

**THE MASSACHUSETTS
TOXICS USE REDUCTION INSTITUTE**

**ALTERNATIVE EQUIPMENT
FOR BULK DEGREASING AND
ABRASIVE BLASTING OPERATIONS**

BELOIT FIBER SYSTEMS

Technical Report No. 22

1995

University of Massachusetts Lowell

Alternative Equipment for Bulk Degreasing and Abrasive Blasting Operations

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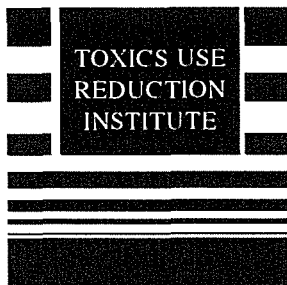
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The Toxics Use Reduction Institute FY 94 Matching Grants Program

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Toxics Use Reduction Institute Matching Grants Program

The Institute annually provides direct funding to Massachusetts industries on a matching basis for toxics use reduction (TUR) feasibility and technology studies. The Matching Grants Program was initiated in FY 93 to facilitate the development and use of innovative techniques that reduce the use of toxic chemicals or the generation of toxic by-products in Massachusetts businesses. Grants are awarded on a competitive basis for companies to conduct TUR studies at their facilities. Recipients prepare project reports which assist in transferring toxics use reduction technologies and methods to other companies.

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I. Executive Summary

The purpose of this project is to improve worker health and reduce the use of toxic chemicals used in the re-manufacturing or refurbishment of used papermill machinery. The specific toxics use reduction techniques evaluated were production unit redesign, production unit modernization, and in-process recycling.

In order to reduce our operating costs and lessen our environmental impact, the Beloit Fiber Systems division attempted to decrease the time involved in the cleaning of customer furnished parts for their new rebuild operation center. This report summarizes the efforts of our in house personnel to reduce and subsequently eliminate the use of 1,1,1-trichloroethane in the cleaning of parts subsequent to inspection and prior to painting. To accomplish this, we investigated combining the initial stages of part examination, cleaning and blasting, into one process with a concept of making it automatic.

Old Method:

Our old methodology used considerable labor to physically scrub large pieces of steel, cast iron and stainless steel with 1,1,1-trichloroethane. This process consumed vast amounts of time and chemical but produced acceptable results for our repair team to tear apart the used equipment for evaluation. The parts were then placed into a wheelabrator abrasive blast machine where they were blasted with steel shot to remove any remaining exterior traces of residue paint and produce a surface finish suitable for painting.

With the assistance of a Matching Grant from the Toxics Use Reduction Institute, Beloit initiated the feasibility and development of a single piece of automated equipment to perform both the cleaning and blasting operations. A joint venture was formed allowing two companies, who often compete for the same customers, to work together to assist us in this endeavor. These two companies had to drop their protective veil of corporate secrecy and join forces to accomplish this task. This project was undertaken with the great effort of many corporate attorneys, and, more importantly, with the dedication of people who believed that this project was possible.

New Method

We have completely eliminated the use of 1,1,1-trichloroethane and in addition we have succeeded in reducing the amount of

cleaning time and blast media. The new cleaning station is not yet 100% effective but has proven to be extremely effective in accomplishing our goals of time and chemical reduction. The primary obstacle to complete utilization has been the problem of grit accumulating with the heavy grease resulting in large clumps which ultimately obstructs the grit blasting nozzle orifices.

This report summarizes the group's efforts and describes our successes and failures. The general opinion of the process as it nears its final stages of testing is that we have succeeded in building a great wash system but that the blast operation leaves much to be desired. It is hoped that the reader understands where our efforts were directed and proceeds to obtain success where we have failed.

We would again like to thank the Toxics Use Reduction Institute at the University of Massachusetts Lowell for their effort and support during this project.

