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EPA Region 5 Records Ctr.
393625

June 17, 1991

Mr. Jae B. Lee
Environmental Engineer
U.S. Environmental Protection Agency
Region V
Waste Management Division, 5 HS-11
230 South Dearborn Street
Chicago, IL 60604

RE: Torch Lake Superfund Site

Dear Mr. Lee:

This letter is a follow-up to and in confirmation of my visit at your office on June 13, 1991, attended by you, Gary Kruger of Geraghty & Miller and myself.

During our visit, we had at one point a lengthy discussion regarding the results of sediment testing at Torch Lake which sampling and testing were performed by a U.S. EPA outside consultant. The result of the sediment testing and the information provided to us was that the only contamination found from that sediment testing were some "hot spots" at the outflow pipe belonging to Peninsula Copper Industries. You also indicated that the sediments in which the "hot spots" were found appeared to be "recent" or "new" sediment deposits as distinguished from "old" sediments. I indicated that I was not surprised in view of public knowledge that Peninsula Copper Industries, owned in part by Michigan Technological University, had been discharging effluent for in excess of the allowable discharge permit levels set forth in the permit issued to Michigan Technological University. In addition, in 1984 Peninsula Copper Industries discharged 30,000 gallons of effluent containing copper sulfide, ammonia and sodium, which discharge blackened the sediment to one (1) foot in depth. As I further noted to you, the Torch Lake Sewage Authority (operating on land owned by the Houghton Department of Public Works) drained 5,000,000 gallons of contaminated water from its Tamarack lagoon because the lagoon was undersized for the effluent it was receiving. You indicated you were unaware of such occurrences relating to Peninsula Copper Industries (PCI), Michigan Technological University (MTU) and Torch Lake Sewage Authority (TLSA). I expressed and continue to express surprise for a number of reasons, including:

a) Since a 104(E) Request has been sent to PCI, MTU and TLSA and since you have fully exchanged data with the Michigan Department of Natural Resources (MDNR), why the occurrences I've outlined in this paragraph were not disclosed to the U.S. EPA; and

b) In Universal Oil Products Company's response dated June 10, 1986 to the U.S. EPA (Attention: Ms. Janet Haff) these occurrences were disclosed. I enclose a copy of newspaper articles bearing Exhibit Nos. 12, 13, 14, 15, 16 17, 18 and 21, which exhibits were attached to the June 10, 1986 letter.

Jae, is it any wonder that, since June 1986, Universal Oil Products Company (UOP) has in writing and in person requested that PCI, MTU, TLSA and the Houghton Department of Public Works be named as potentially responsible parties (PRPs).

For your additional information, I enclose Section X from a Pro Forma business publication by Michigan Copper Co. Ltd. This Section X will give you some meaningful information about the copper oxide manufacturing operations of PCI, along with the well known companies providing scrap materials for processing by PCI.

By copy of this letter to Mr. Peter Felitti, Assistant Regional Counsel, I am requesting a meeting to deal with additional PRPs regarding the Torch Lake Superfund Site.

At another point in our discussion you inquired about help regarding the identity of title holders (landowners) of various properties along the western bank of Torch Lake from Lake Linden south to the Quincy Properties. You were quite taken back to be informed that UOP's involvement in the scheme of things at Torch Lake was that of a mere former land owner who did not conduct mining operations in Michigan. UOP acquired Calumet & Hecla on April 30, 1968 and due to a pending labor impasse, the mines were closed forever to commercial mining operations by September 1968. Not long thereafter, UOP donated or sold all shoreline properties to the following:

Lake Linden-Hubbell Public Schools
Houghton County Historical Society
Edward Koepel
Rudolph Kump
Houghton County Department of Public Works
Superior Crafts
Michigan Technological University
Village of Lake Linden
Schoolcraft Township
Houghton Country Historical Society

In addition, some 288 acres were donated to the State of Michigan DNR covering land at the outlet of Torch Lake to Portage Lake and on Portage Lake.

What I'll do is take a map of Torch Lake and mark it up so you'll have our views of the current land ownerships along the western bank of Torch Lake. During our discussion we spoke about the two different slag piles which I indicated were on lands donated in 1982 (75 acres) to M.T.U. This 75 acre parcel was conveyed by M.T.U. to Technology Development Corporation and in 1986 Technology Development Corporation sold the 75 acres to Keweenaw Development Corporation of Houghton, Michigan for $125,000.00. Not a bad return for having received the property at no cost!

Please let me now if there are any items not covered in this letter and which you were looking for comments or information from me.

I trust UOP's repeated requests for additional PRPs to be named by the U.S. EPA will receive favorable action and that a PRP and additional PRPs meeting will be convened. I request this letter be made a part of the administrative record.

Sincerely,

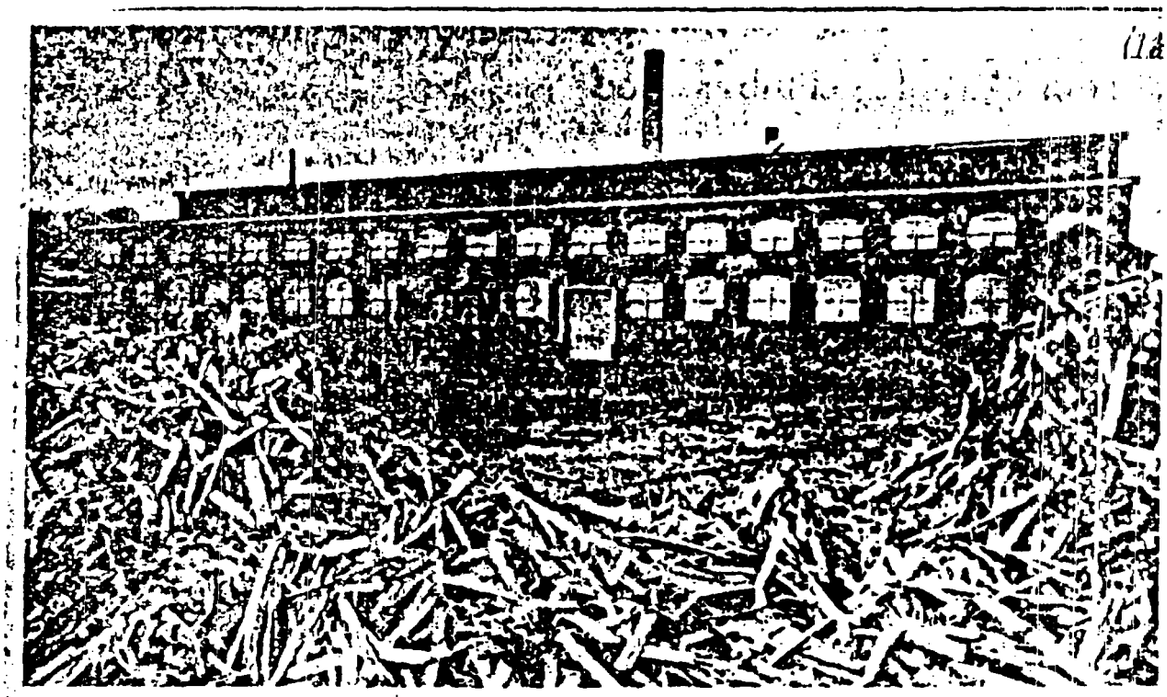
Patrick J. Link

Patrick J. Link

cc: Peter Felitti, Esq. - Assistant Regional Counsel
Ms. Carole Graszer, Emergency Support Section
Gaines Gwathmey, Esq.
Sean Lane, Esq.
Mr. Steven Shapiro

/rc
enc.

Exhibit 12.



THE TORCH LAKE Sewage Authority has given Peninsula Copper Industries, located at Michigan Tech's Industrial Park in the building shown above, 60 days in which to filter copper and ammonia from the discharge water it sends through the authority's Tamarack lagoon system. The plant manufactures copper oxide from scrap electronic circuit boards shown in the foreground. (Gazette photo by Scott Heckel)

OFFICIALS DEMAND CLEANUP— DMB 2/27/84

Industrial discharge copper contaminated

By BARBARA SWIFT
Gazette writer

HUBBELL — The Michigan Tech-sponsored Peninsula Copper Industries has dumped into sewers here processing water containing nearly 2,400 times the copper allowed by permit, officials say.

The Torch Lake Sewage Authority, fearing damage to its Tamarack lagoon system, last week gave MTU and the company 60 days in which to clean up its discharge, which also includes high levels of ammonia.

"The situation is serious and we intend to correct it," said authority Chairman Gerald Perreault.

Perreault authorized tests in January, when manholes near the copper reclamation plant emitted a strong ammonia odor and effluent at one of the sewage system's pumping stations was tinged blue.

He said one of the tests on the plant's effluent — done at a Wisconsin laboratory — showed copper at 1,196 milligrams per liter, equal to parts per million. [illegible] miligrams per liter, then soared back up to 900. The sewage authority's permit — officially issued to MTU — allows .5 parts per million of copper.

Peninsula Copper manufactures copper oxide from scrap electronic circuit boards. It is the first business to lease space at the university's Industrial Park in Hubbell. Tech Capital Corp., a federally-licensed small business investment company established by the university, is one of the stockholders in the company.

