 foot bin.



3. Test a method of screening green pellets from the discs at Eagle Mills.
  - (a) Vibrating screen
  - (b) Stationary trommel
  - (c) Moving trommel
    - (1) 1/8" - openings (Eagle Mills)
    - (2) 1/4" - openings (Research Laboratory)
4. Compute chemical analysis of pellets which will be produced from different properties in the future.
5. Conduct MOC tests at the University of Minnesota, Mines Experiment Station, on a traveling grate.



PART III

RESEARCH AND DEVELOPMENT WORK AND FLOTATION PROJECTS

PILOT PLANT MILLING:

FluoSolids MOC Calcine:

During the first eight months of the year, FluoSolids MOC calcine of Humboldt and Republic crude ores was treated in the magnetic separation pilot mill. The flowsheet consisted of a two or three stage cobbing of a minus 28 mesh rod mill discharge, closed circuit grinding of the cobber concentrate, and a three drum magnetic finisher separation on the cyclone classifier overflow.

Starting in September, Humboldt and Republic duplex MOC calcine was milled in the pilot mill. The circuit consisted of a one or two stage cobbing of the as is calcine, dewatering the cobber concentrate with a cyclone or a spiral classifier, grinding the dewatered sands in a ball mill in open circuit, and finishing magnetic separation on the ball mill discharge using one, two, or three drums of the Jeffrey three drum unit.

About 100 tons of high grade duplex MOC magnetic concentrates have been prepared with the pilot mill and have been shipped to Allis-Chalmers and the Mines Experiment Station for agglomeration tests.

Traveling Grate MOC Calcine:

A small tonnage of MOC calcine was made from Republic crude ore on a traveling grate machine at the Mines Experiment Station. The calcine was milled in a magnetic separation pilot mill circuit at the Station. A report on the results of this test was issued by the Station.

Hardinge Cascade Mill:

A six foot Hardinge Cascade mill was tested at the Republic Mill to get an indication of the applicability of that unit and also to determine energy requirements which could be compared with conventional crushing and grinding. A report on this test was issued by Hardinge.

A small tonnage of minus 1/8" product was made from Republic crude. Some of this was sent to Lurgi for MOC in the pilot plant kiln test and the balance was stockpiled at the Laboratory.



Empire:

Because of the immediate need for the development of the Humboldt and Republic MOC-magnetic separation flowsheets first for crude ore calcine and then for pre-concentrate calcine, only a limited amount of pilot plant milling was done on Empire crude ore.

DRILL CORE TESTING:

Core material from the following named drill holes in the several districts was subjected to concentration tests, the results of which have been presented in metallurgical reports or memoranda. Because of the work load at the Laboratory, drill core composites and field samples were sent to the Institute of Mineral Research. This testing involved MOC-magnetic concentration as for Richmond and Tilden or grinding and magnetic separation as for Albanel.

<u>Property</u>	<u>Drill Hole Nos.</u>	<u>Location</u>
Cascade	47,48,59	Section 27, T47N-R26W
Empire	20 through 34	Section 19, T47N-R26W
Humboldt	8	Section 2, T47N-R29W
Isabella	1,2,3	Section 32, T47N-R26W
Osier	1,2	Section 18, T43N-R21W
Richmond	45,46,49 through 58	Section 27, T47N-R26W
Rock	1	Section 31, T43N-R22W
Tilden	59,60	Section 26, T47N-R27W
Tilden	4,5,6,7	Section 25, T47N-R27W
Tilden	1,2,3	Section 22, T47N-R27W
Tilden	25,26,27	Section 27, T47N-R27W

Composites have been made and metallurgical testing is underway but not completed for the following drill holes:

Empire	36	Section 19, T47N-R26W
Isabella	5	Section 32, T47N-R26W
Ogden	3	Section 24, T47N-R27W

The composites for Bellevue area DDH Nos. 33 and 34, Section 18, T47N-R26W were retested to determine if a finer grind would make possible the separation of concentrates of acceptable grade. The initial test results on these composites were reported in Metallurgical Report No. 186.

Field Samples:

Field samples from the following named areas were processed. The testing involved either grinding and magnetic separation or MOC-magnetic separation.

Empire, Section 19	Vulcan, Section 9
Ogden, Section 13	Gwinn, Sections 17,18,20,28,35
Tilden, Section 34	



Project 17 - Albabel Area:

Albabel Area drill core composites were tested by grinding and magnetic separation with the Davis tube. Field samples were tested in the same way. The bulk of the work was conducted at the Institute of Mineral Research.

NATASHQUAN RIVER SANDS TESTING:

A rather comprehensive group of auger drill samples of Natashquan River sands were composited by the Department of Mines, Province of Quebec. These composites were subjected to concentration at the School of Mines, Laval University in Quebec. The concentration scheme which previously had been outlined by Laboratory personnel consisted of (1) separation of a crude magnetics from the "as is" sand sample, (2) screening the crude magnetics on 65 mesh rejecting the plus 65 mesh as a lower grade middling product, (3) grinding the minus 65 mesh fraction to minus 200 mesh, and (4) final magnetic separation on the minus 200 mesh material.

These composites were shipped to the Laboratory for cross checking. It was established that overall recovery could be increased with no lowering of final concentrate grade by grinding and finishing magnetic separation on the total crude magnetics.

O'KEEFE LAKE CLAIM:

A sample of crude ore from the O'Keefe Lake Claim Group was subjected to a comminution test by Aerofall Mills Limited, Toronto, Canada. Samples of the Aerofall Mill products were submitted to the Research Laboratory for testing.

HIGH TENSION SEPARATION:

Both Humboldt and Republic crude ore samples were sent to Carpc Research and Engineering for high tension separation and high intensity magnetic separation. Of the two methods a quick study showed the former superior to the latter method and thus all of the effort was devoted to high tension.

The results of the earliest work on Humboldt ore ground to 65 mesh and deslimed showed that high tension could isolate a high grade concentrate with high iron unit recovery. However, as Carpc gained experience with Humboldt and Republic crudes and with other iron ores such as very coarse martites and specular hematites, it developed that the Republic ores liberated at too fine a size to get high grade concentrates at economically feasible feed rates in the high tension.



Republic rougher concentrate did not respond favorably to high tension nor did a sample of Tilden ore which was ground to minus 65 mesh and deslimed.

LURGI MOC PRODUCTS:

Samples of MOC calcines of Republic crude ores and Humboldt rougher concentrates from Lurgi kiln pilot plant tests were submitted to the Laboratory for concentration tests. The tests involved grinding and magnetic separation with the Davis tube.

DUPLEX MOC:

Both Humboldt and Republic crude ore samples were subjected to duplex concentration scheme which involves separation of a rougher concentrate with high iron unit recovery by fatty acid flotation and then MOC-magnetic concentration of the rougher concentrate. The duplex MOC process was compared with standard MOC on monthly rod mill feed composites and on special pit samples.

The advantages of duplex MOC are: (1) to reduce the feed to MOC by about 40 per cent, (2) greater ease of separation of a high grade concentrate at coarser grinds than with MOC on crude ore, and (3) a somewhat greater consistency in producing high grade concentrates.

Both Humboldt and Republic rougher concentrates have been sent to Lurgi and to the Laboratory for pilot plant reduction tests.

CONCENTRATION OF MAGNETITE FROM HUMBOLDT ORES:

The possibility of magnetic separation to recover magnetite from Humboldt ores before or after flotation was investigated using monthly rod mill feed composites, mill flotation circuit samples, pit samples, and some high magnetite drill core. Magnetics could be recovered either from the hydrosillator overflow or the flotation tailings. In the duplex MOC scheme, magnetite could be recovered before MOC to still further reduce the feed to MOC.

FLOCCULATING AGENTS FOR FLOTATION TAILINGS:

Eighteen flocculants of the inorganic type or commercially synthesized products were tested individually or in combination as flocculants for Republic plant tailings. Fresh samples of as is tailings were used with the respective flocculating agents following a standardized settling procedure. Several of the inorganic salts were effective as were combinations of inorganic salts and commercial products.

DEFOAMING AGENTS FOR FATTY ACID FLOTATION CONCENTRATES:

About 35 commercial defoaming agents were tested in a qualitative study to determine their relative effectiveness to breakdown froth from the thickener at the Pellet Plant. They were also tested to indicate any ability to prevent the formation or destroy froth formed when Republic reground concentrate was aerated in the flotation cell. Some of the most promising defoaming additives were tested in the Agglomeration Section to determine their effect, if any, on balling.

FILTER AIDS FOR REPUBLIC FLOTATION CONCENTRATES:

In the testing of the commercial defoamers it was observed that a few functioned by a pronounced flocculating action. Batch tests were run with a leaf filter on repulped Pellet Plant filter cake using a few of these additives. A Hercules experimental product HKV-100 used in amounts as little as 0.02 lb. per ton increased filter capacity by 50 per cent and gave a somewhat drier cake.

FILTER TESTS ON MIXTURES OF REGROUND REPUBLIC CONCENTRATE AND IMPROVEMENT PLANT FINES:

Tests have been conducted in the Agglomeration Section on balling of reground Republic concentrate with admixtures of cyclone dust and fines from the Improvement Plant. Batch leaf filter tests were run on these mixed pulps to get an indication of the effect of these fines on filtration.

FATTY ACID FILM REMOVAL STUDY:

Laboratory balling studies and plant operating data indicated that the fatty acid that adheres to the concentrate is detrimental to good pelletizing. A study was initiated to try to find a method to remove the fatty acid after concentration. Several schemes used in the phosphate field to remove fatty acids from concentrates failed to work on Republic concentrate. Quebracho and ferric chloride both appeared to be effective in rendering the concentrate wettable but no improvement was noted in balling so removal of the fatty acid by these treatments was questionable.

FLOTATION STUDIES:Undeslimed Flotation Tests at Republic:

During January and February, tests were made at Republic with an undeslimed flotation system which had been previously outlined by laboratory batch tests. Principally, the scheme involved conditioning of the ore in the grinding mills with fatty acid and caustic soda. The aim was better metallurgy plus recovery of more fine material to aid the pelletizing.



The system as tested at Republic failed to show the improvements which were indicated by batch test results. Generally, the new system was not as good as was the existing mill practice. It was concluded that insufficient reagentizing in the continuous closed circuit grinding was the result of a differential in grinding rates versus conditioning rates for the complete size range of the flotation feed.

#### Fatty Acid Reagent Testing:

Several fatty acid reagents were tested as possible substitutes for the present mill reagents. The distilled tall oil types appear to be the most effective and economical. Both Humboldt and Republic are scheduled to use in the summer months a tall oil fatty acid which is slightly lower in grade and has a higher titer but which cost 1-1/2¢ less per pound than the first grade reagents.

#### Effect of Calcium Chloride on Flotation:

To inhibit freezing of the fine ore in the silos at Humboldt it was proposed that calcium chloride be added to the fine ore being charged into the silos. A batch test investigation showed that calcium chloride added to the ground and deslimed flotation feed definitely reduced recovery.

#### Flotation with Mill Reuse and Humboldt Pit Water:

A drought during the later part of summer reduced the level of Lake Lory which is the source of mill fresh water for Humboldt. A batch test investigation showed that mill re-use water gave practically the same results in flotation as the Lake Lory water. Test results with Humboldt pit water showed a definitely lower recovery than with Lake Lory water. The greater suitability of Lake Lory or mill re-use water for flotation as compared to pit water was related to the relatively high hardness of the pit water.

#### Preparation of Reagent 899 Concentrates for Balling Studies:

Some difficulty has been experienced in the pelletizing of fatty acid flotation concentrates. The question was raised as to whether an 899 concentrate may be more suitable for pelletizing. Using an aggregate sample of Republic rod mill feed composites it was demonstrated with closely controlled batch tests that the 899 system gave superior metallurgy but at higher reagent cost per ton of concentrate. This study is being extended to balling studies on concentrates produced on a batch scale with each flotation system.

Batch Flotation Tests on Republic Crude Ore Types:

The crude ore that has been thus far treated in the Republic Mill has been classified into three basic types according to mineral grain size and texture. A laboratory batch study was initiated to get some indication of the response to these ore types to flotation with respect to liberation size, grade and recovery, reagent addition, and concentrate structure. This study is being tied in with an overall study on the concentratability and pelletizing of various types of Republic crudes.

