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Plant Expansion: Materials Handling

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Die Erweiterung einer Haldenanlage
Développement d'une installation: Manutention des matériaux en vrac
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1. Introduction

U.S. Borax & Chemical Corporation, a member of the RTZ Group, is the leading producer of Boric Acid. U.S. Borax has its mining operation at Boron, California, and refining facilities at both Boron and Wilmington, California.

The mine at Boron has been in operation as an open pit mine since 1957 and underground prior to that time and is currently producing in excess of 1,000,000 tons of ore annually.

The ever increasing energy costs throughout the world, and especially in the USA, have caused a dramatic increase in demand for insulating products. This translated directly to a need for U.S. Borax to double production of Boric Acid since Boric Acid is used extensively as a fireproofing agent in a major insulating material.

A production increase of this magnitude was a major undertaking. At the time, all Boric Acid was produced at the Wilmington facility. Since the Wilmington facilities are quite old, and, being in Los Angeles Harbor, quite cramped, it was rejected as not suitable for such a large increase in production. Several other ideas were evaluated, and it was decided to build a new 200,000 ton/year plant adjacent to the existing Boron Refinery. This created some materials handling problems. Solving materials handling problems has been a tradition at U.S. Borax for a long time. The transportation of ore by the famous "20 Mule Team" was done by U.S. Borax between Death Valley and Mojave California in the late 1800s. Visitors to the plant at Boron can still see an example of the ore and water wagons on display.

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2. New Plant System

There was already a materials handling system at Boron to serve the Refinery (Fig. 1). It consisted of conveying from the pit, storage (single pile), reclaim and plant feed. It was reviewed to determine whether it could be extended or modified to also serve the new Boric Acid Plant, and it proved to be inadequate. The new facility would, of necessity, require its own ore stockpile and reclaim system. It was obvious that an automatic reclaim system of sufficient reliability would be required such that the stockpile would be an integral part of the surge capacity for the plant.

Underground reclaim systems such as rotary plow feeders and tunnel feeders (vibratory, belt, pan, etc.) were considered versus above ground systems. To achieve the same total live reclaim capacity, the underground systems were found to be generally double in length to the above ground systems. This fact, together with the high cost of civil work involved, quickly rules out such systems. Additionally, the real estate needed was not easily available.

Attention was therefore focused on above ground reclaim systems. There are many different types available and all were considered. These were:

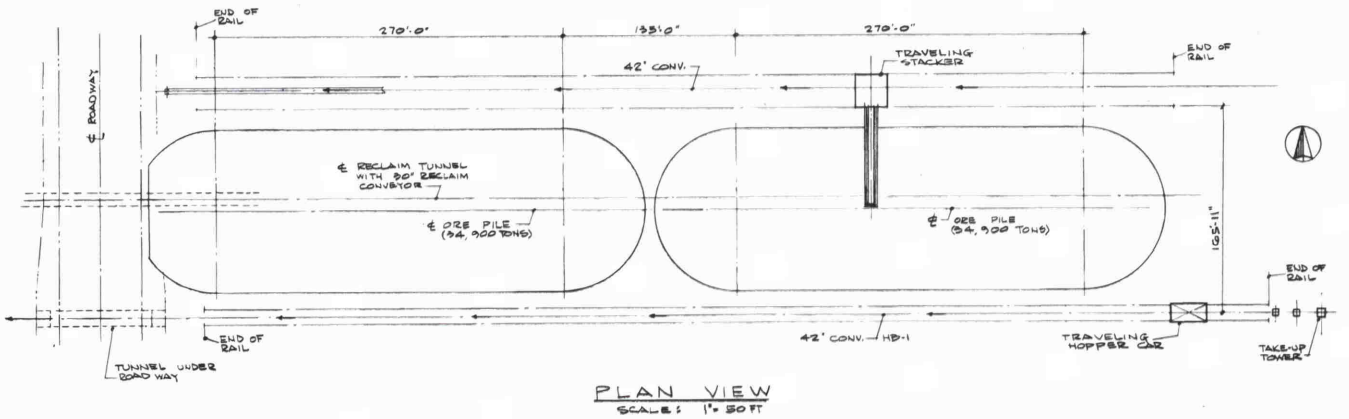
a) Bridge-mounted scraper reclaimers (rake and drag)
b) Bridge-mounted bucket wheel reclaimers
c) Wheel-on-boom reclaimers
d) Portal scraper reclaimers