Perreault said the tests also show a high of 560 miligrams per liter of ammonia. That level is approximately 100 times the allowable limit, he said. Limits were established on information from the company and advice from the Department of Natural Resources.

Operations at the Hubbell plant began last fall. The plant discharged about 140,000 gallons of effluent into the Tamarack lagoon in January. Perreault said most of the discharge is water.

He said the authority has no way of knowing how long the high levels of copper and ammonia have been flowing into the lagoon system.

Lagoon systems purify sewage water through bacteriological action, stimulated by algae and bacteria, which can be killed by high concentrations of copper.

Perreault said preliminary tests on the lagoon show lower levels of dissolved oxygen, which must be present for the system to function. However, those levels are normally lower during winter, when ice covering the lagoon blocks sunlight and oxygen.

"If the dissolved oxygen was all gone, we'd know we have a major problem out there," Perreault said.

The authority is waiting for more test results that will show copper and ammonia levels in the lagoon.

"The Tamarack lagoon doesn't seem to be affected dramatically," Perreault said. "When we get all the test results back then we'll be able to tell what the impact is on our lagoon."

The authority met Tuesday with Bill Stewart of Peninsula Copper. Stewart was out of town today and unavailable for comment. Richard Tieder, head of the university's Bureau of Industrial Development, said this morning he was out of town last week and is unaware of the situation.

According to Perreault, Stewart said the copper/ammonia discharge was occasional, while the plant worked out "a few bugs" in the reclamation process. Perreault said Stewart agreed to install a more advanced filtration system to trap the copper and ammonia. The authority expects the system to be installed by Friday.

Tests monitoring the discharge will continue. Perreault said if the copper/ammonia discharge is not cleaned, the authority could force the university to install its own treatment system.

He said the Department of Natural Resources and the Houghton County Department of Public Works was also notified of the plant's discharge.

Copper-laden lagoon concerns Torch Lake officials

DMG 3/2/84 cc [illegible] OK 3-6

Exhibit 13.

By BARBARA SWIFT
Gazette writer

HUBBELL — The Torch Lake Sewage Authority is asking state officials for advice on how to dispose of the copper-laden wastewater in its Tamarack lagoon.

The authority is concerned with discharging the wastewater when the 10-million gallon lagoon fills — likely before spring — and is asking for a recommendation from the Department of Natural Resources.

"They can tell us whether or not what we have in our lagoon is that far out of line," said authority Chairman Gerald Perreault. "They can give us permission to discharge. Quite frankly, what else can we do?"

Recent test results on the lagoon's wastewater show it contains as high as 13 parts per million of copper (ppm).

DNR officials in Lansing say that level is extremely high, and quote "ballpark figures" around 1 parts per million of copper — and less — as acceptable limits for wastewater discharged directly into Torch Lake or filtered first by a seepage system on the Tamarack Sands, a stamp sand peninsula that juts into Torch Lake.

There are methods of "binding up" the copper. Adding an organic compound like carbon, for example, would possibly give the copper particles something to attach onto and sink to the bottom of the lagoon.

"But you can't be dilly dallying around trying to figure something out when your lagoon's full," said Dr. Elwin Evans, an aquatic biologist in the DNR's surface water quality division.

Evans has done research work on Torch Lake involving fish tumors, some cancerous, in sauger and walleye. Researchers don't know what causes the tumors, but note that the lake has been contaminated with municipal waste and copper mine tailings loaded with heavy metals. Evans estimates thousands of pounds of copper enter the lake each year as water runs through tailings and leaches out of sediment lying on the lake's bottom.

However, Evans and David Kenaga of the DNR's water quality surveillance division noted that, "Our charge is to protect that lake. Even though it may be a small discharge into a large system that is degraded, we have to find some way to turn around" the lake's pollution, said Kenaga.

Evans said that an intense shot of copper water could kill fish and plants around the discharge area. He said he would probably recommend discharging the wastewater slowly, to get it out of the lagoon system with the least amount of damage.

The high copper content is likely the result of industrial discharge from Peninsula Copper Industries, a copper reclamation plant in Michigan Technological University's Industrial Park in Hubbell.

Tests on the plant's effluent in January showed nearly 2,400 times the level of copper permitted for discharge into the sewage system. The company intends to install a new filtration plant to trap copper and the authority will continue testing, Perreault has said.

According to Carey Johnson of the DNR's water quality surveillance division, allowable copper limits are based primarily on the hardness of the water into which the treated wastewater will be discharged and normal background levels for metals.

Copper limits for direct discharge generally range from [illegible] ppm for relatively soft water containing 50 ppm of calcium carbonate to .116 ppm for a hardness of 300 ppm calcium carbonate, Johnson said.

Torch Lake is relatively soft water. Some 80 ppm of calcium carbonate was found near the Tamarack Sands in 1972, according to Dr. David Leddy, director of MTU's Occupational Safety and Heath office.

Johnson said background levels of copper here may be higher than other areas, calling for even stricter limitations. Kenaga said limits for wastewater first filtered, then drained into Torch Lake, might be as low as 13 parts per billion, equal to .012 ppm.

Johnson also noted Keweenaw Peninsula ecosystems may have developed a tolerance to copper.

Copper at 1 ppm is sometimes used as to kill algae. Lagoon systems purify sewage water through bacteriological action, stimulated by algae and bacteria. Johnson did not know if the 13 ppm copper in the lagoon's wastewater would kill that action. It has not happened before in Michigan, she noted.

In summer months, the authority can send treated wastewater through an irrigation system for spraying over the Tamarack Sands.

Although copper is sometimes used to control vegetative growth, "a one-time application probably wouldn't be detrimental" to plants on the Tamarack Sands, according to Dennis Bittner of the DNR's Marquette office.

Dr. Fred Erbisch, an MTU research administrator who has studied copper's effect on vegetation, said some sensitive plants show damage at 5 ppm copper. Others can accumulate large amounts of the metal.

Erbisch speculated that most of the copper in the lagoon wastewater would be "tied up" by organic matter and not available for use by plants. He also noted that the Tamarack Sands does retain water well but allows quick drainage into Torch Lake.

Leddy said the copper would probably stick onto limestone and other material in the mine tailings rather than washing immediately into the lake. However, rainwater would force some copper particles through the tailings.

In addition to copper, high levels of ammonia have been found in PCI's industrial discharge. That is expected to have little effect on the workings of the lagoon system.

What it may cause, however, is an odor problem when the ice covering the lagoon system melts this spring, according to Bittner and Earle Olsen, supervisor of the Marquette ground water quality division.

Olsen said he could not guess how long the odor would last.

"The odors could be a much longer time than people like to have," he said.

Company removes high copper levels entering Torch sewage system

Exhibit 14.

By BARBARA SWIFT
Gazette writer

HUBBELL — Peninsula Copper Industries has nearly completed installing a filter system to remove copper and ammonia from water the plant sends through the Torch Lake sewage system.

The filter will allow processing liquid to pass through while trapping solids on a special cloth, according to Bill Stewart, the company's president and chief executive officer.

In addition, the company has quit hosing down the plant's floors, a practice that had sent spills of processing liquid into the sewage system.

"Everything's well in hand now," said Stewart. "The (Torch Lake) Sewage Authority was here (Monday) morning to check on the system and they found no effluent at all. I think we're back on course."

The company went off course in January, when sewage authority tests showed copper levels 2,400 times greater and ammonia 100 times greater than the PCI permit allows.

Since September the company has manufactured copper oxide from scrap electronic circuit boards. It is the first business to locate at Michigan Tech's new Industrial Park in Hubbell. Tech Capital Corp, an investment company established by the university, is one of PCI's stockholders.

The authority's permit establishing allowable limits of copper and ammonia was issued to Tech as the landowner.

The sewage authority, at a meeting in late February, officially gave Tech and PCI 60 days in which to install a new system. Stewart said Monday the filtering system is 90 percent complete.

"I'm more than confident" it will solve the problem, Stewart said. "I'm positive."

Stewart said the company, which employs 21 persons, already has a similar system operating to treat the plant's effluent.

"All we're doing is boosting the present system to take into account the material that got washed in by hosing down the floors and small spillages that weren't contained," he said.

"We have a system that takes a major spill, storage tanks and pumps to collect. The small stuff was getting away. Now with the other system and more tanks, we'll be able to handle it, too," he added.

After the solids are trapped on the filtering cloth, they can be removed and disposed of separately. Liquid that passes through will be treated to remove copper and ammonia, Stewart said.

"We're just waiting for one other piece to complete the circuit," Stewart said.

Authority members still don't know whether the spill affected the bacteriological action that makes the Tamarack lagoon system function. The authority is waiting for test results showing bacteria count.

The authority is also concerned about how to dispose of the copper-laden wastewater in the lagoon, which is expected to fill before spring. Copper is sometimes used to kill aquatic life or to control vegetation.

Chairman Gerald Perreault said Monday that the authority will continue to monitor the company's effluent and may set up a meeting this week to discuss a schedule of testing.