II. Introduction

Introduction

The Beloit Fiber Systems Division is a machine shop located in Dalton, Massachusetts. Beloit is a subsidiary of Harnischfeger Industries Inc. and is recognized as the leader in paper making equipment. The primary end product of the Dalton facility is the manufacture of paper making equipment, specifically the wet end of the paper making process. The Fiber Systems Division manufactures machines which take wood chip and through manipulative processes produce pulp which is then processed through the other process lines for cardboard, white or other types of paper. These machines range from 5 feet in diameter weighing one ton or less to 40 feet long by 20 feet in diameter weighing 20 tons or more. The machinery is made of primarily stainless steel with mild steel reinforcements or ribbing. This facility is designed to handle all aspects of steel manufacturing including shearing, bending, welding, fabrication and assembly.

In the mid 1980's Beloit Jones, now known as Beloit Fiber Systems, decided to actively pursue the after market repair and rebuild of the equipment we manufactured. We examined all aspects of this venture, the most difficult of which was the cleaning of the apparatus as it arrived from the paper mills. Each paper mill has unique types of paper stock running in their machinery resulting in various conditions of disrepair of the equipment. Each used machine designated for rebuilding requires disassembly and cleaning of up to 10 gallons each of heavy sump oil and bearing grease prior to proceeding with further evaluation. Not only does the size of the machinery vary but so do the contaminants contained within and clinging to the machinery. The stock residue in the units ranged from large pieces of wood chips to small pieces of wood fiber and other materials, which compacted and dried in very tight crevices. Initial cleaning for this machinery was accomplished with 1,1,1-trichloroethane and manual labor using scrub brushes on long poles. The total 1,1,1-trichloroethane usage for Beloit Fiber Systems as reported in the 1991 Form R was 31,161 pounds. That amount was reduced to 20,040 for 1992 through alternative types of cleaning. The use of TCA posed a worker health and safety problem, an ozone depletion problem via air emissions in conjunction with an environmental disposal problem that is complicated by the presence of chlorinated compounds.

A secondary air emission problem occurs later in the rebuilding process. After major machine parts are degreased and inspected, they are abrasive blasted using traditional dry blasting techniques. Dry blasting poses its own unique concerns regarding air quality which we hoped would be eliminated by the application of different technology.

A search was undertaken to find a replacement for both the degreasing and abrasive blasting processes which would be inexpensive, safe to use and would leave the end product suitable for repair and subsequent painting.

IV. Initial Objectives and Options Identification

A. Objectives

To purge the disassembled components of the customer's equipment so that an evaluation can be made about wear and stress fractures. This equipment must have all heavy greases and oils removed from cavities as well as inner and outer surface areas. Old pitted surfaces must be abraded for paint preparation and loose paint removed. This cleaning must be accomplished prior to evaluation of the part's functional condition. Since the status of the equipment must be determined as quickly as possible the time required for cleaning must not take longer than that which we were experiencing.

B. Initial Options

Option 1:

A large tank to completely submerge the soiled machinery. The vat would have to be approximately 15 feet in diameter and approximately 15 feet deep. This unit would have to be heated to remove the grease and oils normally associated with the used equipment. After investigating this option it was realized that the magnitude of this cleaning station was too vast for safety and existing space limitations. There was also a financial consideration for the secondary containment and disposal costs for such a vast quantity of water. Consideration would also have to be made for the large operating costs both for water agitation with pumps and air flow.

Option 2:

A high pressure washer (1,000 psi) with pole mounted scrub brushes was tried. This cleaning procedure took approximately 16 hours to complete a 42" Double D Refiner, however the heavy greases still remained. They had to be subsequently scraped and the remaining film removed with 1,1,1-trichloroethane. This method proved to be too capital intensive and was determined to be unsatisfactory due to the size and lack of portability for this unit to be used effectively on large pieces.

Option 3:

A large machine similar to that of a car wash was considered. This would allow the large pieces of equipment to be placed on railroad tracks and rolled in the unit for cleaning. It was

estimated that this was technology which could be adapted for our application. Careful examination showed this unit to be impracticable as sold from the factory. Beloit would have to engineer changes to the initial design because the unit was not available for the removal and recycle of the contaminated fluid.