The presence of lumps in the ore as delivered from the mine made the rake and drag type reclaimers unsuitable. Since wheel-on-boom reclaimers could not be fully automated, they were eliminated from consideration. The bridge-mounted bucket wheel appeared to be the most suitable choice. Based on published data available, this type of reclaim would provide the plant with a reliable, continuous and uniform rate of ore feed in a fully automatic mode. This method of reclaim also provides a blended feed, a most important feature for the process.

Even though the new Boric Acid Plant was to be located adjacent to the main plant, of necessity two separate stockpiles would be required to make them completely independent of one another. The existing storage for the main Refinery was a single stockpile built by a traveling, fixed boom stacker constructed in 1955. To provide two stockpiles, one for the main Refinery at 75,000 tons, and one for the Boric Acid Plant at 15,000 tons, it was necessary to first provide a double, or twin boom, articulating boom stacker. The necessity for articulating booms were:

1. To provide good stockpile blending by layering,
2. to minimize dusting caused by long free fall, and
3. to enable raising the non-operating boom out of the way of the reclaiming machinery.

Following the decisions to utilize a bucket wheel reclaimer for the new Boric Acid Plant, and a double boom ore stacker to serve both plants, it was necessary to consider the stockpile size and arrangement for the Boric Acid Plant. The mining schedule allowed the stockpile to be of approximately 15,000 tons which would be blended in



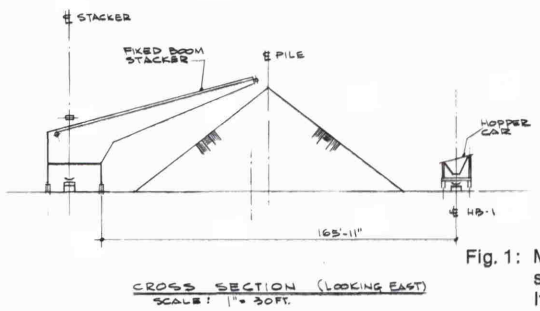


Fig. 1: Materials handling stacking/reclaiming system prior to the new Boric Acid Plant. It consisted of a single, fixed stacker and front end loader reclaim

two piles of 7,500 tons each. Reclaiming would take place on one pile while the second was being layered by the stacker. Since the mine can feed the stacker at 1,200 tons/h, only one shift would be required to build a 7,500 ton stockpile. This would make the scheduling for rebuilding the depleted stockpile quite flexible. The two 7,500 ton piles would be on the same centerline with the reclaimer being a reversible type capable of operating on either with little interruption in feed.

The double boom stacker selected was a custom design capable of building two different pile heights (one for Boric Acid Plant and one for main Refinery) (Fig. 2). It also was unusual in that the existing feed conveyor (yard conveyor) was offset from the centerline of the rails. It was to stack automatically by responding to different limits for the two plant piles. It was rated at 1,200 tons/h with a traverse speed of 30 ft/min.

The bucket wheel reclaimer selected was a 85′—0″ machine, reversible, single digging wheel type with dual harrows (Fig. 3). It was capable of up to 150 tons/h and was completely automatic in reclaiming.