Stewart said the amount of copper being lost through the sewers was minute. The ammonia is not expected to have a negative effect on the lagoon system.

The company also sends non-contact cooling water into Torch Lake. Stewart said the water is about 70 degrees when it re-enters the lake. The company's permit, authorized by the Department of Natural Resources, allows 120 degree water, he said.

Stewart said the warmed water is used to heat the floors and building.

He also said the company, by stopping the floor washes, will also be able to decrease the volume of water it sends through the sewage system.

He said the company had not done any of its own testing and was leaving that up to the sewage authority.

Exhibit 15.

UNDER DNR SCRUTINY

DMG 4/3/84

Tamarack lagoon discharge scheduled

By BARBARA SWIFT
Gazette writer

TAMARACK — The Torch Lake Sewage Authority will begin discharging copper-laden effluent from the nearly filled Tamarack lagoon into a seepage cell this week, officials said.

The discharge will be measured in "inches" and is intended to make room in the six-foot, 10 million gallon lagoon for water it collects during spring runoff.

About six to 10 inches of effluent will be discharged, authority Chairman Gerald Perreault said. He did not know how many gallons the inches represented.

Perreault said the dumping is being monitored by the Michigan Department of Natural Resources. "They're looking over our shoulders," he said Monday.

The lagoon — one of two in the Torch Lake sewage system; the other is in Lake Linden — was contamined earlier this year when a copper oxide plant accidentally dumped high levels of copper and ammonia into it.

Tests show the lagoon's copper is as high as 13 parts per million. At least one DNR official has said an intense shot of that much copper could kill fish and plants in the discharge area. Discharging slowly would have the least damaging effect, the official said.

Perreault said the authority will run tests to determine what effect, if any, the extremely high levels of copper will have on Torch Lake. Because of copper contained in stamp sand, the leftovers from copper mining, the lake ranked 21st on the DNR's list of highly contaminated sites around the state.

The seepage cell, located on a stamp sand peninsula that juts into the lake, allows the effluent to discharge slowly, filtered by sand, before it enters the water system.

Perreault said that samples have been taken at the six monitoring wells near the lagoon to provide background data on how much copper and ammonia the water normally contains. Ammonia, normally considered a nutrient, is not expected to cause a problem, officials said earlier.

Samples after the discharge will provide a comparison, enabling the authority to determine the amount of copper picked up by soil and water near the seepage sell.

If testing and retesting shows little damage, the process of dumping the effluent by inches will continue until the lagoon is emptied, Perreault said.

Lagoon systems work by purifying sewage water through bacteriological action, stimulated by algae and bacteria. Copper at 1 ppm is sometimes used to kill algae.

Although Perreault confirmed that tests show a marked decline in bacteria in the Tamarack lagoon, he said the authority is being "very cautious" in its statements about whether the lagoon is dead.

"We can't tell," said Perreault. "For us to make foolish or rash statements is really up in the air. I can't make that kind of comment, neither can anybody else."

He said the authority is suspicious of the bacteria test because lab technicians couldn't be sure the sample wasn't contaminated.

"One test showed 'Lab Accident' on the doggonned thing," said Perreault. "That's why we're not quoting those figures to anybody."

He added that experts say the authority may have to wait until summer's high temperatures before determining whether the bacteriological action has been killed.

"Every one of the experts we've talked to say the thing would essentially take care of itself. There's no special bacteria action that has got to be created," he said. "If we can dump what's there, the lagoon may revitalize itself."

Exhibit 16.

Tuesday, April 17, 1984

Tech park plant dumps waste into Torch Lake

By BARBARA SWIFT
Gazette writer

HUBBELL — A Michigan Tech-sponsored copper reclamation plant in Hubbell has dumped its industrial wastewater directly into Torch Lake, violating a state permit.

Peninsula Copper Industries, Inc., discharged in March nearly 30,000 gallons of effluent containing copper sulfide, ammonia and sodium, according to data provided the Michigan Department of Natural Resources by Tech officials.

It is the second incident of contamination by PCI in two months. The first incident involved high levels of copper and ammonia being sent into the Torch Lake Sewage System.

After the second incident, the DNR ordered the company to clean up the Torch Lake shoreline.

A Bark River firm, using vacuum-operated boses, has been sucking heavy black silt — some as much as a foot deep — from the lake since April 6, according to David Williams, a surface water quality specialist with the DNR's Marquette office.

PCI was issued a state Water Resources Commission permit in May 1983 to pipe into the lake the clean water it uses for cooling machinery, and ground seepage, snow melt and rain diverted to the pipe by storm drains.

Williams said the DNR ordered the company to pull out a pipe that connected a plant floor sump with the cooling water pipe. The sump collected discharge from the waste treatment system. The disconnection was verified Friday, he said.

PCI, which manufactures copper oxide from scrap electronic circuit boards, is the first company to lease space at Michigan Tech's Technology Park in Hubbell.

Tech Capital Corp., a small business investment group established by the university, is one of the stockholders in PCI and was one of the major movers in setting up the company.

The clean-up company, Stenberg Bros. of Bark River, was expected to sample the lake bottom today to see if any remnants of the copper sulfide remain, according to David Leddy, director of Occupational Safety and Health at Tech.

The discharge — from March 9 through March 27 — contained approximately 560 pounds of copper sulfide, 182 pounds of ammonia and 291 pounds of sodium sulfide.

Leddy said copper sulfide is considered a hazardous waste by the U.S. Environmental Protection Agency because of its high copper content. The DNR has already declared the lake contaminated with copper. The university recently was authorized to receive an $82,500 state grant to study copper and determine whether it may have caused or contributed to fish tumors found in Torch Lake sauger and walleye.

Leddy said the copper sulfide lifted from the lake will be trucked to a state-approved disposal site.

Because of the relatively low acidity of Torch Lake, the copper sulfide — highly insoluble and dense, causing it to sink to the lake bottom — is not expected to leach into the water column, Leddy said.

He said ammonia is generally considered a nutrient; the sodium — used during processing to solidify soluble copper — will have little, if any, effect on the lake, Leddy said.

Ed Koepel, Tech's vice president of operations and finance, said the clean-up was for "aesthetic" reasons. However, "If it was red, white and blue and looked terrific, it simply should not have been put out in the water," said Koepel.

The discharge was reported March 30 to the DNR by Bill Stewart, PCI's president and executive officer, Williams said. Stewart was on vacation and unavailable for comment.

Koepel said the spill was discovered by a Tech employee assigned to oversee construction work at the industrial park.

Koepel said university officials "insisted immediately that corrective action be taken so that it does not occur again. We monitored (the company's) report; they did report it properly to the DNR."

The first incident of contamination by the company was noted by the Torch Lake Sewage Authority. In February, the authority ordered the company to clean up the copper- and ammonia-tainted processing water being flushed through the sewage system into the authority's Tamarack lagoon.

The copper being sent through the system was nearly 2,400 times the level allowed in the TLSA's permit, which was officially issued to MTU as landowner.

Authority officials say they won't know until summer whether the high copper content may have killed the bacteriological action that makes the lagoon system work. The DNR is monitoring the dumping of the lagoon into a seepage cell near the lake.

To prevent further contamination, the company installed a filter meant to trap the copper and ammonia particles. Leddy said the filter was inadequate and another filter has been installed.

Koepel said that contract with Stenberg Bros. was done on a Tech purchase order "because we want to make sure this is done." PCI will, however, foot the clean-up costs, he said. Costs could range as high as $5,000, Koepel said.

Vacuum hoses have been sucking heavy black silt—some as much as a foot deep—from the lake since April 6

Williams said a penalty could be imposed by the DNR. He said the DNR usually looks at how much it would have cost to treat the wastewater properly, plus a fine for damage to the resources.

After data is collected by the Marquette district office, it will be sent to Lansing for review by biologists and others, Williams said.

Leddy agreed that the incident points out the need for MTU to monitor activities at the industrial park.

"We were not very happy at all," said Leddy of the company's discharge, particularly since it was the second incident. "I think we're going to have to keep a closer watch (on site activities) than in the past."

Koepel said the university has "very little if any" technical or legal responsibility to monitor the private companies that operate at the industrial park.

"On the other hand," said Koepel, "our objective is to try to support entrepeneurial development, support jobs and support industry. The only way we can successfully do that is in a way that is compatible with environmental laws, rules and regulations."

CC. J. Corvin
P. Fish
D. Gamble OK 10 4-24

35 Cents

Peninsula Copper Industries, Inc., has been sending wastewater directly into Torch Lake via a piping system meant for clean cooling water. The Department of Natural Resources ordered some piping inside the plant disconnected and a clean-up effort has been underway since April 6. The company plant, shown in the background, is at Michigan Tech's Technology Park in Hubbell. (Gazette photo by Scott Heckel)

Exhibit 17.

Dan 6. 4/18/84

5 million gallons of water drained out of Tamarack lagoon

By BARBARA SWIFT
Gazette writer

LAKE LINDEN — Spring runoff has forced the Torch Lake Sewage Authority to drain off an estimated five million gallons of copper-tainted wastewater from its Tamarack lagoon.