C. Initial Assessment

The problems that were particular to our process were the following:

- o Machinery size was a consideration due to the volume and mass of the object. This presented a problem for transportation within the facility and within the chamber itself. The size of the cleaning chamber was also a problem since most parts washing companies built smaller size units for disassembled pieces.
- o Heavy concentrations of grease in awkward crevices would be difficult to remove. Much of this material was old and heat hardened. Scraping was the preferred method of removal.
- o The exterior of the units needed to be cleaned for analysis of cracks or flaws as well as surface abraded for epoxy painting. All grease and oily films must be removed.

V. Final Assessment

The identification of the problems at the end of the initial assessment made the search for a solution easier. We knew the following requirements:

- 1 - The cleaning equipment had to be able to handle equipment which was at least 6 feet in diameter and weighs 5 tons.
- 2 - The equipment must be heated and or have a chemical for grease and oil removal. This chemical needed to be applied in a forceful manner to remove hard layer of congealed grease.
- 3 - The time for machine cleaning had to be equal or less in time than we were presently experiencing.
- 4 - The surface must be preped for paint application.
- 5 - It was preferred that the system be completely automatic.
- 6 - All cost factors had to be considered from up front initial capital costs to running and ultimate waste disposal costs.

A. High Pressure Spray Washer

We were notified of a large cleaning station at a local facility which was used for the cleaning of paper making machinery prior to the maintenance department working on them. An initial visit proved to be very helpful from a conceptual standpoint but the size of the unit was impracticable for our purposes. The manufacturer was contacted and a visit to a facility for an on site demonstration of a 60 inch diameter rotating table was arranged. This particular facility repaired large diesel engines which had similar grease and grime and had similar size characteristics to what we envisioned. The performance of this unit was exceptional. These parts were cleaned with nozzles containing a detergent at 240 psi pressure. The object was rotated while the nozzles were moved up and down vertically. This process seemed to be extremely viable. We contacted the vendor, Mart Corporation, who apprised us of a 60 inch machine manufactured for a client who no longer desired to purchase the unit. Mart Corporation agreed to allow Beloit to try this unit for a trial period to determine suitability for our machines.

In an effort to obtain a secondary quote we contacted another vendor of similar style equipment. The results were as follows:

Nozzles:

Vendor A MART Corporation:

Non-synchronous oscillating or Power Blast Manifold is a feature that is standard on all models. This unique solution delivery system allows the part to be rotated within the machine, not synchronized with the turntable (wash load) rotation. The subsequent claim was that in a ten minute cycle, all surfaces will be hit from 40 different angles to clean blind tapped holes at odd angles, or get in the center of parts baskets or randomly loaded parts.

Vendor B:

Spray nozzles are hydrodynamically designed and arranged to spray from the top vertically down, from underneath the turntable vertically up spraying through the turntable spokes and from a vertical spray column spraying horizontally from the periphery of the turntable towards the center. All spray nozzles are vee-jet nozzles mounted in two 90-degree elbows each and thereby permit universal adjustability of spray angles. Positioned nozzles which were of fixed on the discharge pipe were adjustable as to direction. Oscillation was not an option for this vendor. The cleaning angle was determined by table rotation only.

Controls:

Vendor A:

Will provide an Omron Programmable PLC and the programming to control the system in the main operator panel. This program will allow for the time duration and speed operation of the independent functions.

Vendor B:

A seven day programmable clock which would turn the machine off for long durations of inactivity, such as weekends or holidays. This option will also allow the machine to be turned on in advance of operations at the start of a work day.

Foundation/Placement:

Vendor A & B:

Washer and ancillary systems shall be designed and constructed such that modifications are not required to existing foundation. Modifications and/or excavations to existing slab shall be unacceptable because of construction costs. Equipment shall be designed and constructed so that it can be set in place, leveled and anchor-bolted to floor.

