REVIEW OF MINING METHODS APPLICABLE TO THE RECOVERY OF BAGHOUSE DUST STORED UNDERGROUND AT THE GIANT MINE, YELLOWKNIFE, NWT

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1.0 INTRODUCTION

Arsenic trioxide dust, a by-product of processing refractory ore at the Giant mine, has been stored underground at the mine since the 1950's. Approximately 260,000 tons of dust are stored in specially excavated stopes as well as mined out production stopes - see Table 1. The dust is currently stored in 16 underground storage chambers. Six of the chambers are former production stopes and the remainder were specifically excavated for the purpose of storing the arsenic trioxide dust. Figures 1&2 show the location of the stopes relative to other surface and underground installations and facilities. The storage chambers were excavated in permafrost to insure that the dust remained dry and the stopes were sealed with bulkheads to contain the dust. Although initially located in areas of permafrost, mining activity and the removal of the overburden has disturbed the permafrost to the point where the wall rock of the storage chambers is no longer frozen. The continued storage of the arsenic trioxide dust in the underground stopes is not acceptable due to increased environmental and public heath awareness and concerns about contamination of the ground water after the mine is flooded.

1.1 Scope of Work

This report summarizes mining and transportation methods that could be utilized to remove the arsenic trioxide dust. It reviews previous mining proposals and provides additional alternatives based on information obtained through a search of the Internet and other sources. Detailed information is provided on equipment that could be used for the removal of the arsenic dust.

1.2 Material Characteristics

The dust stored in the stopes varies from dry and dusty (like processed flour) to damp and compacted, depending on the length of time it has been stored and moisture conditions in the stopes. It has been affected over the years by moisture content, compaction and the angle of repose. In August and September of 1981 Geocon conducted a sampling program to determine the characteristics of arsenic dust contained in several select stopes. The results of the sampling are contained in the Geocon Report V852/01913-63. A summary of the relevant information is outlined in Table 2. In general, the density of the arsenic dust varied from 39.7 to 91.1 lbs./ cu. ft. with specific gravity ranging from 2.59 to 3.79. The angle of repose varied from 46.1 degrees to 48.7 degrees, and the moisture content ranged from less than 1% to 6.4 %. A study was carried out 1982 by Jenike and Johnson on the flow characteristics of the dust - see Appendix A . A sample having 0.7% moisture was taken from the B2-35 storage vault for testing. The test work indicated that the material had funnel flow characteristics and exhibited a strong tendency to "rathole". It had a capacity for arching over a slot of 2.1 feet in width after storage at rest for 168 hours.

The arsenic trioxide dust is slightly soluble and has known toxic and carcinogenic properties. The dust must be carefully managed because of its known health effects.

2.0 MINING METHODS

2.1 Key Criteria

The selection of an extraction and transportation method for the removal of the dust must take into account the toxicity and physical characteristics of the material. The extraction method(s) must consider the following key issues :

- The dust must be confined to prevent air, water or soil contamination during movement.
- Worker exposure must be minimized by using remote control operations and personal protective equipment.
- Equipment must be able to accommodate the variable stope geometries.
- Equipment must be able to deal with varying material characteristics.
- The stopes must be cleaned and secured for abandonment.
- Ideally the mining rate will closely match the milling processing rate to avoid restoring the material on surface.
- Must utilize proven technology.

A number of extraction methods have been evaluated and a listing of the methods with pros and cons is outlined in Table 3. Many of the methods are not deemed suitable because of worker exposure, lack of proven technology, or other environmental factors.

3.0 METHODS FOR RECOVERY OF DRY AND MOIST BULK POWDERS

The arsenic dust stored in the stopes has variable physical properties due to compaction and moisture content. The moisture content varies from 1% to 4% and the density can vary from 39.7 to 91.1 lb/ft^3. Because of the variable physical properties of the arsenic dust, a variety of extraction methods may have to be used. Suitable mining methods for extracting the material as dry and moist bulk powers include remote drawpoint mucking, remote clam mucking and vacuuming. The vacuuming method is only suitable for the removal of the dry powders, while remote drawpoint mucking and remote clam mucking would require the use of water sprays to control dusting. Slurry or solution mining could be used for the removal of arsenic from the stopes. The mining method would provide a high degree of containment and significantly lower worker exposure to the dust.

3.1 Remote Drawpoint Mucking

Remote drawpoint mucking using remote controlled Load - Haul -Dump (LHD) equipment is well known and has been use at a number of mines for several years. In

most operating situations, the operator must maintain visual contact with the scooptram under remote control. The operator normally operates the remote transmitter from a remote mucking stand and must maintain line of sight to control the machine. Because of exposure of the operator to arsenic dust, this mode of operation would not be acceptable. In order to ensure adequate worker protection, the line of sight mode would have to be modified for a Remote Control Station Teleoperation. The Teleoperation configuration would place the operator at a surface control room or a subsurface remote station. This could be achieved by mounting a microphone and two fixed cameras on the vehicle under remote control and sending an Audio/Video signal to the remotely located operator station. Additional cameras could be added to provide better viewing of the machine. A description of a Teleoperation configuration and operation are provided in Appendix B.

Remote drawpoint mucking using LHD equipment could be effectively used for the removal of damp or compacted ATD. However, because the damp and compacted dust tends to funnel flow or "rat hole", methods would have to be developed for dislodging the hang-ups. Traditional approaches such as blasting or air lancing would create significant amounts of dust. In order to contain the dust, the immediate work area would have to be sealed during these operations. Adequate ventilation systems would have to be in place to ensure that the work area was maintained under negative pressure.

Either a remote operated LHD or a road header machine could be used for mucking. The technology is readily available for LHDS' but would have to be developed for roadheaders.

3.2 Remote Clam Mucking

Clam mucking has been used for ship unloading and other industrial applications. In the mining industry, clam mucking is commonly used for shaft excavation work. Although suitable for handling a number of materials, some difficulty would be experienced handling very dry arsenic dust. However, the dry dusty material could be wetted with water sprays to suppress dust generation.

Figure 3 shows a general arrangement for the mining method and the installation of the clam. Access to the top of the stope would be required for the installation of the crawl beam for the clam. Remote operation of the clam would be required to protect the operator from air borne arsenic dust. Remote control technology is currently not available and would have to be developed.

3.3 Vacuuming

The conveyance of dry dusty material using a vacuum system is commonly used in the food processing industry and for grain handling. Equipment is readily available, but the material transported must be dry. Test work carried out to determine the physical

characteristics of the arsenic dust in the stopes showed that the dust in the upper section of the stope was dry, but material below the upper layer was damp and could not be removed by vacuuming. The damp material plugged the hose when the vacuum equipment was used. Because some of the arsenic dust stored in the stopes is damp, the use of a vacuum system, if selected, will have to be used in conjunction with other methods. Information concerning equipment suppliers of vacuum systems is outline in Appendix C.

The use of the vacuum system would require remote control operation with a robot arm. Foster Miller Inc. of Waltham, Massachusetts, is a supplier of robotic equipment and information on their products is given in Appendix D.

4.0 SLURRY MINING WITH HIGH PRESSURE WATER JETS

4.1 Background

Slurry mining with high pressure water jets is not widely used in industry because of its higher inherent operating costs. However, the technology is available and could be readily adapted to removing the dusts from the storage stopes.

4.2 Jet Boring

Cameco Mining Ltd. will be using a Jet Boring method for mining high grade uranium ore at their Cigar Lake mine – see Appendix F for a detailed description of the mining method.

The Cameco orebody is clearly defined with a distinct contact between the ore and waste. In preparation for mining, the walls of the stope are frozen to provide support and restrict the migration of water. Freezing is also extended above the ore body to ensure water control is maintained during the mining.

After the freezing is complete, casing holes are drilled into the orebody from the production area located below the stoping area. A steel casing is inserted to prevent sloughage from the walls of the borehole and a double walled pipe installed for the water jet and removal of cuttings. The inner pipe is used to provide high pressure water to the water jet and the outer pipe to transport the cuttings from the stoping area.

The jet boring of the ore is carried out by using the water jet to shoot high pressure (10,000 psi) water against the rock. The jet boring head is attached to a string of rods and the rods are rotated to allow the jets to cut the ore. The cuttings are removed through the outer pipe and then crushed and slurried for transport to the primary mill.

A similar mining method could be used for removal of the arsenic dust. Because the material is in the form of a powder, lower water pressure could be used to slurry the dust.

4.3 High Pressure Waterjets

The use of high pressure waterjets has also been proposed for the removal of hazardous sludge and saltcake from underground storage tanks. A description of the proposed high pressure water jet system is given in Appendix G. Although the system is still under development, the shrouded waterjet has been designed and demonstrated to be effective on the sludge.

5.0 EXPERIENCE ELSEWHERE ON MINING HAZARDOUS MATERIALS

The mining of uranium ores requires special precautions with respect to worker exposure and protection. Because of their exceedingly high grades, the uranium orebodies in Northern Saskatchewan must be carried out by non-entry methods. This type of mining method, which has been described earlier in this report, would be suitable for the extraction of the arsenic dust.

6.0 EXPERIENCE ELSEWHERE ON HANDLING BULK DRY AND MOIST POWDERS

The transport of bulk dry and powders is quite common in the food, chemicals and industrial minerals industries. More often that not, containment of dust is a top priority to meet requirements for cleanliness and health and safety reasons. The various transport systems used in these industries that would be applicable for handling the arsenic dust include pneumatic conveying, tubular conveyors and vacuum systems

6.1 Pneumatic Conveying

Pneumatic conveying is used in a number of industrial applications to transport dry dusty powders. It is also commonly used in the agriculture industry for handling grain. Information concerning pneumatic equipment for grain handling in given in Appendix H.

Pneumatic conveying is currently used at the Giant mine to transport the dust from surface to the underground storage stopes. The pump and compressors in use at the Giant mine were supplied by Fuller Bulk Handling, a company with considerable experience in the design and supply of pneumatic conveying systems. Information concerning Fuller Bulk Handling is outlined in Appendix I.

6.2 Tubular Conveyors

Tubular conveyors are used in industry for the transport of fine or abrasive dusts. They are ideally suited for applications where dust tightness is essential for safety or cleanliness reasons. The conveyors are very versatile and the construction of the conveyors allows bends to be included so material can be transported at any angle from horizontal to vertical. Maximum run lengths for the conveyors are 50 m for a horizontal / inclined run and 30 m for a vertical lift. Details on manufacturers and tubular conveyors is provided in Appendix J.

6.3 Vacuum Sytems

Vacuum systems have been used in the food, chemicals and pharmaceuticals industries for a number of years for handling products in powder form. They have also been used in industrial applications for the pickup and removal of liquids, slurries and bulk solids. The vacuum system provides the greatest protection against spillage of material while it is being transported . The material being handled must be dry in order for the vacuum method to be successful. Transporting the arsenic dust with a vacuum system may be difficult because of its moisture content. Information pneumatic conveying systems for the food industry is given in Appendix K.

7.0 SLURRY PUMPING

Slurry pumping technology is well known and readily available. A slurry transportation system could be adapted to the extraction method used for the removal of the material from the stopes. If the material is removed as a dry dust, it could be slurried and then pumped to surface. A closed loop system could be installed by removing the arsenic from the water using a centrifuge or thickener. The overflow water would be captured and recycled back to the pumps for reuse, and the arsenic solution pumped to a processing plant for treatment. Figure 4 shows a general arrangement for a slurry reclaim system.

7.1 High Pressure Washers

The walls of the stopes will have to be washed to remove any residual arsenic trioxide after the dust has been removed. Although this may not be required if high pressure water jets are used to remove the dust from the stopes, it certainly would be required if drawpoint mucking, vacuuming, clam mucking or a combination of these methods was used. High pressure water monitors are available and could be used for washing the walls of the stopes. The runoff water would be diverted and collected in an underground storage sump and then pumped to surface for further processing. The effluent water would be recirculated to the stoping area via another dedicated pipeline. Ground water monitoring wells would have to be placed

around the stopes prior to stope wall washing to ensure that there was no leakage into the surrounding wall rock.

High pressure washers have been developed for tank cleaning using remote controls. This technology could be readily adapted for washing the walls of the stopes. Appendix L provides further information on this equipment.

8.0 EQUIPMENT TO PROTECT WORKERS FROM EXPOSURE

8.1 Protective Enclosures

Specialized protective cabs or enclosures have been used in a number of industries to provide additional protection to workers who may be exposed to hazardous materials or conditions. The Martin Cab Company has provided specialized cabs for foundry operations, mining applications and all types of hazardous materials situations. Their products would be suitable for providing protection to workers handling arsenic. Information on the Martin Cabs is given in Appendix M.

8.2 Experience in Other Mines and Industries

Standard practices used in industry for the protection of workers exposed to hazardous substances include providing personal protective equipment, maintaining adequate ventilation and ensuring a high level of personal hygiene.

Employees working with arsenic must wear appropriate personal protective equipment including respiratory protection and protective clothing. The highest standard of personal hygiene must be enforced. Eating, smoking and drinking must not be permitted in the work area and disposable coveralls must be left behind and disposed of as contaminated waste at the end of each shift.

Adequate ventilation must be provided to ensure that the Threshold Limit Values are not exceeded. If the airborne contamination exceeds the TLV, a dust/ mist respirator is recommended. If the concentration exceeds the capacity of the respirator, a self contained breathing apparatus must be used.

Arsenic trioxide dust has been handled at the Giant mine for a number of years and various levels of worker protection have been developed. A copy of the Arsenic Trioxide Safety Procedures for the Giant Mine is given in Appendix N. The procedure details the various types of equipment used to provide worker protection as well as operating procedures

A copy of a Written Arsenic Program and a MSDS are also provided in Appendix N. Key elements of the program are listed including worker protection, hygiene facilities

and practices, medical surveillance, medical removal protection, employee information and training, signs, record keeping and observation of monitoring.

9.0 POTENTIALLY SUITABLE MINING EQUIPMENT

The various mining methods outlined for the removal of the arsenic dust require specialized equipment. Because of the urgency to implementing the Arsenic Management Program, the equipment selected must be proven technology. Listed below are potentially suitable mining equipment and various suppliers. The actual choice of equipment and suppliers would be dependant upon selection of a mining method .

9.1 Remote Operated Equipment

Remote controlled scooptrams are available from Tamrock Canada or Wagner Equipment. The Giant mine is currently operating Tamrock remote controlled scooptrams. Because the operating people at the Giant mine are familiar with the Tamrock remote controlled scooptram, it should be given priority in terms of equipment selection. Teleoperated controlled scooptrams are used by Inco at their Sudbury operations.

Remote controlled high pressure washers are supplied by Tank Cleaning Technologies of Houston, Texas. Product information and pictures of their remote controlled equipment is given in Appendix L.
Information on Robotic Equipment and remote controlled tank cleaning equipment is given in Appendix D.

9.2 Automated Equipment

Automated equipment used for transporting dry dusty powders include the Fuller - Kinyon conveying system (Appendix I) and tubular conveyors. Hapman Conveyor of Kalamazoo, Michigan and Schrage Rohrkettensystem GmbH of Freideburg, Germany are suppliers of tubular conveyors. Company and product information are given in Appendix J.

10.0 POTENTIAL APPLICATION OF THESE METHODS AND EQUIPMENT FOR THE EXTRACTION OF ARSENIC DUST

10.1 Mining Methods and Equipment to Recover Dry and Moist Powders

The mining methods most suitable for the recovery of the materials as dry and moist powders are remote scooptram mucking and vacuuming. The clam mucking system is not viewed as a suitable option because of the level of current technology and the high level of worker exposure to install and operate the system. Remote systems are currently

not available for the clam and would have to be developed. The system is not designed for handling dry powders. Although water sprays could be used to wet the dust, controlling the moisture content would be difficult. The installation of the clam mucking system would involve worker exposure to the arsenic in the stopes and require special protective measures. Similar exposure would also occur with the ongoing operation and maintenance of the system.

10.2 Slurry and Solution Mining Techniques and Equipment.

The slurry mining method employing water jets provides the highest level of worker protection and is an attractive option from a materials handling aspect. The mining method currently being developed for mining the high grade uranium ore at Cameco could be modified for the removal of arsenic from the underground stopes at the Giant Mine. Water pressures required to slurry the arsenic dust would be considerably lower, allowing for the use of more conventional equipment. Marconajet pumps could be used rather than high pressure water jets. Information on the Marconajet Slurry Recovery Unit is given in Appendix O.

11.0 FUTURE INFORMATION REQUIREMENTS

11.1 Proposal for Phase 11 Study on the development of a Technically Feasible Mining Method and Procedure

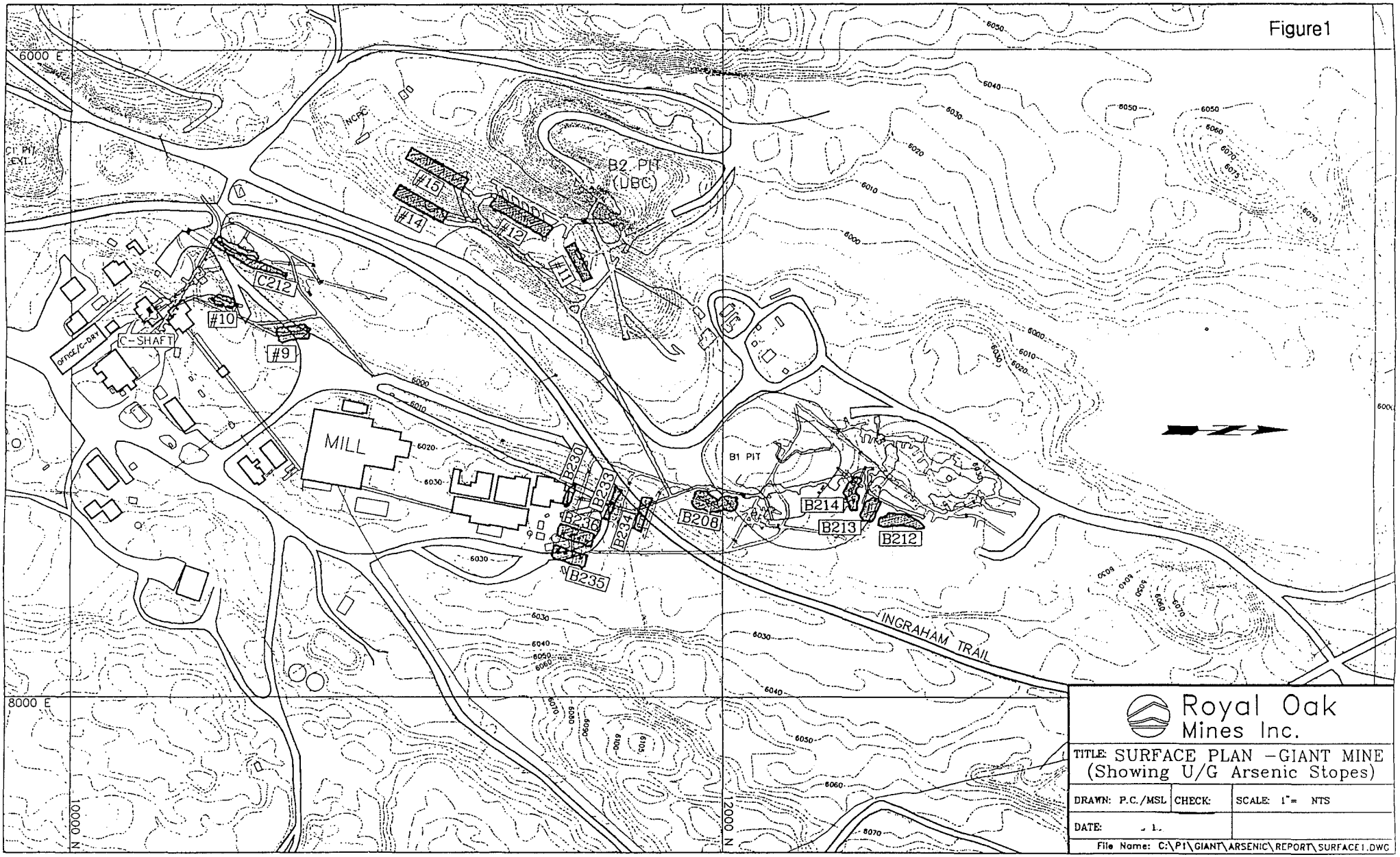
The recovery of arsenic dust from the underground stopes will most likely require a combination of mining methods involving remote controlled LHD scooptrams, vacuum recovery systems or slurry mining methods. Further investigation is required to determine applicability of the mining methods to specific stopes and evaluate the proposed equipment and technology. Phase II of the project would involve the following additional work to develop a technically feasible mining method(s) and procedures for removing the arsenic dust:

- Site visit to the Giant Mine to examine the site facilities and the arsenic storage areas.
- Inspection of the underground workings to determine ground conditions and work required to re-establish access.
- Rehabilitation of the primary access routes to the underground storage stopes.
- Conduct a rock mechanics review of the arsenic stopes and adjacent workings.
- Site visits to Cigar Lake to view the mining operation and discuss the slurry mining method with Cameco technical personnel.
- Selection of a proposed mining method(s) and development of conceptual mining and access development plans

- Preliminary equipment selection and design which would include site visits to suppliers and manufactures of equipment.

FIGURES

Figure1



Royal Oak Mines Inc.

TITLE: SURFACE PLAN –GIANT MINE (Showing U/G Arsenic Stopes)

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DATE:		