The sewage authority discharged the effluent into a seepage pond before hearing the results of tests that were to show whether the high levels of copper would affect Torch Lake.

"Spring thaw stepped in at just the wrong time for us," Chairman Gerald Perreault told authority members in Lake Linden Tuesday.

The authority originally intended to dump 6-9 inches of wastewater — contaminated with industrial discharge from Peninsula Copper Industries, Inc. — into the seepage cell on a stamp sand peninsula that juts into the lake. The authority ordered tests to compare well water samples before and after the dumping.

But after the first discharge — 9½ inches in the first week of April — the lagoon rapidly refilled to its 7-foot level, Perreault said. The authority pulled the plug for a second time last week, allowing three feet of water to drain into the cell before the second batch of tests was completed.

In all, about four to five million gallons of water was discharged, system operator Leland VerBerkmoes said.

VerBerkmoes explained the spring runoff problem to authority members. He held up flow charts to show how much water enters the Tamarack lagoon daily.

The highest per-day figure was 397,000 gallons of water and sewage. Each of the two lagoons in the problem-wrought $8 million system, completed in 1980 and owned by Houghton County, was designed to take in 100,000 gallons a day. The Tamarack lagoon holds a total of 10 million gallons.

"At that rate," he told the board, "we'll be filling the lagoon up in a month. It's supposed to be six months."

The Tamarack lagoon was contaminated earlier this year when PCI, located at the Michigan Tech Technology Park in Hubbell, dumped effluent containing high levels of copper and ammonia into the system.

According to Tech officials, the company has now installed a filtering system to trap the ammonia and copper particles.

Perreault said PCI has since discharged its effluent three times into the lagoon system. Samples were taken and one problem of contamination — Perreault said it came from a plant lunch room sump — was cleaned up before discharge.

Authority members authorized VerBerkmoes and Perreault to check the sewage system's spray irrigation mechanisms and decide whether the ground at Tamarack is saturated. If not, the spray irrigation system may be activated this weekend.

The authority also accepted VerBerkmoes' resignation. He has been system operator for about 1½ years and is taking a job with the Michigan Department of Corrections.

After a lengthy discussion, the board agreed to take applications for the job until 5 p.m. Saturday. A board screening committee will meet at 7 p.m. Saturday to screen applications and the authority slated a special meeting for 7:30 p.m. Monday night for an application review and possible interviews with job candidates.

Exhibit 18.

Fuel oil complicates Tech Park clean-up

By BARBARA SWIFT
Gazette writer

HUBBELL — A str[illegible]ordered clean-up at Michigan Tech's Technology Park was complicated when the material pulled from Torch Lake was contaminated with fuel oil, officials said.

The copper sulfide-lake water mixture was contaminated when it was pumped into two 20,000-gallon fuel tanks on the Torch Lake shoreline, according to the Department of Natural Resources.

"The cleaned-up material got put in tanks that had oil in them," said Jack Rydquist, district supervisor of the DNR's surface water quality division in Marquette. "There were some unfortunate decisions made..."

In early April, the DNR ordered the copper sulfide removed from the lake bottom after Tech employees noticed Peninsula Copper Industries, Inc., was violating state regulations by discharging processed water directly into the lake.

The company, which manufactures copper oxide from scrap electronic circuit boards, is the first to lease a building at the university's industrial park.

Clean-up efforts — organized by Tech but expected to be paid by PCI — involved vacuum-operated hoses which pulled water and the black dense copper sulfide up from the lake's bottom, then stuffed it into the storage tanks.

Rydquist said Tech sent divers down Thursday to survey the dumping area. It appears that most of the copper sulfide has been cleaned up. Samples, however, will be taken at 30-foot depths some 50 feet offshore as a doublecheck, Rydquist said.

Rydquist said the original plan was to treat the water in the tank, then discharge back into the lake. "With the oil, that's not possible," he said.

He said Michigan Tech is doing "pilot studies" to determine the best way to remove the oil from the water.

Ed Koepel, Tech's vice president of operations and finance, said the oil can be soaked up with oil-absorbing pads or filtered through sand which would then be disposed of in a toxic waste dumpsite. Activated charcoal will also absorb oil.

Koepel said university officials knew the tanks had been used to store fuel oil. But they believed, when they made the decision to store the material, that the oil residue was not enough to cause contamination, he said.

Officials also felt time pressure from melting ice, he said.

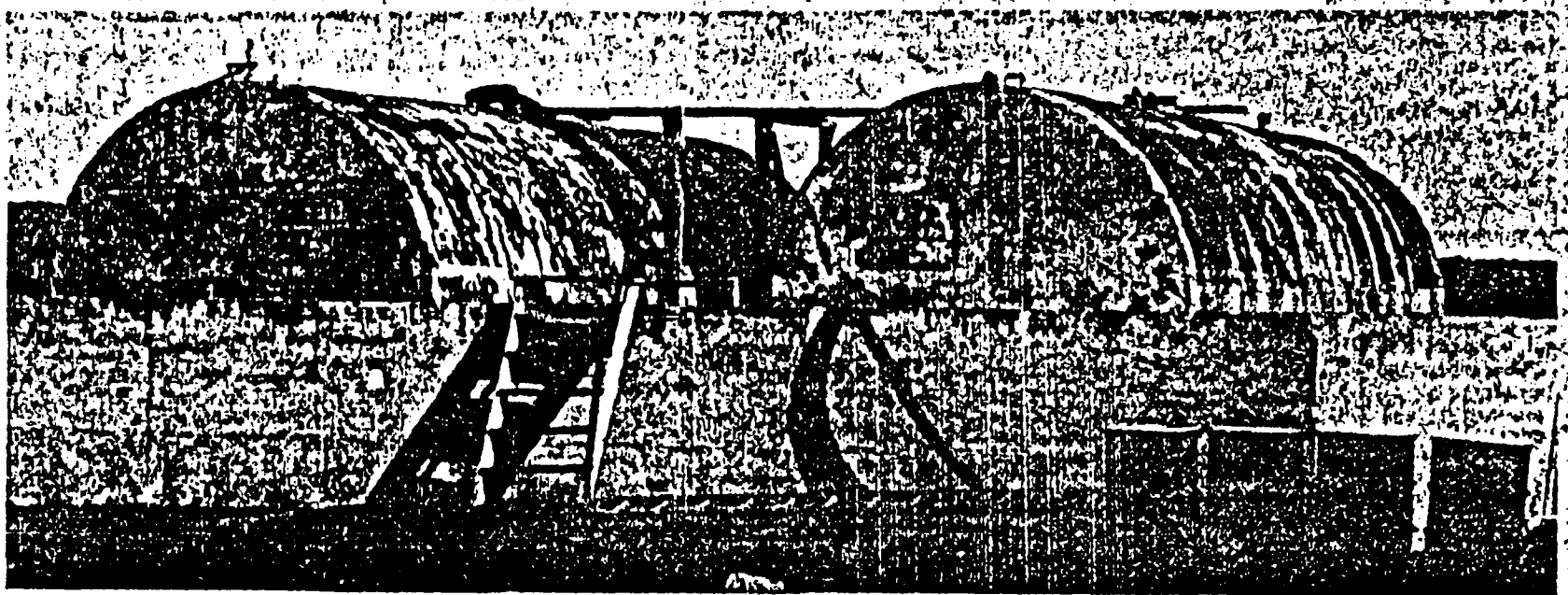
"We opted to (store) it, right then and there," said Koepel. "The ice was there, preventing wave action from dispersing the stuff. The initial driving force was, 'Get it out before it spreads.'"

Koepel said that using the storage tanks was "kind of a stroke of luck." He said that if 3,000-gallon tanker trucks had been used to haul away the water and copper sulfide, the cost would have been greater than treating the oil problem.

"We don't see this as a significant problem," he said. "This is by far the most economical way to do it."

Meanwhile, DNR officials say they expect the copper sulfide dumped into the lake to have little environmental effect.

Tom Rohrer of the DNR's toxic chemical evaluation unit said the copper sulfide — classified by the U.S. Environmental Protection Agency as a hazardous waste — was likely toxic to small organisms living at the discharge site. He said that fish, however, would sense an irritation from the copper and move out of the area quickly.



Clean-up efforts at the Peninsula Copper Industries, Inc., plant at the Michigan Tech Technology Park in Hubbell were complicated when lake water and copper sulfide taken from the bottom of Torch Lake was stored in these two fuel oil tanks. Department of Natural Resources officials say the oil must be removed from the water before it is returned to the lake. (Gazette photo by Scott Heckel)

Exhibit 21.

PCI to test fiberglass piles near Torch Lake

21

By BARBARA SWIFT
Gazette writer

5/23/84

HUBBELL — Peninsula Copper Industries, Inc., will test two piles of treated fiberglass for chemicals that could leach into Torch Lake.

The fiberglass is waste material that is left after the company has chemically treated the electronic circuit boards from which it manufactures copper oxide.

It is stored in two piles outside the company's plant at the Michigan Tech Technology Park in Hubbell and several hundred feet from the lake's shoreline.