Capacity:

	Vendor A:	Vendor B:
Table load Capacity:	20,000 pounds	20,000
Turntable Diameter:	100 inches	96"
Turntable Work Height:	75 inches	72"
Table Load Capacity:	20,000 pounds	20,000

OVERALL DIMENSIONS:

	Vendor A:	Vendor B:
Width:	152 inches	150
Depth:	150 inches	174
Height:	121 inches	147
Floor Space:	158 square feet	
"Loaded" Floor Loading:	278 pounds/Ft-Ft	

Heat System:	Natural gas burner	
Heat Rate:	800,000 Btu Hr	
Tank Capacity		
1st stage	915	1150
2nd stage		550
Total pump horsepower of	95 hp	82.5

Oil-Water Separation:

The method for oil water separation within these two units was completely different.

Vendor A:

The oil and grease would be pumped in to a separate tank where the grease and oil would be removed primarily by flotation and a skimming action of a disk with scraping vanes.

Vendor B:

The oil is drained by raising the water 1/2 inch above the weir into a receptacle.

B. Abrasive Blasting

A second technology works equally well for both degreasing and abrasive blasting. Manufactured by Klieber and Shultz (K&S), it uses an abrasive slurry to clean and degrease simultaneously. This process has been proven for the removal of light soils and loose paint. The abrasive media is carried to the surface of the part

being abraded by an aqueous solution, thus avoiding the usual problems associated with dry grit blasting such as dust and media recovery. Due to this ability the K&S unit has unique applications for our surface preparation requirements. Like the Proceco and Mart pressure washers, the K&S unit features closed loop recycling of all cleaning materials.

C. Final Assessment

Weighing all the options available a final determination was made to merge the abilities of The MART Corporation and the K&S system for a complete clean and subsequent blast process. There were many areas of concern from these companies, not the least of which was the proprietary engineering which could not be shared. After many discourses in writing, the agreement was cast to design and construct this piece of equipment. MART was chosen to build the cabinet and supply the programmable controller, This unit was then shipped to K&S for installation of their abrasive unit and final assembly.

MART then fabricate and ship to K&S, one MART Hurricane 100 (100 inch table) with options as outlined below. The washer frame will consist of: one main reservoir divided into two separate tanks running front to back, diverter plate between tanks, with pneumatic actuator and controls, false floor above solution tank to direct flow toward diverter plate.

System to be an operationally and functionally closed loop system (i.e. zero water discharge). Discharge of rinse water or wash solution during operation at any time, for treatment or disposal, not allowed. System to be capable of washing disassembled castings without the need to scrape or otherwise remove the heaviest soils and oils, in ten to twenty minute cycles, without plugging nozzles, filters or pump system. Pump system to deliver 460 GPM total flow and 19.2 GPM nozzle at 236 PSI measured at nozzle tips, at a temperature 15 degrees below boiling point of water at installation site. 915 gallons (max) solution, capable of accumulating 248.60 gallons (min) of sludge. Automatic Rinse Cycle to deliver heated fresh water at 2.2 gallons per minute (min) at 1000 PSI (min) through separate nozzles and Manifold System.

The cleaning process used is as follows:

FIRST STEP: WASH

The first recirculating stage sprays workpieces with a low concentration detergent solution (.5 - 4% Detergent in water) at ambient to 180 degrees F and spray pressure of 200 PSI.

SECOND STEP: RECIRCULATING FRESH WATER RINSE

Temperature of ambient to 180 degrees F, 60 PSI pressure removes detergent residue from parts.

THIRD STEP: NON RECIRCULATING FRESH WATER RINSE

Using plant water supply to spray workpieces with a fine water mist to remove any remaining detergent residues.

This rinse water is drained into the wash stage tank and will help to replace water lost through evaporation and drag-out.

FOURTH STEP: Initiate K & S System

Using media contained within the sump start the blasting cycle while the table continued rotating the parts. The blasting nozzles are to be stationary relying on the table movement for complete cleaning.