Amine Flotation Upgrading of Tilden MOC Concentrates:

Amine flotation studies were done on MOC magnetic concentrates from a pit sample of Tilden crude ore with satisfactory upgrading with good mineral recovery. About 1500 pounds of Tilden Fire Tower drill core rejects were aggregated into a sample for testing. In addition to amine flotation upgrading of MOC-magnetic concentrates, consideration will be given to preconcentration of the crude for MOC by gravity separation such as heavy media at a relatively coarse size.



PART IV  
MICROSCOPY SECTION

AGGLOMERATION:

Agglomeration study has been one of the major projects for the Microscopy Section during the year.

The materials investigated were pellets produced by the shaft furnace method from Bethlehem Steel and the MalMBERGET operation, Sweden; by the Allis-Chalmers process (traveling grate and kiln); by the Lurgi process (traveling grate), Germany; by the downdraft traveling grate method from the Reserve Mining Company; and by a laboratory unknown pelletizing technique employed by the Pickands Mather's Laboratory.

A number of briquettes from Klockner-Humboldt-Deutz were also studied. The main purpose was to study the micro-structure of the pellets and briquettes, and their mineralogic and textural transformation during the processes.

DIRECT REDUCTION:

Five products related to direct reduction of the Republic MOC concentrate by the direct reduction fluidizing method at Battelle Memorial Institute were microscopically studied. The purpose was to determine the relationship between quartz and metallic iron, to examine the progression of reduction from the iron ore concentrate to the metallic state, and to study the texture and structure of the products.

MOC-Concentration:

The main project was to study the MOC product samples of the Republic ore produced by The Cleveland-Cliffs Iron Company's Research Pilot Plant, Lurgi kiln process, and the Mines Experiment Station, Minneapolis. The purpose was to determine the degree of reduction, reoxidation and textural changes of the ore and gangue particles in the samples and their effect on magnetic concentration.

REPUBLIC TAILINGS:

This study was to determine the mineralogic characteristic and its effect to flotation concentration. The results revealed that the iron in the samples examined is chiefly in the form of specular hematite occurring as specular hematite-chert, specular hematite, and fine inclusions in chert.

The statistic study showed that the efficiency of flotation selectivity reduces with the decrease of particle size.

EAGLE MILLS FILTER CAKE SAMPLES:

The purpose of this study was an attempt to determine whether there are relationships between the mineral composition and particle texture of the filter cake samples and the rate of production at the plant. It was suggested that the ratio between water-repellent and water-wettable particles might be related to the production rate. The samples with higher percentages of water-repellent particles usually give rise to lower production rates.

OGDEN SCHOOLHOUSE PROJECT:

The study of a few core specimens from D.D. Hole No. 1, Section 13, Ogden Schoolhouse, revealed that the core specimens are a magnetite-bearing cherty carbonate resembling most of the Empire magnetite-bearing rocks. However, the average grain size of magnetite is much finer than that from the Empire Area.

PROJECT 17, ALBANEL LAKE AREA:

This project covers the microscopic investigation of both the iron formation and the titaniferous magnetite-bearing rocks. The investigation was to study the concentrating characteristics of the iron formation rocks and to determine the relationships between the magnetite and the titanium-bearing minerals.

LAND OFFERS & OUTSIDE EXPLORATIONS:

During the year, specimens and samples from six land offers and three outside explorations were examined. The objectives were to study the composition, texture, and association of minerals in the samples and specimens and their effects on ore beneficiation.



FLUOSOLIDS REACTOR PILOT PLANT

MOC pilot plant testing throughout this year had three objectives: (1) to so alter and change the reactor that the calcine produced would yield a high grade magnetic concentrate containing under 3% silica from amenable concentrates and crudes; (2) to test various materials in the reactor, and (3) to produce sufficient calcine to meet the requirements of concentration and pelletizing research.

During the year some 1,800 tons of miscellaneous ore materials were processed as part of this research effort and sampling shifts account for about 41% of the gross shifts in the year. This figure (41%) makes no allowance for planned shut-downs or operating shifts during which no samples were taken, but does allow 14 days out of the year for legal holidays plus vacation time.

Major changes made in the reactor this year were: (1) replacement of the two main fluoseals by gravity flow, plug-valve controlled transfers. These control valves are operated by positioners tied in with instruments measuring bed depths and have operated satisfactorily; and while it is likely that fluoseal transfers would perform satisfactorily on a larger unit, they were not dependable nor positive in their action on this small pilot plant unit; (2) installation of a secondary cyclone dust collector and of a wet scrubber to reclaim as much solids as possible from the stack gas and at the same time minimize the nuisance value of the plant effluent; (3) installation of an internal cyclone and baffle in the reduction compartment to minimize short circuiting of the fine particles and prevent their leaving the chamber before being completely reduced; (4) relocation of both the fine and the coarse discharge lines leading into the reduction bed from the preheat section as a further means of minimizing short circuiting; (5) replacement of metal tuyeres by ceramic ones to minimize enlargement of the tuyere holes by sand blasting, successful except for the fact that the tuyeres kept cracking off, forcing a return to the original metal ones; and (6) the application of "upflow operation" to the treatment of fine concentrates at a potential capacity approaching that attainable with crude ore.

In all, twelve test periods were designated during the year, seven of these being ones treating Republic or Humboldt crude ore while the balance treated rougher flotation concentrates from Republic and Humboldt. It was not until rougher concentrates were treated that calcines were obtained which would magnetically concentrate

to less than 2% silica. Testing of various Republic rougher and cleaner concentrates have yielded calcines which can be ground and concentrated magnetically to recover 95% of the iron present in a product analyzing 69-70% iron, 1.00-3.00% silica. Reactor results indicate that it may be possible to make a calcine from which as much as 97% of the iron can be recovered. Material progress has been made in capturing the dust from the plant and either returning it hot to the MOC bed or collecting it for return with new feed. Dust losses from the plant have been reduced from about 10% or more of the feed weight to a low of 3% on the average. Installation of an internal cyclone and baffle was made after the plant started to treat rougher concentrates and served to improve the degree of reduction and hence the iron recovery. Material is on hand crushed to minus 1/8" so that tests can be made, if desired, of both Republic and Tilden crudes now that the reactor is operating in a much more successful fashion than was the case at the beginning of this year.



PART VICHECK SAMPLING PROGRAM

A visit was made in October, 1957 to the McLouth Steel Corporation's plant in Trenton, Michigan at the request of the Ore Sales Department. The purpose of the visit was to obtain general information on McLouth's ore requirements as related to Cliffs Group Ores.

Ore samples were collected from mine pocket and stockpile shipments during the 1957 Season for general sampling correlation data, structure and concentration tests.

A number of samples were collected during the season from the Ore Improvement Plant for testing at the Research Laboratory.

ELECTRIC POWER DEPARTMENT  
ANNUAL REPORT  
YEAR 1957

Electric energy produced in the generating facilities of The Cleveland-Cliffs Iron Company during the year 1957 amounted to 192,962,430 kwh. This was an increase of 25.7% above the amount of energy generated in 1956. Of this amount generated 165,063,644 kwh (85.6%) were billed directly by our Company and used as follows: The Cleveland-Cliffs Iron Company used 43,269,865 (22.4%), Humboldt Mining Company used 16,196,014 kwh (8.4%), The Negaunee Mine Company used 38,926,483 kwh (20.2%), Marquette Iron Mining Company used 32,758,329 kwh (17.0%) and Upper Peninsula Power Company used 33,912,953 kwh (17.6%). The hydroelectric plants of our Company produced 41.8% of the energy, the Presque Isle Plant of Upper Peninsula Generating Company produced 40.6%, the Ishpeming Steam Plant Produced 15.7% and the Ishpeming Diesel Plant produced 1.9%.

In addition to the 33,912,953 kwh (17.6%) billed from our Company to Upper Peninsula Power Company, 27,898,786 kwh (14.4%) were delivered to that Company by Upper Peninsula Generating Company and billed for our account by the Generating Company to the user in accordance with mutual agreements. Of the amount which was supplied to Upper Peninsula Power Company by our Company's wholly owned generating facilities, 89.0% was supplied by the Ishpeming Steam Plant and 11.0% was supplied by the Ishpeming Diesel Plant.

Our Company and the Companies operated by it used 131,150,691 kwh which was an increase of 29.1% over the amount used for these operations during 1956. Energy supplied to The Cleveland-Cliffs Iron Company (including the Humboldt Mine) was obtained entirely from hydroelectric plants. The Negaunee Mine Company and Marquette Iron Mining Company obtained 29.6% of their energy requirements from hydroelectric plants, 70.2% from Upper Peninsula Generating Company's Presque Isle Plant, and 0.2% from the Ishpeming Steam Plant.

In spite of poor hydroelectric conditions, the increased utilization of fuel produced energy and the unfavorable change in the manner of distributing Administrative and General Expense between our Company and the Upper Peninsula Power Company (explained more in detail later herein), the average cost of energy to our Company's operations, including wheeling costs (but exclusive of capital costs) was reduced from \$.00872 per kwh in 1956 to \$.00748 per kwh in 1957. Economics in operation in effect throughout the year coupled with increased production of energy by Upper Peninsula Generating Company's Presque Isle Plant made this reduction possible. Because of rising costs of production materials and future reduction in the use of our high cost generating facilities by Upper Peninsula Power Company, the year 1957 will probably be the year of minimum production cost which will be obtained by our Company.

The income in excess of the operating expenses of the Electric Power Department increased from \$89,091 in 1956 to \$455,804 in 1957. The revenue from the sale of power to Humboldt Mining Company was nearly doubled and the compensation paid by Upper Peninsula Power Company for use of our Company's facilities was increased by 32%. The large portion of the improvement in earnings, however, was due to \$210,830 in additional revenues paid by The Negaunee Mine Company and Marquette Iron Mining Company for the use of our Company's generating facilities under new power agreements reached during the year.

Precipitation during the year 1957 was again below normal as had been anticipated. As indicated at the beginning of 1957, we are in another of the



dry cycles which occur at approximately eleven year intervals and which are of two or three years duration. The output from the hydroelectric facilities has decreased every year since 1951 during which year the output amounted to over 114 million kwh. The annual output has been below 85 million kwh for the years 1955, 1956, and 1957 with the minimum of 80,657,336 kwh being reached during the last year. Precipitation was low throughout the area being 24.53" at the Carp Power Plant and 28.78" at the McClure Power Plant compared with a high precipitation of 43.50" at the Carp Plant and 50.90" at the McClure Plant during the year 1951. The Marquette Weather Bureau has labeled the year 1957 as the third driest since 1872.

In view of the poor water conditions which were experienced, we consider the output of over 80 million kwh from the hydroelectric plants very satisfactory. This high output under such adverse conditions was made possible by the fact that we were able to operate the hydroelectric facilities at the point of maximum efficiency and thus take the best advantage of the water which was available. Addition of fuel burning equipment on our system has made available sufficient capacity to permit the use of fuel burning equipment for variable load operation thus enabling the operation of the hydroelectric plants as base load equipment in the most efficient manner. It has been noted that droughts in other areas, namely in the southwest and on the east coast, seemingly accompany droughts in our region. The drought which they have been experiencing for the past few years broke recently, and we hope that this is an indication of better conditions here for the coming season.

At the beginning of 1957 plans were under way for the installation of a second unit at the Presque Isle Plant of Upper Peninsula Generating Company. Stone & Webster Engineering Corporation was obtaining bids for equipment and some orders for equipment had been placed. Prior to the directors' meeting of that company on April 4, Upper Peninsula Power Company had entered into negotiations with The Celotex Corporation to construct a power plant to supply steam and electricity for a new processing plant which the corporation was installing in L'Anse. Our Company, in the meantime, had reviewed its plans for further development of low-grade ore and pelletizing plants on the Marquette Iron Range. This review indicated that the installation of these additional plants would be later than was originally anticipated. Thus soon after the first of the year it was realized that if the Power Company was successful in its negotiations with The Celotex Corporation and our Company's development plans were delayed, it would not be necessary to have a second unit at the Presque Isle Plant as soon as had been planned. Accordingly, at Upper Peninsula Generating Company's meeting of April 4 this matter was discussed and on April 9 orders were given to the Stone & Webster Engineering Corporation to stop all work on the project and to hold all orders and plans in abeyance for further development. In the Generating Company's directors' meeting of July 9 all work on the second unit for the Presque Isle Plant was postponed until such a time as was necessary to again begin engineering work and purchasing of material in order to have that unit in operation sometime early in 1962. As a further development in this matter the contract between Upper Peninsula Power Company and The Celotex Corporation was completed and ready for signature at the end of the year. This means that a new plant will be constructed at L'Anse by the Power Company which will make available for them approximately 13,000 kw of capacity for that company's use in serving their other properties on the interconnected system.