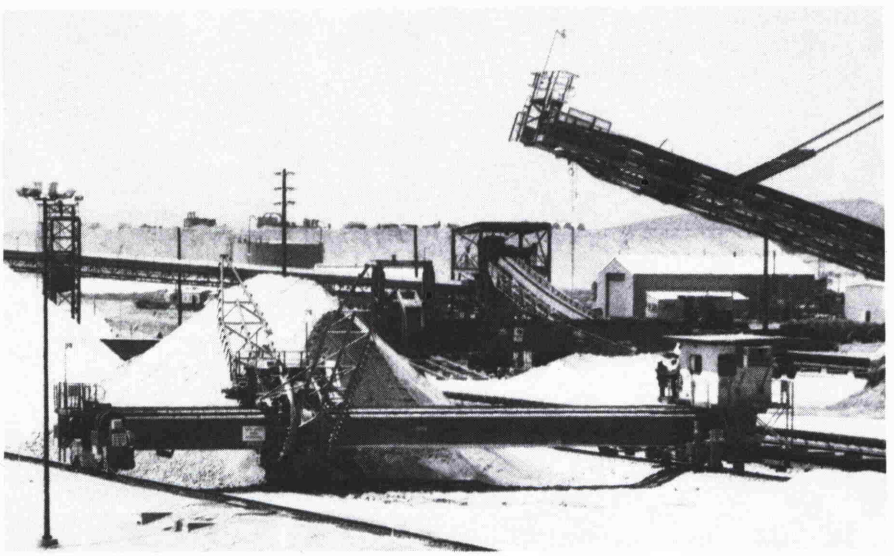


Fig. 3: Boric Acid Plant bucket wheel reclaimer

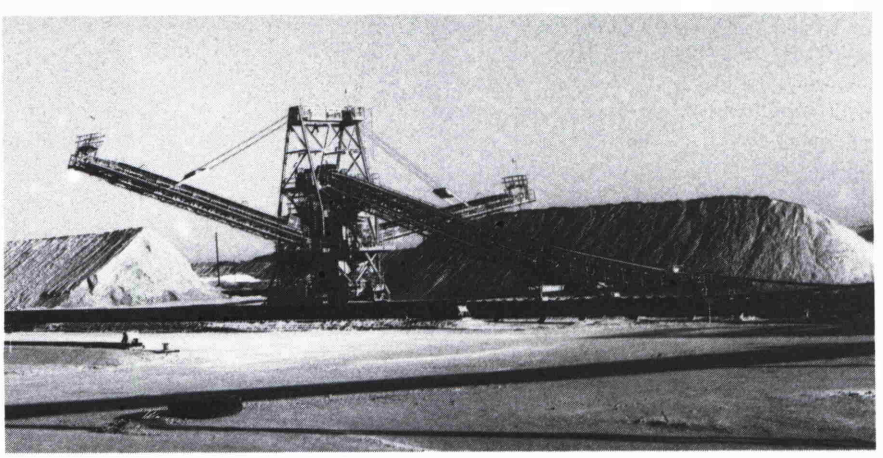


Fig. 2: New double boom stacker. Both booms articulate

3. Main Refinery System

The present method of reclaiming ore for the main Refinery uses 15-yard front end loaders to fill a rail-mounted traveling hopper feeding a belt conveyor system (Fig. 4). Coinciding with the investigations for the Boric Acid Plant, the front end loaders were reaching the end of their useful life and were in need of replacement. In addition, the stockpile for the main Refinery had to be relocated to make room for the Boric

Acid Stockpile. Since an automated reclaim system was being used for the Boric Acid Plant, it seemed that a change in the reclaim system would be appropriate if the present installation could be replaced by a more economically favorable alternative.

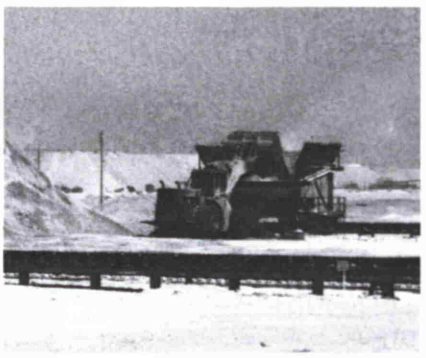


Fig. 4: Front end loader reclaim

Again, several alternatives were considered. These included:

1. Drag conveyor
2. Shovel reclaiming
3. Bridge-type bucket wheel (BW)
4. Front end loader (FEL)

The first three systems were rejected due to high capital costs, higher operating costs, and/or the unproven operating records of the systems. Of the systems considered, the bucket wheel reclaimer was the most attractive from an operating cost standpoint, however, the large width of the stockpile made a bucket wheel system cost prohibitive as the length of the bridge span is the major cost determinant. Therefore, the FEL system was chosen as the reclaiming method to continue to be used.