FIFTH STEP: EXHAUST (Optional)

Removes steam and fumes from spray cabinet prior to opening the door. Keeps work environment moisture steam free.

VI. Implementation & Results

The MART washer was delivered to K&S where a test was made on a test piece. There were several problems with getting that piece perfectly clean but general opinion was that it would be a trial and error judgement in the field as to the oscillation pattern and time dwell to purge the piece as desired of contaminants. The overall quality of the cleaned part was adequate enough to have the equipment shipped to Dalton for final shake down.

Problems

Programmer:

Upon initial start up of the washer there were several problems. The interaction of the wash and the blast nozzles were not as smooth as anticipated. The programmer timer switch did not stop at the zero position, but continued at the hold position, restarting the blast cycle. This leaves grit on the interior of the unit. **Solution** - The timer was adjusted in the field, after several attempts the programming module was removed and sent to the vendor. A secondary unit was inserted, correcting the situation.

Oil & Grease Sump:

The sump seems to accumulate extensive oil and grease that never sees the machine because:

- a. The machine is set up to run on a clock timer only after the day's operations have finished (after midnight), and draws only out of the cleaner side not the blasters side.
- b. The blast sump gets cold when the blast system is not used frequently. We seem to wash with the washer about 60% of the time. The grit gets cold in the blast sump and becomes heavily grease laden. As a result, the grease seems to congeal with the grit and hasten plugging up.

Solution: This has never been rectified because the grit has not been able to separate itself from the oil and grease in a fashion which would allow the slurry to move freely within the pressure nozzles. Experimenting to electrostatically have the aluminum oxide repel like particles and thus break up the larger lobes of grease was not successful. A proposal was considered to replace the aluminum oxide with a plastic media, (Melamine) which would not break down as easily and by nature of content and design would flow in solution freely.

Nozzles:

Four of the six nozzles, as well as the cyclone, plugged with grit. It appears that the grit congeals with the grease and forms clumps which cause the orifices of the blast nozzles to become blocked. Different grit of Aluminum Oxide were tried in an attempt to find a size which would not allow congealing. The arrangement was not adequate for proper dwell time on irregular surfaces. An articulating arm had to be installed.

Solution: There has been none. This is the integral flaw in the merging of these two technologies. The K&S system was designed for paint or grit not grease. The grease and oil tends to completely foul the entire system. Until a way to separate the grit from the grease is found the blast side of this system is not satisfactory.

Economic Analysis

Savings:

Prior to the installation of this system we were spending the following:

12-16 hours of manual degreasing @ \$25.00 per hour =	\$375-475
* expected number of units per year	75
Total yearly dollars saved	\$28 - 36,000
Dollars saved from the complete elimination of the 1,1,1-trichloroethane	
Purchase..45 barrels at \$2,500/.....	\$ 112,500
Disposal.....	\$ 2,000
Form S fee.....	\$ 1,100

Costs:

Total electric cost of MART washer \$6.09/hr * 3hr/day.....\$ - 9,460

Gas Consumption is estimated to be \$9.67/hr
using 6.4 therms/hr based on heating 4 hr/day.....\$ -10,056

Total cost for purchase

The MART Corporation.....	\$ 112,000
K & S	\$ 69,865
TOTAL.....	<u>\$181,685</u>

First year Savings for the cleaning system \$ 80,265

VIII. Future Research - Background & Process Description

As the 21st century evolves it is important to note the aspect of recycling has critical importance to the effort of paper making. The machinery used from this facility is being specified in more of the paper mills as the preferred product. Knowing the mill and the process contained within assists in the understanding of the machinery cleaning problems associated with our products making Beloit the preferred supplier of paper making equipment.

The flow from the blast system over flows the containment sump and discharges into the wash side mixing with the heavy thick grease removed initially. This trial was undertaken to test a concept which is unique to the manufacturing world. While we have not achieved total success, we are pleased with our results.