At the time of the annual adjustment between Upper Peninsula Power Company and our Company for the intercompany billings in accordance with the power exchange agreement between us, several questions arose concerning the interpretations of certain parts of the agreement. The major item questioned by the

Power Company was the manner in which the Administrative and General Expenses of the Electric Power Department were distributed between our Company and their Company. After several meetings and discussions of the situation there was a meeting held in New York on April 29 between representatives of our Company and their organization and an agreement was reached. This agreement provided for the charges which had been made prior to the end of 1955 remaining as they had been made, but that beginning on January 1, 1956 and thereafter the distribution of the Administrative and General Expense would be made upon the interpretation of the contract which was placed upon it by the Power Company. In addition to this there were also several ambiguities in the contract all of which were discussed and agreed upon at this same meeting.

Under the terms of the basic agreement between our Company and the Upper Peninsula Power Company it was agreed that at the end of five years or the beginning of operation of the second unit at Presque Isle, whichever was the earlier, a review of the agreement of July 15, 1953 would be conducted with the idea of making such changes in that agreement as might be deemed desirable by both parties. While plans for the second unit at the Presque Isle Plant were in progress and it was felt that this unit would be in operation early in 1959, several meetings were held to arrive at an agreement on the changes which should be made to correct difficulties experienced during the life of the agreement and also to correct any inequities which had resulted from its terms. These meetings had resulted in a general agreement as to the broad principles which would be involved in such an agreement. A meeting was held in Cleveland on January 9 and 10 which was attended by members of our Company and of the Stone & Webster Engineering Corporation which was retained by us together with the representatives of the Upper Peninsula Power Company and of the Stone & Webster Service Corporation which is retained for advisory service by them. This meeting resulted in the drafting of a summary of the points upon which agreement tentatively had been reached, together with points which should be reviewed and covered in the agreement.

At that time it was anticipated that the new agreement would be brought into final shape so that it could be adopted by January 1, 1959. Postponement of the plans for the installation of the second unit at Presque Isle, however, removed the immediate necessity for the adoption of a new contract. The Upper Peninsula Power Company suggested in the meeting on April 29, that an attempt be made to get a new contract into effect by January 1, 1958. This advanced the effective date of the new contract by one year from the effective date which had been originally anticipated. Our Company did not commit itself to such a change but agreed to consider a revised contract if it were drafted and forwarded to them. The redraft was sent by Stone & Webster Service Corporation on October 31. Prior to the end of the year the revised draft had been reviewed by our Company and by Stone & Webster Engineering Corporation. Indications were that the contract was not acceptable to us in its present form and that it would not be accepted by us without extensive revisions. It is not anticipated that the revised agreement will be adopted before active work is again resumed on the second unit for the Upper Peninsula Generating Company Power Plant.

The two hydraulic generators at the McClure Plant had not been overhauled since 1941. Accordingly, plans were made to overhaul these two units early during the year 1957. The number 1 unit was taken out of service on January 14, and a complete overhaul was given to the hydraulic turbine. At this time a stainless steel runner which had been purchased several years ago was installed and other major improvements were made. The top plate of the hydraulic turbine was found to be badly cracked when the unit was dismantled and was repaired. The difficulty experienced in fitting replacement parts into the turbine prolonged the period of overhaul and it was not until February 21 that the unit was again placed in



service. Immediately after it was found that the number 1 unit performed satisfactorily, the number 2 unit was taken out of service on February 25 and dismantled. The same condition in regard to the top plate was found on this unit as had existed on the number 1 unit, and it was also reinforced. The stainless steel runner was installed on this unit, but less difficulty of fitting the new parts into the old turbine was encountered than in the repair of the former unit. It was possible to get this unit back into service by March 12.

During 1955 Upper Peninsula Power Company had been negotiating with the city of Escanaba for the lease of a power plant which the city of Escanaba proposed to construct. These negotiations were concluded in January 1956 and construction of the power plant was begun. It was the intention of the Power Company to connect the power generating facilities thus acquired to their interconnected system by construction of a line from Escanaba to Gwinn and thence to the Cedar Substation in Ishpeming. The portion of the line between Gwinn and the Cedar Substation would comprise facilities jointly used by our Company and their Company and constitute a part of the jointly used system as defined in the agreement between those Companies. Construction was started on that portion of the line which was in the jointly used system early in 1957. During February a study was made on the calculating board of the University of Wisconsin at Madison of the conditions which would exist after the Escanaba Power Plant and the tie line between Cedar Substation and Escanaba had been completed. This board study was necessary to provide information for the purchase and adjusting of the relaying and protective equipment on the transmission system. The major portion of the work on the transmission line had been completed by the end of the year 1957 and approximately 90% of the charges to the construction work had been made. The line between Cedar Substation and Gwinn was placed in operation in the fall of the year, and it is expected that the entire line will be complete and tied into Escanaba early in 1958.

The Presque Isle Plant of the Upper Peninsula Generating Company delivered 156,461,600 kwh to the jointly used transmission system this year. This was an increase of 28% above the amount delivered last year. This increased production assisted in reducing the average cost of energy delivered (including fixed charges) from \$.0083 to \$.0078 per kwh. Since the full capacity of the plant as defined by our agreement with Upper Peninsula Power Company was utilized, the fixed costs were equally spread on the energy used by each. This resulted in a reduction in energy cost to our Company from \$.0118 to \$.0077 per kwh. No major difficulties were experienced and the economy of the station was good. On February 24 there was a field failure on this unit caused by a fault in the brushes of the pilot exciter and the machine ran for a short period of time without excitation. For a machine of this size to operate without its excitation sometimes causes serious damage to the field winding insulation. Accordingly, it was felt advisable to give the machine a thorough examination after this difficulty was experienced. The generator was shut down on February 26, and a specialist from the General Electric Company inspected the machine thoroughly and reported that no damage had been done. During this shutdown the boiler and all associated equipment were also given a thorough inspection. The plant was placed back into operation on March 6.

The Ishpeming Steam Plant was operated during every month of the year. Energy delivered to the jointly used system by the Ishpeming Steam Plant during 1957 amounted to 30,360,114 kwh which was an increase of 31% above the amount delivered in 1956. The production expense of this station was reduced from \$.0104 per kwh to \$.0096 per kwh in 1957. Of the energy produced by this plant, 99.5% was used by the Upper Peninsula Power Company. The cost of this energy to that Company was \$.01215 including that portion of the Fixed Charges assigned to them under the power purchase agreement. Operations were satisfactory and no major difficulties were experienced. The Steam Plant was shut down for its

annual inspection April 1 to April 8. No serious conditions were found.

A small amount of flyash erosion within the boiler is still being experienced, however, and on September 14 this erosion caused a leak in a boiler tube in the rear pass of the boiler. The erosion occurred at a point where the tube passed through a baffle and it was found that other tubes in the same locality were showing signs of extreme wear. Accordingly, this entire baffle was removed and all of the tubes were built up by electric welding. This boiler was returned to service on September 19. On September 26 a leak caused by erosion in the lowest rear tube in the economizer was discovered. The plant was shut down and this tube was built up by electric welding. The boiler was placed back in service on September 30. This problem of erosion has again been called to the attention of the manufacturer, and it is hoped that some suggestions for its reduction will be had in the future.

On September 23 a new conveyor belt was installed to replace the one used for transporting the coal from the bucket elevator to the coal hopper. This belt goes over a mechanical tripper which caused excessive wear where the ends were joined together by a mechanical splice. The ends of the new belt were vulcanized and it is felt that the life of the new belt will be much greater than the one joined by the mechanical connector. The sprocket in the upper end of the bucket elevator which takes the coal from the ground level to the bunker broke on November 2. Because the sprocket was cast iron and could not be repaired locally, it was necessary to procure a replacement sprocket from the manufacturer. The elevator was repaired and the plant was returned to service on November 5.

Both units of the Carp Power Plant were taken down, inspected, and cleaned beginning early in September. They were found to be in excellent condition except the rotor of the number 1 unit. The field windings of this machine were loose on the field poles. The same condition had been experienced in the number 2 unit several years ago but had been corrected. Since our shops were not equipped to do the work required, bids were taken on the repair work and the rotor was sent to the Westinghouse Repair Shops at Milwaukee for repairs during October. The repair work was completed and the unit was placed in service on November 9. No operating restrictions were placed on the plant by this generator being out of service, as water conditions were such that only one of the two units could be operated economically. Thus whichever machine was not under inspection or repair could be operated with no actual reduction in plant capability.

Several interruptions were experienced on the transmission lines during the year, but none were of great duration and no extensive loss of equipment was encountered. In several instances the duration of the interruption was extended because of faulty relay operations and because of faulty system dispatching. The transmission system served out of Ishpeming has expanded very rapidly in the last few years, and the operating personnel has not become thoroughly familiar with all of the various system conditions which may be experienced. The result is that new conditions sometimes cause confusion and delay in restoration of service. This condition is greatly aggravated by improper relay action. A new system of relaying has been installed at the Cedar Substation in connection with the Escanaba line. These relays have operated falsely several times and as a result the Presque Isle Plant has been kicked off of the line. Studies are being made both by the personnel of the Upper Peninsula Power Company and by representatives of the relay manufacturers to try to correct these conditions and it is hoped that a satisfactory decision will be reached in the immediate future.



ELECTRIC POWER DEPARTMENT  
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STATISTICAL DATA - 1957

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Precipitation -	0.25	0.91	0.57	2.35	2.60	2.55	1.13	2.17	5.88	1.50	3.74	0.88
Total precipitation at Ishpeming during 1957 -	24.53" (2.044 ft.)											
Average " " " "	- 30.71" (45 year record)											

CARP RIVER PLANT:

Drainage area above intake dam													66.66 sq. miles
Cubic feet precipitation in 1957													3,798,516,750
Kilowatt hours generated in 1957													15,112,000
Cubic feet water utilized in 1957 (90 cu. ft. - 1 kwh)													1,360,980,000
" " " wasted over intake dam in 1957													42,372,000
" " " in Carp storage Dec. 20, 1956													332,412,360
" " " " " " Dec. 20, 1957													372,625,940
" " " increase in Carp storage in 1957													40,213,580
Total run-off in 1957 (cubic feet)													1,443,565,580
Run-off per square mile of drainage area (cubic feet)													21,655,649
Second-feet run-off													0.687
	<u>1913</u>	<u>1914</u>	<u>1915</u>	<u>1916</u>	<u>1917</u>	<u>1918</u>	<u>1919</u>	<u>1920</u>	<u>1921</u>	<u>1922</u>	<u>1923</u>	<u>1924</u>	<u>1925</u>
Total Precip.	30.11	26.53	38.40	36.83	25.46	31.05	29.50	27.40	30.38	33.67	21.90	22.95	20.71
Sec.-ft. Run-off	1.03	0.67	0.93	1.29	0.70	0.79	0.83	0.73	0.68	1.06	0.59	0.50	0.25
	<u>1926</u>	<u>1927</u>	<u>1928</u>	<u>1929</u>	<u>1930</u>	<u>1931</u>	<u>1932</u>	<u>1933</u>	<u>1934</u>	<u>1935</u>	<u>1936</u>	<u>1937</u>	<u>1938</u>
Total Precip.	35.69	29.86	36.06	32.28	23.14	36.70	31.20	32.72	32.87	27.10	30.23	30.10	35.32
Sec.-ft. Run-off	0.85	0.98	1.11	0.67	1.10	0.83	1.13	1.14	1.00	0.79	0.89	0.86	1.33
	<u>1939</u>	<u>1940</u>	<u>1941</u>	<u>1942</u>	<u>1943</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>	<u>1951</u>
Total Precip.	33.58	30.34	32.20	34.26	32.04	32.77	30.81	26.12	32.88	22.87	37.23	30.64	43.50
Sec.-ft. Run-off	1.47	1.05	0.83	0.84	1.17	0.70	0.81	0.56	0.88	0.44	0.77	1.09	1.54
	<u>1952</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>1957</u>							
Total Precip.	24.35	35.42	33.77	30.82	25.52	24.53							
Sec.-ft. Run-off	0.69	0.85	0.84	0.93	0.77	0.687							