File Name: C:\P1\GIANT\ARSENIC\REPORT\SURFACE1.DWG

Figure2

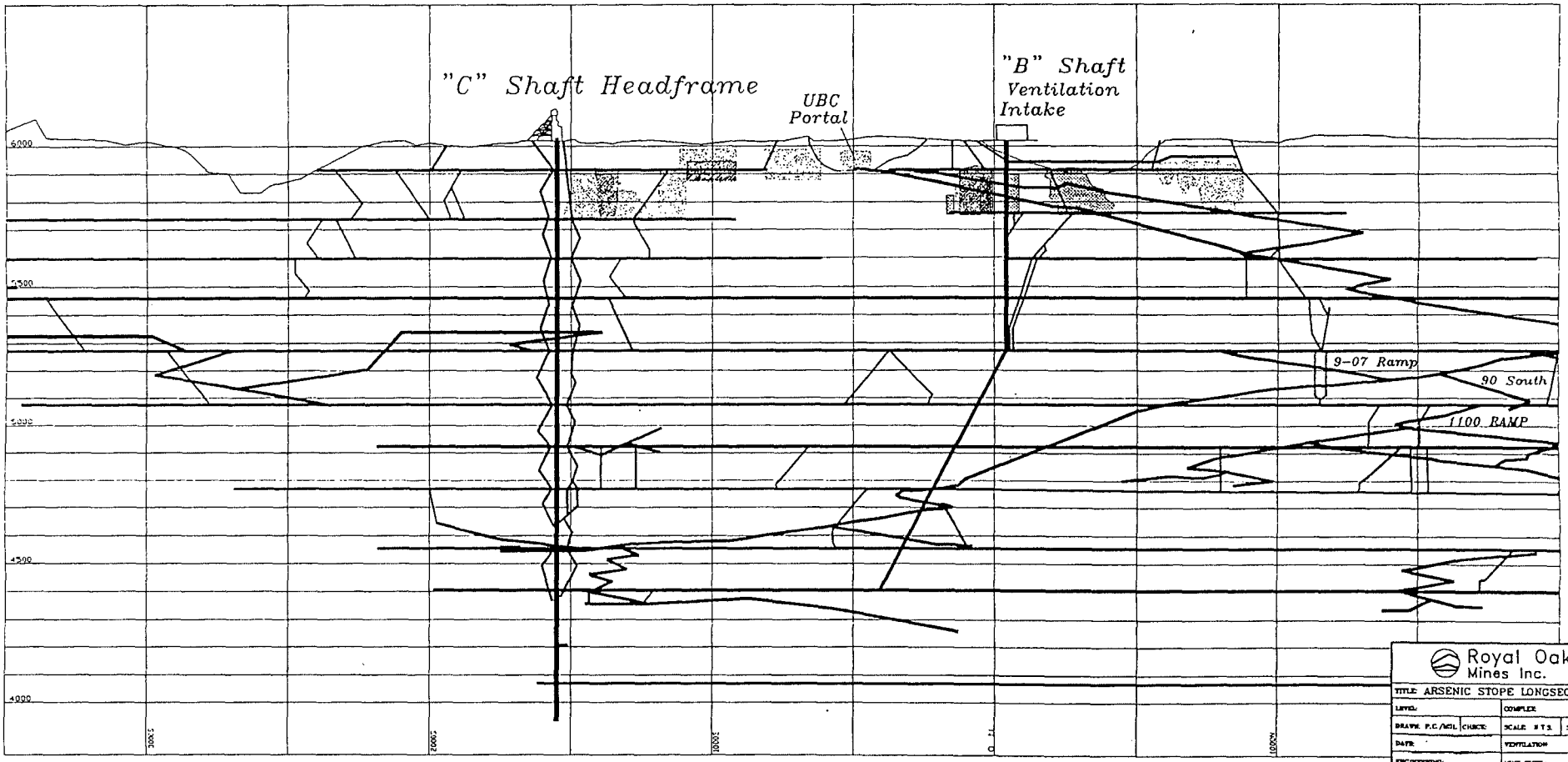
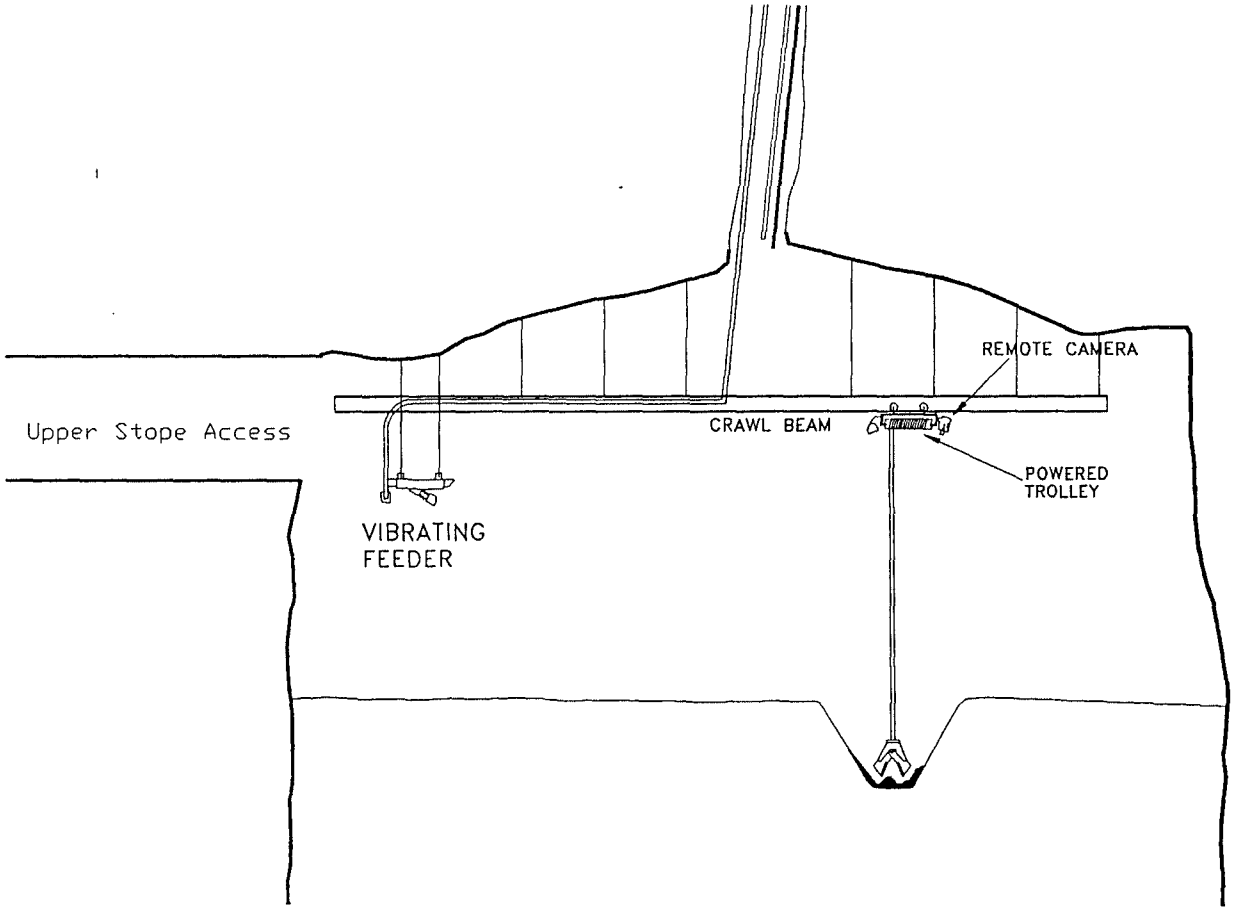
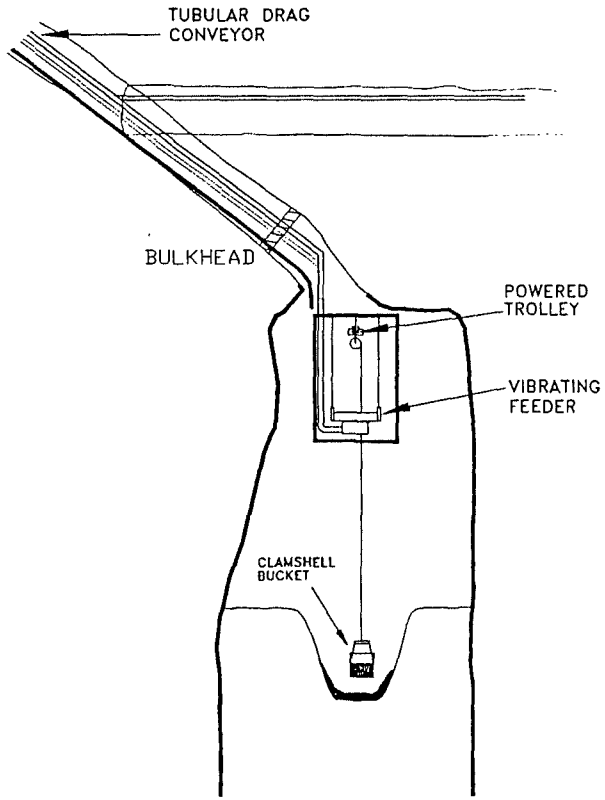

B230
B236
B233
B234
B208
"C" Shaft Headframe
UBC Portal
"B" Shaft Ventilation Intake
9-07 Ramp
90 South
1100 RAMP
Royal Oak Mines Inc.
TITLE: ARSENIC STOPE LONGSECTION

Figure 3





Remote Clam Assembly

Royal Oak Mines Inc.

TITLE: MINING METHOD DETAILS

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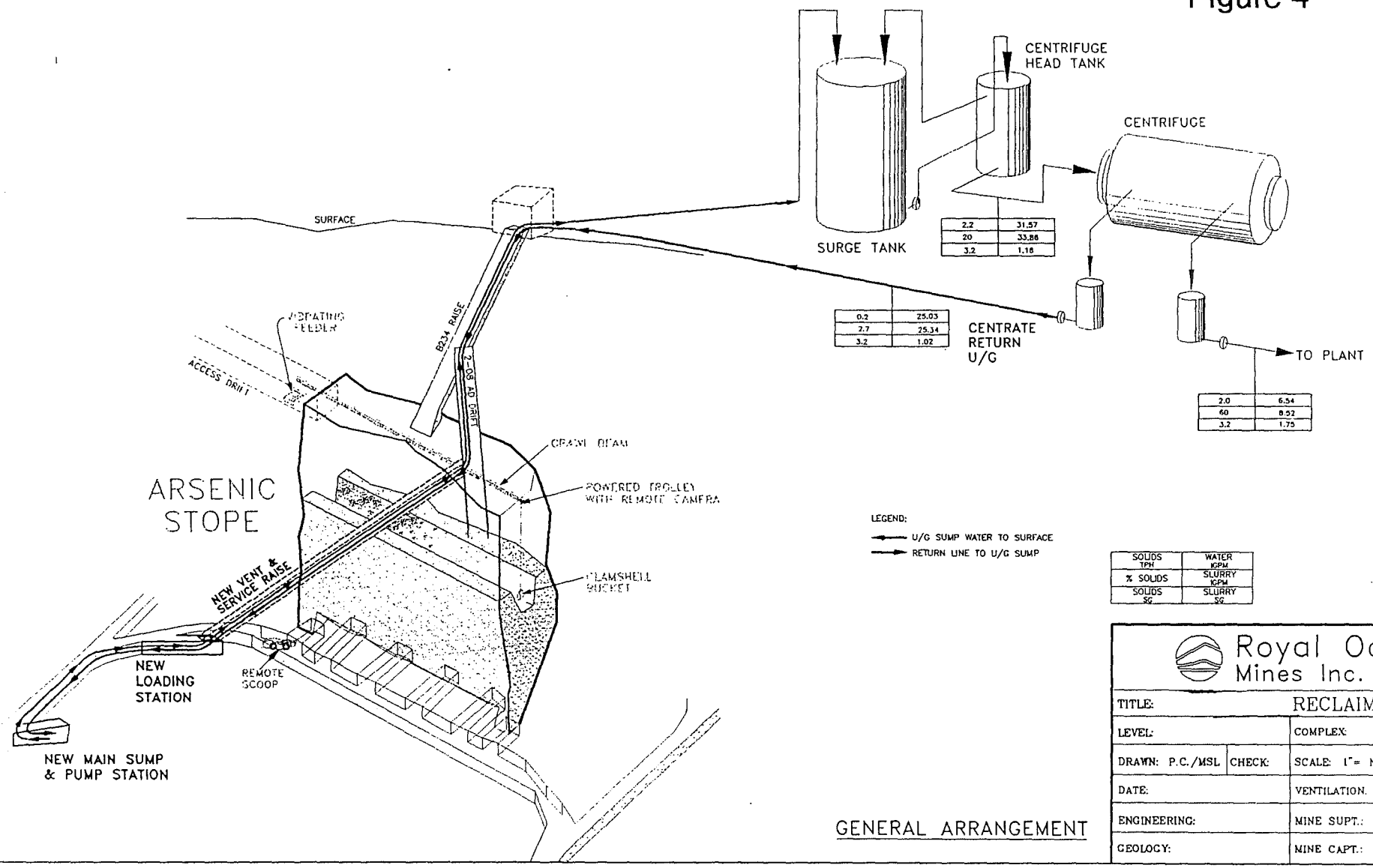
DRAWN: P.C./MDL. CHECK:	SCALE: NTS S.F.:
DATE: APR. 29, 1997	VENTILATION:
ENGINEERING:	MINE SUPT.:
GEOLOGY:	MINE CAPT.:

Figure 4



GENERAL ARRANGEMENT

Royal Oak Mines Inc.

TITLE:		RECLAIM
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DRAWN: P.C./MSL	CHECK:	SCALE: 1"= NTS
DATE:		VENTILATION.
ENGINEERING:		MINE SUPT.:
GEOLOGY:		MINE CAPT.:

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TABLES

Table 1: Summary of arsenic trioxide stored underground

ROYAL OAK MINES INC. - NWT DIVISION
UNDERGROUND WAROX RECOVERY PROJECT MINERAL INVENTORY - DECEMBER 31, 1996

STOPE	DATE FILLED	VOLUME CU.FT.	TONS OF DUST	PERCENT ARSENIC	TONS OF ARSENIC	OPT GOLD	OUNCES OF GOLD
B 2-30	OCT. 28/51 - DEC. 15/52	100,000	3,125	45.31%	1,416	0.724	2,26
B 2-33	DEC. 16/52 - MAR. 1/56	434,626	12,595	36.93%	4,651	1.671	21,04
B 2-34	MAR. 2/56 - JUL. 10/58	425,000	13,281	36.10%	4,794	2.332	30,97
B 2-35/36	JUL. 11/58 - MAR. 15/62	1,125,000	35,156	53.37%	18,763	0.790	27,77
B 2-35	AUG. 22/88 - NOV. 29/88		1,160	60.78%	705	0.142	16
B 2-36	DEC. 12/88 - DEC. 30/88		184	63.59%	117	0.228	42
			36,500	53.66%	19,585	0.767	27,980
B 2-08	MAR. 16/62 - DEC. 31/64	806,840	25,033	65.75%	16,458	0.381	9,52
	JAN. 1/72 - SEPT. 1/72		4,704	64.86%	3,051	0.330	1,600
	JUL. 1/75 - JUL. 31/75		394	63.71%	251	0.120	4
	DEC. 17/75 - JAN. 9/76		355	65.92%	234	0.195	6
	MAR. 11/86 - SEPT. 26/86		1,882	66.95%	1,260	0.120	22
			32,368	65.66%	21,254	0.354	11,468
B 2-12/13/14	JAN. 1/65 - DEC. 31/71	1,920,000	60,410	61.48%	37,141	0.468	28,27
	SEPT. 1/72 - JUNE 14/73		4,945	64.99%	3,214	0.262	1,294
			65,355	61.75%	40,355	0.452	29,567
C 2-12	JUNE 14/73 - JUNE 30/75	638,139	10,243	64.23%	6,579	0.217	2,22
	AUG. 1-/75 - DEC. 17/75		1,794	65.44%	1,174	0.130	234
	JAN. 10/76 - MAY 21/76		1,875	65.12%	1,221	0.140	25
	JUNE 1/80 - JAN. 9/82		3,757	69.68%	2,618	0.101	37
	MAY 22/85 - MAR. 1/86		1,011	65.48%	662	0.120	12
			18,680	65.60%	12,254	0.172	3,215
C 9	MAY 21/76 - MAY 31/80	471,000	20,276	67.48%	13,683	0.124	2,51
C 10	APR. 1/82 - MAY 22/85	200,000	10,548	66.83%	7,049	0.134	1,408
B 11	SPET. 26/86 - AUG. 22/88	347,250	6,331	67.52%	4,275	0.137	86
	NOV. 30/88 - DEC. 12/88		128	61.72%	79	0.227	29
			6,459	67.41%	4,354	0.139	896
B 12	DEC. 30/88 - JUNE 30/89	900,000	1984	67.04%	1,330	0.174	34
	JUL. 1/89 - DEC. 31/90		7411	81.22%	6,019	0.163	1,206
	JAN. 1/91 - JUNE 30/91		2626	65.31%	1.715	0.203	53
	JULY 1/91 - DEC. 31/91		2609	62.97%	1,643	0.225	58
	JAN. 1/92 - DEC. 31/92		4392	64.23%	2,821	0.213	92
	JAN. 1/93 - DEC. 31/93		4259	65.77%	2801	0.156	664
	JAN. 1/94 - DEC. 31/94		4136			0.122	50
			27,417	59.56%	16,329	0.174	4,76
B 14	JAN. 1/95-DEC. 31/95	424,000	3789	70.04%	2654	0.123	466
			3626	60.56%	2196	0.18	654
TOTAL	OCT. 28/51 - DEC. 31/96	7,791,855	254,019	59.28%	150,574	0.540	137,212

data corrected March 25/96
KA.

Table 2

Physical Characteristics of Arsenic Trioxide Dust Stored in Underground Stopes at the Giant mine

Stope No.	% Moisture	Density (lbs/cu.ft.)		Specific Gravity	Angle of Repose
		Maximum	Minimum		
B2-08	2.8	69.1	39.7	3.22	46.4
B2-30	6.4	77.3	48.3	3.17	47.7
B2-33	2 - 6	82.3	50.7	3.15	46.7
B2-34	1	85.3	53.3	3.23	46.1
B2-35	<2	84.2	53.3	2.59	46.7
B2-36	<1	74.6	41.6	3.79	48.7
C-9	1 - 2	91.1	55.1	3.06	48.1

Table 3

Pros & Cons of Alternate Extraction Methods

Arsenic Stope Extraction

Extraction Methods

Ideas	Pros	Cons
Remote LHD	• Proven technology • High productivity • Low human exposure	• Dust control • Clogging of air filters • Ventilation requirements • Exposure to dust during maintenance • High maintenance costs
Clam Shell	• Proven technology • Can be automated • Low human exposure	• Dust control • Exposure to dust during maintenance • Difficult to Install • Not applicable in all stopes
Slurry	• Very low human exposure • Extraction and transport method are the same system • Minimum or no ventilation requirements • Low operating costs • Low maintenance costs	• Possible contamination of ground water • Not proven for this material
Road header	• High productivities	• High capital costs • High maintenance costs • Dust control • Exposure to dust during maintenance • Large amounts of development required before extraction • High power requirements • Currently not remote capable • High human exposure

Ideas	Pros	Cons
Bucket Wheel Excavator	• High productivities	• Available units are too large
Hagloader	• High productivities	• High maintenance costs • Dust control • Large amounts of development required before extraction • Exposure to dust during maintenance • Currently not remote capable • High human exposure
Vacuum	• Very versatile • High productivities	• Tests indicate arsenic will build up on hose walls and plug vacuum
Slusher	• low operating & capital costs	• No mill holes available to slush to • Size of stopes
Drill & Blast		• Not applicable
Auger	• Low human exposure	• Large amounts of development required before extraction
In situ Re-fuming	• Very low human exposure • Extraction and transport method are the same system	• No proven technology • High energy costs
In situ Leaching/Bio Leaching	• Low cost	• Not environmentally sound • Not proven
Mucking Machine	• Low operating & capital costs	• High human exposure • Not versatile • Not remote capable
Solidify then stope (freeze,melt,cement)	• Able to use conventional mining methods	• No known technology
Open Pit	• Low operating costs	• Not environmentally sound
Shovel & Bucket	• Low capital costs	• High human exposure • Labor intensive

Transportation Methods

Ideas	Pros	Cons
Tubular Drag Conveyor	• Enclosed system • Proven technology	• High capital costs • High development costs for installation (raises)
Tote Bags	• Easily transported	• High capital costs • High human exposure
Standard Conveyor	• Proven technology • Low Operating Costs	• High capital costs • High human exposure • Not environmentally sound
Pneumatic Conveyance	• Low Operating Costs	• Tests indicate arsenic will build up on hose walls and plug vacuum
Haul Truck	• Proven technology	• High human exposure • Not environmentally sound

Closure

Ideas	Pros	Cons
Leave Stope Empty & Bulkhead all Openings	• Low Cost	• Possible Ground water contamination
Coat Stope Interior & Bulkhead all Openings	• Will bind residual arsenic	• Labor intensive
Backfill Stope & Bulkhead all Openings ◆ Cemented Tailings ◆ Rock/Sand ◆ Pneumatic Slurry	• Will bind residual arsenic • Will prevent surface subsidence	• High capital cost

APPENDICES

APPENDIX A

Material Characteristics

3.0 MATERIAL FLOW PROPERTIES

Two samples of arsenic were tested by Jenike & Johanson Ltd. for flow properties at ambient temperature and with the "as received" moisture content of 0.7% water.

Complete flow tests were done on the "worst" of the two samples at conditions simulating continuous flow and flow after time of storage at rest of 24 hours and 168 hours.

The arsenic dust is a very fine powder (similar to flour) which is highly compressible. The bulk density varies from 57 pcf loose to 100 pcf at an effective head of 80 feet.

The referenced Jenike & Johanson Ltd. Standard Test Report which is derived for storage in bins shows a material which has a strong tendency to ratholing. It could be handled satisfactorily in a mass flow bin but has the capacity for arching over a slot of 2.1 ft. width after storage at rest for 168 hours.

The flow properties which are particularly relevant to the problem of reclaiming the arsenic are the critical rathole diameters. The results of the laboratory tests are shown on figure 1. The critical rathole diameter is the maximum size of the cylindrical void which the material can support. The figure shows that at a depth of 10 ft., the material can support voids 12 ft. in diameter after 168 hours storage at rest.

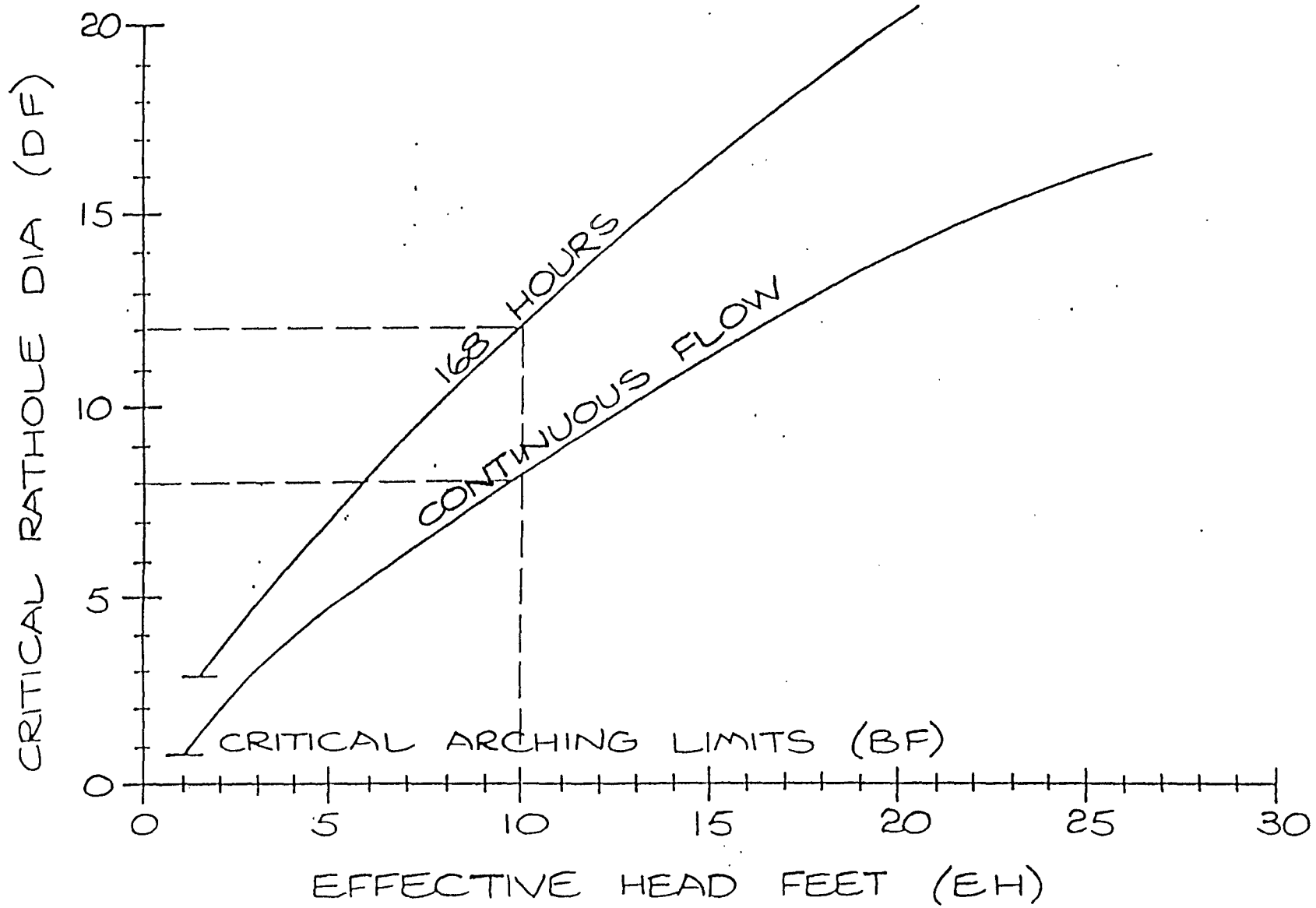
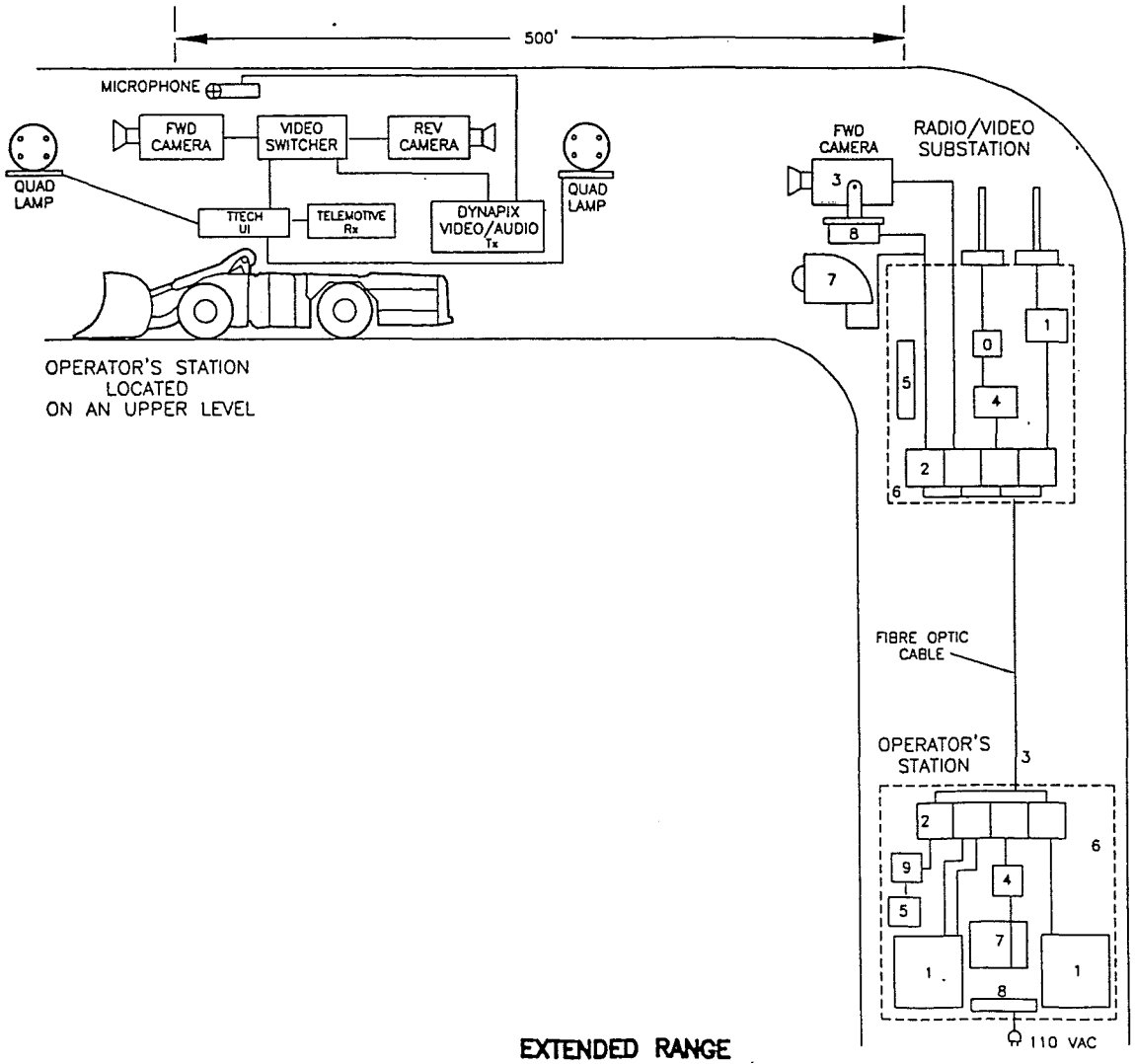