Figure 1. Mart Cleaning Equipment



Figure 2. Mart Cleaning Equipment- door open showing revolving parts table

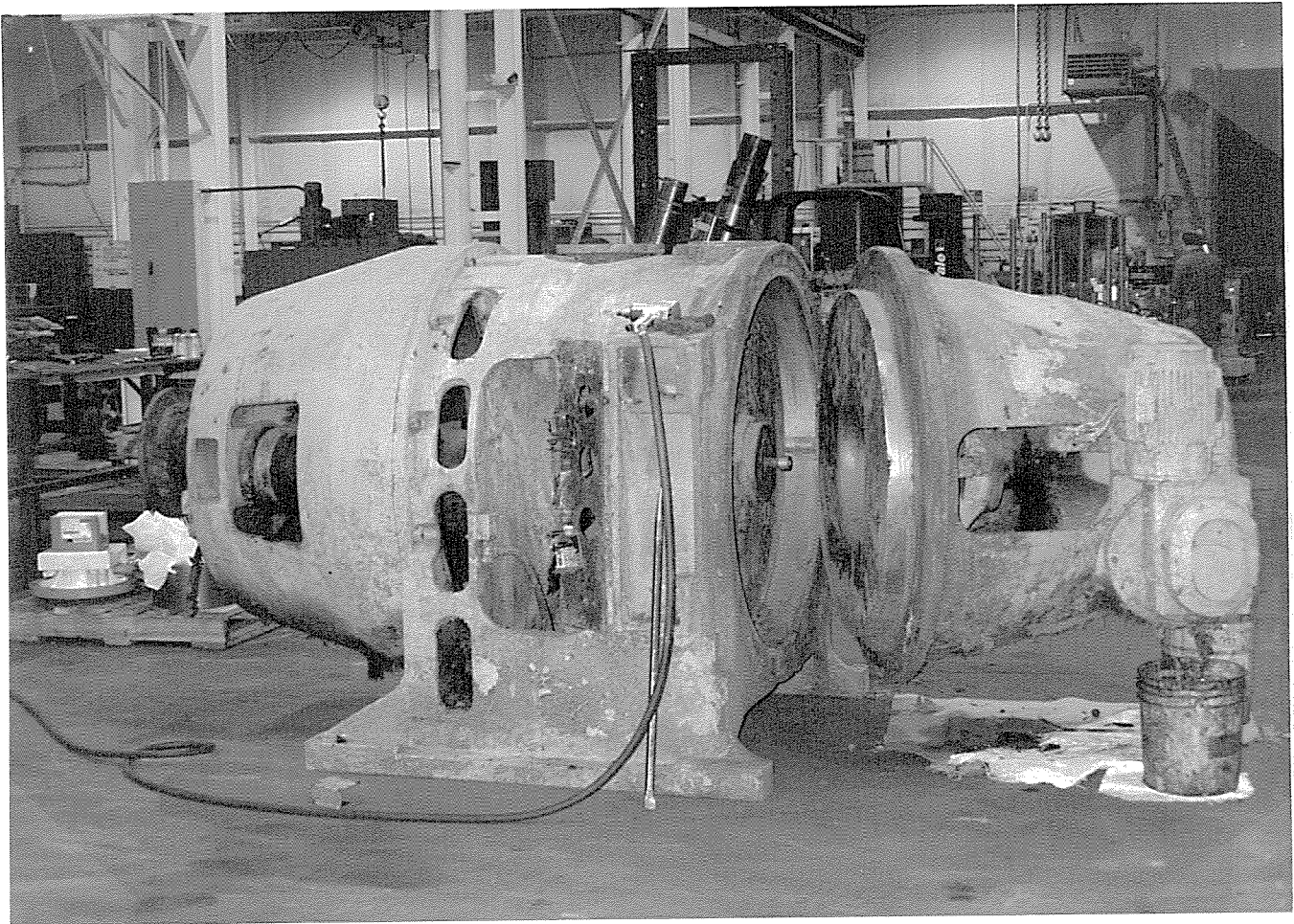