McCLURE PLANT:

Drainage area above intake dam													140.52 sq. miles
Cubic feet precipitation in 1957 (Hoist Plant - 28.78"-2.398')													9,394,099,698
Kilowatt hours generated in 1957													41,603,000
Cubic feet water utilized in 1957 (125 cu. ft. - 1 kwh)													5,200,375,000
" " " wasted over intake dam in 1957													0
" " " in Hoist storage basin Dec. 20, 1956													1,554,892,584
" " " " " " " Dec. 20, 1957													1,320,423,500
" " " decrease in 1957													234,469,084
" " " in Silver Lake Dec. 20, 1956													91,408,800
" " " " " " " Dec. 20, 1957													0
" " " decrease in 1957													91,408,800
Total run-off in 1957 (cubic feet)													4,874,497,116
Run-off per square mile of drainage area (cubic feet)													38,995,977
Second-feet run-off													1.237
	<u>1921</u>	<u>1922</u>	<u>1923</u>	<u>1924</u>	<u>1925</u>	<u>1926</u>	<u>1927</u>	<u>1928</u>	<u>1929</u>	<u>1930</u>	<u>1931</u>	<u>1932</u>	<u>1933</u>
Total Precip.	35.10	42.03	26.60	30.49	24.06	43.95	35.51	43.80	38.75	30.81	37.02	32.54	35.07
Sec.-ft. Run-off	1.02	1.54	0.85	0.92	0.52	1.52	1.80	2.22	1.36	1.45	1.10	1.23	1.30
	<u>1934</u>	<u>1935</u>	<u>1936</u>	<u>1937</u>	<u>1938</u>	<u>1939</u>	<u>1940</u>	<u>1941</u>	<u>1942</u>	<u>1943</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>
Total Precip.	35.02	29.96	32.16	38.18	40.93	41.22	36.59	38.15	40.20	35.64	37.62	37.94	31.91
Sec.-ft. Run-off	1.16	0.90	1.05	1.19	1.75	1.69	1.47	1.28	1.15	1.43	1.17	1.36	0.86
	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>1957</u>		
Total Precip.	37.27	28.81	43.28	40.65	50.90	29.27	41.56	38.13	35.70	31.71	28.78		
Sec.-ft. Run-off	1.22	0.78	1.24	1.37	2.09	0.97	1.33	1.29	1.03	1.18	1.237		

Average precipitation at Hoist Plant - 36.14" (37 year record)

ELECTRIC POWER DEPARTMENTSTATISTICAL DATA - 1957Energy Delivered to Transmission System  
by CCICo. Generating Facilities

	<u>Kwh Delivered to Lines</u>				
	<u>CCICo. Steam</u>	<u>CCICo. Hydro</u>	<u>CCICo. Diesel</u>	<u>UPGCo. Steam</u>	<u>Total</u>
Jan.	1,898,980	8,586,175	83,395	721,950	11,290,500
Feb.	3,102,825	6,003,295	119,365	4,201,495	13,426,980
Mar.	2,465,840	7,464,425	445,140	2,476,623	12,852,028
Apr.	1,190,830	8,236,860	13,900	1,563,015	11,004,605
May	1,299,350	7,919,955	327,155	3,271,606	12,818,066
June	2,957,735	6,472,815	449,315	4,708,263	14,588,128
July	3,494,750	4,757,510	293,825	5,223,885	13,769,970
Aug.	3,910,010	4,691,195	689,765	7,170,719	16,461,689
Sept.	3,140,410	5,356,746	960,860	7,207,900	16,665,916
Oct.	2,921,690	5,789,030	98,835	7,343,658	16,153,213
Nov.	2,374,380	7,426,310	33,655	3,773,725	13,608,070
Dec.	1,603,314	7,953,020	198,970	2,669,175	12,424,479
Total annual use by UPPCo. of CCICo. energy from UPGCo.				<u>27,898,786</u>	<u>27,898,786</u>
Total energy produced by CCICo. generating facilities	30,360,114	80,657,336	3,714,180	78,230,800	192,962,430



ELECTRIC POWER DEPARTMENT

STATISTICAL DATA - 1957

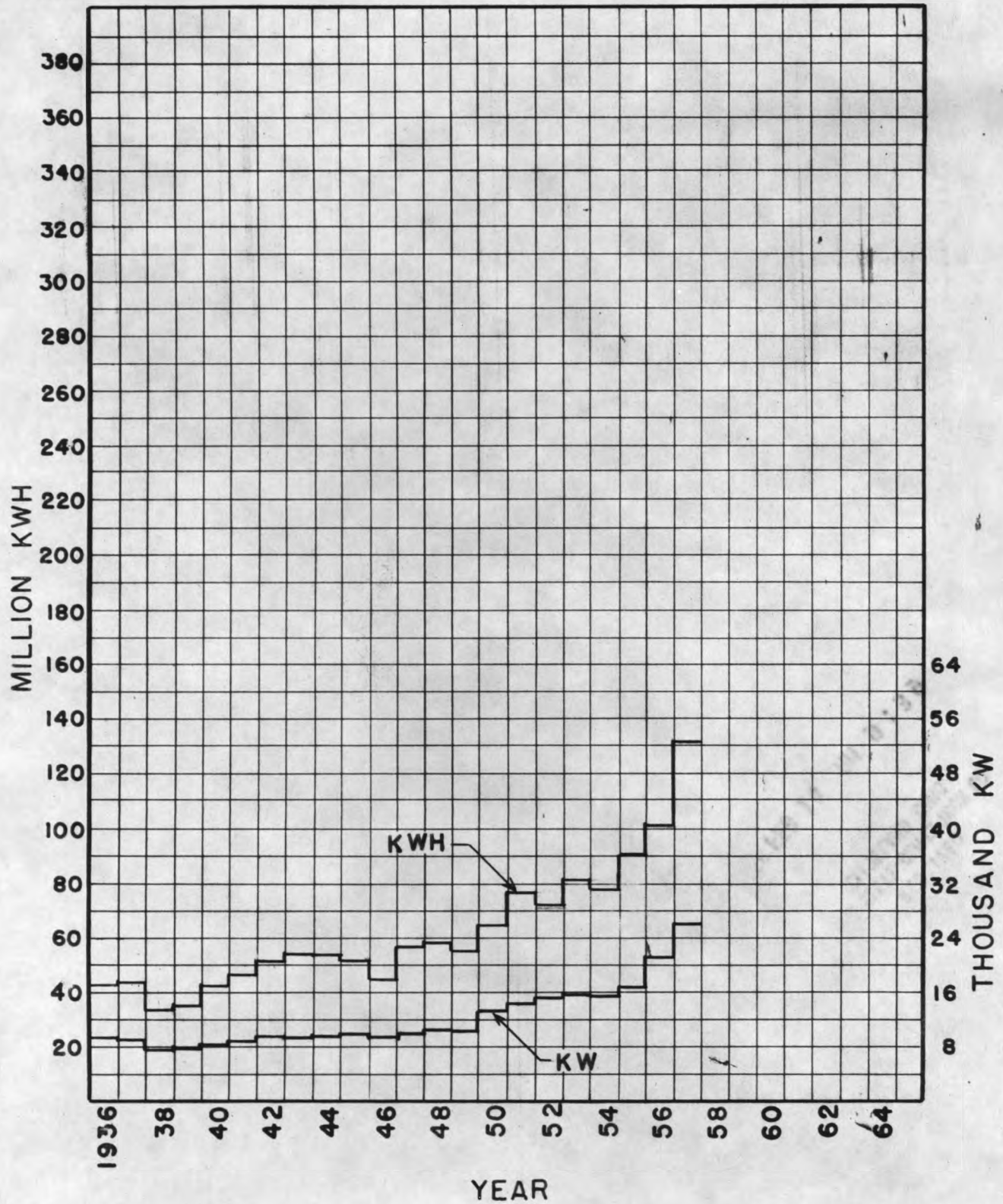
Utilization of Energy Delivered to  
Transmission System by CCICo. Generating Facilities

	<u>Ishpeming Steam</u>		<u>Hydro</u>		<u>Diesel</u>		<u>UPGCo.</u>		<u>Total Kwh</u>	<u>% of Total</u>
	<u>Kwh</u>	<u>%</u>	<u>Kwh</u>	<u>%</u>	<u>Kwh</u>	<u>%</u>	<u>Kwh</u>	<u>%</u>		
The Cleveland-Cliffs Iron Co.	161,341	0.1	64,461,322	33.4			50,332,014	26.1	114,954,677	59.6
Humboldt Mining Co.			16,196,014	8.4					16,196,014	8.4
Upper Peninsula Power Co.	<u>30,198,773</u>	<u>15.6</u>	_____	_____	<u>3,714,180</u>	<u>1.9</u>	<u>27,898,786*</u>	<u>14.5</u>	<u>61,811,739</u>	<u>32.0</u>
Total	30,360,114	15.7	80,657,336	41.8	3,714,180	1.9	78,230,800	40.6	192,962,430	100.0

\*Sold directly to UPPCo. by UPGCo.

RECORDED  
INDEXED  
MAR 11 1958  
U.S. DEPT. OF THE INTERIOR  
BUREAU OF MINES

# ENERGY & POWER REQUIREMENTS C.C.I. CO. OPERATIONS





SUBJECT: Operating Research Department - Year 1957

Mr. J. S. Westwater  
Manager, Michigan Mines

Dear Sir:

I would like to submit to you a report on the work that has been done by the Operating Research Department in 1957.

First, I will summarize the various projects that we have been working on throughout the year, and following the summary is a discussion of various projects with the savings that can be justified as a result of the efforts of this department.

INCENTIVES

1. Mather Mine "B" Shaft - Excavation of 10th Level crusher station plat.
2. Mather Mine "B" Shaft - Payment of miners on drilling footage incentive versus cars per shift.
3. Mather Mine "B" Shaft - Incentive for placement of 36" steel tube liners in raises.
4. Mather Mine "B" Shaft - Drift repair work.
5. Cliffs Shaft - Loading and Trammig incentive for front end loader.
6. Mather Mine "A" Shaft - Revise long hole stoping incentive and improve working procedure.
7. Bunker Hill - To determine incentive, proper crew size and best operating procedure in 2102 Block.
8. Maas Mine - Long hole stoping rates.
9. Mather Mine "A" Shaft - Inclined drift incentive study.

TIME STUDIES

1. Republic Mine - Comparison between Gardner Denver DH-143 Air Trac and Jet Piercer.
2. Humboldt Mine - Comparison of the Joy Rotary rig with the DH-143 Air Trac.
3. Tilden Mine - Comparison of Joy Rotary with a Bucyrus-Erie 29-T churn drill.
4. Bunker Hill-Maas Mine - Caging schedule.
5. Bunker Hill-Maas Mine - Trammig practises.

TIME STUDIES -contd.

6. Bunker Hill-Maas Mine - Comparison of caving on chain conveyor with scraper operation in 2414 Block.
7. Bunker Hill Mine - Comparison of Toussaint-Heintzmann yieldable arches with Bethlehem Steel sets in 2102 Block.
8. Bunker Hill Mine - Several different carbide insert bit tests.
9. Cliffs Shaft Mine - Testing various suppliers' bits.
10. Cliffs Shaft Mine - Comparative study on 11 different makes of drill machines and jacklegs.
11. Mather Mine "B" Shaft - Comparative bit tests.
12. Mather Mine "B" Shaft - Comparative study on six different makes of American made drill machines.
13. Mather Mine "A" Shaft - Study in inclined drift for proper working procedure.