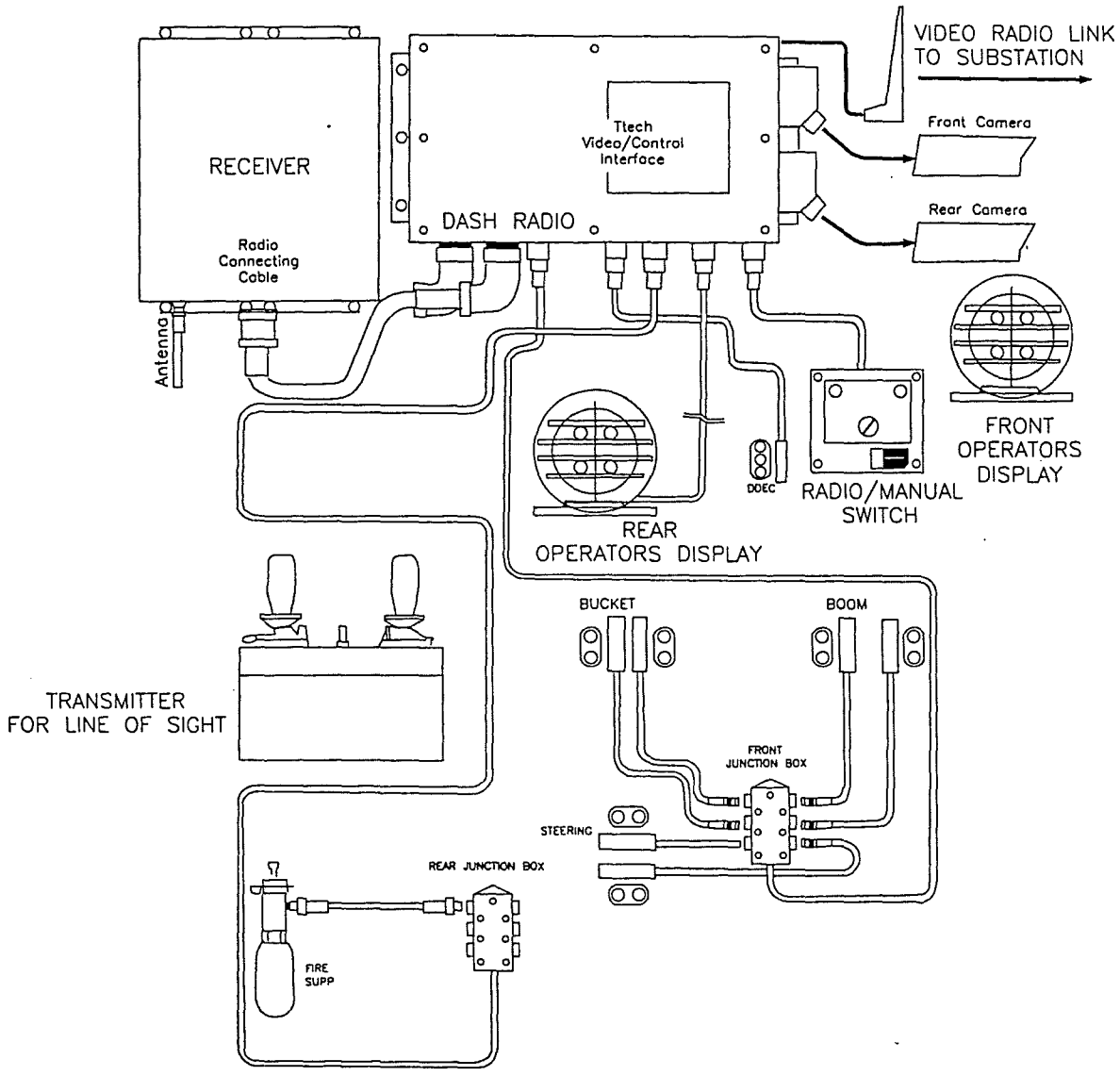
FIGURE 1 CRITICAL RATHOLE DIAMETER AS A FUNCTION OF EFFECTIVE HEAD

APPENDIX B

REMOTE LHD PRODUCT INFORMATION



EXTENDED RANGE
TELE OPERATED ASSISTED MINING



Teleoperation
LHD Layout

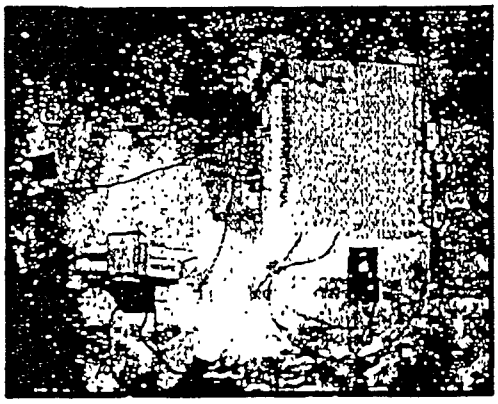
Teleoperation Configuration Options and System Overview

The basic Universal Interface System is designed for "Line of Sight" radio remote control of Load Haul Dump (LHD) or similar machines. This Universal Interface System and radio control function in line of sight mode, but have been adapted for Sub-Surface Control Station or Surface Control Room Teleoperation.

In line of sight mode, visual contact must be maintained with the vehicle under remote control. The operator typically operates the remote transmitter from a remote mucking stand that is placed in a secured area. Line of sight operation allows the operator to send the vehicle into unsafe ground or unscreened areas. Remote operation allows the use of alternate mining methods such as vertical retreat, and room and pillar. These methods greatly reduce the cost of ore and waste extraction, providing an almost immediate return of investment for the remote system. After the short payback period, the remote system then continues to lower overall production costs. The remote also allows the operator to minimize his exposure to unsafe areas and conditions. The effectiveness of remote systems and their associated mining methods is proven by wide industry acceptance of the techniques.

Teleoperation takes this strategy a few steps further. A microphone and two fixed cameras are mounted on the vehicle under remote control. A front and rear camera switch is added to the transmitter face. The Audio/Video signal from the selected vehicle camera is broadcasted to a Teleoperation Substation. The signal used to control the vehicle is also broadcasted from the Substation to the vehicle at a boosted signal strength allowing increased range. An additional Quad Lamp Display is added to the vehicle so that machine statuses are visible to the operator when the rear camera view is selected.

SCOOP MOUNTED CAMERA

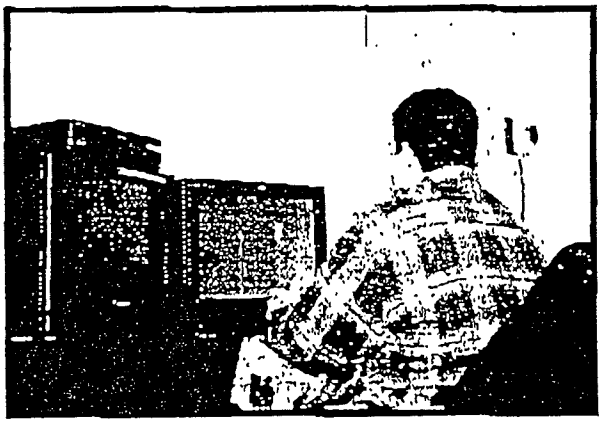


SUBSTATION

The Substation is connected to either a Surface Control Room or Subsurface Remote Station where the operator can see the captured live video image and hear the vehicle in operation. Surface Control Room type applications typically require a longer connection between the control center and the underground Substation. The Subsurface Remote Station type application typically has shorter cabling requirements that allow hard wiring. Correct placement the Substation allows teleoperated control of the vehicle in two or more directions from the substation when placed at drift intersections or stope entrances.

When a Subsurface Remote Station is utilized, the mucking stand is equipped with a monitor. The radio control and video signals are hard wired between the mucking stand and the positioned Substation. This system allows the operator to increase the effective range of his remote operation. He can operate the vehicle around corners where line of sight is not possible. This added capability is useful for the recovery of muck in corners not visible from the safe mucking stand locations. This mode is also useful for the recovery of pillars. This system is also very portable. The Substation can be mounted on a LHD movable pedestal.

The system may also be configured for a Surface Control Room type of operation. In this mode, the control room is located at greater distances from the Substation. Fiber optic links are typically used between the two stations. Vehicle control, audio and video signals are carried on the fiber optic lines. Fiber optics lines allow signals to be carried for greater distances without signal degradation. Signal line boosters are not necessary. High power cables do not induce the signal corrupting effects typically found in hard wire applications. Response times of actuated control functions are near instantaneous. Teleoperation from a Surface or Underground Control Room enables production to be accomplished during blasting periods. Production is also possible in areas where environmental conditions warrant minimal exposure to mine personnel.



CONTROL STATION SETUP

Operating range can be increased by upgrading to a Tandem Substation configuration. This system allows the broadcast and reception of signals from two adjoining areas of operation. When traveling between the areas, the operator can switch control points on the fly. The increased area of coverage can provide production solutions at a fraction of the cost typically found in systems requiring intricate backbone communications systems. The system is also more portable than backbone type systems.

To increase the operator's perception of the vehicle's area of remote operation, the system may be equipped with wall mounted fixed or remotely controlled cameras. A second monitor is added to the control station. When the system is equipped with a video control unit and remotely controlled cameras, the operator can select between cameras, and control the camera image with the touch of a button. With remotely controlled cameras, the tilt, pan, zoom and focus can be manually controlled. The video controller can also be used to store preset views, with all the parameters, in the tilt/pan unit's memory. An example would be a zoomed in and focused image of the draw point that is available at the touch of a button.

Subsurface Remote Station - System Setup

To operate in this mode, a location for the Substation and Remote Station must first be selected. Depending on the application, the Substation should be placed at the intersection of two or more drifts or near the entrance to an active stope. Substation placement should have direct line of sight to all operating areas if possible. The capability that the system has to communicate around additional corners is a function of the transmitted signal distances, drift size, content and nature of the ore body. The Substation can be designed to be mounted on a LHD movable pedestal for placement in unsecured areas.

The Remote Station should be located in a safe area, as specified in the mine's remote operating procedures. The area should provide as much visibility as possible while providing minimal traffic exposure and a retreat area for the operator. In this application, the Remote Station is typically located close enough to the Substation to allow hard wiring. A control line and coax video line must be connected between the two stations. AC power is required at both the Substation and the Remote Station. If AC power is available at only one of the stations, an AC line will also have to be ran between the stations.

A signal cable is supplied with indexed connectors. One end is attached to the mating connector on the side of the Substation. The other end is connected to the side of the transmitter. Attaching the cable to the transmitter automatically detaches the transmitter's internal lead acid battery (used in line of sight operation). It also disconnects the control signals from the transmitter's transmission can and redirects the output through the control line for broadcast from the Substation at higher power.

The video coax cable is connected between the BNC connector found on the side of the Substation and the video input of the Remote Station's monitor.

Apply AC power to both stations. A power disconnect switch is provided on the side of the Substation.

If both options were equipped with the system, a switch is provided for Subsurface Remote Station or Surface Control Room operation. Place the switch in the Subsurface Remote Station position.

If the system is equipped for dual frequency operation, make sure the appropriate switch position is selected to match the frequency of the vehicle selected.

Surface Control Station - System Setup

A system configured for operation from extended range locations, such as an on surface or underground control room, will already be configured for Subsurface Remote Station operation as described in the previous section. The procedures for selecting a Substation location are the same. Initially following the procedures outlined for Subsurface Remote Station operation will verify communications and functionality of the Substation and radio transmitter.

The transmitter will be attached to the Control Station using the same connector used for Subsurface operation. A shorter control cable is provided. The other end will be attached to the mating connector on the Control Station enclosure.

This mode of operation allows extended distances between the Control Station and Substation. As described earlier, fiber optic links are established. Recommended fiber should be utilized for optimal performance. Length of runs, quality and quantity of connections should follow manufacturer's recommendation to minimize signal loss (dBs) and provide a solid communications link.

To operate over fiber at these extended ranges, the Control Station and Substation is equipped to translate radio control signals from the transmitter over the fiber and into the Substation for broadcast to the vehicle, to translate the transmitted vehicle video and audio received at the Substation into fiber optic signals for reception at the on surface monitor, and to translate wall mounted auxillary camera video signals for transmission into fiber optic cable and reception at their on surface monitor(s). Two way communications are provided in each of the fiber optic links.

Multiple Substation Applications

An additional Substation may be added for an increased operating range. The second Substation will have the same configuration as the first station. Placing the Control Station chair switch in the "Single" position with the transmitter in the "ON" position enables the first substation to be powered for broadcast in its area of operation. Similarly, placing the Control Station chair switch in the "Tandem" position with the transmitter "ON" enables the second substation to be powered for broadcast. Turning this switch powers one Substation and de-powers the other Substation. The switch also changes the state of the control station which determines which video receiver input (Single - First Substation or Tandem - Second Substation) is sent to the vehicle audio/ video monitor.

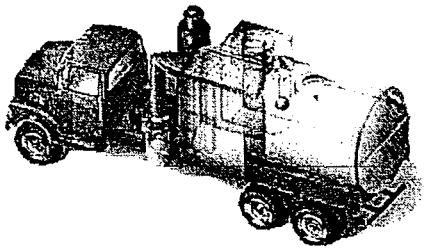
Switching between Substations can be done on the fly without stopping the machine. Switching should be completed at the midpoint of the two stations (or point of similar signal loss). Don't leave the control chair switch's "OFF" position for very long or all radio links to the vehicle will be broken and the vehicle will shut down.

APPENDIX C

Equipment Suppliers - Vacuum Equipment

NELSON SERVICE GROUP INC.
Protective Coatings - Industrial Service

Introducing the Guzzler-Power Vacuum System from Nelson Service Group, Inc



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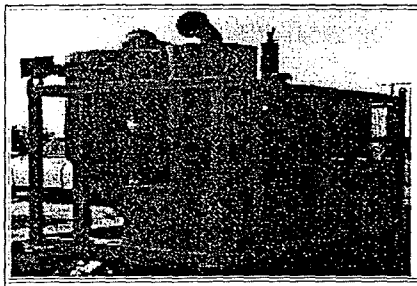
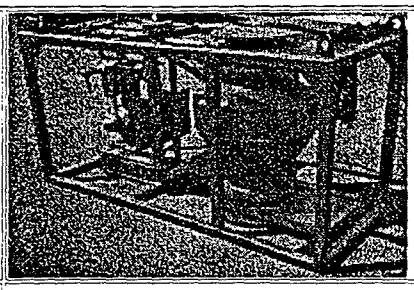
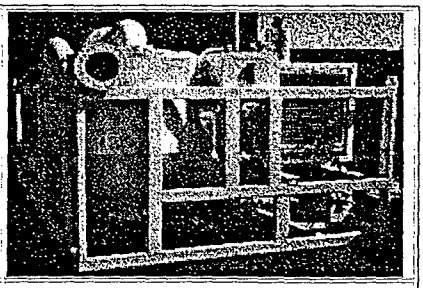
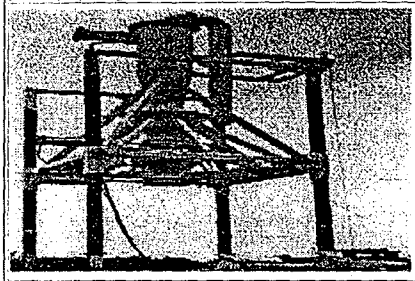
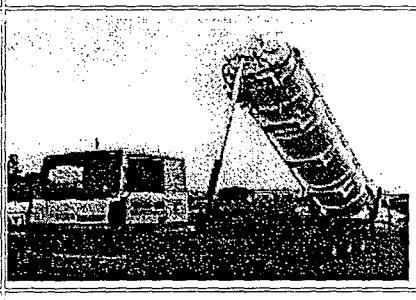
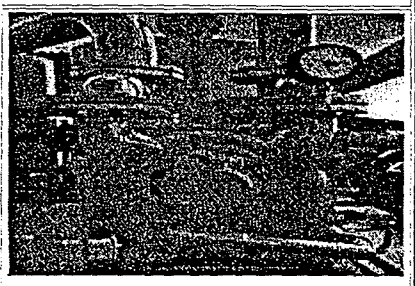
E-MAIL

NELSON SERVICE GROUP Designe

NELSON SERVICE GROUP, INC.

TCT Vacuum Picture Gallery 6 Vacuum handling equipment

		
2000 m3/hour Liquid ring vacuum unit	**Continuous discharge double valve**	**2500 m3/hour Liquid ring vacuum unit**
		
Continuous Vacuum and Discharge Cyclone for Catalyst Handling	**25,000 liter Stainless Steel Vacuum Tanker with 2000 m3/h vacuum pump opening rear door with hydraulically operated locking clamps full ADR spec**	**2000 m3/hour liquid ring vacuum pump**

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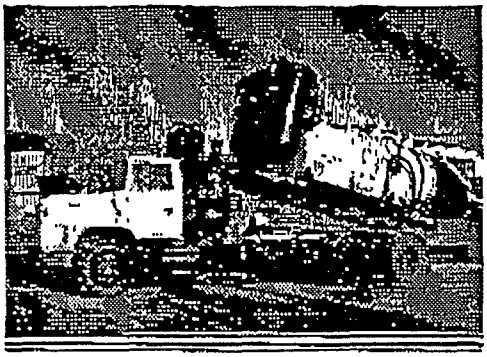
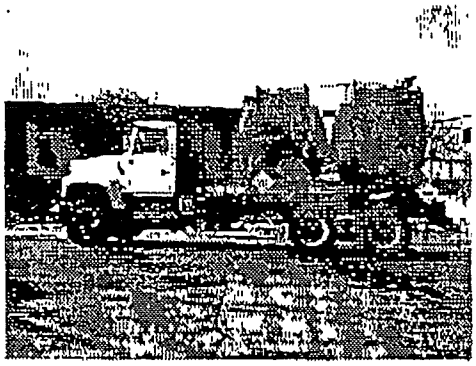
MASTERVAC 3127DC
Premier Industrial Baghouse Systems



- Cyclonic filtration with Cyclonic Bag™ technology offers complete filtration for all materials.
- Positive displacement blower: 3100 CFM at free air, 27" Hg. maximum vacuum.
- Dual mode, wet and dry material change over.
- Available in DOT 407/412 configuration for transportation of hazardous waste; also available as non-DOT.
- Can be equipped with pressure unloading systems and Hepa filtration for asbestos removal.

CIRCULATOR - 1000
Chemical Recirculating System



- DOT 407 A.S.M.E. national board certified.
- Dual 1000 USG circulating tanks.
- Centrifugal 4 x 3 transfer pump, 450 GPM at 150 PSI.
- Control box with tachometer, throttle and value controls.
- 4" air actuated dual inlet/outlet butterfly circulation values with SCH 80 piping and 150 lb. flanges.
- 50" x 96" wide front storage drum holder platform with header cage and swing out side cage doors.
- Full length safety walkway with railing and access ladders each end.
- Wrap around sidetrays for hose storage.

WASTEQUIP
CUSCO

Cusco Industries, Inc.
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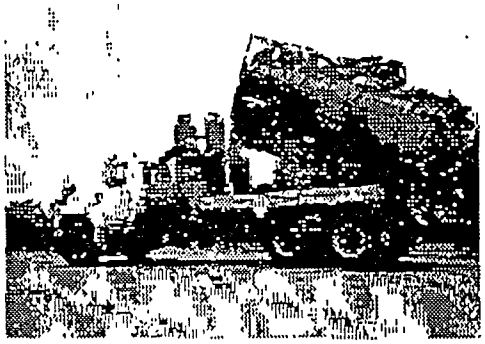
Offers the most extensive range of vacuum equipment to meet all your service requirements.

TURBOVAC SERIES
Premier Site Remediation Systems



- Positive displacement blower: 2100 CFM to 4600 CFM, 27" Hg. maximum vacuum.
- Single or dual cyclonic filtration with pre blower inlet 100 micron s.s. filter element.
- Ideal for pickup and removal of liquids, slurries and bulk solids.
- Available in DOT 407/412 configuration for transportation of hazardous waste; also available as non-DOT.
- Can be equipped with pressure unloading system.
- Can be supplied in semi trailer configuration

INDUSTRIAL VAC-70
Proven System For Hazardous Waste

- Capable of 5 minute loading.
- Industrial standard 70 barrel tank
- 750 CFM and 28" Hg. liquid cooled pump.
- DOT 407/412, A.S.M.E., National Board certified.
- Full hydraulic drive for all system functions.
- Standard 20 ton hydraulic hoist.
- Standard full opening hydraulic rear door

Cusco Industries is pleased to announce a variety of financial programs now available. Cusco now offers lease and rental programs. We also offer financial assistance through Wastequip Financial Services. Custom-tailored financing that fits your business. To take advantage of any of our financial programs please call Cusco Industries at:

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The Power in Vacuum Loading

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THE MUDLARK

Sir,

We are the Global suppliers of the highest vacuum production unit called The Mudlark, designed specifically for the recovery of free gold out of fines, pillar stoping or slurry.

The Mudlark works continuously loading up to 20 tons per hour depending on the type of hoppers and the tipping system in your mines and operated by only 3-4 personal.

We wish to send to you, a video of the Mudlark in operation, to be followed by a personal visit to answer any questions that you will have after viewing the Mudlark in operation.

Please advise by fax return, your choice of a video or computor disc. This is a free offer.

Mines on orderly closure due to the drop in grades have received a new lease of life as a result of the Mudlark.

We await your earliest reply.

Best regards,

BRIAN BISSETT
SALES MANAGER

Royal Oak Mines
American and Toronto Stock Exchanges - Symbol RYO

Richard D. Allan P. Eng.
Manager-Mining Projects

Corporate Office
5501 Lakeview Drive
Kirkland, WA 98033
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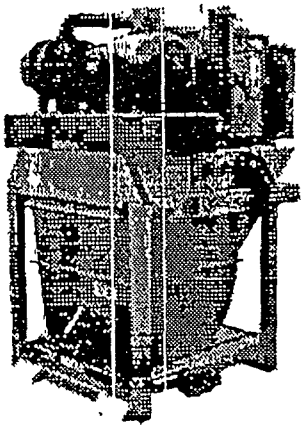
XR Series

25 to 200 HP Industrial Vacuum Systems & Conveyors



Our ruggedly constructed XR Series MAX VAC vacuum cleaner/loader is used for long distance vacuuming applications and extremely high conveying rates requiring up to 14" diameter hose size. MAX VACs are proven and well known to the industry worldwide as the most powerful, versatile, reliable and low maintenance vacuums.

Powerhead

- Motor/Pump Driveline: Direct-driven or V-belt.
- Drive Options: Electric, LPG, diesel or gas.
- Required Plant Compressed Air Pressure: 70 PSI @ 15 SCFM.
  (Option) Self-contained on-board air compressor.
- (Option) HEPA Secondary Filtration: For hazardous material vacuuming.

Electrical Control Panel

- Power Supply: 460V/3Ph/60Hz or as required.
- Enclosure: NEMA 12, NEMA 4 or explosion proof.

Stationary Models

- 30 or 50 cubic foot (or as required) bottom dump hopper with various types of valve arrangements for continuous or batch discharge.
- (Option) Service platform with railing and access ladder.

Portable Models

- Roll-type 1, 1-1/2 or 2 yard end dump hopper with skid-mount forklift transportable base.
- 4-point air-lift support stand.
- Towable trailer types and truck mounted for in-plant or over-the-road.

Intercept Hopper

MAXceptor™ Intercept Hopper can be used with any portable or stationary vacuum to intercept bulk material that is vacuumed for deposit to remote conveyor, pit, hopper, silo, etc.

Powerhead Specifications									
Model No.	XR25	XR30	XR40	XR50	XR75	XR10	XR12	XR15	XR200
Horsepower	25	30	40	50	75	100	125	150	200
Vacuum Capability*	18" Hg.	18" Hg.	18" Hg.	18" Hg.	18" Hg.	18" Hg.	18" Hg.	18" Hg.	18" Hg.
Length	6'-6 1/	6'-6 1/	6'-6 1/	6'-6 1/	6'-6 1/	7'-0"	7'-6"	7'-6"	7'-6"
Width	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-7"	5'-7"	5'-7"
Height	4'-5"	4'-5"	4'-5"	4'-5"	4'-5"	4'-11"	5'-3"	5'-6"	5'-8"
Weight (lbs.)	3300	3400	3800	4200	4600	5000	5500	6000	6600
Range of Conveying Line or Hose Sizes** (in inches)	2	2-1/2	3	3-1/2	4	5	5 & 6	6	8
	2-1/2	3	3-1/2	4	5	6	6	8	10
	3 & 3-1/2	3-1/2 & 4	4 & 5	5 & 6	6 & 8	8 & 10	10	10 & 12	12 & 14
Nominal Capacity Tons/Hr @ 50 ft.***	9.5	11	15	19	29	38	48	57	76
Maximum Conveying Distance	Depends on material and its characteristics								

*Various sizes available to 26" Hg. **From SG .3 to SG 4.6 Free Flowing Materials ***Average for free flowing SG 1 materials

U.S.A. & Foreign patents issued and pending

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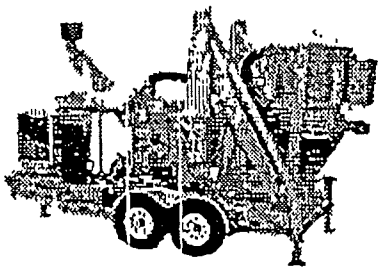
DeMarco MAX VAC Corporation
674 South County Line Road
Bensenville, IL 60106 USA
Phone: 630-766-1119 · Fax: 630-766-1077
e-mail: maxvac@maxvac.com

MAX$_{LOADER}$™



Towable Lift-Dump Vacuum Loaders

Direct belt, hopper, truck, dumpster or receptacle loading. Ideal for blast media, mine spillage, roof clean-up and contractors.