Hank Switzer of the Department of Natural Resources regional office in Marquette said he suggested the company perform the tests because of a strong ammonia smell coming from the waste material.

Switzer said at this point he does not consider the material a threat to the environment and less serious than the company's previous contamination problems.

"Of all the problems, it's the last I'm concerned with," Switzer said.

The company has been cited by the DNR for illegally dumping processing water into Torch Lake and by the Torch Lake Sewage Authority for sending excessive amounts of copper and ammonia into the sewage system.

"It's not a hazardous waste piled up out there," Switzer said Tuesday. However, he added, "the only thing that should be on there is fiberglass."

Switzer said the material, which he estimated at several thousand yards, did not appear blown around the area by wind.

Company officials originally told the DNR — when the plant location was planned for the Quincy Mining Co. property in Ripley — that waste material would be dumped at the Portage Township landfill, said Switzer.

The Hubbell location is out of the Portage landfill's collection area, he said.

Switzer said he suggested the company contact Calumet Township officials about dumping there, perhaps in a Type 3 landfill — which allows material such as flyash from coal and foundry sand — that he said township Supervisor Paul Lehto is planning.

However, "If it's clean and just fiberglass that's inert, then it wouldn't require any landfill," Switzer said.

Switzer said he suggested that if the company intended saving the fiberglass for resale or as an energy source, a better way to store the material would be bailing rather than stockpiling.

He said that company officials had assured him "something will happen in the next few weeks."

SECTION X

SECTION X
COPPER OXIDE MANUFACTURING PLANT

10.1 INTRODUCTION

Ammonia leaching as a process to dissolve copper from Calumet and Hecla conglomerate tailings and scrap was pioneered in the Michigan Copper District. The process consists of dissolving metallic copper in ammoniacal solutions and then distilling the solutions to produce cupric oxide.

In 1983, PCI constructed a copper oxide manufacturing plant to use new technology for increasing efficiency and decreasing cost. Low grade copper scrap such as copper clad circuit boards, electric motors, and copper clad metals have been the principle source of metallic copper. Between 1983 and 1989, PCI's production of cupric oxide has increased from 2.5 million to eight million plus pounds annually. A 10 to 15 percent annual increase in consumption of copper oxide in wood preservation and catalyst applications has made continued plant expansions necessary. At present, PCI consumes in excess of 80% of the available low grade copper scrap in the United States and Canada. In order for PCI to maintain market share and to diversify its copper based product lines, it has become necessary to develop alternative sources of copper. There are three other major sources of metallic copper available:

(1) No. 2 Recycled Copper Scrap
(2) No. 1 Recycled Copper Scrap
(3) Native Copper Ore Concentrates

No. 2 recycled copper scrap has a contained copper content of 95% The balance being tin, lead, zinc and other metals which are not desirable in a copper oxide or copper sulfate product. No. 1 recycled copper scrap is 99.9% contained copper and is a very suitable product for ammonia leaching. The big disadvantage is the high price and competition for this source of copper. It is a very desirable product for smelters and refineries for conversion to cathode or wire bar. The most suitable alternative is native copper concentrates from the area mines, which are very suitable for ammoniacal leaching and do not contain contaminates harmful to the copper products produced.

With the addition of native copper concentrates as an additional source of copper, the PCI plant will be able to expand its copper oxide production capabilities to 16 million pounds per year and allow a portion of the production to be converted to other copper chemicals such as copper sulfate.

10.2 HISTORY OF AMMONIA LEACHING

In 1870, A. J. Duffield reported that significant amounts of copper were being lost in tailings from the mills in the Michigan native copper district. Duffield and W. G. Frue experimented with numerous reagents to dissolve copper from the tailings, and concluded that this could be best accomplished with ammonia leach solutions. Thomas MacFarlane - a Canadian well acquainted with Lake Superior metallurgy - stated he had successfully removed copper from fine grains of conglomerate ore with ammonia solutions. Ernest LeSueur, a Canadian metallurgist, obtained a patent in 1904 for recovery of ores with ammoniacal solutions. LeSueur specifically mentioned that the method worked well with Calumet and Hecla conglomerate ores. Although ammoniacal leach solutions had proved to be an effective method to remove copper from tailings, there was no method to recover copper from the solutions. A chance notice of a Russian patent by a Mr. Gadmosky on distillation of waste products to recover ammonia provided the key. Subsequent laboratory and pilot plant testing at Calumet and Hecla showed that boiling or steam distillation resulted in complete precipitation of copper oxide and driving off of the ammonia. Under the direction of C. H. Benedict, Chief Metallurgist, a 2,000 ton-per-day plant, with projected expansion to double the size, went into operation in July 1916. For the first thirty years, the primary purpose of the Calumet and Hecla plant was to produce copper oxide to be smelted into metallic copper, although small amounts of oxide were sold. As the demand for copper chemicals grew the need to convert oxide to metal was discontinued.

10.3 PRODUCT USES

The leaching process will produce a product whose physical and chemical characteristics make it suitable for direct marketing. Cupric oxide is in great demand by many industries and agriculture.

Industrial uses:

- Pressure preservation of wood
- Catalyst for petroleum refining and coal gasification
- Catalyst in processes involving alkenes, alkynes, ammonia, ethanol, cumene, and carbon dioxide
- Color formulations in glass and ceramics
- Components of electric batteries
- Preparation of brake linings
- Pyrotechnics (Fireworks and flares)
- Igniters for solid fuel rockets
- Propellant for auto safety air-bags
- Catalyst for producing artificial vanilla and sweeteners
- Mercerization of cellulose and artificial silk fiber
- Catalyst in self cleaning ovens
- Heat collecting surfaces in solar energy units
- Regeneration of copper plating solutions
- Copper powders
- Copper sulfate and other copper salts

Agricultural Uses:

Fungus control on nut groves, peanut plants and citrus
Copper deficient soils
Micronutrients in cattle and poultry feeds

10.4 PROCESS DESCRIPTION

Copper oxide can be manufactured by dissolving metallic copper with a solution of cupric ammonium carbonate. The reaction can be represented by the chemical equation:

$$CuO + Cu(NH_3)_4^{++} + CO_3^{--} \longrightarrow 2\,Cu(NH_3)_2^{+} + CO_2^{--}$$

In the presence of air, oxygen will oxidize the cuprous solution as follows:

$$1/2\ O_2 + 2Cu(NH_3)_2^{+}\ 3NH_3 + NH_4^{+} + HCO^{-}_3 \longrightarrow 2Cu(NH_3)_4^{++} + CO_3^{--} + H_2O$$

thereby regenerating the cupric ammonium carbonate. Copper oxide can be produced from either the cuprous or cupric solutions by distillation. The reactions are as follows:

$$2\,Cu(NH_3)_2^{+} + CO_3^{--} \xrightarrow{\text{Heat}} Cu_2O + 4NH_3 + CO_2 \text{ or}$$

$$Cu(NH_3)_4^{++} + CO_3^{--} \xrightarrow{\text{Heat}} CuO + 4NH_3 + CO_2$$

The overall process consists of four steps:

1. Leaching
2. Distillation
3. Solution Regeneration
4. Oxide Recovery

Leaching of the native copper concentrates and copper scrap will be carried out as a batch operation or in a continuous leaching reactor.

The pregnant solution will be continuously distilled in a proprietary distillations vessel developed by PCI, producing a copper oxide slurry and the recovery of ammonia and carbon dioxide gases.

The leach solution will be regenerated by absorbing the ammonia and carbon dioxide from the distiller into the liquid (still liquor) obtained by filtration of the slurry. This will be combined with a portion of the pregnant solution which has been oxidized with air to form new leaching solutions.

The copper oxide slurry will be filtered and the oxide filter cake will be dried, calcined and packaged for shipment.

10.5 PROCESS FLOWSHEET

The following flowsheets give a detailed description of the leaching process, from the addition of native copper concentrates to the leaching reactors through the packaging of the copper oxide for shipment.

10.6 PROCESS EQUIPMENT

The following sections describe the equipment required for the four basic steps of the process. Detailed descriptions and costs of the components are listed in the appendix.

10.6.1 LEACHING

Low grade scrap - this source consists of three basic types - copper clad circuit board trimmings, copper clad metals and electric motors. Copper clad circuit board is shredded, chipped and conveyed to a silo prior to leaching. The chipped laminate is leached in a continuously rotating reactor. The reactor is a cylindrical steel shell with a discharge cone mounted on trunnions. The 40-foot long reactor is driven through a series of reduction gears to turn the reactor very slowly (one revolution every 12 minutes). The chipped copper board is conveyed through the reactor with the help of flights and lifters. The lean leaching liquor is pumped counter current to the board and dissolves the copper and thus becomes a rich liquor when discharged. The retention time required is approximately eight hours. The barren board chips discharge into a rinsing cycle prior to being heat cleaned. The other two low-grade copper scrap products, electric motors and copper clad metallics are leached in stationary reactors. Mobile scrap handlers load the scrap into a cylindrical reactor generally nine feet in diameter and 12 feet high. The reactor lid or cover fits tightly into a waterseal to prevent loss of ammonia vapors. The bottom of the reactor has a perforated screen deck with a pipe manifold to allow passage of leach solutions and at the same time add oxygen for oxidation of the leach solutions. The lean leaching solution is pumped into the reactor from a 12 thousand gallon storage tank located near the reactors. The solutions are circulated through the reactor using a pump until the solution becomes enriched with copper. After the leaching cycle is complete the substrate residue ore in the form of steel wire, stainless and motor shells are removed from the reactor and further processed for resale.