GENERAL PROJECTS

1. Chain Conveyors.
2. Auger Miner.
3. Method of rope inspection at Cliffs Shaft.
4. Raise Cage.
5. Yieldable Arches - Bethlehem Steel and Toussaint-Heintzmann.
6. Revision of Company's safety rules.
7. Vibrating bars for barring mills.
8. Vibrating plates in the foot of mining raises to avoid build-up of ore.
9. Chain conveyor and scraper hoist maintenance records.
10. Chain mill blocking devices.
11. Gafner ditch cleaner.
12. Designed new pan for chain conveyors.
13. Escorted visiting mining men underground.
14. Bunker Hill-Maas Mine studies with G. J. Holt.
15. Cascade development.



Before proceeding into the discussion of the various projects which show the savings that are attributable to the efforts of this department, I would like to recap these savings below:

RECAP OF SAVINGS FOR YEAR 1957 -

1. Chain Conveyors - Operating Labor (See p.4).....	\$ 152,941.82
2. Chain Conveyors - Maintenance (See p.4) .....	53,061.70
3. Chain Conveyors - Specific Cases:	
Mather Mine "A" Shaft - Motor Crews .....	7,409.44
Mather Mine "B" Shaft - Caving Drift .....	8,983.92
Bunker Hill - Accelerated Drawing of Block - Reduction in Drift Repairs .....	48,000.00
4. Incentives - Maas Mine Long Hole Drilling .....	35,145.82
5. Incentives - Mather Mine "A" Shaft - Labor .....	53,240.00
Supplies .....	25,000.00
6. Yieldable Arches - Bunker Hill Mine - Toussaint - Heintzmann vs. Bethlehem Steel ...	3,887.00
7. Cage Method of Raising - Mather Mine "B" Shaft .....	7,574.00
8. Caging Method at Bunker Hill-Maas Mines .....	<u>23,940.00</u>
Gross Savings - 1957	\$ 419,183.70
Cost to Operate Department in 1957 - Actual	<u>49,789.00</u>
Net Savings - 1957	\$ <u>369,394.70</u>
Other Savings (Per Year) (See p.10)	99,666.00
"Fringe" Labor Savings	<u>91,681.04</u>
Total Cost Reduction on a Yearly Basis - Obtained in 1957	\$ <u>560,741.74</u>

GENERAL SAVINGS USING CHAIN CONVEYORS

Average number of chain conveyors in operation at a time at all properties .....	17 Chains
Number of Chains working steady every day .....	7 Chains
Balance of chains working $\frac{1}{2}$ time/shift - 10 chains x $\frac{1}{2}$ = 5 chains working full time .....	5 Chains
Total chain conveyors working full time .....	12 Chains
Average saving in labor per shift per chain .....	1 Man
Shifts Per Day .....	3 Shifts
Average operating days in 1957 for all properties excluding Bunker Hill January shutdown period .....	232 Days

GENERAL SAVINGS USING CHAIN CONVEYORS -contd.

Average Rate/Hour for the man eliminated by chain conveyor operation = Job Class 8 .....	\$2.289 Per Hour
(Transfer Scrapperman - J.C. 6 / Stope Scrapperman-J.C. 10)	
12 chains x 232 days x 3 shifts x 8 hours/shift x \$2.289=	
<u>Total Labor Saving</u> realized by the C.C.I. Co. by using chain conveyors instead of scraper hoist operation =	<u>\$152,941.82</u>

For a general comparison of cost of maintenance between chains and scrapers, a basis has been established at the Mather Mine "B" Shaft. Repair costs for a scraper hoist operation is \$.063 per ton of ore handled while it costs only \$.006 per ton to maintain the chain conveyors. This amounts to a saving of \$.057 per ton or a saving of \$53,061.70 for 930,907 total tons of ore handled at all properties by chain conveyors in 1957.

Mather Mine "A" Shaft

In a mining area where the practise had been to scrape directly into cars, the application of a chain conveyor in an inclined crosshaul drift eliminated the need for a steady motor crew in a congested tramming area by delivering the broken ore to a sub level belt conveyor.

According to the Mather Mine "A" Shaft figures, the following calculation is the saving realized on a three shift operation in three months time.

Cost of one motor crew for 3 months on a three shift schedule .....	<u>\$ 7,409.44</u>
---	--------------------

Actually, the chain conveyor enabled mining this area to completion in one-half the estimated time allotted for a scraper-tram operation.

Mather Mine "B" Shaft

At the Mather Mine "B" Shaft in #85 contract above the 7100 Cross-cut on 7th Level near the 71C Block from September 15, 1957 to October 29, 1957, it was possible to observe a chain conveyor operation handling ore from the mills in a caving drift directly to a sub-level belt conveyor. Previously, a scraper hoist operation had been studied in the same area under exactly the same conditions.

During the six weeks time the chain conveyor was operating in the caving drift, a total of 20,418 tons of ore were pulled from the mills on one side of the drift. The saving per ton realized (\$.53 scraping - \$.09 chain) was \$0.44 per ton or a total of \$8,983.92.

The maximum daily production from this caving drift was 2,088 tons. It should probably be pointed out that this is an exceptionally high daily production. However, the reason special mention is made of this high rate of production with this type of continuous ore transportation system underground, is to substantiate the planning programs the superintendents of the soft ore properties have for future continuous belt tramming with chain conveyors in caving or transfer drifts feeding these sub level gathering belts. This accelerated production will minimize the amount of repairs in these caving drifts.



GENERAL SAVINGS USING CHAIN CONVEYORS -contd.

Bunker Hill-Maas Mine

In checking over the labor savings in the chain conveyor applications at this property, we can calculate a 1.1 man saving per chain, but for practical purposes we'll call it a saving of one man as is the case at the other properties.

One of the bigger savings that the Bunker Hill can justify is the saving in repair costs. As an example, an average block caving drift would normally require two complete repair jobs for the life of the block. The average condition in a Bethlehem yieldable arch drift requires only one repair with a chain conveyor operation, initially, because accelerated drawing of the ore alleviates ground pressures, and secondly, the chain can operate in a much more confined drift than a scraper. The average cost to repair a transfer approximately 150' long is \$6,000 per repair job. This situation has been true in 8 different transfers which indicates a saving of \$48,000.00 in repairs.

Mention should be made of the chain mill blocking device that was designed as a safety measure in caving drifts that have chain conveyors installed in them.

We have designed a new pan section for the chain conveyors, and if the proposed pan proves successful, we will be able to make our own pans for approximately \$100 cheaper than our purchase price. This would be a saving of \$4,600 on each 250' chain conveyor.

This project will be continued in 1958.

Vibrating Plates in Mills

In conjunction with chain conveyors in caving drifts, we have designed a vibrating plate which is installed on the foot of the mining raises or mills, that has completely eliminated the build-up of ore on the foot. It also serves to keep the ore moving out of the raise so that a minimum amount of barring of the mills is necessary except for large chunks that require blasting. From a safety standpoint, this set-up could greatly reduce the number of leg and hand injuries that plague this type of work.

One of these plates was used in #85 contract above 7th Level at the Mather "B" when they were making their production record of 2,088 tons per day from one caving drift.

Prior to the use of the vibrating plates, we tried to perfect a mill bar with a small vibrator on the barring end to use in barring down mills, but it didn't work out too well. It would have required heavier construction which would have been too heavy to handle safely.

INCENTIVES

Prior to the time that time studies were used to establish incentive rates, the method of figuring these rates was based on past experience, comparisons with similar types of work, and common sense. This, however, did not eliminate the possibility of "run away" rates, especially after the reclassification of jobs in 1952.

INCENTIVES -contd.

When an incentive rate is established by time study methods, every movement of the persons involved in the operation is timed and recorded for a period of several weeks or as long as is necessary to determine an average time for each movement or duty performed in a cycle or shift. From the study, all productive and unproductive time is calculated. From these records, it is possible to determine what unproductive time can be eliminated from the cycle. It is also possible to check over the production time to determine if the method of performing different tasks in the cycle can be improved. With the deletions of unproductive time and improved methods, an average performance can be established and, in turn, an average incentive rate that will be fair to the company and to the worker.

It is difficult to say how much money has been saved by using time study methods for establishing incentive rates, but it is a known fact, that in every case except one, the time studied rate has been lower than anticipated. After these lower than expected rates have been introduced, they are found, as previously mentioned, to be fair and acceptable to both management and labor union.

As an example of savings from incentive rates established by time study methods, a new rate per foot of drilling in long hole stoping was requested by the Maas Mine. The Maas operators wanted to cut the price per foot because they thought it had become too high.

Rate per foot paid for long hole drilling before time study .....	\$ 0.50 Per Foot
Rate per foot paid after time study and methods improvements .....	\$ 0.31 Per Foot
Savings in Price Per Foot .....	\$ 0.19 Per Foot
Feet Drilled (Year) .....	184,978 Feet
Total Savings .....	<u>\$35,145.82</u>

An example of savings due to change in basis for paying the incentives is best illustrated by the Mather Mine "A" Shaft undercutting procedure. Originally, the miners were paid on a footage basis with an established pattern for each undercut blast. The supervisory personnel found that the miners were always pleading the case of longer and more holes to properly undercut a block. Our department was requested to study the situation and provide an answer. In the final analysis, we determined the original pattern for drilling to be adequate and proper, but that the miners were to be paid on a flat rate per ring blast rather than on a footage basis.

It was found that this new method of paying reduced complaints from the miners after they accepted it, and it also reduced the undercutting time by 25% per block. This saving was directly reflected in the cost of undercutting.

The following calculation is the estimated labor saving for 1957 realized by revising this method of incentive payment.

Approximate feet of undercut drift .....	12,000 Feet
One pattern for each 4' section of drift .....	3,000 Patterns



INCENTIVES -contd.

Average incentive pay for Mather "A" pattern .....	\$	53.24
Total Cost of Labor for Undercutting Since New Incentive .....		159,720.00
Labor Saving in 1957 (Approx.) .....		53,240.00
$159,720 = \$212,960 - \$159,720 = \$53,240$		
.75		

There is also a saving of approximately \$25,000 for supplies and equipment.

YIELDABLE ARCHES

In January 1957, this department initiated the investigation of the applicability of the Toussaint-Heintzmann yielding steel arches to our ground support problems. The Bunker Hill Mine operators were willing to try the T-H steel in an area where it would be possible to compare these yieldable sets with the Bethlehem Steel sets. The "C" and "D" caving drifts of the 2102 Block above 12th Level were used for the comparison. A chain conveyor was installed in each drift so that the test would be in line with our present and future thinking for materials handling.

The results of the test showed that the Bethlehem yieldable arches cost 2.84 times more in labor and supplies to maintain as compared to the T-H arches. In actual money, it cost \$2,113.00 to keep the T-H drift in repair as compared to \$6,000.00 for the Bethlehem drift for a saving of \$3,887.00.

The overwhelming superiority of the T-H sets over the Bethlehem sets has spurred the Bethlehem Steel Company to improve their product so that in the near future they hope to equal or out-perform the T-H yieldable sets. Until this comparison had been made, the Bethlehem Steel Company's sales representatives had been complacent and rather unimpressed with our mine operators' requests for heavier sections of the arches, but now they are willing to go all out to please us on any little request.

This development and the keeping of the price of ground supports and other mining equipment competitive is another important function of this department that cannot be measured in actual dollars.

CAGE METHOD OF RAISING

The first raise advanced by the cage method has been completed and a saving of \$7,574.00 was realized for this 6' x 6', 200 foot long raise over the conventional method of raising. The saving in time was 50 shifts by cage versus 139 shifts by the old method.

This new system is presently gauged for naked raises and is therefore adaptable to ventilation and ore pass raises. However, it is our intent to try to apply it to the other types of raising as well. Presently, the properties that would use this method of raising would each require an average of two raises, varying in height from 200' to 400' per year. The savings could well amount to \$30,000 to \$40,000 per year.

### CAGING SCHEDULE STUDY AT THE BUNKER HILL-MAAS

When the Bunker Hill and the Maas Mines were consolidated, the caging schedules at the beginning and end of the shifts became a problem, especially on day shift. The Bunker Hill personnel requested a time study and a suggested schedule for handling the Maas and Bunker Hill underground workers.

There were approximately 200 men to be handled. At the Maas Mine, there were two different level stops and at the Bunker Hill Mine there were four stops.