Figure 3. Paper Making Equipment To Be Cleaned

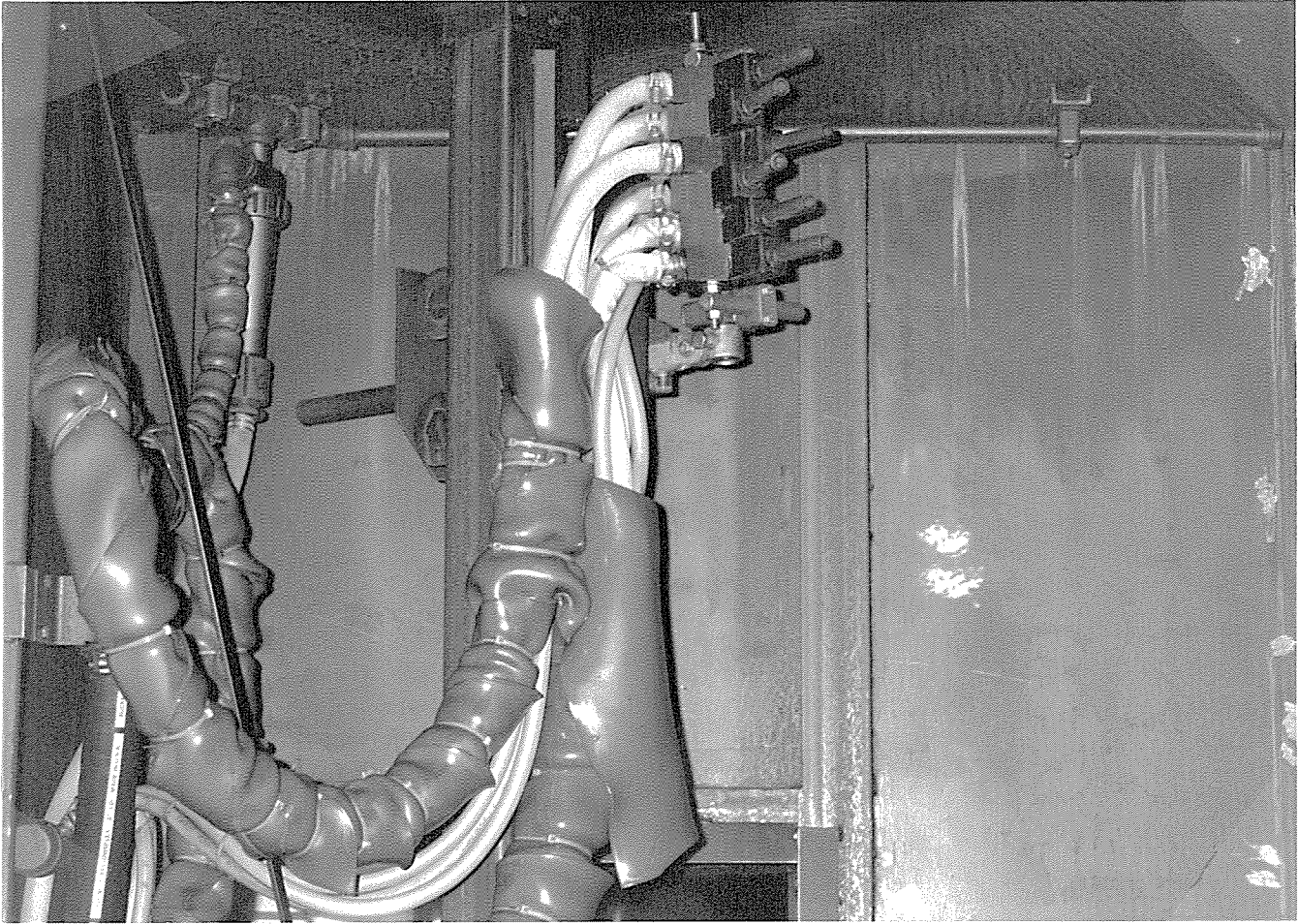


Figure 4. K&S Blast Nozzle Arrangement