Native copper concentrates - this consists of two products - jig concentrate and flotation concentrate. The jig concentrate is 90% copper and is course enough to be loaded into stationary digestors. The flotation concentrate is 43% copper and fine and dense enough to require leaching in a continuous reactor. The flights and lifters will allow agitations and mixing for more effective removal of the copper by the leaching solutions. The residue from both the stationary and continuous reactors will be rinsed and shipped to a smelter for silver recovery.

The enriched solutions from the leaching process are pumped to a rich storage tank prior to the distillation step. A portion of the rich liquor is returned to the leaching section for regeneration of the leach solutions. This process will be further discussed under solution regeneration.

10.6.2 DISTILLATION

The process by which the enriched liquor from the leaching process is heated to precipitate copper oxide and drive off ammonia and carbon dioxide is herein called distillation. The enriched liquor to be used in the distillation step is pumped from the rich liquor storage tank into the direct-fired distiller in which copper oxide is precipitated and carbon dioxide and ammonia are driven from the solutions. The Distiller is especially designed to eliminate the problems of scale build-up, a serious problem in distilling ammonia leach solution. The Distiller is heated with natural gas. The slurry containing cupric oxide is discharged from the distiller under pressure and into a holding tank before entering the oxide recovery stage.

10.6.3 SOLUTION REGENERATION

Solution regeneration refers to the make-up, recycling and effluent treatment of solutions used in the process, and therefore is an essential step from both environmental and economic points of view. The principle objectives in this step are to recover the ammonia and carbon dioxide, to reconstitute the leaching solution and to treat waste solutions when necessary for discharge to the environment. Solution regeneration consists of three steps:

10.6.3.1 Condensing the ammonia and carbon dioxide vapors from distillation.

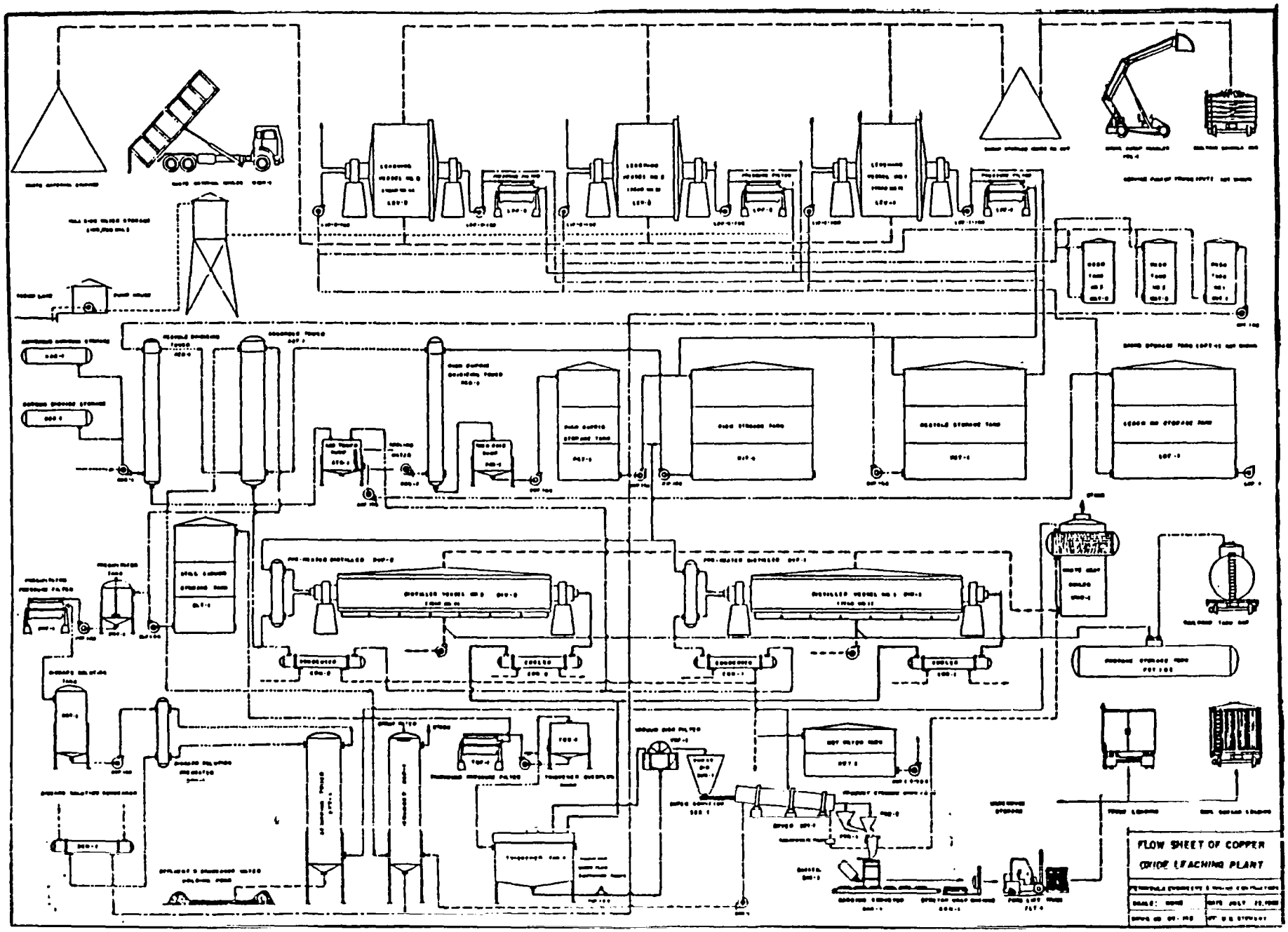
10.6.3.2 Oxidation of the recycle solution to convert cuprous copper to the cupric form.

10.6.3.3 Bleeding a certain quantity of solution from the system to maintain the water balance of the system and removing the copper, ammonia and carbon dioxide from the solution before discharging into the environment.

The mixture of ammonia, carbon dioxide and vapors leaving the Distiller will be condensed in a heat exchanger, using fresh water as the coolant. The condensate is collected in the recycle solution tank. The hot water from the heat exchanger can be used for building heat.

The recycle solution is passed through a packed tower counter-current to the flow of oxygen. The oxygen oxidizes the cuprous copper to the cupric form and the oxidized recycle solution is then pumped to the leaching tank for reuse. Any excess oxygen exiting the oxidation tower carrying ammonia and carbon dioxide must be recovered. This is done in an absorption tower using filtrate (still liquor) from the copper oxide filtration as the absorbing liquid. The oxygen from the absorbing tower still contains traces of ammonia and carbon dioxide which was recovered in a scrubbing tower which uses water as the scrubbing fluid.

FIGURE 10.5



The volume of the bleed stream will be approximately equal to the water used in rinsing the conglomerate residue plus the water used in the scrubber. If the evaporation rate is greater than the rinse water and scrubber water, make up water will be added to balance the plant liquid volume. If the rinse and scrubber water volume increases (winter months) due to lack of evaporation, a small bleed stream will be withdrawn from the rinse system. The small amount of copper in this solution will be precipitated as copper sulfide by the addition of sodium sulfide. After filtering off the copper sulfide, the solution will be distilled in a small tower to remove any remaining carbon dioxide and ammonia. This solution will be pumped into the torch Lake sewage evaporation ponds per agreement. Make up anhydrous ammonia and liquid carbon dioxide are introduced to the system by adding small amounts at the recycle storage tank.

10.6.4 Oxide Recovery

This is the process by which copper oxide is recovered from the slurry after distillation. The hot slurry from distillation is discharged under pressure through a cooler and into a holding tank with a mixer to keep the slurry in suspension. The slurry is pumped from the mixing tank into a thickener. The heavy copper oxide settles to the bottom of the thickener, where it is pumped to a rotary drum vacuum filter. The copper oxide filter cake is conveyed into the top of a rotating tray dryer. Scrapers move the cake down slots in the trays which are revolving in a circle. A gas fired heater circulates hot air over the trays to remove the moisture from the oxide. When the oxide is discharged from the tray dryer, 95% of liquid has been removed from the product. The product is conveyed into a rotary gas fired calciner and heated to 1,100 degrees F to remove the balance of the liquid and also calcine the oxide so it will be soluble in wood treating solutions. The dry copper oxide is cooled and pulverized to remove any lumps prior to being conveyed to a storage bin. The bin is constructed in two sections to allow the material to be packed in paper bags or bulk containers.

10.7 RAW MATERIALS

10.7.1 Low Grade Copper Scrap

10.7.1.1 Copper Foil Laminated Scrap

The circuit board stock used by the electronics industry is prepared by laminating copper foil to resin-impregnated fiberglass cloth with heat and pressure. If the fiberglass cloth is woven, the material is rigid, whereas if the fiberglass is felted, the material is semi-rigid or flexible. The majority of the material is rigid.