When the study was completed and the new schedules were made, it was found that an average of 15 minutes per man per day was saved. For the 200 men affected, this would amount to a daily saving of approximately \$140.00 or a saving for 1957 of an estimated \$23,940.00.

### AUGER MINER

After the Bunker Hill completed the installation of their new hoisting equipment in January, 1957, production with the auger miner was resumed. We were able to determine that the auger equipment had been constructed heavy enough to do the job of drilling the Bunker Hill ore. We were able to establish the best bit design, the proper speed of rotation, the correct size of hole to drill, and the most convenient method of handling flights, but we were not able to predict, induce or control the caving or settling action of the orebody. The only thing that we could determine about the ground in this particular block at the Bunker Hill was that it did not properly lend itself to auger mining.

One of the most important points that we did prove was that we could mine a good, clean high grade product with the auger.

With the Bunker Hill experience to guide us, we are of the opinion that a trial of the auger miner in the interbedded ore at the Mather Mine "A" Shaft will prove successful. This would make available a sizeable tonnage of desirable high grade ore that has been left behind because of the high cost and contamination previously encountered in mining this orebody.

Everybody concerned knows that we haven't realized any particular return on our investment, but we do feel that the auger, or some variation of the present equipment, will have an application in our soft ore mines for mining low-cost ore.

### DRILL MACHINES, DRILL STEEL & BIT TESTS - UNDERGROUND & OPEN PIT

During the year 1957, there have been a great many tests of carbide insert bits in the underground mines, and our department has correlated the information and passed it on to all of the operators.

The most significant development in 1957 was in the performance of the Kenametal bits at the Bunker Hill and Cliffs Shaft properties. The Kenametal representatives brought us two different grades of carbide bits, one softer and one harder carbide, that they had developed and gave them to us to try at any properties we desired.

The first trial was made at the Bunker Hill Mine. The harder carbide bits performed 12% better than the Rok Bit which up to that time was performing the best at the Bunker Hill and was considered the standard bit.



DRILL MACHINES, DRILL STEEL & BIT TESTS - UNDERGROUND & OPEN PIT -contd.

In discussing the performance of the bits with the sales representatives, it was suggested to them that their flutes or waterways be enlarged to provide better removal of the drilled material from the face of the bit. The Kenametal people were willing to try our suggestion and we ground the waterways to what we thought would be the proper size without harming the overall structure of the bit. The results of the following tests proved that the Kenametal hard carbide bits out-drilled all others by 16 to 24% in Bunker Hill ground.

After the Bunker Hill tests were completed, the same type of Kenametal bits were used in a test at the Cliffs Shaft Mine versus the standard bit which was manufactured by Ingersoll-Rand. The results of this test proved that the softer Kenametal carbide bit was by far the best; out-performing the Ingersoll-Rand bit by 39.6% on a footage basis and 53.3% on a footage and cost comparison basis.

This would represent a reduction in bit costs at the Cliffs Shaft Mine of approximately 35% if the Kenametal bits were to be used in place of the Ingersoll-Rand bits in 1958. The total savings would amount to 35% of \$36,483.47, which is the amount of money spent by the Cliffs Shaft on carbide bits in 1957, or \$12,769.21.

An extensive test was conducted on six different American made jack hammer drilling machines mounted on integral jack legs at the Mather Mine "B" Shaft and on eleven different American and foreign made machines at the Cliffs Shaft.

In both tests the machines were compared in hard and soft ground, and they were judged on drilling performance and handling characteristics. When the tests were completed, the machines were all disassembled to determine the amount of wear on all parts.

The results proved conclusively which machines were best, because in both tests the same drills outperformed the others.

This is another case where our department has provided an important service to the company that cannot be measured in actual dollars at the present time.

Other drilling tests have been conducted at the open pits comparing the performance of the jet piercer, the rotary drill, the churn drill, and the percussion wagon drills.

As an example, the Joy rotary drill and the Bucyrus-Erie 29-T churn drill were compared at the Tilden Pit. It was determined that the rotary rig could drill holes, for both the 40' and 60' benches, 17.2% cheaper than the churn drill. This saving amounts to an average saving of \$.80 per foot of hole drilled.

This, however, was not the most important result of the test. It was also proved that the rotary rig could drill six times as fast as the churn drill. At an intermittent operating property such as the Tilden Pit, a machine such as the rotary rig can provide quick tonnages with a small crew in a much shorter length of time than the churn drills.

Again, it is hard to evaluate the actual savings achieved by a study of this nature, other than to say that for an estimated 1,000' of drilling per summer at the Tilden Pit the saving would be \$800.00. However, it could be compared in this manner. Since the rotary rig drills six times as fast as the churn drill, one rotary rig and two men can do the work of six churn drills and twelve men in a days

DRILL MACHINES, DRILL STEEL & BIT TESTS - UNDERGROUND & OPEN PIT -contd.

time. This amounts to a saving of five machines and ten men per shift. In 1,000' of drilling, it would amount to a saving of 86 man shifts or \$1,597.88.

Other tests at the open pits were conducted to help determine which type of drill machine would best be adapted for the type of ground to be drilled. In these cases, a direct saving in money on a cost per foot basis may not amount to a great deal, but it helped the operators determine which machine would perform the best. The savings again would be determined in drilling time.

DITCH CLEANER

This department redesigned a pulp loading machine into a ditch cleaner that has quadrupled the output of the two men required for the operation. In other words, this \$2600 piece of equipment with two men will do the work of eight men. This would amount to an annual saving of \$19,920.00 on a four day per week schedule.

HOIST ROPE INSPECTION

This department initiated the study of the new hoist rope inspection with the use of motion pictures. After our first few attempts, it was decided to ask Mr. Dana Cory of the Electrical Department to help out because of the complex timing and lighting that will be required to obtain the results desired. Mr. Cory is continuing the study with the cooperation of Mr. Lindquist of our department.

CONCLUSIONS

In the Recap of Savings, we show a total of \$419,183.70 saved through the efforts of the Operating Research Department with a net savings of \$369,394.70. However, we have also pointed out in the general discussions that additional savings could be justified, but since these projects were completed during the latter part of 1957 the savings will be reflected in 1958.

If these projected savings were to be totaled, it would amount to:

Chain Conveyor Pans (Replacement of 200).....	\$ 20,000.00
Cage Method of Raising .....	30,000.00
Cliffs Shaft Savings on Carbide Bits .....	12,770.00
Rotary Drilling at Tilden .....	800.00
Ditch Cleaner .....	6,000.00
T-H Sets or Comparable Bethlehem Set (Est.) .....	<u>30,096.00</u>
Projected Savings .....	\$ 99,666.00
Gross Savings - 1957 .....	<u>419,183.70</u>
Total Gross & Projected Savings .....	<u>\$518,849.70</u>
Less Expense .....	<u>49,789.00</u>
NET SAVINGS .....	<u>\$469,060.70</u>



CONCLUSIONS -contd.

Not included in the gross savings figure is the 24% (Industrial Relations Department's calculations) that should be added to the cost of direct labor for fringe benefits. Of the \$469,060.70 net savings shown in the table above, \$382,004.34 is direct labor. Adding 24% for labor fringe benefits to the net savings figure, shows a total savings of \$560,741.74.

Calculation:

Net Savings .....	\$469,060.70
Fringe Benefits 24% x \$382,004.34 (Labor) = .....	<u>91,681.04</u>
Grand Total Net Savings .....	<u>\$560,741.74</u>

Aside from placing a monetary value on the efforts of this department, it should be pointed out that from the day this department was organized in February, 1956, we have been constantly engaged in perfecting and adapting chain conveyors, the auger miner, and other equipment for use in our underground properties.

In the case of the chain conveyors, it was necessary for us to make this equipment work under all kinds of conditions, types of ground and various installations, but the biggest job was to educate the mining personnel at the properties in the use and care of chain conveyors.

It may seem odd, but many of our older mining supervisors and other underground employees are immediately opposed to anything new. In 1956 and the beginning of 1957, this situation was hard to buck, however, we have managed to prove to everyone that our prime purpose is to make their jobs more productive and safer.

As far as the operating personnel is concerned, we have had excellent cooperation from them from the very start.

In conclusion, it should be pointed out that in every case where new equipment or methods are introduced one of our primary goals is to improve safety conditions that may be affected by our efforts.

*John M. Haivala*

John M. Haivala  
Operating Research Department

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EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT

YEAR 1957

The Annual Report of the Employees' Insurance, Compensation and Pension Department is presented herewith.

The usual activities of the Department were carried out during the year 1957. These activities cover matters of general welfare of employees, compensation, insurance, pensions and various activities on a community basis. The Department also supervises the Police and Plant Protection and cooperates with the public relations program and Company sponsored employee activities. The Superintendent of the Department is also Associate Editor of "The Cliffs News."

Each year in our Annual Report we point out for the purpose of carrying a continuous record that this Department was formerly known as the Pension Department and was under the supervision of Mr. W. H. Moulton, whose title was Secretary of the Pension Department. Mr. Moulton retired on July 1, 1938. The Department then became the Welfare Department and carried on under that name until the newer activities covering compensation, insurance, and pension became a more important function of the Department. Mr. Walter F. Gries assumed charge of the Department in 1938 and at that time was given the title of Superintendent of the Welfare Department.

The Department carries on a great many functions having to do with the health, welfare and general happiness of our employees. Many of the activities carried on by the Department are not of a welfare nature in the sense that welfare is generally understood. Much of the activities of the Department might well be described as coming under the heading the Employee and Public Relations.

The Employees' Insurance, Compensation, and Pension Department and its divisions work very closely with the Safety Department, which is under the direction of Mr. A. J. Stromquist. The coordinated efforts of the two departments has undoubtedly benefited all employees.

Mr. W. E. Johnson, Compensation Agent, has served in this capacity since 1926. Mr. Johnson's background of experience has made him a very valuable employee. His efficiency as well as his cooperation and loyalty to the Company have proved over the years to be a great asset to the Company and to its employees.

Mr. Lowell C. Holmgren has for several years been in charge of our insurance and hospitalization matters, as well as pension and retirement payrolls. The insurance and hospitalization program has expanded over the years and Mr. Holmgren has assumed charge of the expanded program.

Mrs. Shirley O. Mattson has served as secretary to the Superintendent and to the Department since October 15, 1954. Mrs. Mattson is in charge of the files, all reports, safety glasses, and correspondence.

Mr. Fred Olson continues to serve as a clerk in the compensation and insurance division. He makes out many of the forms and keeps the records on hospitalization and insurance matters.



## EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORTYEAR 1957

Mr. Emil Hoff continues to serve in the capacity of Chief of Police for the Company. He is an experienced and trained police officer and was formerly captain of police at the Mather Mine "A" Shaft. Mr. Hoff keeps abreast of new developments in police work and is kept busy covering the whole area, supervising plant protection and making investigations of various kinds. The Superintendent of the Department acts as the head of the Police Department and Mr. Hoff confers with him practically daily on matters which concern plant protection and police coverage. Mr. Hoff is an officer of the U. P. Law Enforcement Officers Association and we have had the advantage of excellent cooperation with the Michigan State Police.

The personnel of the Employees' Insurance, Compensation, and Pension Department is as follows:

Walter F. Gries, Superintendent  
Walter E. Johnson, Compensation Agent  
Lowell C. Holmgren, Assistant, Compensation and  
Group Insurance Division  
Mrs. Shirley O. Mattson, Secretary to the Superintendent  
Emil Hoff, Chief of Police  
Fred Olson, Stenographer, Compensation Bureau.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT  
ANNUAL REPORT YEAR 1957

1.  
a. WORKMEN'S COMPENSATION

The direct work of the Compensation Department has been taken care of by Mr. Walter E. Johnson, Compensation Agent, as has been the plan since 1926.