U.S.A. & Foreign Patents issued and pending

ML Series - Diesel Powered

Model ML102D and ML110DS

- Engine Type: Diesel, liquid-cooled, cast iron block
- Engine Configuration: 4-cylinder, in-line
- Engine Rated Gross Power: 102 BHP (ML102D); 110 BHP (ML110DS)
- Vacuum Pump Type: Rotary lobe positive displacement
- Engine/Pump Driveline: Direct-drive
- Vacuum Pump Airflow: 1800 CFM
- Pump Vacuum (max): 18" Hg (247" WC) for ML102D; 22" Hg (300" WC) for ML110DS
- Vacuum Hose Sizes: 4", 5" or 6" (depending on particle size, density and conveying distance)

Model ML81D

- Engine Type: Diesel, liquid-cooled, cast iron block
- Engine Configuration: 4-cylinder, in-line
- Engine Rated Gross Power: 81 BHP
- Vacuum Pump Type: Rotary lobe positive displacement
- Engine/Pump Driveline: Direct-drive
- Vacuum Pump Airflow: 1300 CFM
- Pump Vacuum (max): 18" Hg (247" WC)
- Vacuum Hose Sizes: 3", 4" or 5" (depending on particle size, density and conveying distance)

Towable Trailer Chassis

- Suspension: Semi-elliptical leaf springs, 12,000 lb. rated tandem axles.
- Tow Package: Pintle or ball type with manual trailer tongue raising jack system.

Dimensions

- Height (unloaded): 11'-11-1/2"
- Length: 18'-0"
- Width: 7'-5-1/2"

Compressed Air System

- Volume: 12.5 SCFM @ 100 PSI
- Power Source: Direct-driven off engine

Fuel System

- Fuel Cell: 50 gallon capacity
- Fuel: Diesel

Hopper-Receiver

- Hopper Load Capacity: 1 cubic yard
- Lift Receiver System: Hydraulic cylinder
- Lift Clearance Height (under the discharge valve): 10'-0"
- Extension Clearance (out from trailer frame): 6'-0"
- Batch Dump: Counterweighted discharge valve
- Continuous Dump: Consult factory

Main Control Panel

- Voltage: 12V DC
- Enclosure: NEMA 4 (other NEMA rated control panels are available depending on environmental conditions)

Optional Equipment

- HEPA Filtration
- Air Bypass Cooling System (for high temperature material vacuuming)

Return to Home

DeMarco MAX VAC Corporation
674 South County Line Road
Bensenville, IL 60106 USA
Phone: 630-766-1119 · Fax: 630-766-1077
e-mail: maxvac@maxvac.com

APPENDIX D

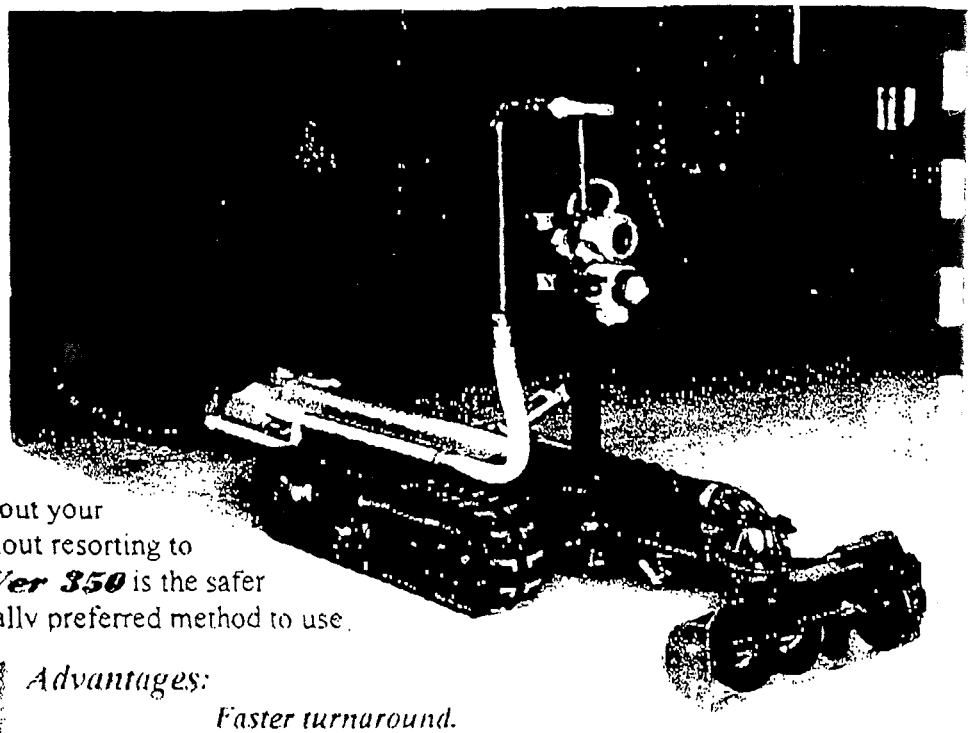
Robotic Equipment

Remote Systems for Hazardous Environments

Non Entry Systems Ltd . ROVer 350 NESL

Factory Langdon Road. Prince of Wales Dock. Swansea. SA1 8QY Tel +44 (0)1792 462026 Fax +44 (0)458743

Asphyxiation.
Poisoning.
Drowning.
Falling.
Burning



If you have to consider the risks associated with man entry then maybe its time for you to consider one of the alternatives

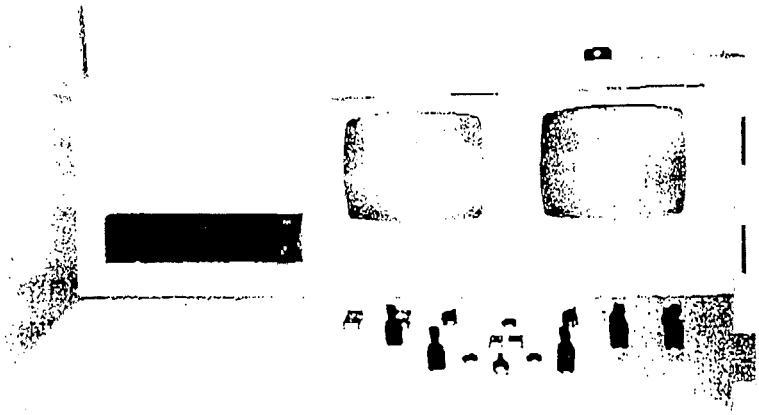
If you would like to carry out your storage tank cleaning without resorting to Man-Entry then the ***ROVer 350*** is the safer Quicker and environmentallv preferred method to use.

Advantages:

Faster turnaround.
Less site contamination.
Enhanced Safety.
Cost Efficient.
24 Hour Capability.
Reduced VOC emissions.

Conforms to the confined spaces Regulations 1997

The system comes mounted in a 20 ft ISO container with a control roor one end and the power pack, umbilical reels and cotrol equipment mou... in the other end. During transportation the ***ROVer 350*** Vehicle is stor alongside the tank camera system for added protection. The system is fi with a variety of attachments to suit different materials, in addi... operations can be carried out on pyrophoric tanks or restricted emissi tanks under live purge conditions



The consol is situated in the control room which is fully insulated fo operator comfort. All in tank equipmen Classified to -
EExd IIc T4 (Europe)
Class I Div 1 Grps C & D (USA)

NESL Non Entry Systems Ltd

TONY BENNETT

TANK CLEANING EQUIPMENT MANUFACTURERS

Technical Specifications

	European Version	USA Version
General		
• Total Weight	9,000 Kgs	19,800 lbs
• Power Pack	Diesel	Diesel
• Vehicle Light	12v 50 Watt Tungsten Halogen EExdeIICT4	110v 100/150W HPS Class I Div 1 Groups C&D
• Camera Housing	EExdeIICT4	Class I Div 1 Groups C&D
• Umbilical	80 m Standard	250 ft Standard

Container

20 ft ISO divided into 2 compartments

Compartment 1 Double doors to Power Pack - Rover Vehicle –Umbilical – Pressure washer – Manway Camera and Light – Insertion Ramp - electrical and hydraulic panels and spare parts.

Compartment 2 Single door to Air Conditioned Control room – Operators Control Panel – Video Recorder CCTV screens

Track Base

• Width Open	48 inches (1220mm)
• Width Closed	22 inches (560mm)
• Length	105 inches (2,670mm)
• Weight	1220 lbs (550 Kgs)
• Ground Pressure	< 1 Psi (.068 Kgs/cm2)
• Attachment	Powered Rotating Auger Suction as standard
(optional)	Onboard Pump Helical Screw, Nitrile stator 600 bbs/h (60m3/h)

Controls

• Left & Right track	Fwd/Rev		Joysticks
• Suction	Up & Down		Joystick
• Suction Auger/Pump	Fwd/Rev		Switch
• Track	Open/Close		Push Button
• Cannon/Camera	Up/Down/Left/Right		Joystick
• Tank Camera	Up/Down/Left/Right		Joystick
• Tank Camera	Zoom/Focus		Rocker Switch
• Video VHS		Europe PAL	USA NTSC
• Monitors	12"	B&W 450 Line	

• On Board Gas Level Monitor (optional)

Triple Hydraulic Power Pack NES 403

Engine- Iveco 804I 4 cyl diesel water cooled
Power(*intermittent*)-56KW@2500rpm
Power(continuous) -50.5KW@2500rpm
Displacement 3.9 l - 12v electrics
Pump- 134l/m @ 250 Bar variable displacement
Mounting Protection Frame with lifting point
Fuel and Hydraulic Tanks- incorporated
Full instrumentation and controls fitted
Safety- Spark Arrestor/Chalwyn inlet valve/Engine protection
Electric Generator – 6.5KW 3Phase 230/400v 50/60hz 3000rpm belt driven

Manway Camera and light

8.1 Zoom B+W .1 Lux
110v 100/150W HPS

Power Washer for Light and Camera Clean View

110/240 volt
1.6KW
Pressure max 1450 psi
Flow max 79 GPH (360 l/h) psi (100 bar)

Insertion Ramp

Manway fixing – Umbilical roller guide - Hand Hydraulic Power Pump and hoses

General Electrical Characteristics

1. Lighting-12 V CENELEC/BASEEFA EEx de 11C T4 50 W halogen floodlight
   Equivalent USA Classification UL Class I Division 1 Groups C & D
2. Camera Housing 12 V CENELEC/BASEEFA EEx d 11C T4
   Equivalent USA Classification UL Class I Division 1 Groups C & D
3. Junction Boxes 12 V CENELEC/BASEEFA EEx d 11B T6
   Equivalent USA Classification UL Class I Division 1 Group B
4. Static electricity protection-14 separate static discharge earth routes through vehicle umbilical
5. Earth leakage and overcurrent protection in main console
6. Camera cable double armoured and positioned in centre of umbilical for added protection.

Standard Spare Parts

1 Set of ROVer Tracks
1 Helical Screw Stator

Specifications subject to change without prior notice

Remote Systems for Hazardous Environments

Non Entry Systems Ltd . Lagooner

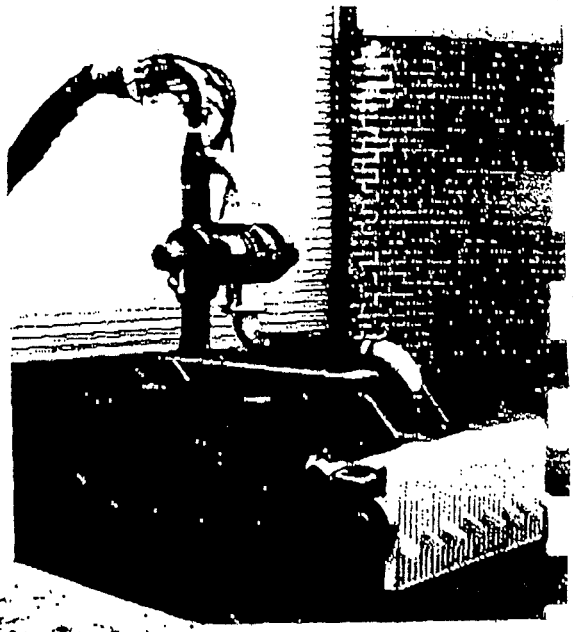
NESL

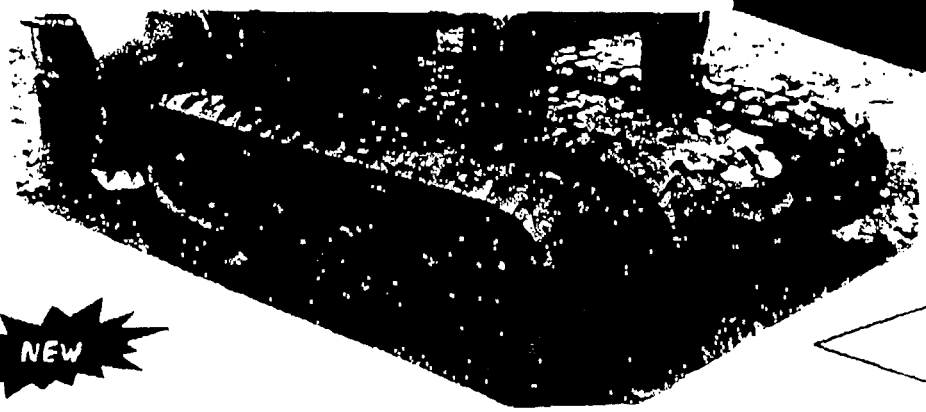
Factory Langdon Road. Prince of Wales Dock. Swansea. SA1 8QY Tel +44 (0)1792 462026 Fax +44 (0) 1792 458

Sludge Lagoons.
Settlement Ponds.
Intake Channels.
L.P.I Separators

For fast, safe and environmentally friendly De-Sludging of lagoons and settlement ponds the New ***NES Lagooner*** is the answer With its on board screener and pumping system it works tirelessly removing the heaviest sludge and slurries.

Fully Submersible.
Suitable for operation in Zone 1 areas.
Ground pressure < 0.5 psi.





NEW

Standard tracks for concrete or steel

Double track systems for clay or soft linings

Description:

The system comprises of the hydraulically powered vehicle, Umbilical, control station and hydraulic power-pack in a 20 ft ISO container with the control station at one end. During transportation th ***Lagooner*** Vehicle is stored alongside the umbilical inside the container for added protection. The system can be fitted with a variety of attachments to suit different materials, including in line macerators or cutter pumps. *Pump Capacities to 100 Cu Mtr / Hr.*

Specification:

Vehicle	-	Hydraulically powered with onboard powered suction strainer/cutter and lobe pump
Power Pack	-	Diesel driven with twin pump hydraulic system. Mounted inside ISO containe
Umbilical	-	200 ft standard floating umbilical contains all control lines and sludge discharge hose
Control	-	Manual hydraulic control station mounted on swing out arm at container doors.

Technical Specifications

NES LAGOONER 370A

- Track length :1420mm
- Track width :230mm
- Track height :330mm
- Total width assembled :1105mm
- Total length with suction :2720mm
- Total weight assembled :830kgs
- Drive :2 hydraulic motors with integral gearboxes
- Controls :Manual levers on control stand
- Tracks :Continuous Nitrile rubber self tensioning
- Suction device :Duckbill for API separators
- Speed :Variable 0 to 40m/min
- Pump :NES640 Lobe Pump 84m3/h @ 6.2 bar
- Mast : 2 metres with direction indicator
- Control Stand :Manual Control Levers on stand
- Umbilical : 35 metres sheathed

NES LAGOONER 370B

- Track length :1420mm
- Track width :230mm
- Track height :330mm
- Total width assembled :2405mm
- Total length with suction :2720mm
- Total weight assembled :1355kgs
- Drive :4 hydraulic motors with integral gearboxes
- Controls :Manual levers on control stand
- Tracks :Continuous Nitrile rubber self tensioning
- Suction device :NES Rotary Filter Mascerator
- Speed :Variable 0 to 40m/min
- Pump :NES640 Lobe Pump 84m3/h @ 6.2 bar
- Mast : 2 metres with direction indicator
- Control Stand : Manual Control Levers on stand
- Umbilical : 35 metres sheathed

NESL 402B Hydraulic Power Pack	NESL 640-140 Lobe Pump
Engine- Iveco 8061 6 cyl diesel water cooled	Max Flow-84m3/h Max Pressure 6.2 Bar
Power(intermittent)-84.5KW@2500rpm	Suction inlet-4"/100mm Discharge-4"/100mm
Power(continuous) - 76KW@2500rpm	Drive-Hydraulic Motor Max Speed 540RPM
Displacement 5.9 l - 12v electrics	Mounting-4 wheeled trolley
Pump- 134 l/m @ 250 Bar	Control- Hydraulic valve Forward/Reverse/Stop
Mounting Protection Frame with lifting point	Dimensions-720 X 274 X 463 Weight 154Kgs
Fuel and Hydraulic Tanks- incorporated	Number of Lobes-4 Materiel-Nitrile Rubber
Full instrumentation and controls fitted	
Safety- Spark Arrestor/Chalwyn inlet valve/Engine protection	
Use-NES Lagooner + NES 670 or 2 X NES 670	

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Non Entry Systems Ltd

NESL

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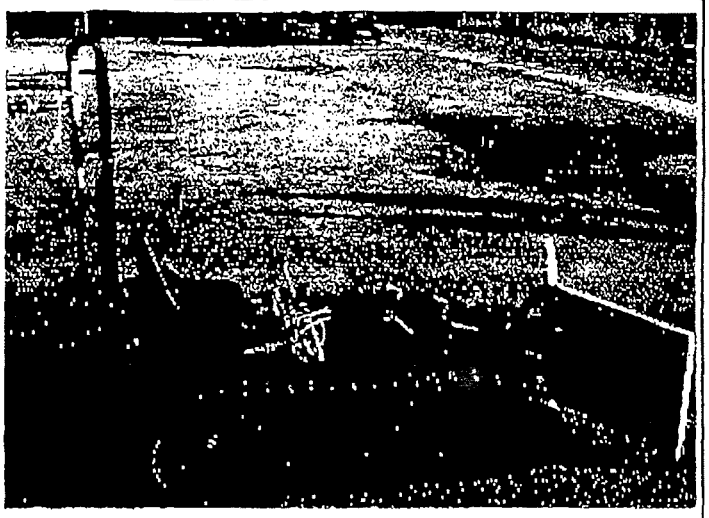
email tankcleaning@technologist.com

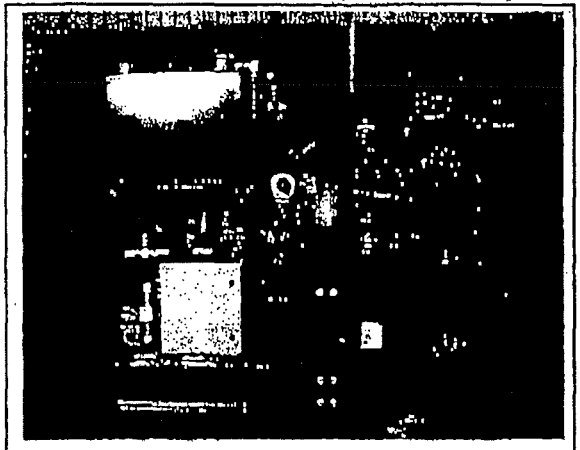
NES MOVer THE TANK CLEANER

The NESL **MOVer** system is a purpose built tank cleaning tool for large diameter above ground storage tanks. Fully hydraulic with an operator breathing air supply built in, it is the fastest safest and most efficient way to carry out de-sludging operations.
Typical de-sludging rates of up to 200 m3 per day can be achieved by an experienced operator

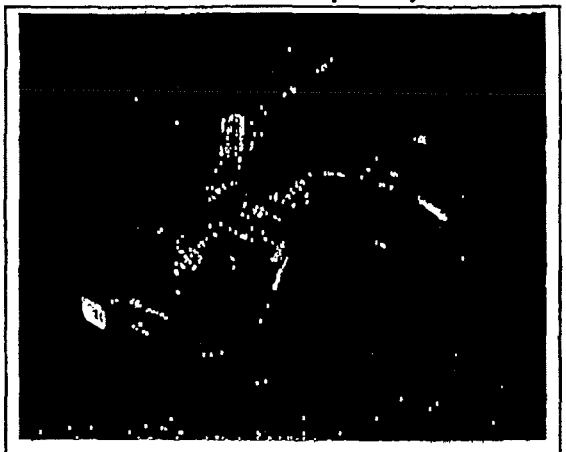


NES 320 **MOVer** Sit & Ride Vehicle

The **MOVer** system is ideal for the cleaning of Crude oil, Black oil and other tanks up to 100 metres diameter. Insertion and assembly in a tank is simple, takes about one hour and does not require any tools.



NES 402 56Kw Double Power Pack



NES 670 Rotary Lobe Pump

The MOVer and the Lobe Pump are powered by the Power Pack via umbilicals and two hose reels mounted on a separate frame in order that the Power Pack may be sited away from the tank.
The engine is fitted with safety features including a spark arrestor and Chalwyn shut down valve. Both the Power Pack and hose reels are frame protected and are equipped with lifting points.

The 670 Rotary Lobe pump can pump up to 140 m3 per hour with a maximum discharge pressure of 6.3 bar. Fitted to a trolley for ease of movement inside a tank it can be used up to 100 metres away from the reels via an umbilical.
To maximize pumping efficiency, suction is direct into the pump via the 90 degree elbow. Discharge is normally through lightweight bauer type piping(separate supply).Control of the pump is inside the tank and also on the power pack.

For more information call our sales department or visit http://tankcleaning.hypermart.net/index.html

Technical Specifications
NES MOVer Sit & Ride TANK CLEANING Kit

Vehicle

- Track length :1420mm
- Track width :230mm
- Track height :330mm
- Total width assembled :1105mm
- Total length with blade :2420mm
- Number of assemblies for passing manway :9
- Total weight assembled :550kgs
- Drive :2 hydraulic motors with integral gearboxes
- Controls :Hand proportional valves with centre detent
- Tracks :Continuous Nitrile rubber self tensioning
- Blade :UHMW Plastic with brass backing plate
- Assembly fixings :Pins/slot-in/quick release couplings
- Speed :Variable 0 to 40m/min

Specification of NESL ROTARY LOBE PUMPS & HYDRAULIC POWER PACKS

NESL 640-140 Lobe Pump	NESL 670-270 Lobe Pump
Max Flow-84m3/h Max Pressure 6.2 Bar	Max Flow-162m3/h Max Pressure 6.3 Bar
Suction inlet-4"/100mm Discharge-4"/100mm	Suction inlet-6"/150mm Discharge-6"/150mm
Drive-Hydraulic Motor Max Speed 540RPM	Drive-Hydraulic Motor Max Speed 540RPM
Mounting-4 wheeled trolley	Mounting-4 wheeled trolley
Control- Hydraulic valve Forward/Reverse/Stop	Control- Hydraulic valve Forward/Reverse/Stop
Dimensions-720 X 274 X 463 Weight 154Kgs	Dimensions-873 X 274 X 463 Weight 194Kgs
Number of Lobes-4 Materiel-Nitrile Rubber	Number of Lobes-8 Materiel-Nitrile Rubber

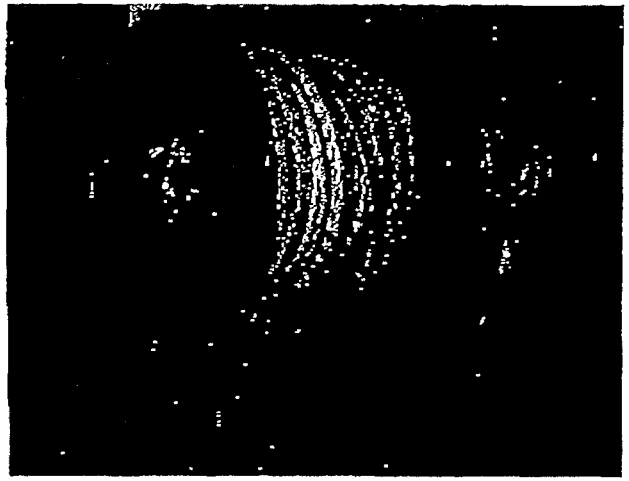
NESL 402 Hydraulic Power Pack	NESL 402B Hydraulic Power Pack
Engine- Iveco 8041 4 cyl diesel water cooled	Engine- Iveco 8061 6 cyl diesel water cooled
Power(intermittent)-56KW@2500rpm	Power(intermittent)-84.5KW@2500rpm
Power(continuous) -50.5KW@2500rpm	Power(continuous) - 76KW@2500rpm
Displacement 3.9 l - 12v electrics	Displacement 5.9 l - 12v electrics
Pump- 134 l/m @ 250 Bar	Pump- 134 l/m @ 250 Bar
Mounting Protection Frame with lifting point	Mounting Protection Frame with lifting point
Fuel and Hydraulic Tanks- incorporated	Fuel and Hydraulic Tanks- incorporated
Full instrumentation and controls fitted	Full instrumentation and controls fitted
Safety- Spark Arrestor/Chalwyn inlet valve/Engine protection	Safety- Spark Arrestor/Chalwyn inlet valve/Engine protection
Use- NES Mover + NES 670 or 2 X NES 640	Use-NES Lagooner + NES 670 or 2 X NES 670

NESL 405 Mobile Hose Reel

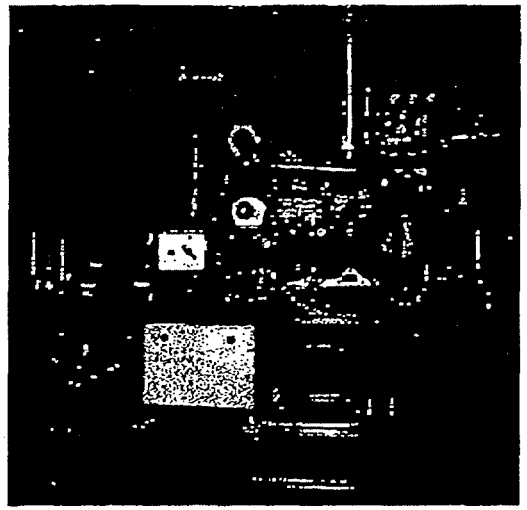
- Number of reels 2 (1-supply to vehicle 2- supply to Lobe pump)
- All steel construction frame with lifting point
- Length of Umbilicals 300 feet fully sheathed with QR couplings each end
- Extension hoses to Power pack 2 X 50 feet with QR couplings

The above are all standard NES package Kits, any special requirements are not included. For special requirements details should be given to our technical sales department for evaluation and costing.