The FEL system has been used at Boron for 25 years. The operating, maintenance and capital replacement costs for this system are high. The Boric Acid Plant and pile relocation created an opportunity to lengthen the main Refinery stockpile and reduce the width to 110 ft while still maintaining the necessary surge capability. This warranted the reconsideration of alternate reclaiming systems, especially bucket wheel reclaimers. Drag systems and shovel systems were again ruled out as uneconomical and were also unable to achieve blending requirements.

The choice narrowed to FEL versus BW systems, and detailed forecasts of annual operating costs were made and a comparative summary of this study is shown in Table 1.

Table 1:
Forecast of annual operating costs

	In 1978 Dollars, Annual Cost		
	Proposed Method Bucket Wheel	Present Method Front End Loader	Savings
Operating/Labor/Clean Up	$ 3,400	$ 113,000	$ 109,600
Power/Fuel	13,000	29,000	16,000
Maintenance	63,200	253,000	190,400
Back Up Support	9,200	49,100	39,900
Pro. Tax/Insurance	26,400	7,200	(—19,200)
Total	$ 115,200	$ 451,900	$ 336,700

The largest savings are in maintenance and operating costs, both escalating items. No operating labor is required for the bucket wheel. It is entirely automated with its movements controlled by an operator in the secondary crushing facility.

The mechanical availability of the BW system was investigated and found to be 97 % based on existing operations both in Europe and the USA. During the time the BW system is down for repairs and preventive maintenance, approximately 3 % of the scheduled operating hours, a back up system must be used to provide an uninterrupted supply of ore to the refinery. The existing reclaim hopper was retained for this purpose. It will be loaded by front end loaders borrowed from other parts of the plant.

