



# Hibbing Taconite Company Saves \$260,000 by Reducing Ore Spills

Minnesota Technical Assistance Program ■ INTERN SUMMARY

## Equipment and Maintenance Changes Reduce Waste

<b>Company</b>	Hibbing Taconite Company Hibbing, Minnesota
<b>Results</b>	Ore spills were reduced over 75 percent (19,000 tons), saving \$260,000 per year. Full implementation is planned to save \$330,000 annually.

Hibbing Taconite Company (HTC) is an ore pellet producer that extracts, concentrates and pelletizes ore into taconite for use in steel manufacturing. It operates nine mills as part of its ore concentrating process.

At each of the nine large mills, two chutes pour ore into the mills to grind it into a fine powder before magnetic separation into iron-rich and iron-poor streams. The feed chute can deliver ore up to 10 inches in diameter. The base of the chute is a cart that sits on rails, which allow the cart to be moved for maintenance. The other chute, the cyclone underflow (CUF) pipe, returns oversized iron-rich concentrate to the mill in a slurry for further grinding. The CUF pipe empties into the feed chute.

The feed end of each mill sits on trunnion bearings that allow the mill to rotate. The bearings are susceptible to damage from spills near the mill opening, as well as from water from floor cleanup. Spills increase the need for maintenance on the bearings, resulting in production downtime and increased use of lubricating oil.

A bucket wheel—somewhat like the wheel of a centuries-old water mill—forms the rim of the rotating mill, capturing spills and emptying them into the mill. The splash plate attached to the feed chute

fills most of the space between the bucket wheel and the chute, physically blocking spills. The splash plate has a thick rubber seal at the bottom in contact with the rotating mill. This seal would wear away within a few months of operation. Spillage increased as the seal deteriorated.

Approximately 25,000 tons of ore concentrate was spilled per year. A low value was placed on this material and spills were washed into tailing ponds.

Production engineers had made a number of efforts to control mill spillage in order to reduce oil waste and maintenance downtime, including new designs for splash plates and for liners at the mill mouth. They wanted to further reduce oil waste and maintenance downtime due to contamination and bearing damage. Lacking time to research additional changes, they requested a **MnTAP intern** to help reduce contamination of the trunnion bearing lubrication oil.

### Spill Prevention

The intern evaluated the spilled material and determined it contained more iron-rich concentrate than unconcentrated ore. Because HTC learned that the spilled material had more value than previously thought, spill prevention gained greater priority.

As a result of his research, the intern recommended several equipment and maintenance changes to reduce spills. However, the 2001 downturn in the steel industry prevented immediate implementation. After economic conditions improved in late 2003, HTC staff made changes on seven of the nine mills, with plans to modify the two other mills.

### Chute Modifications

The intern suggested replacing the rubber-on-steel seal between the bucket wheel and the chute's splash plate with a urethane-on-rubber seal. HTC tested four different configurations for the seal between the bucket wheel and the splash plate: urethane on rubber; urethane on urethane; rubber on rubber and

rubber on steel. With improved chute-mill alignment, the original rubber-on-steel seal had the slowest wear rate. The average seal life was extended from six months to over 12, with the oldest seal still operating well at 18 months.

The intern recommended installing a second steel splash-plate at the end of the feed chute, further into the mill, to block ore and fines from reaching the seal. He also recommended extending the CUF pipe into the mill to prevent fine concentrate from wearing the feed chute and leaking out before reaching the mill.

HTC tested a number of splash plate designs starting with the intern's recommendations. The CUFs chute extension and the new primary splash plate that extended into the mill were quickly knocked off by ore pieces. These design features were discarded.

The intern suggested installing troughs alongside the bottom of the feed chute so that the bucket wheel could return more of the material it captured back to the mill. HTC added the catch troughs, which worked well at capturing spills from the bucket wheel. Their life is expected to be similar to the life of the ore chute.

### Trunnion-bearing Seal

HTC implemented these changes recommended by the intern: increase the frequency of grease applications to maintain trunnion-bearing seals, and fix broken or missing grease lines.

### Chute Alignment

The intern suggested that better realignment was needed when the chute was rolled back into place after being moved for maintenance, to improve the mating of seals and minimize leaks and wear.

HTC improved feed chute alignment by replacing the carts' wheels and adding axel bushings to make up for vibratory wear. The company found that as the cart rails wore down from abrasion, they contributed to chute misalignment. Reducing spills on the rails should also help reduce the rate of wheel abrasion.

When the feed chute was properly aligned with the center of the mill opening, it solved many of the spill issues and proved that the original splash plate design was the best configuration.

### Cost and Savings

Through April 2005, the improvements to the seven mills had saved HTC approximately \$260,000. After

all nine mills are modified savings should total \$330,000 annually. The mill modifications paid back in less than nine months.

#### Savings

Improvement	Per mill	Total (9 mills)
Oil maintenance downtime decreased 50%	4 hours	\$5,500
Ore spillage decreased 75%	2,100 tons	25,000
Waste oil decreased 62%	600 gal	6,500
<b>Ongoing annual savings</b>		<b>\$37,000</b>
		<b>\$333,000</b>

#### Cost

Improvement	Per mill	Total
Realigning ore chute carts	\$20,000	\$180,000
Replacing seals	4,000	36,000
Testing seal designs	NA	25,000
	<b>\$24,000</b>	<b>\$241,000</b>

### Application to Other Companies

Although some of the intern's suggestions for new modifications made minor improvements to the mill, adhering to the original design proved to be the best option for reducing spills. Ensure that systems are working as designed, then evaluate improvements.

Excluding the value of the spilled iron-rich ore, this project would have had a payback of around 20 months and a projected net savings of \$36,000 per year, based on the estimated modification cost. At HTC, including the spillage value substantially raised the profile of the recommendation to decrease spills.

Accurately assessing the value of lost material is critical to understanding the total operating cost. Whether the waste material is spilled iron-rich ore or a waste oil, understand the causes of the waste and all of their related cost to get a complete picture of your system's efficiency.

### For More Information

MnTAP has a variety of technical assistance services available to help Minnesota businesses implement industry-tailored solutions that maximize resource efficiency, prevent pollution and reduce costs. Our information resources are available online at <mntap.umn.edu>. Or, call MnTAP at 612/624-1300 or 800/247-0015 from greater Minnesota for personal assistance.

*This intern project was conducted in 2001 by MnTAP intern Francis Sobolik, a mechanical engineering junior at the University of North Dakota.*