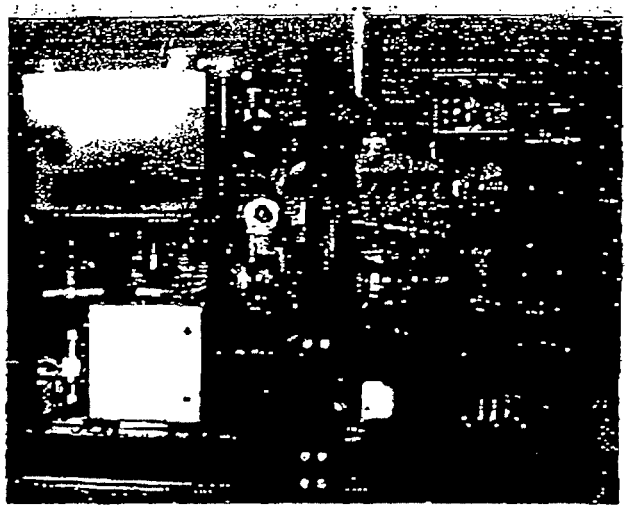
Specifications are liable to changes without notice



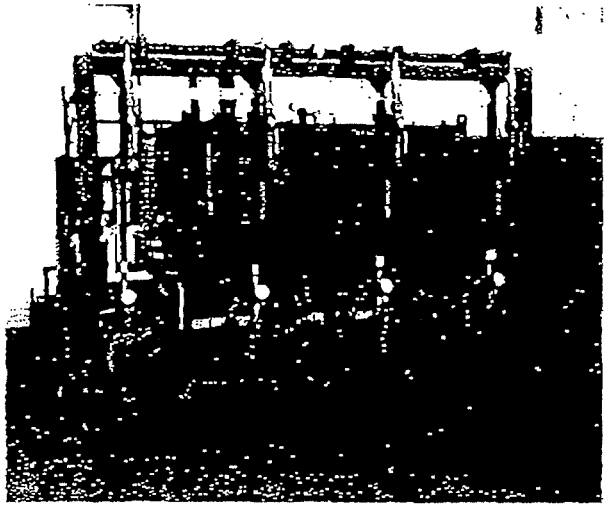
Double Umbilical Reel Unit with sheathed hoses



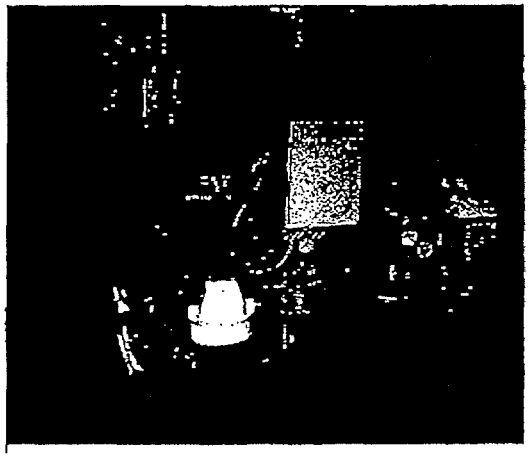
56 Kw diesel powered mobile unit



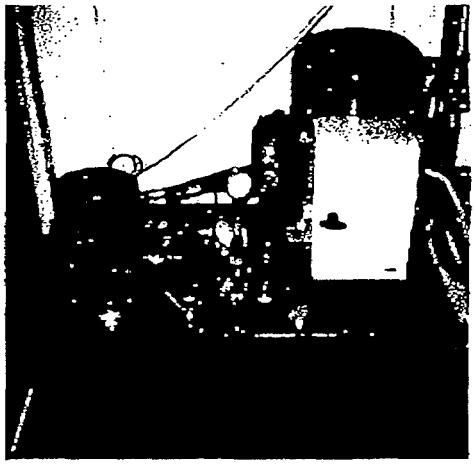
76 Kw diesel powered mobile unit



4 X 37Kw Electric power pack



2.5 Kw Electric unit for manway cannon



5Kw + 2.5Kw Electic unit

Non Entry

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Non Entry Systems Ltd

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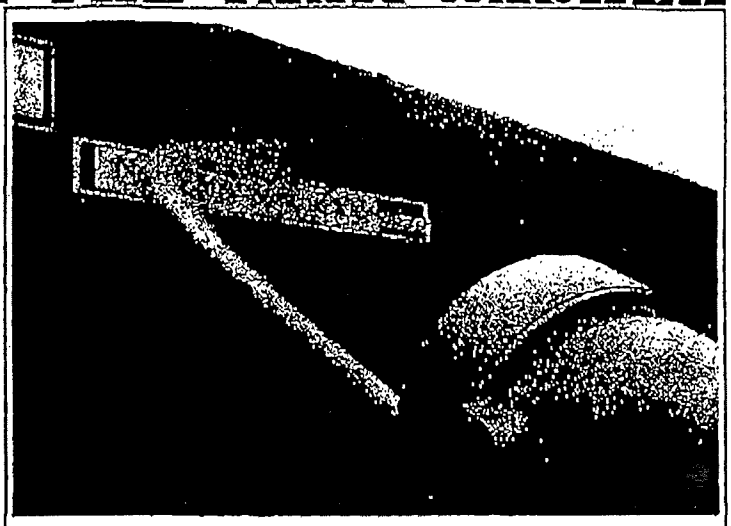
email tankcleaning@technologist.com

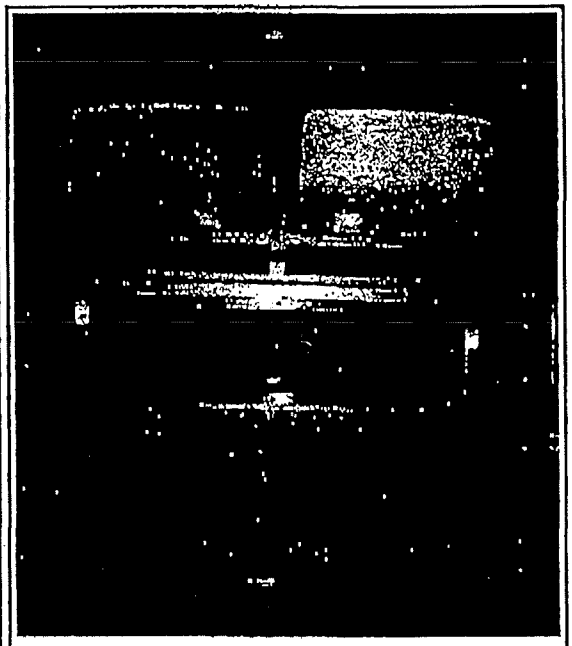
NES CANNon THE TANK WASHER

NES Manway **CANNon**
Designed for the Non Invasive cleaning of Chemical and Oil storage tanks up to 50 metres diam. The Cannon can quickly remove bottom sludge by dilution or sweeping to pump suctions. With its onboard camera and lighting system the unit can be totally sealed in the tank to minimise VOC emissions and can be operated under live purge conditions. All movement control is hydraulic the Intank camera and lighting systems are Flameproof to Cenelec or NEC (UL) standards for use in Zone 1 areas.



Water or Cutter jetted where you want it that's the NES 320 Remote CANNon

Front view of **CANNon** in manway with camera and lighting



Black Box **CANNon** Remote Control Video Station

For more information call our sales department or visit http://tankcleaning.hypermart.net/in-

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NESL Manway cannon system USA Version

Unit is fitted with DAS Nozzles giving the following characteristics:-

Supply Pressure PSI	Typical Nozzle Diameter							
	5/8"		3/4"		7/8"		1"	
	Flow GPM	(ft) Jet Length	Flow GPM	(ft) Jet Length	Flow GPM	(ft) Jet Length	Flow GPM	(ft) Jet Length
120	129	72	162	84	226	90	290	95
150	149	81	184	100	248	100	319	105
175	158	84	193	110	257	105	334	110

Hydraulic Power is supplied by a 110V 2.5 KW power pack giving 5 lpm @ 1500 psi
Light & Camera wash Pump pump 110v 2.5 KW
Camera B&W CCTV <1/3 lux 8X zoom auto iris manual zoom
Control station is mounted in Instrument case with 2 x 9" CCTV Monitors
Pan & Tilt control
Zoom & Focus
Light Dimmer
Ground Monitor
Video recorder
Manway adapters for 24" , 30" 36" & 48" manways

Umbilical 150 ft fully sheathed for protection.

All In Tank equipment to NEC Class 1 Division 1 Groups C & D

Power Pack and wash system are mounted on a trolley with rain protection.

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NES 801 Pre-Treatment Unit & Centrifuge Decanter Unit (Hydraulic Version)

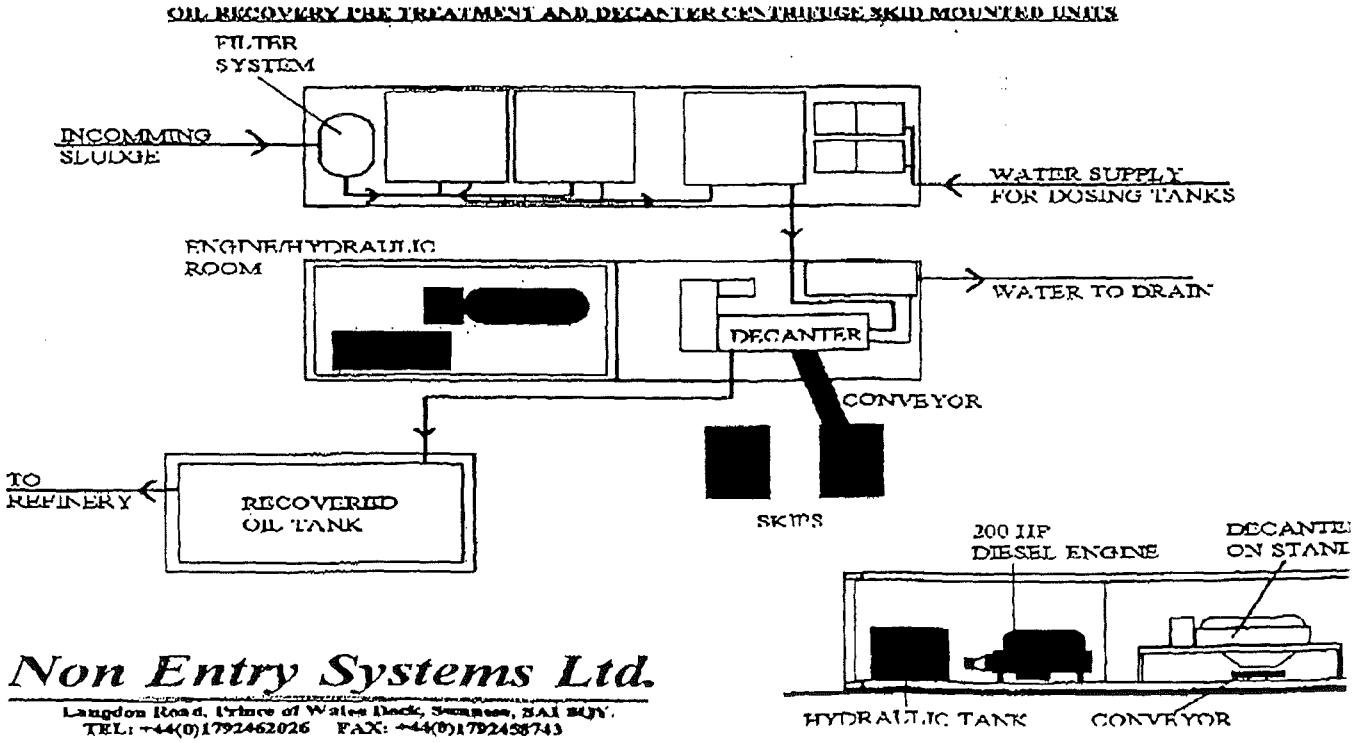
- 2 X 40 ft Skids - 12.192m X 2.439m X 2.591m - Weight (per skid) 11,500 KGs
- One side of each skid fitted with lift up and drop down awning and walkway

Skid 1 fitted with:

- 2 heated resuspension tanks of 10m3 each
- 1 heated blending tank with paddle mixer
- 3 Rotary Lobe transfer pumps 84 m3/h (500Bbl/h) @ 6.2 Bar (91 psi) hydraulically powered with main pipework in 3" - Ball valves fitted allowing all possible variations of product flow direction including feed to decanter centrifuge
- High and Low level visual and audible alarms - 6"overflow pipe from all tanks terminating in flange for site connection
- Control Panel for hydraulic operation Forward/Reverse/Stop of pumps, agitators and mixers
- Steam Control systems with steam traps on all three tanks
- Steam Heating coils : 2" Pipe
- 2 Chemical and 2 polymer stainless steel dosing/mixing tanks with paddle mixers and pumps for continuous dosing of chemicals and polymers - pumps and mixers hydraulically powered
- Twin continuous inline quick clean filters on incoming line with change over valves - back flush and steam injection facility
- Emission control chimneys on resuspension and blending tanks
- Removable tank lids
- Removable access plates on tank sides for cleaning purposes
- Sandblasted and Painted in choice of 1 colour

Skid 2 fitted with:

- Horizontal 3 Stage Decanter Centrifuge various models with hydraulic drive (see attached specs)
- Belt conveyor with swing and height adjustment for solids discharge hydraulically powered
- Separated oil outlet 3"
- Water outlet to inbuilt settling tank with drain and draw off points and submersible discharge pump
- Bulkhead separation to Ventilated Power Pack engine room
- Diesel Hydraulic Power Pack - Engine Iveco 836 SR 10 6 cylinder Turbocharged and Intercooled diesel continuous rating at 2200rpm 200HP, intermittent rating 225 HP, maximum rating 235 HP. Water cooled and fitted with spark arrestor exhaust and Chalwyn over speed shut down valve on air inlet. Engine protection on over temperature and loss of oil pressure.
- Engine fitted with a Triple variable delivery Vickers hydraulic piston pump, pressure compensated to give 250 litres/minute @ 170 Bar, 65 litres a minute @250 Bar and 40 litres/minute @ 250 Bar, all able to be run at full load simultaneously, hydraulic oil reservoir with return filtration, sight level and temperature gauge, low level shut down, cleaning trap - hydraulic oil cooler. 3kva generator 220 volt 1 Ph for lighting and control purposes
- All control systems outside of engine room intrinsically safe or flameproof to CENELEC standards
- Sandblasted and Painted in choice of 1 colour



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Remote Systems for Hazardous Environments

Non Entry Systems Ltd.

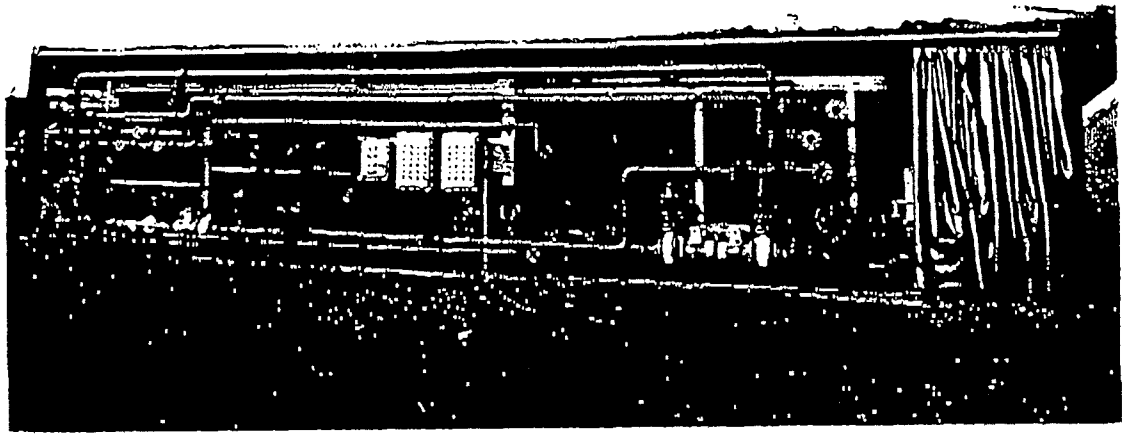
NESL

Factory Langdon Road. Prince of Wales Dock, Swansea. SA1 8QY Tel +44 (0)1792 462026 Fax +44 (0) 458743

Oil Treatment and separation Systems

The NES Pre treatment unit is a self-contained system for preparing oil and chemical sludges for separation by centrifuge systems. It contains all the necessary equipment to Modify the viscosity by temperature and the addition of Polymer's or Surfactants. All electrical controls and systems are built to Zone 1 Standards

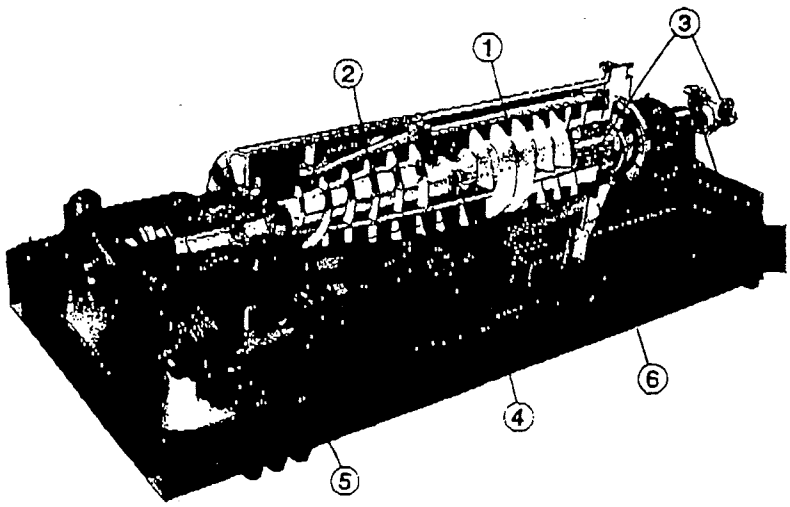
NES Pre Treatment Unit



Once the sludge has been conditioned to prepare it for Centrifuging it is Pumped from the PTU to a horizontal Three phase Decanter Centrifuge for separation into Solids, Recovered Oil and Water. The Quality of the three phases can be adjusted on the run by the decanters variable weir adjustment. Enabling the quality to be maintained without having to shut down for adjustments.

Three Phase Decanter Centrifuge

1. Bowl
2. Scroll
3. Inlet pipe
4. Feed Chamber
5. Solids Discharge
6. Light Phase discharge
7. Heavy Phase discharge



Remote Systems For Hazardous Environments email:tankcleaning@technologist.com

Non Entry Systems Ltd.

Registered Office
108 Saunders Way.
Sketty,SwanseaSA2 8BJ.

NES

Company registered in England number:30502061 V.A.T. number GB666896169 Directors: D.Shipton J.Shipton
Factory: Langdon Road. Prince of Wales Dock , Swansea. SA1 8QY. UK Tel:+44(0)1792462026 Fax:+44(0)1792 428971
Mobiles: +44(0)976 269466 or +44968152187 Website http://tankcleaning.hypermart.net/Index.html

EQUIPMENT PRICE LIST as of 01/01/99 (Europe & N. America)

See Reference numbers for full supply specification details

Reference	Equipment Item	Price ex works Swansea U factory in Pounds STC
NES 320	NES MOVer Hydraulic Tank Cleaning Dozer	16,200
NES 402	NES 56KW Diesel Hydraulic Power Pack	19.250
NES 402B	NES 76KW Diesel Hydraulic Power Pack	21,350
NES 405	NES Mobile Hydraulic Hose Reel set (4)	5,600
NES 370A	NES LAGOONer Single Track	24,600
NES 370B	NES LAGOONer Double Track	31,400
NES 501	NES Cavity Screw Pump 100m3/h @ 6 Bar	5,800
NES 640	NES Rotary Lobe Pump 140 model 70m3/h@6Bar	5,400
NES 670	NES Rotary Lobe Pump 270 model 140m3/h@6Bar	6,200
NES 350	NES ROVer Robotic Tank Cleaning Unit	132,000
NES 701	NES MANway Cannon Black Box SXS	37,100
NES 720	NES MANway Cannon Containerised	43,350
NES 801	NES Pre-Treatment Oil Recovery Unit Containerised	from 81,500
NES 805 Z4D4	NES 3 Phase Centrifuge	from149,755
NES 901	NES KW High Pressure Pump Unit 125l/m@1000bar	82,654
NES 902	NES KW High Pressure Pump Unit 13l/m@ 300bar	14,200
NES 906	NES Internal 4 Lance Tube Cleaner	29,062
NES 1001	NES Liquid Ring Vacuum Unit	32,375
NES 1005	NES Liquid Ring Vacuum Tanker	P.O.A.

The above are all standard NES package Kits, any special requirements are not included. For special requirements details should be given to our technical sales department for evaluation and costing.

next

Robotic Equipment

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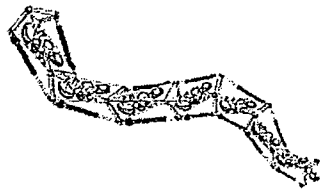

Serpentine Truss is a maintenance tool for sensitive areas of the Space Shuttle, once those areas become unreachable by humans. Because it is capable of snake-like motions along complicated pathways, this robot is used for inspection and light lifting. Its microprocessor based controls remember its entry trajectory and withdraws it the same way, without touching or disturbing anything in its path.

Contact Bob Torbin: btorbin@foster-miller.com or Mike Reinhardt: mreinhard@foster-miller.com or call (781) 684-4369.

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APPENDIX E

FULLER KINYON CONVEYING SYSTEMS

FULLER - KINYON CONVEYING SYSTEMS

FOR over a quarter of a century, Fuller-Kinyon Conveying Systems have been used for conveying bulk Portland cement, pulverized coal, limestone dust, flue dust, fly ash, pulverized phosphate rock, and many other similar materials.

The system is most commonly used for conveying from pulverizer mills and collecting conveyors serving a plurality of mills, to storage silos; from storage silos to packer bins, or for loading and unloading cars, ships and barges. Also for mixing and blending dry-cement raw materials; recovering packer and bag-cleaner spill; and air-separator fines.

Fuller-Kinyon Systems have been adopted as standard conveying practice by the cement industry of the United States, in which more than 96 percent of the operating mills use one to a dozen, or more, such systems for conveying bulk cement and other dry pulverized materials. They are used throughout the World by cement manufacturers.

They have been used for unloading and conveying cement on substantially all major construction projects, such as Hoover, Bonneville, and Grand Coulee Dams, and many other large industrial structures.

The system comprises (1) a stationary Fuller-Kinyon Pump, directly driven through a flexible coupling by an electric motor or internal-combustion engine.

Pumps are available in seven standard sizes to provide a wide range in capacity. Capacities are specified on the basis of the conventional full-load speed of the pump screw at 1160 r.p.m., and in terms of Portland cement (94-lb. per cu. ft., or 376-lb. per barrel), range from 40 barrels to 1000 barrels an hour, (or 8 to 200 tons).

The volumetric displacement being constant, the capacities, when handling other pulverized materials, such as pulverized limestone or other asphalt fillers, may be determined by direct ratio of density.

By controlling the feed to the pump, each pump size can have a capacity range from full load down to ¼ full load.

(2) The pipe line, consisting of standard steel pipe, furnished in cut lengths, fitted with flanges, bolts and gaskets, and long-radius pipe bends, ranges in size from 3-in. diameter to 10 inches.

(3) Two-way and three-way, positive cut-off diverting valves, hand-operated, or two-way motor-driven valves, actuated by remote control, permit direction of flow of material through branch lines to any part of a plant or number of receiving bins.

(4) High-and low-level material indicators are furnished for bin, hopper or silo, for any predetermined level indication.

(5) Automatic and remote control of material distribution can be furnished. It is recommended when large tonnages are handled to a large number of small bins, or when the diverting valves are in remote locations, difficult of access. This control operates the motor-driven distributing valves so that bins can be filled continuously in any desired sequence. A central-control panel indicates, at all times, by means of illuminated, graphic flow lines, the direction of flow of material, and the condition of bins is registered by the material-level indicators. The control panel is provided with remote-control switches, whereby any bin or bins can manually be cut out of the system, or divert material immediately to any desired bin.