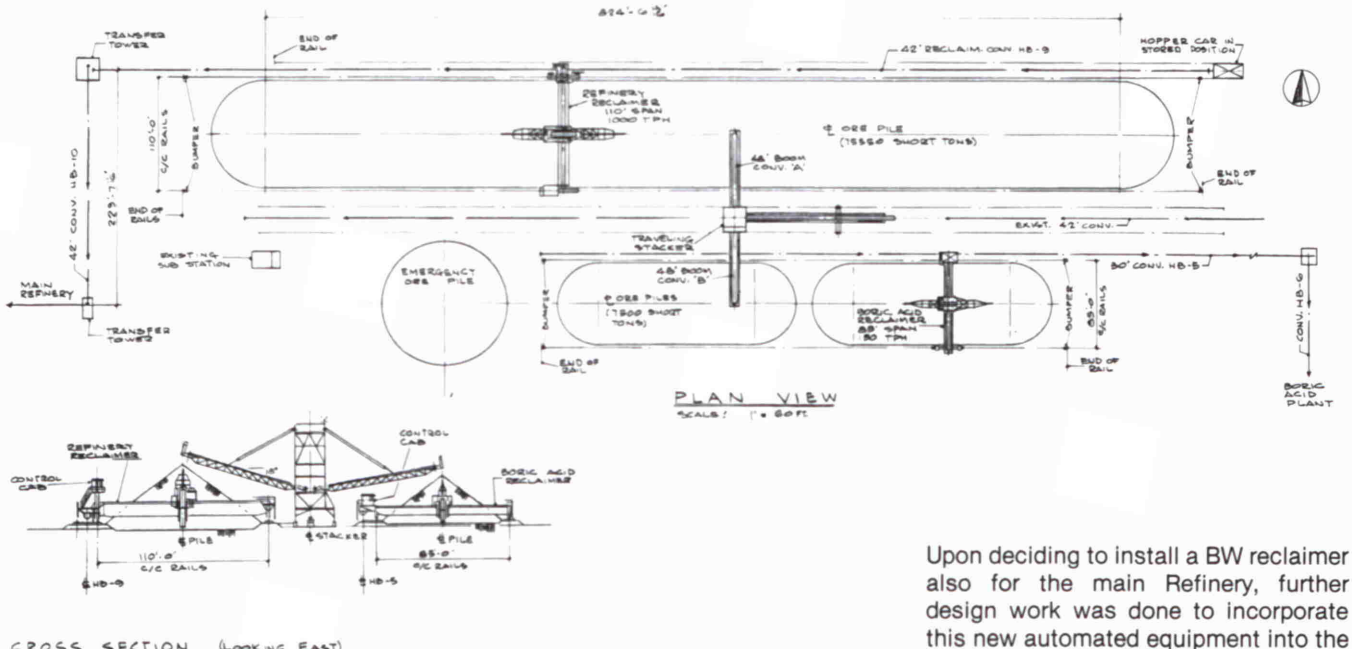


Fig. 5: New system lay-out incorporating bucket wheel reclaimers for the Boric Acid Plant and the Main Refinery

Upon deciding to install a BW reclaimer also for the main Refinery, further design work was done to incorporate this new automated equipment into the overall scheme for both plants (Fig. 5). As previously mentioned, the large ore stockpile had to be relocated, and the design was such that it could be instal-

led without interruption of feed to the Refinery. The new reclaim belt conveyor system including trackage for the reclaim hopper was installed and tested without conflict with the existing system. The extension of the stacker runway and the belt conveyor machinery were also installed prior to the relocation. On the day set to make the final relocation, all that was necessary was to make two belt splices for the stacker conveyor installation, remove the old stacker and relocate the existing hopper car. This was accomplished in a single 24 hour day. During this period alternate means of providing ore feed to the refinery was used.

As of this writing, U.S. Borax's new Boric Acid Plant has undergone final test and is now into start-up operations. The stacking and reclaiming system has justified the original selection and has performed as expected. The new, automated reclaim system for the main Refinery is presently undergoing final installation and preparation for test (Fig. 6).

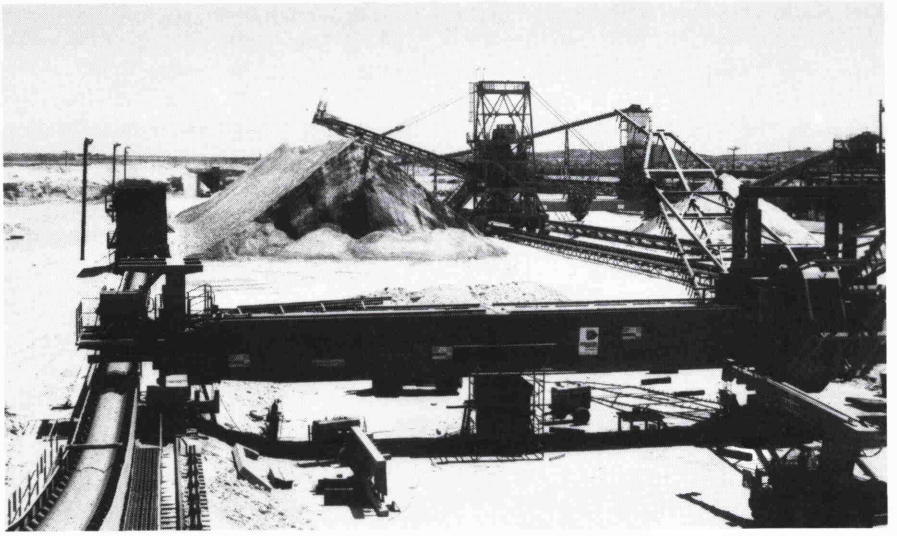


Fig. 6: Main Refinery bucket wheel reclaimer, final installation phase