While there were a number of cases that required additional attention during the year, most of them were largely routine. Some, however, were unusual and required wider investigation and at times the advice of our legal department. The following two cases are examples of these latter cases:

LAWRENCE ZARDUS - Bunker Hill Mine

Mr. Zardus entered a formal claim for compensation through his attorney for back and leg injuries alleged to be the result of "repetitive trauma to back and leg as a consequence of repeated strains." As a matter of course we denied liability and conducted a thorough investigation of the facts in the case. We found in our records several reported occupational episodes involving slight injury to the back and particularly an injury on January 7, 1955 which Mr. Zardus claimed as the point of origin of his back trouble. He was examined at the Mayo Clinic in 1956 where he underwent back surgery and we check these records and referred him to an orthopedic surgeon of our choosing for further examination. Our doctor corroborated the findings of the Mayo Clinic and traced his trouble to injuries resulting from his occupation. Over a period of five months Mr. Zardus withdrew his claim and refiled it bringing in more information to substantiate his claim. The case was set for hearing before a Hearing Referee and continued on two occasions. It was finally set for hearing on August 16, 1957. Prior to this hearing our attorney discussed the case with the attorney of Mr. Zardus and we agreed to pay compensation without going to further litigation. This decision was based on verification of the facts which Mr. Zardus claimed and on the extreme difficulty of opposing a claim for a back injury. Compensation of \$1,906.67 was paid to Mr. Zardus for periods of disability in 1955 and 1956 and 1957 totaling 47 weeks and four days. Medical expenses of \$929.56 were also paid.

THOMAS J. LAWER - Mather A Shaft

Mr. Lawer was injured on September 1, 1955. He and his partner were proceeding slowly to shaft with a motor train using battery power because the trolley wire current had gone out. The trolley current came back on suddenly and a trolley motor train coming back out from shaft collided with the battery train and Lawer was thrown against his motor injuring both his upper arms. Compensation was paid to Mr. Lawer until November 22, 1956 and discontinued then on the basis that he had recovered. This was done because he was claiming injury to his neck and lower spine which had not been involved before. Mr. Lawer entered a claim for further compensation through his attorney, and we opposed it. We had Mr. Lawer examined by two specialists in Duluth, both of whom stated that Mr. Lawer had recovered from the effects of his injuries and was not disabled from ordinary work. A compensation hearing was held before Hearing Referee Louis J. Gregory on February 15, 1957 at which time we had both of our specialists appear as medical witnesses. Mr. Lawer countered with a local orthopedic surgeon as his witness, and he testified that Mr. Lawer's present complaints could have been caused by a "whipsnap injury" to the neck at the time of the motor collision. The Referee chose to accept the opinion of Mr. Lawer's doctor over ours and awarded further compensation. In accordance with his award we are continuing to pay weekly compensation to Mr. Lawer.



EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT  
ANNUAL REPORT YEAR 1957

1.  
a. WORKMEN'S COMPENSATION (Continued)

We continue to operate under the Workmen's Compensation Laws of Michigan and Minnesota.

A description of the changes which occurred in the Michigan law is a part of the 1956 Annual Report. No further changes have occurred in the laws of the two states during 1957.



## EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT

YEAR 1957

1. a. WORKMEN'S COMPENSATION

Following is a list of the more serious cases other than fatalities which occurred in 1957:

<u>Mine and Report No.</u>	<u>Name</u>	<u>Nature of Injury</u>	<u>Compensation Paid to 12/31/57</u>
Gliffs-Shaft 1359	Arthur Luoma	Severe fracture, right tibia and fibula.	\$1,452.00*
Maas 814	John E. Blanck	Fracture, left lateral tibial plateau-surgery followed.	2,142.00*
Maas 815	Lawrence Armatti	Ruptured vertebral disc-surgery followed.	1,890.00*
Maas 831	Norman Powers, Jr.	Fracture of kneecap-surgery followed.	228.00*
Bunker-Hill 57	Louis E. LaJole	Fractured right tibia.	1,080.00*
Bunker-Hill 64	Leonard Tambling	Dislocation, left ankle & fracture lower 1/3 of fibula.	405.00*
Mather "A" Shaft 316	Arthur Linna	Fracture right tibial crest-surgery followed.	2,397.00*
Ore Improvement Plant - 1	Ronald E. Saari	Multiple fractures of both feet.	1,140.00*
Ore Improvement Plant - 4	Marvin B. Willett	Torn cartilage, right knee followed by surgery	480.00*
Mather "B" Shaft 175	Charles Delmont	Fractured bone in foot with swelling & hematoma.	1,207.00
Mather "B" Shaft 171	Arven Takanen	Fracture, left fibula. Fracture dislocation of bone in foot.	960.00
Sargent 49	John Damjanovich	Fracture of 4 bones in hand with muscle injury.	1,260.00*
Hill-Trumbull	Oscar Haapoja	Traumatic mangling of right hand. Substantial settlement will follow.	423.00
Canisteo 77	Ralph Trout	Fracture, left clavicle & multiple upper rib fractures	540.00*

\* Payments still being made.



EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT  
ANNUAL REPORT YEAR 1957

1.  
 a. WORKMEN'S COMPENSATION-Continued

Settlements were made in the following cases during 1957. The table below indicates the percentage of permanent disability and the member involved.

Donald Hurlbut	Hill-Trumbull	40% left middle finger	596.60
Robert E. Nelson	"	10% left foot	596.60
Robert Boatman	Holman-Cliffs	15% back	2,098.80
Anthony Benaglio	Athens	Redemption - a/c back	1,500.00
Peter Bollero	"	Redemption - a/c back	1,500.00
Mile Pervar	Sargent	5% left wrist	306.00
Charles Townsend, Jr.	Mather "B"	Redemption - a/c back	4,500.00
William Lehto	Sargent	10% left index finger	190.80
William Lehto	"	Left hand	1,782.79

ANNUAL REPORT - 1957  
 STATEMENT OF COMPENSATION PAYMENTS FROM  
 JANUARY 1, 1957 TO DECEMBER 31, 1957

543

	No. of Fatal Accs.	No. of Non-Fatal Accidents		Actual Comp. Paid in 1957	1946 & 1947		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	Estimated Compensation Still Pending	Medical & Special Expense	Cases Pending			
		Comp. Lost Time	No Lost Time		1946	1947													Fatal	Acc.	O.D.	
Bunker-Hill	1	23	25	47										3,570.67	72.00	6,830.83	22,206.00	7,716.79	1	4		
Cambria-Jackson		1	5	13					912.00						2,407.50	294.00	998.00	2,810.64		1		
Cliffs-Shaft		21	16	94										3,946.35	1,759.17	5,472.99	6,195.15	11,796.63		6		
E&A cc-345 - Negaunee Shaft												1,512.00					4,816.00	1,622.80	1			
General Storehouse			1	11														1,984.90				
Ishpeming Office																		1,544.55				
Lloyd																		5,097.57				
Maas	23	10	25	8			1,092.00		1,352.00	1,404.00	1,296.00	3,024.00	1,245.24	315.00	2,124.00	7,807.84	13,779.63	1,544.55	1	2	2	
Ohio	1	2	8								1,620.00		384.00			720.00	9,206.00	882.62	2	5		
Princeton																		800.00				
Spies																		1,118.00			1	
Tilden				2															110.60			
Cliffs-Shaft Lab Sample Crusher																						
General Shops	1	1	8																204.96			
Research Laboratory		1	10																67.50			
Miscellaneous		4	8																238.30			
Cleveland Roll																			467.96			
E&A cc-491 - Republic																						
Unc. Const. E&A cc-739	1																		771.67			
Unc. Const. E&A cc-770																						
Unc. Const. E&A cc-825	1																		56.05			
Ore Improvement Plant	6	2	35																2,560.50			
Electric Power Department			1	2																		
Humboldt			2	43																		
Republic		5	3	45															902.50			
Pelletizing Plant	2	8	28																273.83			
Negaunee																						
Mather Mine "A" Shaft		24	30	125															924.00		1	
Mather Mine "B" Shaft	1	30	63	257															43,312.50		13	
Athens																			38,105.00		3	
																			15,000.00		1	
																			15.00			
Total - Michigan Mines	2	139	174	766	120,331.21	1,858.50	1,092.00	1,092.00	4,856.00	1,404.00	9,296.00	10,105.00	6,877.24	16,584.42	26,310.34	40,855.71	146,250.28	68,913.49		12	39	4
Hibbing Office				1															812.25			
Hibbing Miscellaneous																			285.00			
Agnew																			780.05			
Canisteo	4	1	66		926.67														1,800.20		1	
Hawkins	3	5	42		3,766.00														1,599.50		1	
Hill-Trumbull	5	3	34		4,381.20														2,785.00		2	
Holman-Cliffs	1	4	29		7,055.27														6,005.00		1	
Sargent	3		7		6,587.04														1,877.39		3	
Sally			1																290.25		1	
Wanless			15																129.00			
Total - Minnesota Mines	0	16	13	195	22,716.18				306.00	44.80	3,674.67	1,664.00		2,014.24	8,605.07	6,407.40	33,177.55	13,785.10		4	7	-
Total - All Mines	2	155	187	961	143,047.39	1,858.50	1,092.00	1,092.00	5,162.00	1,448.80	12,970.67	11,769.00	6,877.24	18,598.66	34,915.41	47,263.11	179,427.83	82,698.59		16	46	4



EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT  
ANNUAL REPORT YEAR 1957

1. a. WORKMEN'S COMPENSATION (Continued)

ANNUAL STATEMENT OF COMPENSATION PAYMENTS  
 FROM JANUARY 1st, 1957 TO DECEMBER 31, 1957

Compensation paid on 1957 cases	47,263.11	
Estimated compensation still pending	179,427.83	
Cost of medical and hospital service and special expenses	<u>82,698.59</u>	
		309,389.53
Less pending for years 1946-1956 incl.	130,370.54	
Less medical and special expense on accidents occurring prior to January 1, 1957	<u>17,559.98</u>	
		<u>147,930.52</u>
		161,459.01
Less compensation paid on 1957 occupational disease cases		<u>754.50</u>
Estimated cost of 1957 accidents		160,704.51
Percentage of payrolls on accident cases		.00701
Percentage of payrolls including Occupational Disease cases		.00704
Number of fatal accidents		2
Number of compensable accidents		155
Number of lost-time accidents - non-compensable		187
Number of slight accidents		961

The following occupational disease cases occurred during 1957. The cost of these cases is included in the regular compensation costs, but for statistical purposes they are not included in the accident table.

Number of deaths	0
Number of disability cases	3

During 1957 a total of \$7,183.74 was paid on occupational disease cases and it is estimated it will cost \$22,495.30 to complete payments on the four cases still active on December 31, 1957. Of these two originated in 1953, one in 1954, and one in 1956.





EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT  
ANNUAL REPORT YEAR 1957

1. GROUP INSURANCE - Bargaining Units

The hourly-rate, bargaining employees were protected during the year by the Company-Union negotiated plan which became effective September 1, 1956. The details of this plan with respect to benefits and employee and Company contributions may be found in the 1956 Annual Report. Carriers of this insurance are the Aetna Life Insurance Company for life and disability insurance and Minnesota Hospital Service (Blue Cross-Blue Shield) for the hospital and surgical insurance.

Employee contributions toward the cost of the group program (See 1956 Annual Report) were unchanged through October 31, 1957. On November 1, 1957 because the balance in the insurance benefits account, from which premiums are paid, had fallen below the agreed minimum contributions per employee were increased by twenty-five cents per month, or a total additional payment to this fund of fifty cents per employee per month.

- Premium rates beginning 11/1/1957 follow:
- Life - .84 per thousand
- Sickness and Accident - .073 per dollar
- Retired Life Insurance
  - Pensioners Life Fund - \$3.81 per thousand
  - Fund charge per employee - \$1.03 per employee
  - Hospital and Surgical - \$12.00 per employee.

Reference is made to the Annual Reports of 1936 and 1937 for the details of the Company's original group insurance plan which provided only life and disability coverage and to 1947 which hospitalization and surgical benefits were added.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT

YEAR 1957

1. GROUP INSURANCE - Salaried and Non-bargaining

Salaried employees and the non-bargaining policemen were covered during 1957 by a group life, disability, hospitalization and surgical, and major medical expense insurance carried with the Aetna Life Insurance Company. The details of this program - basic plan as effective September 1, 1956, and major medical expense coverage as effective May 1, 1956, are outlined in the Annual Report of 1956. Employee contributions and benefits remained unchanged in 1957.