(6) LOW-PRESSURE AIR, DIRECT-CONNECTED COMPRESSORS. Compressed air is supplied at pressures normally ranging between 15 and 45-lb., depending upon the capacity, the kind of material handled, and the conveying distance. The maximum pressure is determined by the line resistance, three to five pounds being the differential between the maximum line pressure and the source of supply. A Fuller Rotary Compressor, direct connected to the pump, is the ideal and economical unit to use, the air being delivered in a uniform flow, without pulsations. No unloaders or air receivers are necessary. Connected in this manner, the power input conforms automatically to the work-load (back-pressure) of the conveying system, economizing in power when conveying to near, or intermediate bins, in a series.

To the user of bulk materials, Fuller-Kinyon Systems offer unique over-all plant economy. Materials can be conveyed literally anywhere a pipe-line can be run, under ground, under water, vertically, over long distances, and to any number of delivery points. (Single systems are conveying materials to as many as 48 bins). Material unloading, handling, and storage, involve no plant design problems. Plant layouts can be designed for maximum convenience and economy in handling and storing aggregates, in production, and shipment of products. Systems are easily applied to existing plants, without interrupting production, or interfering with structures or equipment. Material can be conveyed far beyond the practical limits of mechanical conveyors.

One man can operate a Fuller-Kinyon System, and the equipment requires little supervision. Maintenance requirements are few. The working parts are made of wear-resisting materials, and are renewable at low cost. Recent improvements, in the dust seal, protect and prolong the life of the bearing assembly. Pump screws are now dynamically balanced, at our factory, by means of an oscillograph, which materially reduces screw and barrel bushing wear.

There is no adverse effect, from the pumping of material, either of its quality or behavior, or in the operation of related equipment. The operation of feeders and weighing batchers is not changed.

Power requirements are not excessive. For average plant conveying distances, the power input compares favorably with mechanical systems, and increasing relative savings are made on long conveying systems.

The system is especially recommended to handle combustibles, such as starch, pulverized coal, and coke dust, to eliminate fire and explosion hazards. The quantity of air required for aeration of the material is less than one percent of that necessary to support combustion, and the seal of the pump forms an effective choke.

The Fuller-Kinyon Pump of today represents the result of many years of development-work, through practical operational experience, in handling diversified pulverized materials. Under the most severe operating conditions, this pump successfully meets all requirements, maintaining a constancy of operation, and proving itself to be the most economical conveyor per ton of material.

The outstanding features, that contribute to the economical performance of the pump, are:

Low-pressure air requirements (15 to 45-lbs., depending upon capacity and conveying distance), with stable operation under all load conditions.

Ability to maintain full capacity irrespective of horizontal or vertical conveying distance.

Ability to adapt itself automatically, with minimum power output to uncontrolled, or controlled, variations in rate of feed.

Field adjustment of seal can readily be made to minimize power consumption and wear.

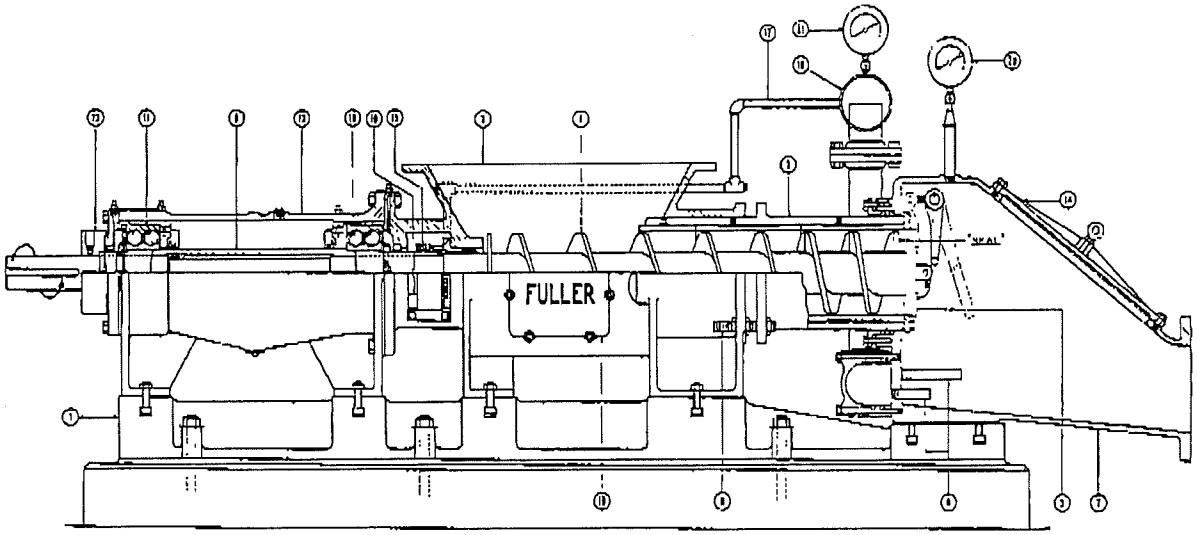
All parts are adequately protected against wear, and the design minimizes danger from tramp iron.

Standard Alemite lubrication to grease-packed bearing assemblies.

Screw removal and replacement, through front cover plate of check valve body, is accomplished without disturbing bearings or any other parts.

Unit bearing assembly assures permanent alignment.

Improved air-cooled, fan-type seal ring for bearing-assembly protection.



The general arrangement of the various sizes is similar and comprises the following essential parts:

All parts are mounted on a cast iron base (1). The materials to be conveyed enter the hopper (2) by gravity from the usual sources of supply, and are advanced through the barrel (3) by the impeller screw (4), the latter being directly driven through a flexible coupling connection to the driving motor.

As material advances through the barrel it is compacted by the decreasing pitch of the impeller screw flights, and is further increased in density by the space or "Seal" between the terminal flight of the impeller screw and face of check valve disc (5). The exact density required is further controlled by an adjustment of the seal length by means of the screw jacks (6).

The material then enters the check valve body or mixing chamber (7) wherein it is made fluent by compressed air introduced through a series of air-jets (8), and from there enters the transport line.

The pump impeller screw is supported in a hollow shaft (9) which in turn is supported by the ball bearings (10) and (11) in a single-bearing housing (12). The supporting hollow shaft is rotated in the bearings by the impeller screw shaft by means of an eccentric lock collar (13). The impeller screw (4) can readily be removed through the check valve body or mixing chamber by removing the cover plate (14) and loosening the lock collar (13).

There are no packing glands. The material in the hopper is sealed from the bearings when pump is in operation and under pressure by means of a Graphitar air-cooled, fan-type seal ring (15), in the chamber (16). The seal ring is kept clear of material from the hopper by means of compressed air supply through air piping (17) from the header (18).

Ample clearance is provided for the impeller screw in the hopper section. This hopper section has a catch basin on the bottom for tramp iron, and a clean-out door (19) on each side.

The barrel is protected by renewable wear-resistant liners, and the screw flights are also protected with a special alloy to give a maximum of service.

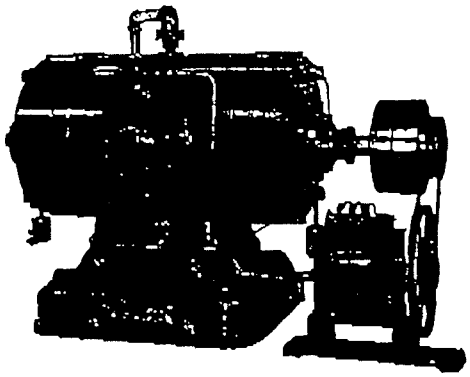
The air supply enters the air-manifold which supplies the air-jets (8).

The transport line pressure is indicated on the gauge (20); gauge (21) shows the air-jet pressure, which, with low pressure operations is but a few pounds higher than the pressure shown on gauge (20).

Cleaning or blowing out the transport line is done by stopping the impeller screw and blowing air through the air jets for a few minutes. The check valve (5) in this case prevents the air from blowing back through the pump.

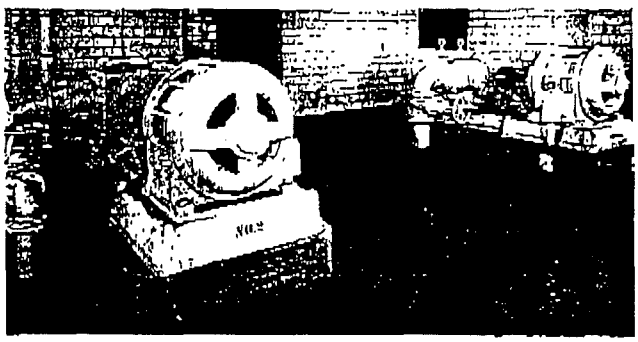
SINGLE-STAGE COMPRESSORS

Fuller Rotary Single-stage Compressors offer considerable power savings to plants using compressed air at pressures not exceeding 50 pounds gauge. The power losses incurred by carrying high main-line pressures and reducing a considerable volume of this air for low-pressure process work, involves a waste of power that warrants the most careful investigation. In addition, these compact units make it unnecessary to operate a large central compressor for light air demands, and expensive distribution loss resulting from a net-work of plant air lines is avoided.



Single-stage Rotary Compressor, showing lubricating quill in intake port, lubricator and oil-line arrangement.

COMPRESSOR		C.F.M. ACTUAL FREE AIR DELIVERY — LB. GAUGE DISCHARGE PRESSURE				H.P. RATING OF NEAREST COMMERCIAL SIZE SQUIRREL CAGE MOTOR — LB. GAUGE DISCHARGE PRESSURE				APPROXIMATE OVER ALL DIMENSIONS INCLUDING MOTOR		SHIPPING WEIGHT
Size	60 Cycle R.P.M.	20	30	40	50	20	30	40	50	Length	Width	(Exclusive of Motor)
C- 11	1160	32	31	—	—	5	5	—	—	3'-11"	2'-1"	490 lb.
C- 12	1160	44	42	—	—	5	7½	—	—	4'- 0"	2'-1"	510 lb.
C- 13	1160	52	50	—	—	5	7½	—	—	4'- 0"	2'-1"	515 lb.
C- 15	1160	76	74	72	70	7½	10	15	15	4'- 3"	2'-2"	680 lb.
C- 16	1160	83	82	80	78	7½	10	15	15	4'- 3"	2'-2"	700 lb.
C- 24	1160	112	109	107	105	10	15	20	20	5'- 5"	2'-3"	840 lb.
C- 25	1160	129	127	124	122	15	15	20	25	5'- 6"	2'-3"	870 lb.
C- 30	1160	154	152	149	146	15	20	25	25	6'- 0"	2'-8"	1090 lb.
C- 40	1160	197	194	190	186	20	25	30	30	6'- 4"	2'-8"	1120 lb.
C- 50	1160	232	228	224	220	20	25	30	40	6' 6"	2'-8"	1150 lb.
C- 60	870	284	280	275	270	25	30	40	50	7'- 3"	3'-2"	2000 lb.
C- 70	870	339	334	329	324	30	40	50	50	7'- 3"	3'-2"	2150 lb.
C- 75	870	377	370	365	360	30	40	50	60	7'-11"	3'-4"	2350 lb.
C- 80	870	403	396	390	385	40	50	60	60	7'-11"	3'-4"	2450 lb.
C-100	870	482	473	467	460	40	50	75	75	8'- 3"	3'-4"	2550 lb.
C-110	690	534	526	519	512	50	60	75	100	8'- 6"	3'-8"	3100 lb.
C-120	690	607	598	592	585	50	75	100	100	8'- 6"	3'-8"	3300 lb.
C-135	690	685	675	665	656	60	75	100	100	9'- 6"	3'-8"	3950 lb.
C-150	690	773	763	754	745	75	100	100	125	9'- 7"	3'-8"	4200 lb.
C-175	575	890	878	866	855	75	100	125	150	10'- 7"	4'-4"	5600 lb.
C-200	575	1050	1037	1023	1010	100	125	150	150	10'- 7"	4'-4"	5800 lb.
C-250	575	1410	1392	1374	1355	125	150	200	200	12'- 0"	4'-4"	7100 lb.
C-300	575	1610	1592	1572	1554	125	200	200	250	12'- 9"	4'-4"	7450 lb.



SEWAGE DISPOSAL PLANT: Two "air-cooled" sewage agitation compressors. Capacity each, 1750 C.F.M. actual free-air delivery, 8.4-lb. average discharge pressure.

ICE PLANT: Two single-stage compressors. Capacity each 100 C.F.M. actual free-air delivery, 17-lb. pressure.

APPENDIX F

Jet Boring Mining

In order to transfer the mine rock from the production level to the freeze level, a 1.5 metre diameter raise will be bored on the south side of the orebody. The waste pass will allow the dumping of the mine rock directly to the freeze level from the production level without the requirement to haul the material down the various connecting ramps.

3.2.4 Mine Ore Production

3.2.4.1 Jet Boring Mining Method

As shown in Figure 3.2.4.1.1 the jet boring mining method involves several distinct operations. These are drilling of the freeze holes, freezing the orebody, drilling of 'casing holes', installation of the casings, jet boring of the ore, and backfilling of cavities created by the jet boring machine.

Based upon surface and underground ore delineation drilling the freeze holes are drilled along the boundaries of a mining panel in a pattern which ensures complete freezing of the orebody. Freezing is also extended above the orebody to ensure water control is maintained during mining. Calcium chloride brine is piped in the freeze holes to accomplish the freezing.

Casing holes are drilled from below the orebody on the production level to provide the jet boring mining system with access to the ore zone.

Upon completion of the freeze hole and the casing hole drilling, the majority of the holes will be probed with geophysical instrumentation. The geophysical instrumentation will provide an indication of the ore grade and provide an outline of the upper and lower boundaries of the ore intersection. This information will then be utilized to determine the upper and lower mining limits for individual holes.

The jet boring of the ore involves the application of high pressure water (80 MPa) shooting against the frozen ore material. The jet of water breaks the material away from the wall of the cavity and the material falls to the base of the cavity. Additional water is also introduced into the cavity to flush

the material towards the casing hole and dilute the slurry for passage down the steel casing.

3.2.4.2 Mine Ore Production - Phase 1

Due to the phasing in of production, the total mine capacity will not be attained during the first two years of operation. Upon completion of year 2, the yearly mine production for Phase 1 will have been established at 18 million pounds U_3O_8 per annum. It has been estimated year 1 would provide sufficient ore for 6 million pounds of U_3O_8 and year 2 would provide sufficient ore for 12 million pounds of U_3O_8. The phasing in of production allows for training of the workforce and commissioning of the various pieces of equipment.

The total ore production during Phase 1 is estimated to be 323,700 tonnes with an average grade of 21.7% Uranium. The Phase 1 reserves will sustain production for 11 years. The Phase 1 daily ore production rate is estimated to be approximately 100 tonnes per day.

3.2.4.3 Mine Ore Production - Phase 2

Phase 2 ore production will be approximately 852,400 tonnes with an average grade of 7.7%. Phase 2 maintains the Phase 1 level of equipment and staffing with uranium reserves sustaining production at 6 million pounds U_3O_8 per annum for approximately 28 years. The Phase 2 daily ore production rate will be similar to the rate experienced during the Phase 1 mining (100 tonnes per day).

3.2.4.4 Mine Rock Production

Based on the mine production requirements the mine rock produced, which will require surface disposal, is estimated to be 273,000 m^3 (525,000 tonnes) and 836,000 m^3 (1,608,000 tonnes) for Phase 1 and Phase 2 respectively. This translates into an average of approximately 58 m^3 (110 tonnes) and 82 m^3 (160

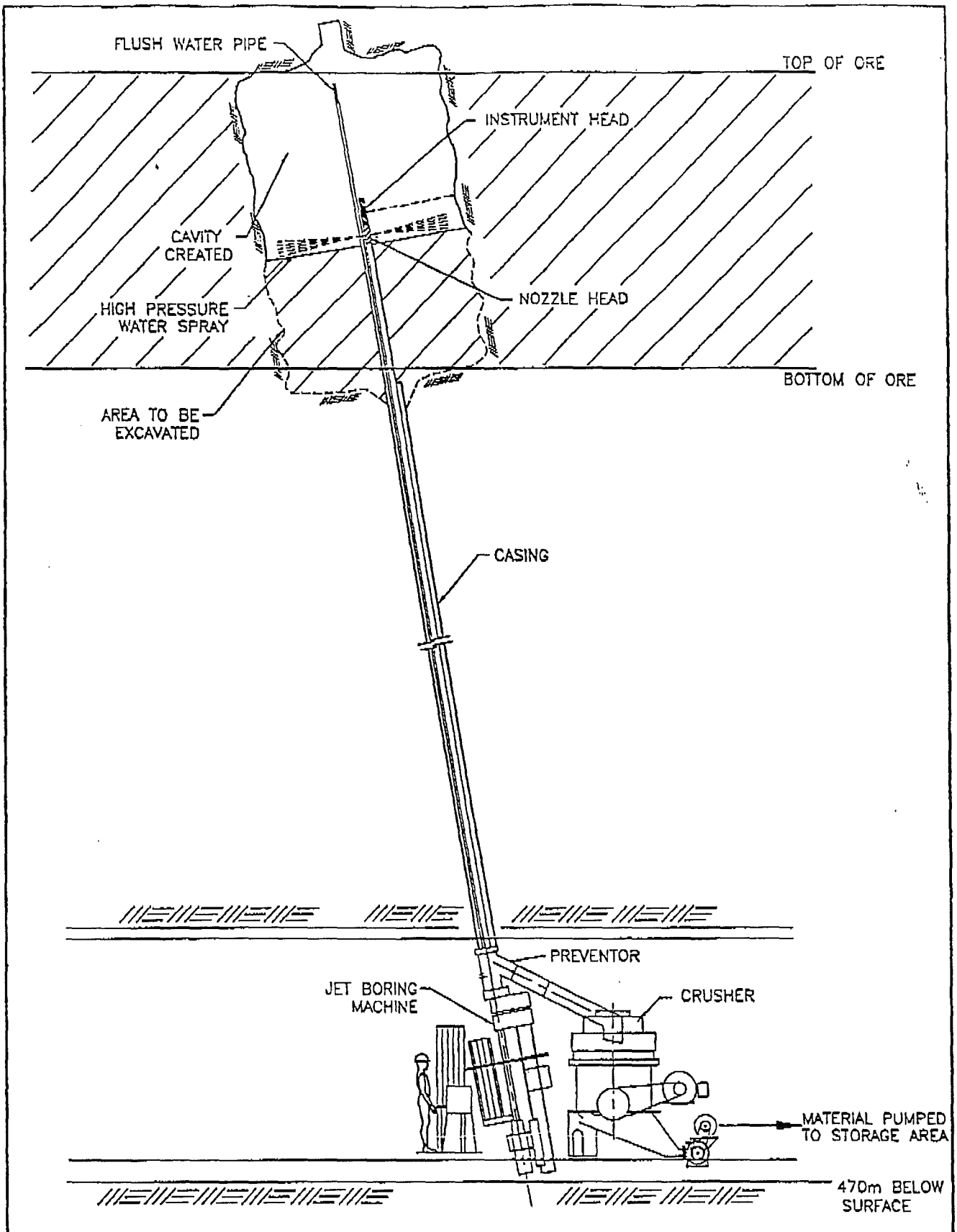
All of the above equipment will be electrically powered. The freeze hole drills will be utilized to accomplish the installation of the freeze pipes. The casing hole drills will be utilized to install the casings prior to jet boring. The raise drill will be primarily used to develop the raises between the production and freeze levels.

The mine development system, as described in Subsection 3.2, will be used to develop the mine openings on the production and freeze levels below the orebody.

Figure 3.2.5.1.1 illustrates the conceptual arrangement of the jet boring system. The general principles for the system:

- incorporate a preventer system integral to the rod feeding system which will control a possible water inrush;
- provide a closed system, which would minimize the potential for spills and thus limit the radiation exposure;
- include a high pressure water pump to supply water to the jet boring head and possibly incorporate steam injection into the water (prior to the water entering the pump) to elevate the water temperature during jet boring;
- incorporate a decontamination capability to include a rod cleaning system;
- mobility in design to allow the equipment to be relocated from hole to hole;
- include a suitable slurry handling system to transport the cuttings to the primary mill;
- incorporate a backfilling system which would allow backfilling of the mined out hole while continuing jet boring.

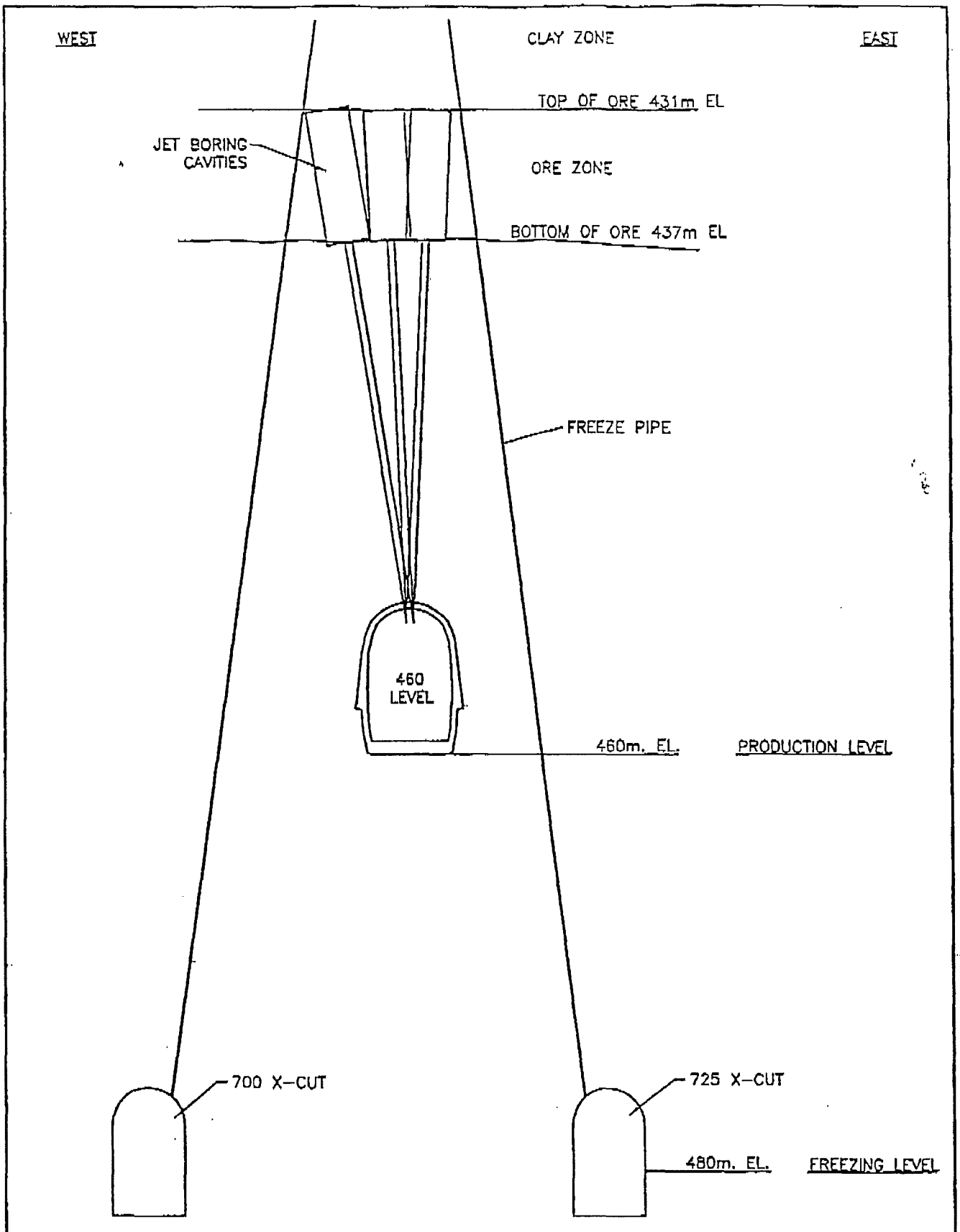
It is envisaged the jet boring head will mine the ore from the top of the hole downwards creating approximately a 2 metre diameter cavity. The string of rods is rotated in a full circle to allow the jets to cut the ore. The rods can also be moved upwards and downwards. Since the jet boring head is the same diameter as the rods, the rods can be moved into the casing and the high



CIGAR LAKE MINING CORPORATION

TITLE	CONCEPTUAL DESIGN OF THE JET BORING MINING METHOD		
DATE 94.11.09	DRWG. NO. L700-041	FIG. NO. 3.2.2.5	REV. NO. A

NTS.



CIGAR LAKE MINING CORPORATION

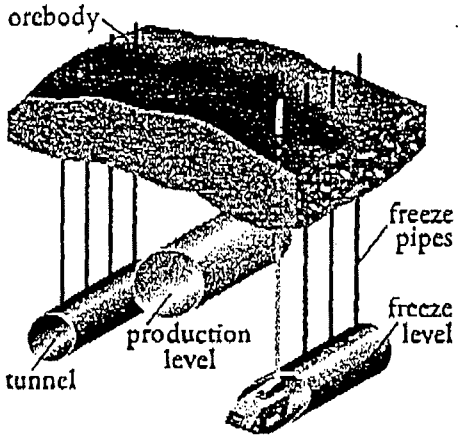
TITLE CROSS SECTION SHOWING THE JET BORING MINING METHOD DURING THE TEST MINE PERIOD

DATE	DRWG. NO.	FIG. NO.	REV. NO.
94.10.05	L700-042	3.2.2.6	A

N.T.S.