After laminating the copper foil to the resin-impregnated fiberglass, the sheets are trimmed by cutting off the rough edges. These trimmings constitute the main source of primary scrap. When cutting the sheets to the specifications required by circuit board consumers, additional waste trimmings are produced. In addition, defective sheets are occasionally manufactured and must be discarded. Seventy percent of the copper scrap presently processed at the plant originates from these sources.

The thickness of the copper foil ranges from .001 to over .004 inches. The industry purchases copper foil ranging from 1/2 oz. to 10 oz. per square foot. The resin-impregnated foil also varies in thickness depending upon the number of layers of laminate used in the producing of the laminate. Combinations of foil thickness and number of layers of laminate can vary the copper content of the scrap from 15 to 70 percent.

At present, there are not many other economic methods to treat this type of scrap. The ammonia leach system is ideally suited to process this material, as the copper is dissolved in a matter of a few hours and the fiberglass is not effected by the leach solutions.

10.7.1.2 Electric Motors

The American economy produces millions of pounds of AC & DC motors each year. Motor sizes range from fractional HP to large 1,000 HP motors to drive mine hoists. Motors consist of windings and armatures using copper wire for conduction of electrical current. Approximately 17% by weight of the average motor is copper. The balance being steel and aluminum. Recycling of motors is a problem due to the low copper content and the mixture of steel and aluminum which is undesirable for the steel and foundry industry. To recycle motors properly, they must be processed through a hammer mill or shredder to demolish the steel housings. then a burning process is used to remove varnish and insulation from the copper windings. After the leaching process removes the copper the balance of the motor can be further processed to magnetically separate the steel from aluminum.

10.7.1.3 Copper Clad Metals

The ammonia leach process is also used to recover copper from a wide variety of clad materials. A key feature of the ammonia leach process is that it does not attack, iron, steel and stainless, and therefore, many types of scrap such as copper clad grounding wire, telegraph wire, copper clad heat exchangers and cooking utensils, etc. are easily treated with this process. It is important to note that removal of the copper from the steel or stainless increases the value of the substrate. It is then easy to recycle into the steel mills and foundries.

10.7.2 Native Copper Concentrates

To supplement low-grade copper scrap, native copper concentrates will be used from the Centennial and Kingston mines. The Keweenaw Copper District contains the world's largest deposits of native copper, a form ideal for ammonia leaching. Conglomerate ores from the Centennial and Kingston mines will be concentrated in the Centennial mill producing a native copper concentrate containing approximately 63% copper. The mill will produce two principle products for the leaching circuit:

10.7.2.1 Jig copper: 1/16 inch to 2 inches; a product derived from gravity concentration; and, containing plus 90% copper.

10.7.2.2 Flotation copper fine copper; less than 1/16 inch; obtained by the mill flotation process; and, containing plus 40% copper.

When these products are combined, a copper concentrate containing plus 53% copper is produced. Energy and environmental cost of processing copper concentrates by leaching are considerably lower than conventional smelting. Furthermore, the product copper oxide has a greater value than metallic copper. The residue from the leaching of native copper concentrates will contain native silver which is left as an insoluble metal sludge in the leaching reactors. The copper concentrate contains silver that averages 2.93 oz. per ton of concentrate. The leaching process will also leave 5-percent of the copper along with the silver. Removal of 95% of the copper will leave a residue containing 7.3 Oz. of silver and 157 pounds of copper per ton.

Metal Value -	Silver 7.30 Oz. @ $6.00 per Oz.	=	$ 43.80
(of sludge)	Copper 157 Lbs.@ $1.00 per Lb.	=	$167.00
	Total Value		**$200.80**

The leaching plant will increase its leaching capacity to produce 15,680,455 lbs. of cupric oxide per year, using a combination of low-grade scrap and native copper concentrates.

Leaching plant raw material requirements:

Low Grade	22,026,000 Lbs. @ 25% Recovery =	5,505,095 Lbs. Cu.
Concentrates	11,499,524 Lbs. @ 60% Recovery =	6,882,465 Lbs. Cu
	Total	**12,387,560 Lbs. Cu**
	12,387,560 Lbs. Cu ÷ 0.79 =	15,680,455 Lbs. CuO

10.8 PROCESS CHEMICALS

10.8.1 Anhydrous Ammonia (NH_3)

Anhydrous ammonia is a comparatively low cost, bulk produced, readily available industrial chemical and is one of the essential components of copper ammonium carbonate that is required for leaching metallic copper. Ammonia is a pungent colorless gas manufactured in large plants throughout the entire United States. Locally ammonia is produced in South St. Paul, Minnesota. Ammonia is synthesized from natural gas and air and is stored and transported in the liquid form. Anhydrous ammonia is shipped in specially constructed steel railroad cars or tractor trailer units. The Interstate Commerce Commission classifies anhydrous ammonia as a nonflammable compressed gas. At the PCI plant site, ammonia will be transferred from trucks to a steel storage tank. The tank is designed to have a working pressure of 250 psi and is located outside and adjacent to the plant building. Additions of ammonia are required to make up for losses that occur in the absorber towers, pump seals, leaching tank seals, oxide drying and calcining equipment, etc. Ammonia losses are 0.006 Lbs. per pound of oxide produced.

10.8.2 Carbon Dioxide (CO_2)

Carbon dioxide is another reagent required to make copper ammonium carbonate solution for leaching copper scrap. Carbon dioxide is a colorless, odorless, nontoxic gas about one and one-half times the weight of air. Carbon dioxide is usually obtained as a by-product from coking ovens, where it is cooled, compressed, and converted to liquid for transport in railroad cars or tractor trailers. At the PCI plant site, carbon dioxide is transferred to a steel pressure storage tank adjacent to the ammonia tank. Liquid carbon dioxide is pumped from the storage tank through a vaporizer assembly, flow meter, and metering pump. Carbon dioxide is lost from the system in much the same manner as ammonia which results in 0.002 pounds CO_2 being lost per pound of copper oxide produced.

10.8.3 Oxygen (O_2)

Oxygen is required to oxidize the cuprous oxide to cupric oxide in the oxidizing towers and leaching tanks. The substitution of oxygen over air reduces the loss of ammonia and carbon dioxide from the leaching system. The use of pure oxygen eliminates the use of air blowers which greatly improves working conditions both inside the plant and the area surrounding the plant. Oxygen is a colorless, odorless, nontoxic gas. Oxygen is manufactured in oxygen generators utilizing molecular sieve beds. Oxygen will be delivered to the plant in tractor trailer units and stored in a large steel vessel. The net cost of oxygen is about 0.007 pounds O_2 per pound oxide produced.

10.8.4 Sulfide Reagents

A small amount of soluble sulfide is required to precipitate the copper from the bleed system and to maintain a water balance in the system. Ninety-nine percent of the operating time, make-up water is added to the system to maintain balance, with the cost incremental to the operating cost of the plant.

10.9 ENVIRONMENTAL

10.9.1 General

A generalized flow sheet (drawing No. OX-146) details the points of discharge for liquid and gaseous effluents. The following details each effluent.

10.9.2 Liquid

There will be two sources of liquid discharge from the process. At the production rate of 12 million pounds of copper oxide, the flow rate of cooling water will be 750 gallons per minute. This water can be used for building heat during the winter months. The water will be discharged into Torch Lake through a diffuser system. The present system at PCI's oxide plant is licensed with the Department of Natural Resources Water Quality

Control Division and no problems are envisioned for permitting a 16-million lb. per year plant. The second liquid discharge happens on rare occasions. Natural evaporation due to the exothermic reaction of the system normally requires the addition of water to maintain water balance in the process. On occasion when treating is required, approval from the Torch Lake Sewage Authority is obtained prior to dumping treated effluent into the evaporation ponds.

10.9.3 Gaseous

There are two types of gaseous emissions from the plant. The first is stack gases from the distiller and calciners. These gases will be clean and high quality because clean natural gas will be used in the burners. The other gas streams will originate from the tray dryers and calciners. Baghouse collection systems remove fine particles of oxide prior to emission to the atmosphere.