The overall monthly premium rates beginning November 1, 1957 follow:

- Life - \$1.03 per thousand
- Disability - .097 per dollar or 4.51 per employee
- Retired Life Insurance
  - Salaried Inactive - \$6.49 per thousand
  - Pensioners before 1/1/55 - \$5.84 per thousand
- Basic employee hospital and surgical - \$3.92 per employee
- Basic dependent hospital and surgical - \$9.48 per employee
- Employee major medical expense - \$.99 per employee
- Dependent major medical expense - \$1.55 per employee



## EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT

YEAR 1957

1. b. GROUP INSURANCE (Continued)

The following death claims were paid during the period from September 1, 1956 through October 31, 1957.

<u>Name</u>	<u>Mine</u>	<u>Date of Death</u>	<u>Amount of Insurance</u>
Arthur Dunaquist	Bunker-Hill	11-18-56	\$ 5500.00
Waino Heikkila	Bunker-Hill	12-8-56	5500.00
Joseph Paris	Bunker-Hill	12-22-56	2500.00
Ellsworth Chapman	Bunker-Hill	1-27-57	5500.00
Sanfred M. Koldko	Bunker-Hill	6-13-57	5500.00
Alfred Cory	Bunker-Hill	10-4-57	5500.00
James E. Chapman	Cambria-Jackson	5-4-57	5500.00
Joseph E. Roberts	Cambria-Jackson	6-14-57	5500.00
James H. LaCombe	Cambria-Jackson	7-20-57	5500.00
Victor Tynismaa	Cliffs-Shaft	11-1-56	5500.00
Lawrence Nelson	Cliffs-Shaft	3-1-57	5500.00
Fred H. Baldwin	General Roll	11-25-56	4000.00
John A. Peterson	General Roll	6-20-57	10000.00
Joseph A. Nardi	General Storehouse	3-31-57	5500.00
Thomas W. Sharp	General Storehouse	5-3-57	4000.00
George O. Dompierre	General Storehouse	9-12-57	5500.00
Telesphore LaTandresse	Maas	4-28-57	5500.00
Henry Housman	Maas	8-8-57	5500.00
Carl Raisanen	Mather Mine "A" Shaft	12-7-56	5500.00
Reino S. Salo	Mather Mine "A" Shaft	4-29-57	5500.00
Bruno Lehtinen	Mather Mine "B" Shaft	11-9-56	5000.00
John Valota	Mather Mine "B" Shaft	9-6-57	5500.00
Leo Antilla	Mather Mine "B" Shaft	10-19-57	5500.00
Kaino A. Walitalo	Ohio	5-17-57	5500.00
Edward J. Bissonnette	Pelletizing Plant	12-11-56	5500.00
Sigmund Mohn	Pelletizing Plant	5-8-57	5500.00
Luigi Basegio	Inactive	5-8-56	1250.00
William H. Palmer	Inactive	9-29-56	1250.00
David Pynnonen	Inactive	7-13-56	1250.00
Thomas G. Hill	Inactive	10-15-56	1250.00
Louis Senical	Inactive	10-31-56	1250.00
Jacob Piirainen	Inactive	8-18-56	1250.00
George Young	Inactive	11-20-56	750.00
Charles H. Collycott	Inactive	11-21-56	1250.00
Lorenzo Marta	Inactive	7-20-56	750.00
Tony Philippi	Inactive	12-5-56	750.00
Thomas Hemming	Inactive	12-6-56	750.00
Jacob Korpi	Inactive	11-28-56	750.00
Thomas C. Hodge	Inactive	12-29-56	2500.00
George M. Waldie	Inactive	12-13-56	6250.00
Joseph L. Riberdy	Inactive	1-11-57	5000.00
Fred L. Prudom	Inactive	12-30-56	750.00
Frank T. Helgren	Inactive	1-17-57	750.00
Osear Pulkinen	Inactive	10-11-56	1250.00

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT

YEAR 1957

1. b. GROUP INSURANCE (Continued)

Death claims continued.

<u>Name</u>	<u>Mine</u>	<u>Date of Death</u>	<u>Amount of Insurance</u>
John Steve	Inactive	1-22-57	\$ 1250.00
Otto Hanninen	Inactive	2-19-57	2500.00
Arthur Truscott	Inactive	2-18-57	1250.00
Henry J. Mayrand	Inactive	3-15-57	5000.00
Erick Soyrinki	Inactive	5-4-57	750.00
Jacob Kivisto	Inactive	5-25-57	2500.00
Russell Pascoe	Inactive	7-4-57	1250.00
Sam Trevarton	Inactive	8-18-57	1250.00
Jacob Hakala	Inactive	8-31-57	1250.00
Battista Cavallo	Inactive	9-20-57	1250.00
Jules Verstraete	Inactive	9-24-57	500.00
Gust A. Wernholm	Inactive	10-2-57	500.00
Harry Johns	Inactive	10-13-57	1250.00
Charles W. Urquhart	Inactive	10-7-57	2500.00



## EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT

YEAR 1957

1.  
b. GROUP INSURANCE (Continued)

The following statement shows the amount of Bargaining Unit claims paid during the 10-month period from September 1, 1956 through October 31, 1957.

	<u>Disability</u>	<u>Workmen's Comp. Make-up</u>	<u>Death</u>	<u>Total</u>
Bunker-Hill	16,390.48	1,567.16	30,000.00	47,957.64
Cambria-Jackson	4,968.65	238.42	16,500.00	21,707.07
Cliffs-Shaft	12,996.75	1,929.85	11,000.00	25,926.60
General Storehouse	10,299.02	260.50	15,000.00	25,559.52
Maas	15,660.64	1,417.49	11,000.00	28,078.13
Miscellaneous	106.29	10.50		116.79
Ohio	910.07	66.25	5,500.00	6,476.32
Ore Improvement Plant	677.57	108.00		785.57
Inactive			<u>35,750.00</u>	<u>35,750.00</u>
<b>Total-C.C.I. Company</b>	<b>62,009.47</b>	<b>5,598.17</b>	<b>124,750.00</b>	<b>192,357.64</b>
Mather Mine "A" Shaft	28,021.84	2,347.72	11,000.00	41,369.56
Mather Mine "B" Shaft	<u>33,194.14</u>	<u>2,870.88</u>	<u>16,000.00</u>	<u>52,065.02</u>
<b>Total-Negaunee Mine Co.</b>	<b>61,215.98</b>	<b>5,218.60</b>	<b>27,000.00</b>	<b>93,434.58</b>
Republic	963.22	272.92		1,236.14
Pelletizing Plant	<u>2,139.02</u>	<u>314.32</u>	<u>11,000.00</u>	<u>13,453.34</u>
<b>Total-Marq. Iron Mng. Co.</b>	<b>3,102.24</b>	<b>587.24</b>	<b>11,000.00</b>	<b>14,689.48</b>
Electric Power Dept.		7.75		7.75
Humboldt Mining Company	<u>1,634.16</u>	<u>59.50</u>		<u>1,693.66</u>
<b>Total-Michigan District</b>	<b>127,961.85</b>	<b>11,471.26</b>	<b>162,750.00</b>	<b>302,183.11</b>
Number of Claims	486	256	52	794

## EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORTYEAR 19571.  
b. GROUP INSURANCE (Continued)

The following statement shows the amount of Salaried and Non-Bargaining Unit claims paid during the year September 1, 1956 through October 31, 1957.

	<u>Hospitalization</u>	<u>Health &amp; Accident</u>	<u>Comp. Make-up</u>	<u>Death Claims</u>	<u>Total</u>
Bunker-Hill	5,538.35	974.71			6,513.06
Cambria-Jackson	2,358.41	62.86			2,421.27
Cliffs-Shaft	2,776.05	815.15			3,591.20
Cleveland Roll	4,444.20	609.15			5,053.35
General Roll	35,679.58	4,088.46		14,000.00	53,768.04
Electric Power Dept.	2,220.78	511.07			2,731.85
General Storehouse	438.50				438.50
Lloyd	543.99	400.00			943.99
Maas	3,715.29	511.50			4,226.79
Miscellaneous	25.00	279.00			304.00
Ohio	7.50				7.50
Inclusive	<u>1,861.49</u>			<u>16,250.00</u>	<u>18,111.49</u>
 Total-C.C.I.Co.	 59,609.14	 8,251.90		 30,250.00	 98,111.04
Mather Mine "A" Shaft	5,961.88	1,513.94			7,475.82
Mather Mine "B" Shaft	<u>8,071.55</u>	<u>863.56</u>	<u>15.50</u>		<u>8,950.61</u>
 Total-Negaunee Mine Co.	 14,033.43	 2,377.50	 15.50		 16,426.43
Humboldt Mining Company	208.71	112.93			321.64
Republic	67.70				67.70
Pelletizing Plant	<u>232.85</u>				<u>232.85</u>
 Total-Marq.Iron Mining Co.	 300.55				 300.55
  Total-Michigan District	  74,151.83	  10,742.33	  15.50	  30,250.00	  115,159.66
 Number of Claims	 563	 69	 1	 6	 639



EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT  
ANNUAL REPORT YEAR 1957

2.  
a. PENSION SYSTEM

Pension Plan of 1/1/1909

The Company's original pension system went into effect on January 1, 1909 and the forty-ninth year of its operation was completed in 1957.

The monthly allowance of each retiree was increased by \$7.50 effective November 1, 1957 by direction of the Cleveland Office. This increase was a result of the increases granted to pensioners under the Funded Pension Plan. On January 1, 1933 pensions being paid were reduced by fifty per cent, those under \$20.00 remaining the same and those over \$20.00 having a minimum rate of \$20.00. There have been no additions to these payrolls since January 1, 1932.

During the time the Plan was active individual payrolls were written for the following Departments:

Mining Department  
Holmes Mine Department  
Republic Mine Department  
Land Department  
Furnace Department.

Of these only the Mining Department payroll was active during the year. There are three pensioners being paid over the Mining Department Pension Payroll at the close of 1957. Total expenditure over the payroll for 1957 was \$781.00.

10:08 AM JUN 11 1957

CLEVELAND OHIO  
THE CLEVELAND TRADING CO.  
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## EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORTYEAR 19572.  
a. PENSION SYSTEMS (Continued)Contributory Retirement Plan for Salaried Employees

For the purpose of record it is here mentioned that the Company has had in effect for its salaried employees, since December 31, 1940, a Contributory Retirement Plan to which both the Company and the employees contribute. This Plan is carried with the Aetna Life Insurance Company of Hartford, Connecticut under group policy GA-228, and it is administered completely by the Cleveland Office. Participation upon meeting certain eligibility requirements is optional.

Funded Pension Plan - Hourly-rate bargaining employees

The Funded Pension Plan was in force without change through October 31, 1954. The details may be found in the Annual Report of 1950. This department handles the taking and initial processing of all pension applications. The applications are submitted to the Pension Committee in Cleveland for final decision. This plan was revised on November 1, 1954 and as revised remained in force through October 31, 1957. The details of the plan during this period are recorded in the Annual Report of 1956.

The Funded Pension Plan was further revised on November 1, 1957. A resume of the plan as it became effective November 1, 1957 follows.

AGE PENSION - Eligibility - Age 65 and a minimum of 15 years of continuous service as in the past. A new provision for earlier retirement is described later.

Amount of Pension - Computed in two ways. The greater amount becomes the employee's pension.

- 1) The "one per cent formula" as in the past - a monthly pension equal to one percent of the average monthly wage (computed over the 120 months preceding retirement) multiplied by the years of continuous service and reduced by a fixed Social Security deduction of \$85.00 (normally the only deduction) and in applicable cases by other public pensions, federal and state disability pensions (not military), workmen's compensation payments, severance and termination allowances.
- 2) The new "minimum pension formula" - a monthly pension equal to \$2.50 times the years of continuous service after 11/1/57 and \$2.40 times the years of continuous service prior to that date to a total maximum of 30 years. No deduction for Social Security but subject to other deductions listed in the "one per cent formula." The previous monthly minimum for 30 years was \$55.00 reduced for service less than 30 years by \$2.00 per year to the minimum 15 years.

DISABILITY PENSION - Eligibility - Minimum of 15 years of continuous service; total disability for six months with incapacity for gainful employment expected for remainder of life as certified by competent medical authority.

Amount of Pension - Computed in three ways with greater amount becoming the employee's monthly pension.