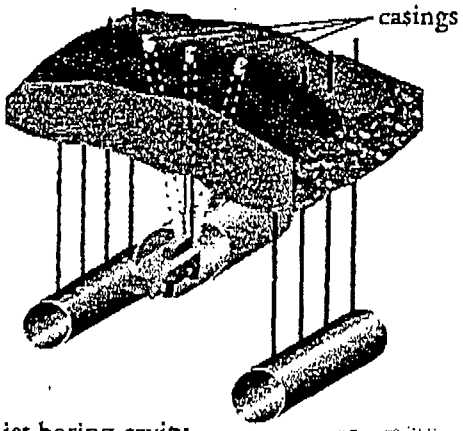
Step One

- Freeze pipes are installed in rows up through the ore body from tunnels below.
- Refrigerated brine is circulated through the freeze pipes to freeze a block of ground.



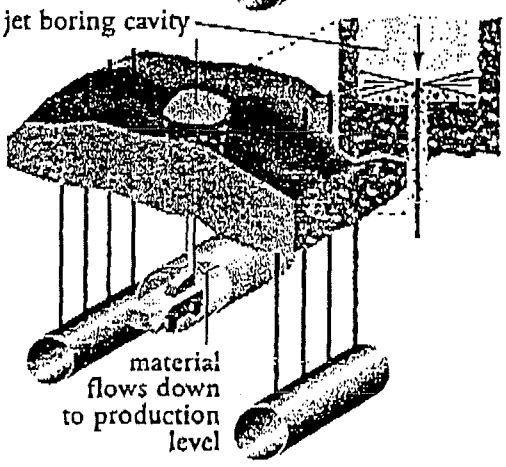
Step Two

- Holes are drilled into the orebody in a regular pattern and steel pipes are inserted into the holes from the tunnel to the bottom of the ore. These are called casings.



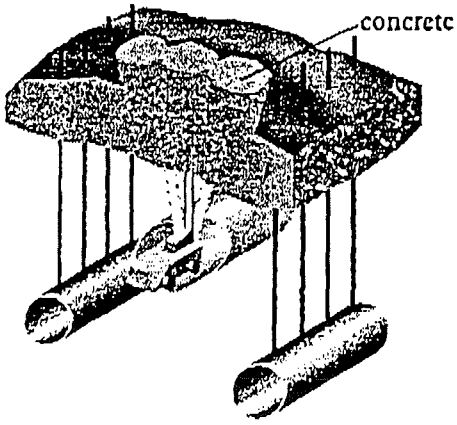
Step Three

- A steel pipe is inserted into the casing to the top of the orebody.
- Water under high pressure is pumped into this steel pipe and "mines" out a cavity in the ore body.
- The mined material is drawn out of the hole into the casing by gravity. It is then pumped away from the mining area.

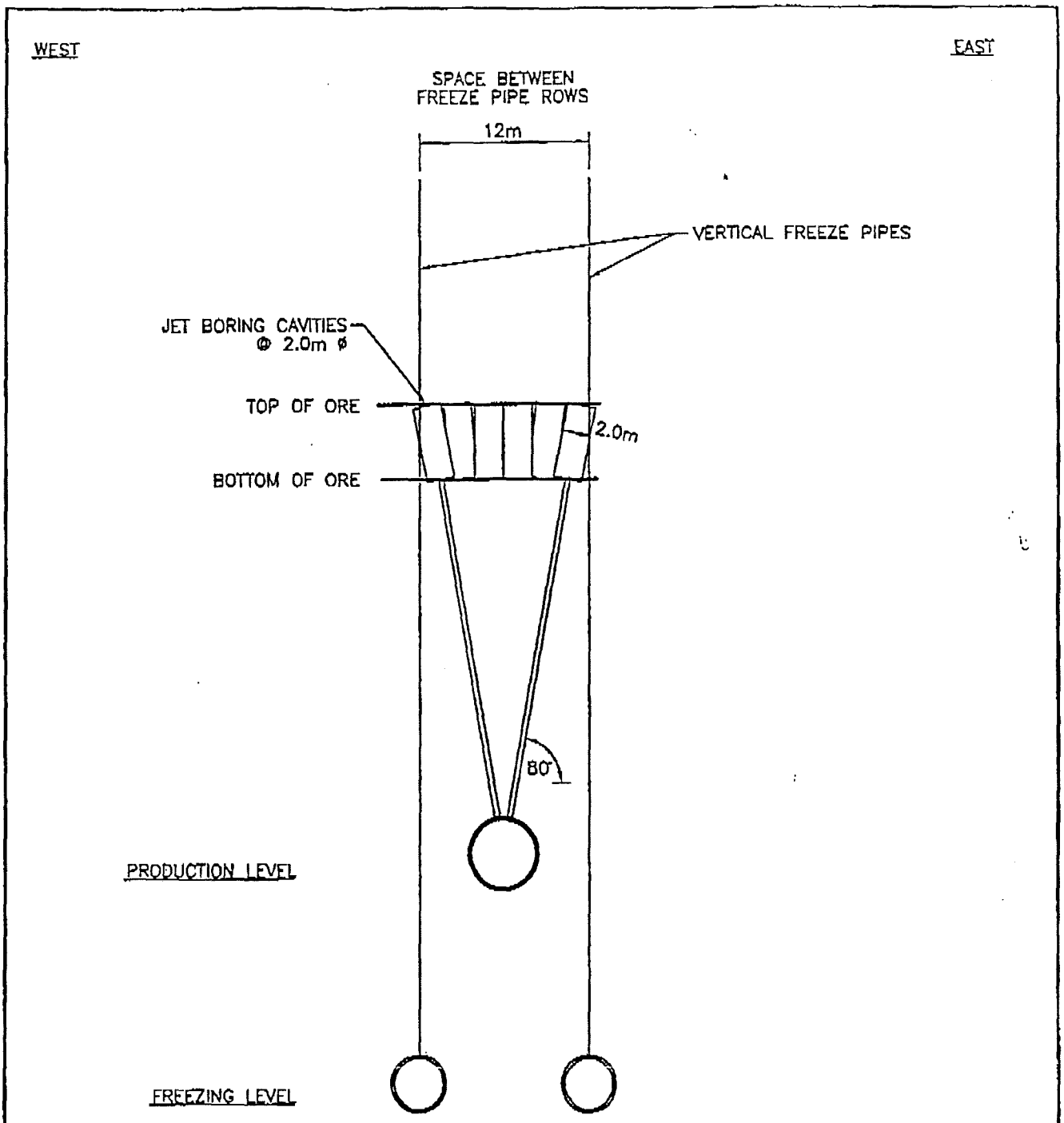


Step Four

- After a cavity is mined out, it is refilled with concrete.
- Adjacent area can be mined when the concrete has set.



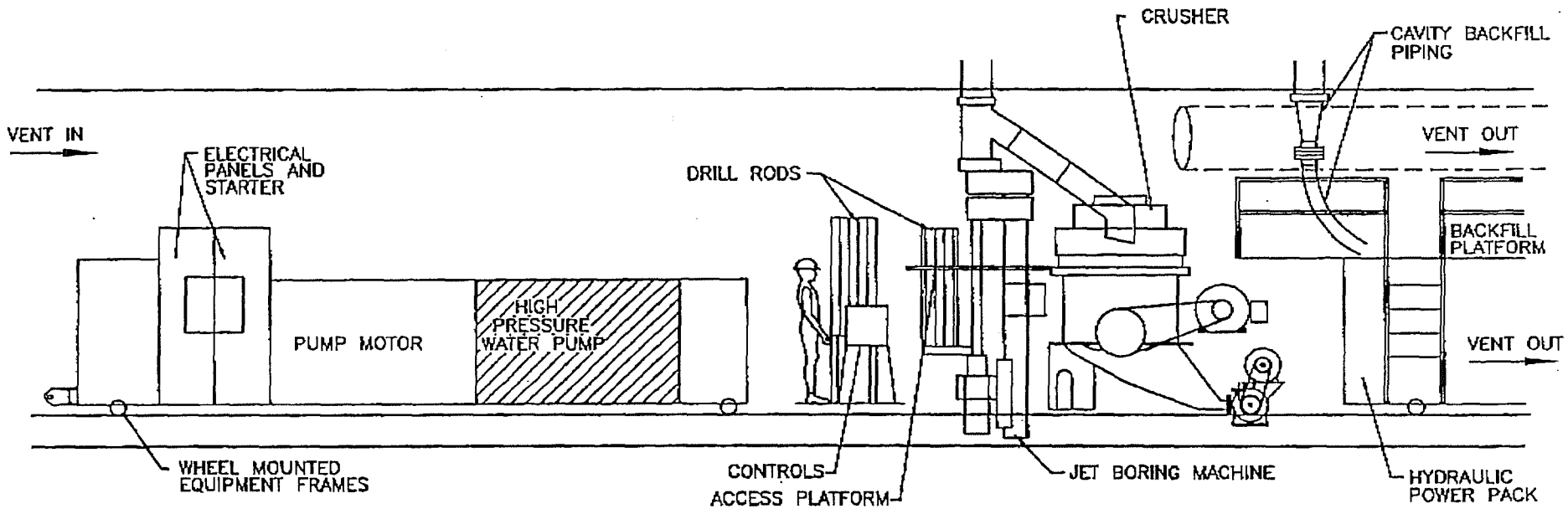
SCHEMATIC OF THE MINING SEQUENCE FIGURE 3.2.4.1.1



CIGAR LAKE MINING CORPORATION

TITLE: TYPICAL CONCEPTUAL CROSS SECTION THROUGH A MINING PANEL			
DATE: 94.11.25	DRWG. NO.: L700-054	FIG. NO.: 3.2.3.5.1	REV. NO.: A

N.T.S.



N.T.S.

CIGAR LAKE MINING CORPORATION

TITLE	CONCEPTUAL ARRANGEMENT JET BORING SYSTEM			
DATE 94.10.05	DRWG. NO. L700-052	FIG. NO. 3.2.5.1.1	REV. NO. A	

APPENDIX G

High Pressure Water Jet Mining

2.1 HIGH PRESSURE WATERJET DISLODGING AND CONVEYANCE END EFFECTOR USING CONFINED SLUICING

Task Description

The underground storage tanks at Hanford contain three basic material types, both individually and in combination: liquid supernatant, sludge, and hard saltcake. Removal of the sludge and saltcake has presented a technological challenge. A high pressure waterjet can be used to cut up and dislodge the tenacious sludge and saltcake. Combined with a conveyance system operating simultaneously, this confined sluicing can be used to effectively remove and convey waste from the tanks (see Figure 12).

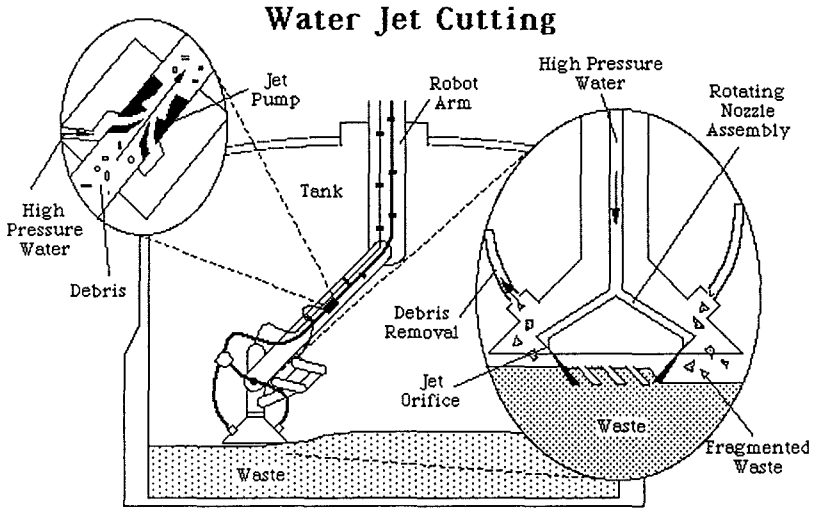


Figure 12. Water Jet Cutting

The University of Missouri-Rolla, in conjunction with Sandia National Laboratory, has been developing a confined sluicing technique to dislodge and convey difficult wastes from the underground storage tanks. Confined sluicing uses high pressure (70 MPa or 10,000 psi) to cut the material in the tank into small pieces and then sucks the material out using a high pressure (50 MPa or 7,000 psi) jet pump. All the water and debris is removed without significant water loss to the tank. The device is attached as an end effector to an articulated arm that enters the tank through an existing riser. The result of the process is a steady flow (at around 1.9 liters/second (30 gpm)) of extracted material from the tank as an aqueous slurry. This minimizes handling problems and converts the tank wastes to a form that can be more easily treated.

Technology Needs

The baseline technology calls for sluicing techniques used in past practices. This method introduces a large quantity of water into the tank that is not immediately removed, increasing the possibility of uncontrolled leakage, even if only for a short time. Developing other methods or improving the

sluicing method for removing these difficult materials from the tanks makes cleaning out the tanks safer and more efficient. Confined sluicing reduces the water needed to clean the tanks, and therefore reduces the quantity of waste that must be processed.

Accomplishments

The operational parameters of the waterjets that control the cutting and removal of waste material have been identified in the feasibility study. A shrouded waterjet has been designed and demonstrated to be effective on the sludge and is within the required pressure and volume flow requirements. Results to date show that the method has the potential to meet or exceed the performance requirements expected of it.

Collaboration / Technology Transfer

This technology is an adaptation of existing systems for cleaning materials. Modifications are required to establish the parameters of performance and to design the equipment to work effectively within the restricted conditions encountered in the underground storage tanks at Hanford.

Informal discussions with possible industrial partners have taken place with some interest being expressed. As the system becomes better defined, development of a commercial vendor has become a greater part of the program. An advisory group of interested equipment manufacturers has been assembled and a commercial partner bringing the necessary industrial expertise will be brought on line as the program moves toward the point of field application.

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APPENDIX H

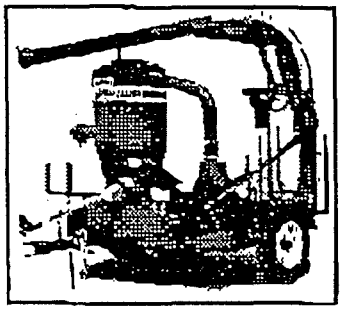
Pneumatic Grain Handling Equipment

Grain Handling

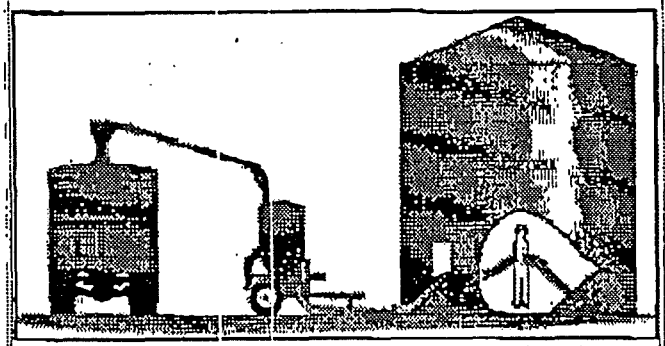
Pneumatic Grain Conveyors

High Performance

Successful grain handlers understand the many benefits of moving grain with air. Pneumatic conveying offers versatility, convenience and performance that other systems can't match. And with models delivering 100 tonne/hour plus, Agri-Vac operators are very serious about moving grain efficiently.



Walinga Agri-Vac Model 610



Clean-up flat floor storages easily and safely.

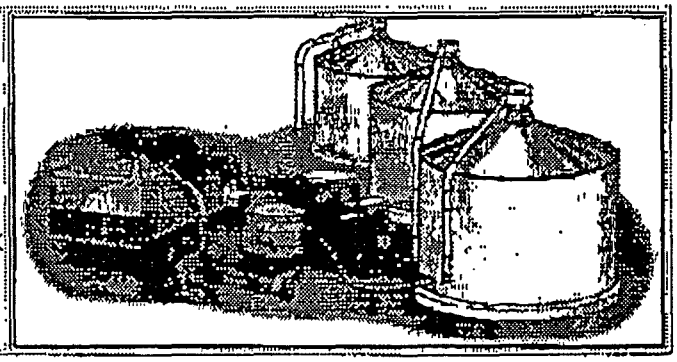
Safer

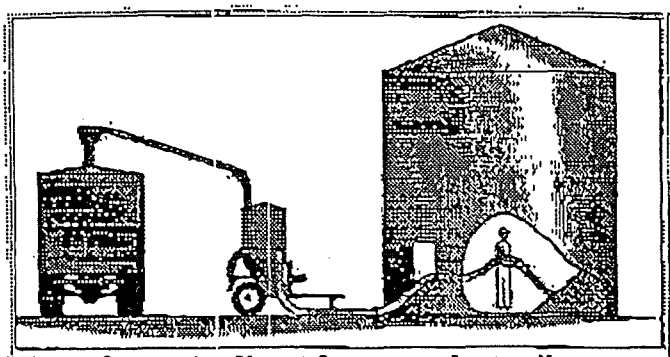
Agri-Vac conveyors set high standards in health and safety. Their powerful vacuum action makes life easier and safer for workers - efficient grain removal without the shovelling and dust. And unlike other conveying systems, air does the work - so there are no grain-moving parts to cause injury.

Agri-Vacs fill and empty storages without the shovelling and dust.

Reliable

Agri-Vac's Walinga blowers and heavy-duty airlocks have a well-earned reputation for reliability and easy maintenance. Hard-chroming reduces blower wear rates dramatically and adjustable stainless-steel airlock blades ensure long-life. Time-tested design features keep Agri-Vac a leader in the grain handling field.





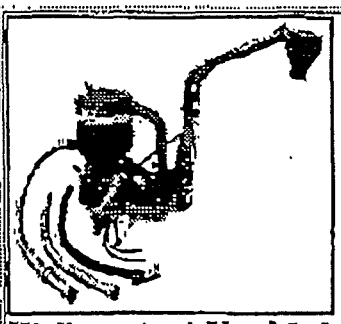
Transfer grain direct from trucks to silos

• Versatile •

Grain handlers use Agri-Vacs to fill, empty, and clean every storage type - elevated and flat-floor silos, sheds, pits, bunkers, and dumps. Spills, bridged grain and contaminated loads are all easier to manage using an Agri-Vac conveyor.

• Easy To Use •

Hydraulically-controlled booms simplify truck loading. Flexible hoses attach easily and give access to the tightest spots. Self-cleaning features minimise insect and cross contamination problems.



Walinga Agri-Vac Model 714 DLX

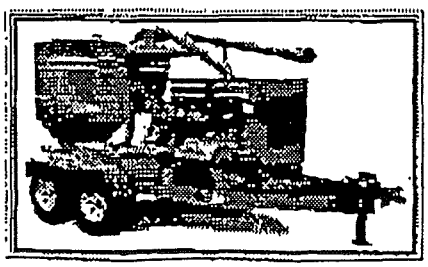
• Popular Agri-Vac Units •

Agri-Vac Model	Nominal Capacity	PTO Power & Speed	Piping Diameter
310	10-15t/hr	20-25hp/540 rpm	4"
510	50-60t/hr	60-80hp/1000 rpm	5"
610	65-75t/hr	70-90hp/1000 rpm	5"&6"
614	75-85t/hr	115-130hp/1000 rpm	5"&6"
714	100-110t/hr	120-140hp/1000 rpm	6"&7"

•Walinga Ultra - Vac 614D •

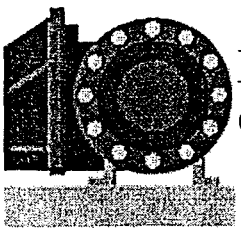
a self-powered pneumatic conveyor.....

Driven by a 160 hp diesel engine, the 614D is fully self-contained. Simply pull the unit into place, attach intake and delivery lines, and start moving grain. A cast iron precision machined 10 vane airlock moves the product into the delivery line, where it is taken ti its destination by a Walinga Super Chrome Blower. This combination allows the 614D to gently and quickly move over 3500 bushels per hour. Fully equipped to be transported over-the-road, the 614D is extremely versatile.

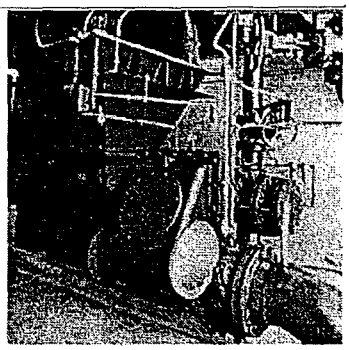


APPENDIX I

Fuller Bulk Handling Equipment



PNEUMATIC CONVEYING



Dependable Dry Bulk Material Handling. Making it Happen.

A foremost supplier of pneumatic conveying equipment around the world, Fuller Bulk Handling delivers the reliability, efficiency and endurance that keep your productivity moving.

Since 1926, Fuller Bulk Handling has been supplying a diversity of industries with advanced pneumatic conveying equipment that stands the test of time. The original Fuller-Kinyon pump began a long line of innovative products engineered to meet your toughest demands with outstanding reliability and versatility:

- Dilute phase vacuum & pressure conveying systems
- Fuller-Kinyon screw pump conveying systems
- Dense phase conveying systems
- MODU-DENSE® conveyors
- Vacu-Dense™-Pull/Push conveyors
- SK Valve (diverting/converging)
- Rotary feeders/rotary valves
- Airslide® conveying systems
- Fulload™ Railcar- & truck-loading systems
- Blending silos (fluidized/gravity)
- Storage silo withdrawal systems
- Modu-Flo Multi-Tank Conveyors

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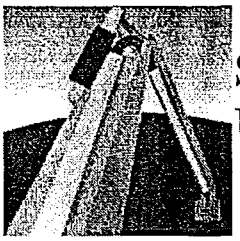
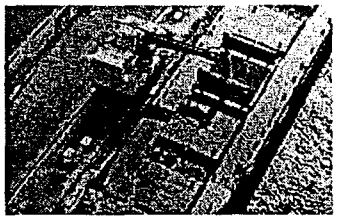


SHIP LOADING & UNLOADING SYSTEMS

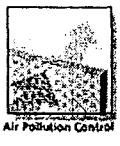


High-Capacity Bulk Material Distribution. Making it Happen.

A leading supplier to a wide range of global industries, Fuller Bulk Handling's pneumatic ship unloaders are the world standard for high- capacity, environmentally-clean discharge of bulk cargo.

With capabilities including pneumatic and mechanical ship/barge loaders and unloaders for general and hard-to-handle bulk materials such as cement, alumina, coal and others, Fuller Bulk Handling supports your terminaling requirements with innovative technology and customized solutions - backing our full range of equipment and services with a proven commitment to excellence and dependability.

- Dock mobile and rail gantry unloading systems
- Fully enclosed, self-discharging ships & fluidized vessels
- Shore-based pneumatic ship & barge loading systems
- Road-mobile ship unloaders
- Vessel loading systems
- Railcar loaders and unloaders, including Fulload™ & Vacu-Dense™ systems
- Terminal handling & floating terminal equipment
- Mini-terminals for direct barge-to-truck transfer
- Material transshipment & bulk-truck handling
- Complete terminal storage systems & equipment



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FULLER BULK HANDLING
1554 Creekmill Tr SW
Lawrenceville, GA
30244
Jim McCammon
Office Phone: (770) 985-5572
Mobile: (404) 550-7569
Home: (770) 985-1985
Fax: (770) 982-9750

Alabama	Georgia	South Carolina
Florida	North Carolina	Tennessee

MIDWEST DISTRICT

FULLER BULK HANDLING
15070 Mayflower Drive
New Berlin, WI 53151
Rolf Ekstrand
Phone: (414) 782-9698
Fax: (414) 782-8184
E-mail: rekstrand@wynd.net

Illinois	Michigan	North Dakota
Indiana	Minnesota	South Dakota
Iowa	Missouri	Western Kentucky
Kansas	Nebraska	Wisconsin

SOUTHWEST DISTRICT

FULLER BULK HANDLING
11777 Katy Freeway
Suite 375 North
Houston, TX 77079
Ken Elrod
Phone: (281) 752-0222
Fax: (281) 752-0111

Arizona	Mississippi	
Arkansas	New Mexico	
Colorado	Oklahoma	Texas
Louisiana		

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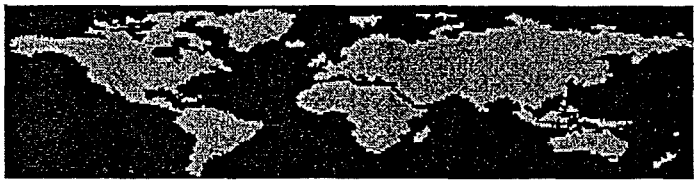
District Offices

Direct Solutions. Making it Happen.

With 5 strategic district offices in the U.S., Fuller Bulk Handling saves both time and money - networking customers from around the world with the resources that best meet their specific needs.



Serving our customers in the most responsive, time- and cost-efficient manner is one of Fuller Bulk Handling's top priorities. The support staff in each of our district offices specializes in connecting customers with the proper sales representatives and other experts based on criteria such as geographical location and type of inquiry. This means that whenever you call us, you will benefit from the most direct solution possible - no matter how large or small the request.