10.9.4 Solids

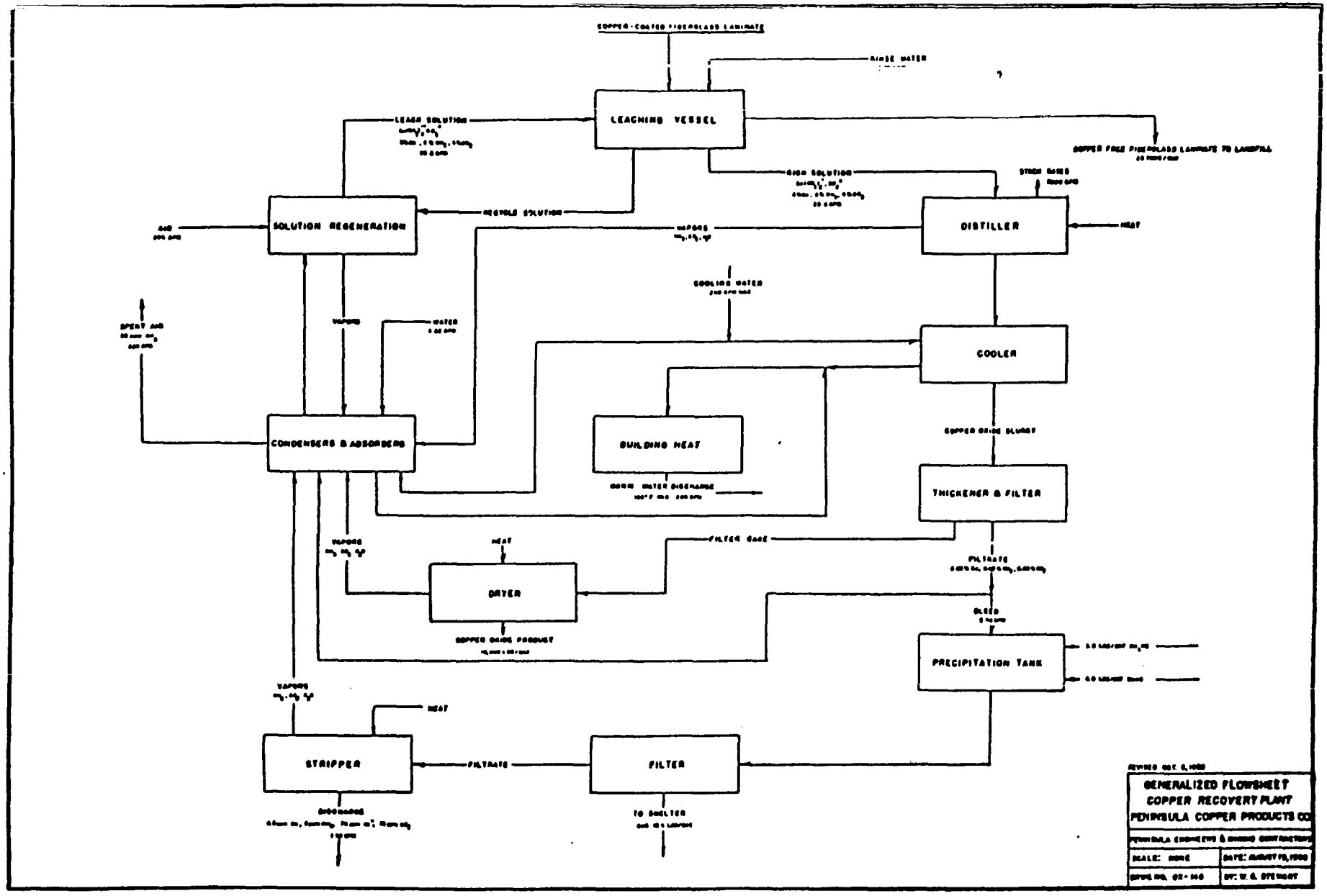
The leaching of native copper concentrates will produce a conglomerate residue. Thirty-seven percent of the concentrate will produce 5,860,652 lbs. per year containing copper and silver values. The residue will be rinsed to remove residual ammonia and carbon dioxide, then shipped to a smelter and refinery for recovery of metal values.

10.10 COST OF GOODS

This section will deal with all costs related to manufacturing a pound of copper oxide. The following is a list of cost items that will be detailed in this section:

10.10.1	Chemicals
10.10.2	Raw Materials Freight
10.10.3	Raw Materials
10.10.4	Packaging
10.10.5	Wages
10.10.6	Payroll Taxes
10.10.7	Vehicle Expense
10.10.8	Rent
10.10.9	Electric Power
10.10.10	Natural Gas
10.10.11	Process Water
10.10.12	Maintenance
10.10.13	Supplies
10.10.14	Insurance
10.10.15	Contracted Services
10.10.16	Plant Utilities
10.10.17	Equipment Rental
10.10.18	Safety Equipment & Supplies
10.10.19	By-Product Sales

FIGURE 10.9.1



COPPER-COATED FIBERGLASS LAMINATE
RINSE WATER
LEACHING VESSEL
LEACH SOLUTION
COPPER FREE FIBERGLASS LAMINATE TO LANDFILL
RICH SOLUTION
STACK GASES
SOLUTION REGENERATION
RECYCLE SOLUTION
DISTILLER
HEAT
AIR
VAPORS
COOLING WATER
SPENT AIR
VAPORS
WATER
COOLER
CONDENSERS & ABSORBERS
BUILDING HEAT
COPPER OXIDE SLURRY
THICKENER & FILTER
VAPORS
HEAT
FILTER CAKE
FILTRATE
DRYER
BLEED
COPPER OXIDE PRODUCT
PRECIPITATION TANK
VAPORS
HEAT
STRIPPER
FILTRATE
FILTER
DISCHARGE
TO SMELTER
GENERALIZED FLOWSHEET
COPPER RECOVERY PLANT
PENINSULA COPPER PRODUCTS CO
SCALE: NONE

10.10.1 Cost of Chemicals

Copper oxide is manufactured by dissolving native copper concentrates with a solution of cupric ammonium carbonate. The reaction can be represented by the chemical equation.

$$Cu + Cu(NH_3)_4^{++} + Co_3^{--} \longrightarrow 2Cu(NH_3)_2^{+}\ CO_3^{--}$$

and in the presence of pure oxygen will oxidize the pure solution as follows

$$1/2\ O_2 + 2\ Cu(NH_{3)2}^{+}\ 3NH_3 + NH_4^{+} + HCO_3^{-} \longrightarrow 2Cu(NH_3)_4^{++} + CO_3^{--}H_2O$$

Sodium Sulfide in the presence of cupric ammonium carbonate

$$NaHS + Cu(NH_3)_4^{++} \longrightarrow CuS + Na^{+} + NH_4^{+} + NH_3$$

Anhydrous ammonia, carbon dioxide, oxidizing oxygen and sodium sulfide reagents will be required. The following four tables summarize the requirements of these reagents and their total cost.

10.10.2 Cost of Raw Materials Freight

PCI Transportation Co. is a wholly owned subsidiary of Penninsula Copper Industries Inc., it was created to service PCI transportation needs during a time when their needs were receiving inadequate service from outside. In addition to acting as a private carrier operation for PCI, the Division acquired I.C.C. authority to act as a common carrier servicing outside shippers' transportation needs. The Transportation Division has increased from one power-unit and two trailers in January of 1986 to a level of four power units and thirteen trailers during the course of 1988. As a logistic's management service, PCI Transportation will coordinate and carry out all transportation needs for the mining, milling and manufacturing groups. This will be accomplished by increasing the amount of support equipment and the use of outside transportation as needed.

Pricing Policy - The Smeester Brothers Trucking Co., located in the Iron Mountain Michigan area, is the largest local carrier in the region servicing large companies such as Celotex Corporation, Champion International Paper Company as well as outside support for PCI Transportation. PCI Transportation has accepted Smeester Brothers' rate structure for service to the mining and manufacturing group.

Transportation costs for shipping in low-grade copper scrap and native copper concentrates from the Centennial Mill to the leaching plant are summarized in Table 10.10.2-A. Table 8.10 B & C freight calculations are based on actual Smeester & PCI Transportation 1989 freight rates for the various raw material sources.

Table 10.10.2-B

Projected Freight Cost for Copper Laminates

Transportation Cost Source	Type	Available	Pounds Cost Per Lb	Freight Cost $	Freight Per Lb. CuO
GE	Laminates	3,360,000	$0.0325	$109,200	$0.1275
Oak-Franklin	Laminates	1,187,000	$0.0211	$ 25,046	$0.1226
West H-Hampton	Laminates	442,000	$0.0471	$ 20,818	$0.2653
West H-Pend.	Laminates	679,000	$0.0504	$ 34,222	$0.2677
Rubbish	Laminates	540,000	$0.0376	$ 20,304	$0.1398
Aura II	Laminates	180,000	$0.0147	$ 2,646	$0.0621
Ideal	Laminates	2,886,000	$0.0465	$134,199	$0.1217
NVF	Laminates	1,013,000	$0.0352	$ 35,658	$0.1536
Polyclad	Laminates	390,000	$0.0376	$ 14,664	$0.0582
Yank	Laminates	530,000	$0.0341	$ 18,073	$0.0753
Steel Supply	Laminates	1,056,000	$0.0105	$ 11,088	$0.0390
Empire Norplex	Laminates	1,000,000	$0.0558	$ 55,800	$0.1729
IBM	Laminates	240,000	$0.0478	$ 11,472	$0.0889
Custom Alloys	Laminates	390,000	$0.0657	$ 25,623	$0.1221
Advanced Dielec	Laminates	240,000	$0.0657	$ 15,768	$0.1153
Misc. Laminates	Laminates	1,560,000	$0.0400	$ 62,400	$0.1170
	Total	**15,693,000**	**$0.0317**	**$496,981**	**$0.1015**

Projected Freight Cost for Electric Motors

ER/Howell	**Motors**	**240,000**	**$0.0143**	**$3,432**	**$0.0738**