EASTERN DISTRICT

FULLER BULK HANDLING
3225 Schoenersville Rd.
Bethlehem, PA 18016-0805
Tom LaFavor
Phone: (610) 264-6055
Fax: (610) 264-6735

Connecticut	Massachusetts	Rhode Island
Delaware	New Hampshire	Vermont
Eastern Kentucky	New York	Virginia
Maine	Ohio	West Virginia
Maryland	Pennsylvania	

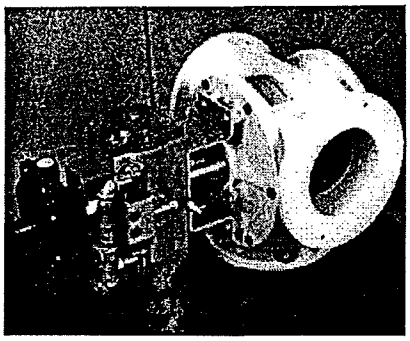
WESTERN DISTRICT

FULLER BULK HANDLING
16 Mitchell Blvd.
San Rafael, CA 94903
Dick Gerbec
Phone: (415) 499-0695
Fax: (415) 499-0698

California	Nevada	
Idaho	Oregon	Utah
Montana	Washington	Wyoming

SOUTHEAST DISTRICT

Fuller Bulk Handling's solutions encompass everything from:



- Installation
- Maintenance
- Customized Engineering
- Training
- Service

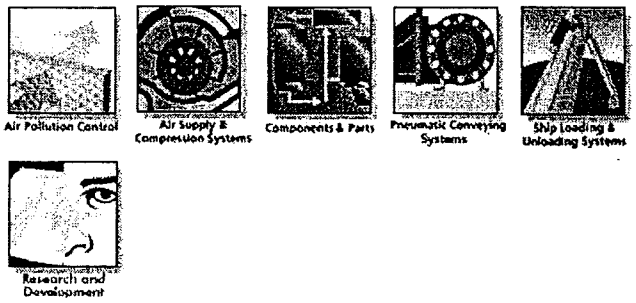
built on:

- Teamwork
- Experience
- Dedication
- Knowledge

to deliver:

- Efficiency
- Smooth Operation
- Trouble-free Maintenance
- High Performance

As an ISO 9001-certified company, you can count on Fuller Bulk Handling for quality in every product and service we offer:



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PRODUCTS and SERVICES

Dry Bulk Material Handling Systems

Making it Happen

Backed by a global network of leading engineering and manufacturing capabilities, Fuller Bulk Handling offers both the cement industry and non-cement industries the most comprehensive line of products and services.

Fuller Bulk Handling goes beyond providing products and services, delivering dependability and solutions to customers worldwide. Whether we supply a single part or engineer an entire system, complete customer satisfaction is our team's number one commitment - a commitment that continues to set standards for excellence all over the world.

Dependability: our #1 product

Fuller Bulk Handling is your best resource for:

- Parts
- Equipment
- Complete Systems

built on:

- Superior Technology
- Innovation
- Expert Engineering

to deliver:

- Reliability
- Cost-effectiveness
- High Performance

Solutions: our #1 service

FULLER - KINYON CONVEYING SYSTEMS

FOR over a quarter of a century, Fuller-Kinyon Conveying Systems have been used for conveying bulk Portland cement, pulverized coal, limestone dust, flue dust, fly ash, pulverized phosphate rock, and many other similar materials.

The system is most commonly used for conveying from pulverizer mills and collecting conveyors serving a plurality of mills, to storage silos; from storage silos to packer bins, or for loading and unloading cars, ships and barges. Also for mixing and blending dry-cement raw materials; recovering packer and bag-cleaner spill; and air-separator fines.

Fuller-Kinyon Systems have been adopted as standard conveying practice by the cement industry of the United States, in which more than 96 percent of the operating mills use one to a dozen, or more, such systems for conveying bulk cement and other dry pulverized materials. They are used throughout the World by cement manufacturers.

They have been used for unloading and conveying cement on substantially all major construction projects, such as Hoover, Bonneville, and Grand Coulee Dams, and many other large industrial structures.

The system comprises (1) a stationary Fuller-Kinyon Pump, directly driven through a flexible coupling by an electric motor or internal-combustion engine.

Pumps are available in seven standard sizes to provide a wide range in capacity. Capacities are specified on the basis of the conventional full-load speed of the pump screw at 1160 r.p.m., and in terms of Portland cement (94-lb. per cu. ft., or 376-lb. per barrel), range from 40 barrels to 1000 barrels an hour, (or 8 to 200 tons).

The volumetric displacement being constant, the capacities, when handling other pulverized materials, such as pulverized limestone or other asphalt fillers, may be determined by direct ratio of density.

By controlling the feed to the pump, each pump size can have a capacity range from full load down to ¼ full load.

(2) The pipe line, consisting of standard steel pipe, furnished in cut lengths, fitted with flanges, bolts and gaskets, and long-radius pipe bends, ranges in size from 3-in. diameter to 10 inches.

(3) Two-way and three-way, positive cut-off diverting valves, hand-operated, or two-way motor-driven valves, actuated by remote control, permit direction of flow of material through branch lines to any part of a plant or number of receiving bins.

(4) High-and low-level material indicators are furnished for bin, hopper or silo, for any predetermined level indication.

(5) Automatic and remote control of material distribution can be furnished. It is recommended when large tonnages are handled to a large number of small bins, or when the diverting valves are in remote locations, difficult of access. This control operates the motor-driven distributing valves so that bins can be filled continuously in any desired sequence. A central-control panel indicates, at all times, by means of illuminated, graphic flow lines, the direction of flow of material, and the condition of bins is registered by the material-level indicators. The control panel is provided with remote-control switches, whereby any bin or bins can manually be cut out of the system, or divert material immediately to any desired bin.

(6) LOW-PRESSURE AIR, DIRECT-CONNECTED COMPRESSORS. Compressed air is supplied at pressures normally ranging between 15 and 45-lb., depending upon the capacity, the kind of material handled, and the conveying distance. The maximum pressure is determined by the line resistance, three to five pounds being the differential between the maximum line pressure and the source of supply. A Fuller Rotary Compressor, direct connected to the pump, is the ideal and economical unit to use, the air being delivered in a uniform flow, without pulsations. No unloaders or air receivers are necessary. Connected in this manner, the power input conforms automatically to the work-load (back-pressure) of the conveying system, economizing in power when conveying to near, or intermediate bins, in a series.

To the user of bulk materials, Fuller-Kinyon Systems offer unique over-all plant economy. Materials can be conveyed literally anywhere a pipe-line can be run, under ground, under water, vertically, over long distances, and to any number of delivery points. (Single systems are conveying materials to as many as 48 bins). Material unloading, handling, and storage, involve no plant design problems. Plant layouts can be designed for maximum convenience and economy in handling and storing aggregates, in production, and shipment of products. Systems are easily applied to existing plants, without interrupting production, or interfering with structures or equipment. Material can be conveyed far beyond the practical limits of mechanical conveyors.

One man can operate a Fuller-Kinyon System, and the equipment requires little supervision. Maintenance requirements are few. The working parts are made of wear-resisting materials, and are renewable at low cost. Recent improvements, in the dust seal, protect and prolong the life of the bearing assembly. Pump screws are now dynamically balanced, at our factory, by means of an oscillograph, which materially reduces screw and barrel bushing wear.

There is no adverse effect, from the pumping of material, either of its quality or behavior, or in the operation of related equipment. The operation of feeders and weighing batchers is not changed.

Power requirements are not excessive. For average plant conveying distances, the power input compares favorably with mechanical systems, and increasing relative savings are made on long conveying systems.

The system is especially recommended to handle combustibles, such as starch, pulverized coal, and coke dust, to eliminate fire and explosion hazards. The quantity of air required for aeration of the material is less than one percent of that necessary to support combustion, and the seal of the pump forms an effective choke.

The Fuller-Kinyon Pump of today represents the result of many years of development-work, through practical operational experience, in handling diversified pulverized materials. Under the most severe operating conditions, this pump successfully meets all requirements, maintaining a constancy of operation, and proving itself to be the most economical conveyor per ton of material.

The outstanding features, that contribute to the economical performance of the pump, are:

Low-pressure air requirements (15 to 45-lbs., depending upon capacity and conveying distance), with stable operation under all load conditions.

Ability to maintain full capacity irrespective of horizontal or vertical conveying distance.

Ability to adapt itself automatically, with minimum power output to uncontrolled, or controlled, variations in rate of feed.

Field adjustment of seal can readily be made to minimize power consumption and wear.

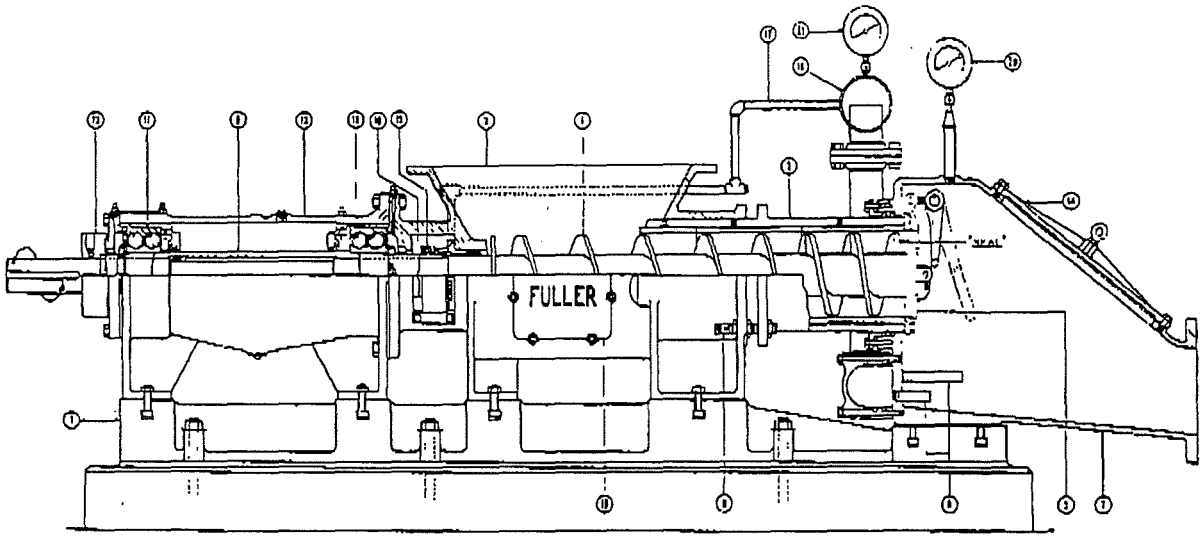
All parts are adequately protected against wear, and the design minimizes danger from tramp iron.

Standard Alemite lubrication to grease-packed bearing assemblies.

Screw removal and replacement, through front cover plate of check valve body, is accomplished without disturbing bearings or any other parts.

Unit bearing assembly assures permanent alignment.

Improved air-cooled, fan-type seal ring for bearing-assembly protection.



The general arrangement of the various sizes is similar and comprises the following essential parts:

All parts are mounted on a cast iron base (1). The materials to be conveyed enter the hopper (2) by gravity from the usual sources of supply, and are advanced through the barrel (3) by the impeller screw (4), the latter being directly driven through a flexible coupling connection to the driving motor.

As material advances through the barrel it is compacted by the decreasing pitch of the impeller screw flights, and is further increased in density by the space or "Seal" between the terminal flight of the impeller screw and face of check valve disc (5). The exact density required is further controlled by an adjustment of the seal length by means of the screw jacks (6).

The material then enters the check valve body or mixing chamber (7) wherein it is made fluent by compressed air introduced through a series of air-jets (8), and from there enters the transport line.

The pump impeller screw is supported in a hollow shaft (9) which in turn is supported by the ball bearings (10) and (11) in a single-bearing housing (12). The supporting hollow shaft is rotated in the bearings by the impeller screw shaft by means of an eccentric lock collar (13). The impeller screw (4) can readily be removed through the check valve body or mixing chamber by removing the cover plate (14) and loosening the lock collar (13).

There are no packing glands. The material in the hopper is sealed from the bearings when pump is in operation and under pressure by means of a Graphitar air-cooled, fan-type seal ring (15), in the chamber (16). The seal ring is kept clear of material from the hopper by means of compressed air supply through air piping (17) from the header (18).

Ample clearance is provided for the impeller screw in the hopper section. This hopper section has a catch basin on the bottom for tramp iron, and a clean-out door (19) on each side.

The barrel is protected by renewable wear-resistant liners, and the screw flights are also protected with a special alloy to give a maximum of service.

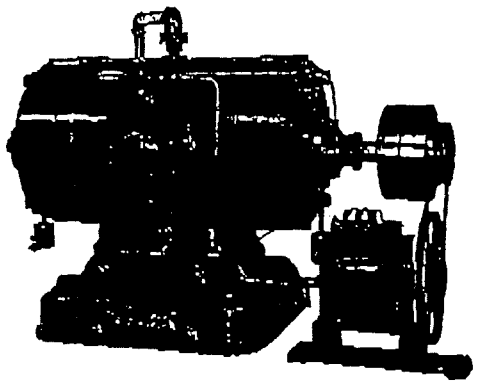
The air supply enters the air-manifold which supplies the air-jets (8).

The transport line pressure is indicated on the gauge (20); gauge (21) shows the air-jet pressure, which, with low pressure operations is but a few pounds higher than the pressure shown on gauge (20).

Cleaning or blowing out the transport line is done by stopping the impeller screw and blowing air through the air jets for a few minutes. The check valve (5) in this case prevents the air from blowing back through the pump.

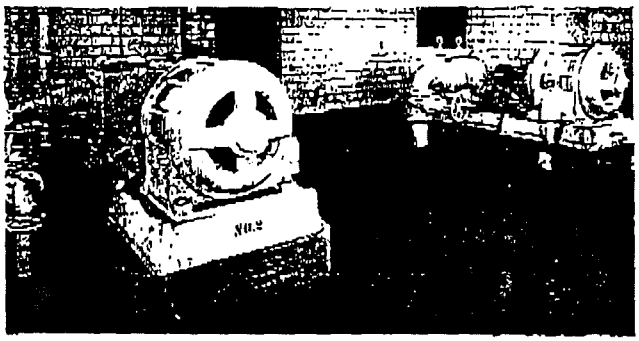
SINGLE-STAGE COMPRESSORS

Fuller Rotary Single-stage Compressors offer considerable power savings to plants using compressed air at pressures not exceeding 50 pounds gauge. The power losses incurred by carrying high main-line pressures and reducing a considerable volume of this air for low-pressure process work, involves a waste of power that warrants the most careful investigation. In addition, these compact units make it unnecessary to operate a large central compressor for light air demands, and expensive distribution loss resulting from a net-work of plant air lines is avoided.



Single-stage Rotary Compressor, showing lubricating quill in intake port, lubricator and oil-line arrangement.

COMPRESSOR		C.F.M. ACTUAL FREE AIR DELIVERY — LB. GAUGE DISCHARGE PRESSURE				H.P. RATING OF NEAREST COMMERCIAL SIZE SQUIRREL CAGE MOTOR — LB. GAUGE DISCHARGE PRESSURE				APPROXIMATE OVER ALL DIMENSIONS INCLUDING MOTOR		SHIPPING WEIGHT
Size	60 Cycle R.P.M.	20	30	40	50	20	30	40	50	Length	Width	(Exclusive of Motor)
C- 11	1160	32	31	—	—	5	5	—	—	3'-11"	2'-1"	490 lb.
C- 12	1160	44	42	—	—	5	7½	—	—	4'- 0"	2'-1"	510 lb.
C- 13	1160	52	50	—	—	5	7½	—	—	4'- 0"	2'-1"	515 lb.
C- 15	1160	76	74	72	70	7½	10	15	15	4'- 3"	2'-2"	680 lb.
C- 16	1160	83	82	80	78	7½	10	15	15	4'- 3"	2'-2"	700 lb.
C- 24	1160	112	109	107	105	10	15	20	20	5'- 5"	2'-3"	840 lb.
C- 25	1160	129	127	124	122	15	15	20	25	5'- 6"	2'-3"	870 lb.
C- 30	1160	154	152	149	146	15	20	25	25	6'- 0"	2'-8"	1090 lb.
C- 40	1160	197	194	190	186	20	25	30	30	6'- 4"	2'-8"	1120 lb.
C- 50	1160	232	228	224	220	20	25	30	40	6' 6"	2'-8"	1150 lb.
C- 60	870	284	280	275	270	25	30	40	50	7'- 3"	3'-2"	2000 lb.
C- 70	870	339	334	329	324	30	40	50	50	7'- 3"	3'-2"	2150 lb.
C- 75	870	377	370	365	360	30	40	50	60	7'-11"	3'-4"	2350 lb.
C- 80	870	403	396	390	385	40	50	60	60	7'-11"	3'-4"	2450 lb.
C-100	870	482	473	467	460	40	50	75	75	8'- 3"	3'-4"	2550 lb.
C-110	690	534	526	519	512	50	60	75	100	8'- 6"	3'-8"	3100 lb.
C-120	690	607	598	592	585	50	75	100	100	8'- 6"	3'-8"	3300 lb.
C-135	690	685	675	665	656	60	75	100	100	9'- 6"	3'-8"	3950 lb.
C-150	690	773	763	754	745	75	100	100	125	9'- 7"	3'-8"	4200 lb.
C-175	575	890	878	866	855	75	100	125	150	10'- 7"	4'-4"	5600 lb.
C-200	575	1050	1037	1023	1010	100	125	150	150	10'- 7"	4'-4"	5800 lb.
C-250	575	1410	1392	1374	1355	125	150	200	200	12'- 0"	4'-4"	7100 lb.
C-300	575	1610	1592	1572	1554	125	200	200	250	12'- 9"	4'-4"	7450 lb.



SEWAGE DISPOSAL PLANT: Two "air-cooled" sewage agitation compressors. Capacity each, 1750 C.F.M. actual free-air delivery, 8.4-lb. average discharge pressure.

ICE PLANT: Two single-stage compressors. Capacity each 100 C.F.M. actual free-air delivery, 17-lb. pressure.

APPENDIX J

Tubular Conveyors

Schrage Rohrkettensystem GmbH Conveying abrasive dusts and sludges

The transport of fine and abrasive dusts is a regular source of problems in materials handling industries. Containment of dust is essential to comply with modern health and safety requirements.

The Schrage Rohrkettensystem tube chain conveyor provides the solution to many conveying problems. Offering completely dust-tight conveying, the tube chain conveyor is very versatile. The system is based upon drag chain technology, but rather than using a horizontal base, the chain is fed through a round cross section tube. There is a disk fitted to every other chain link and these drag material through the tubes. The construction of the conveyor allows bends to be included so material can be transported at any angle from horizontal to vertical. Furthermore, the change of direction can be made without the need for an additional transition point.

A further feature of the system is that the disks form a seal over a distance of approximately two metres. Therefore, material can be fed into the conveyor directly from a pressurised system whilst maintaining the pressure differential. Rotary valves can therefore be eliminated. The result of this is a significant reduction in maintenance requirements. The system is also Ibexu tested for explosion performance.

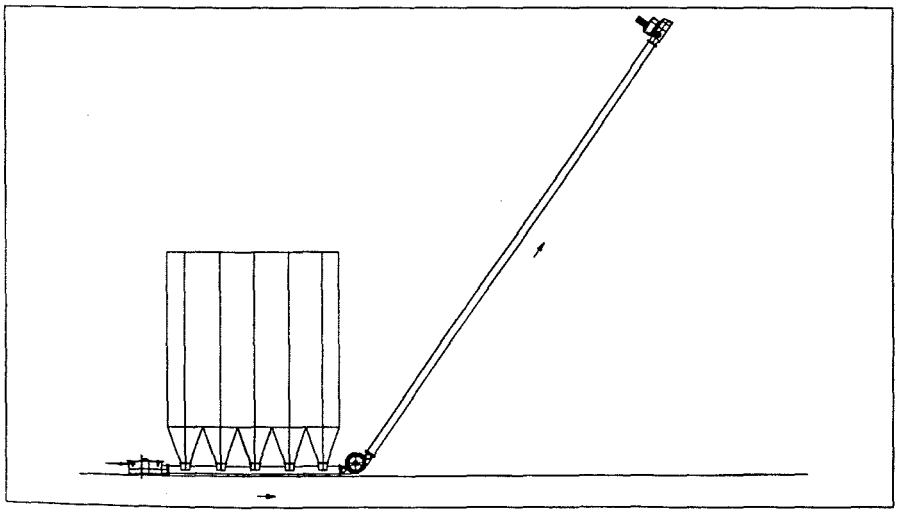
Material is conveyed through the conveyor at low speeds and at ambient pressure which minimises the opportunity for wear. Other conveying techniques often move material at high speeds causing high rates of wear at bends, and once the bends are worn through, material is then blown out at speed. This cannot happen with a tube chain conveyor.

Many processes also need to load different materials at different points into the conveyor. The tube chain conveyor can have any number of inlets and also, more importantly, any number of outlets. By fitting an integral slide valve to each outlet of the conveyor, material discharge points can be automatically selected from a central controller. No special diverters are required to remove material from the conveyor.

Offering completely dust-tight conveying, the tube chain conveyor is very versatile

The conveyors are available in a range of sizes with maximum capacities ranging from 28m^3/h to 60m^3/h. Each size conveyor can run from empty to its maximum capacity. The conveyors can be started and stopped with a full load which simplifies plant operation, especially when a process calls for intermittent feed rates. Maximum run lengths for each conveyor are 50m for a horizontal/inclined run and 30m for a vertical lift.

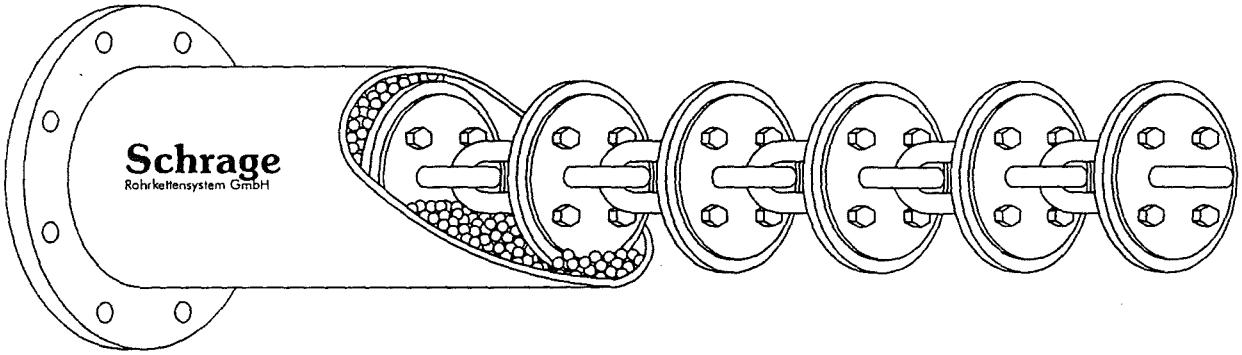
With over 1,000 systems installed worldwide, the Schrage Rohrkettensystem tube chain



Discharge of dust from dust collectors

Eliminate costly rotary valves

- use the Schrage tube chain conveyor



ost types of conveyor systems used to transport bulk materials need rotary valves which require regular and expensive ntenance. The Schrage tube chain conveyor is a completely closed system which totally eliminates ne need for rotary valves in the conveying run. Plus, the Schrage conveyor delivers these additional benefits:

- **Totally dust tight** - so no environmental problems
- **Versatile routing** - up, down, left, right, diagonally
- **High capacity** - transports up to 60 m³/h over 50 m
- **Particle size** - handles <100 micron to 50mm
- **Low maintenance** - just a few minutes per quarter
- **Self cleaning** - quick, clean product changeover
- **Non-abrasive** - material attrition less than 1%
- **Easy restart**- after a stop, restart when fully loaded
- **Energy efficient** - uses 25% of the power of others
- **Pressure tight** - so no need for rotary valves

So if you want to reduce your rotary valve maintenance, plus benefit from the superb efficiency of the tube chain conveyor, contact **Schrage Rohrkettensystem GmbH** on +49 4465 1828.

chrage Rohrkettensystem GmbH, Raiffeisenstrasse 1, D-26446 Freideburg, Germany Fax: +49 4465 1821

onveyor is proving itself to be a reliable workhorse a broad range of industry sectors. The following are examples of typical applications for the system:

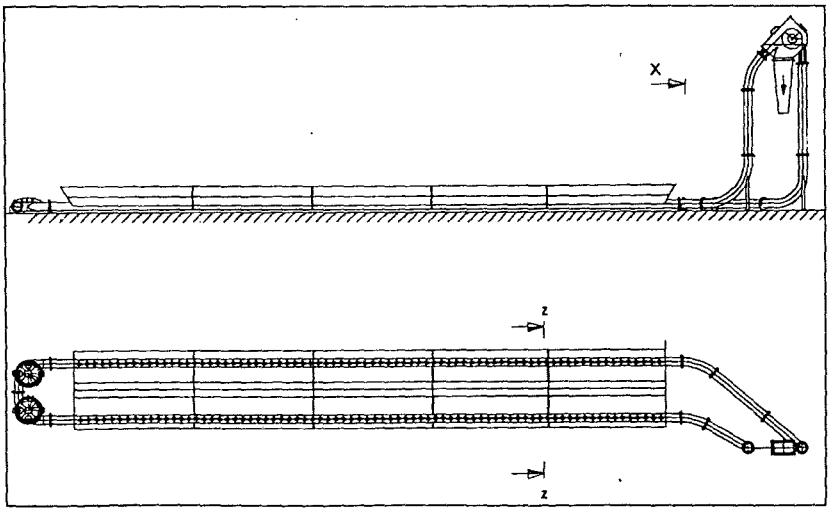
Example 1 – Discharge of dust from a dust collector

Dust collector systems generally have several outlets and operate as either pressurised or vacuum systems. Usually, rotary valves are connected to each outlet to preserve the pressure differential and then material is conveyed away either by a screw conveyor or a pneumatic conveyor. While these approaches work and are used extensively, a radical reduction in both maintenence and down time can be achieved with the tube chain conveyor. Figure one illustrates a typical configuration.

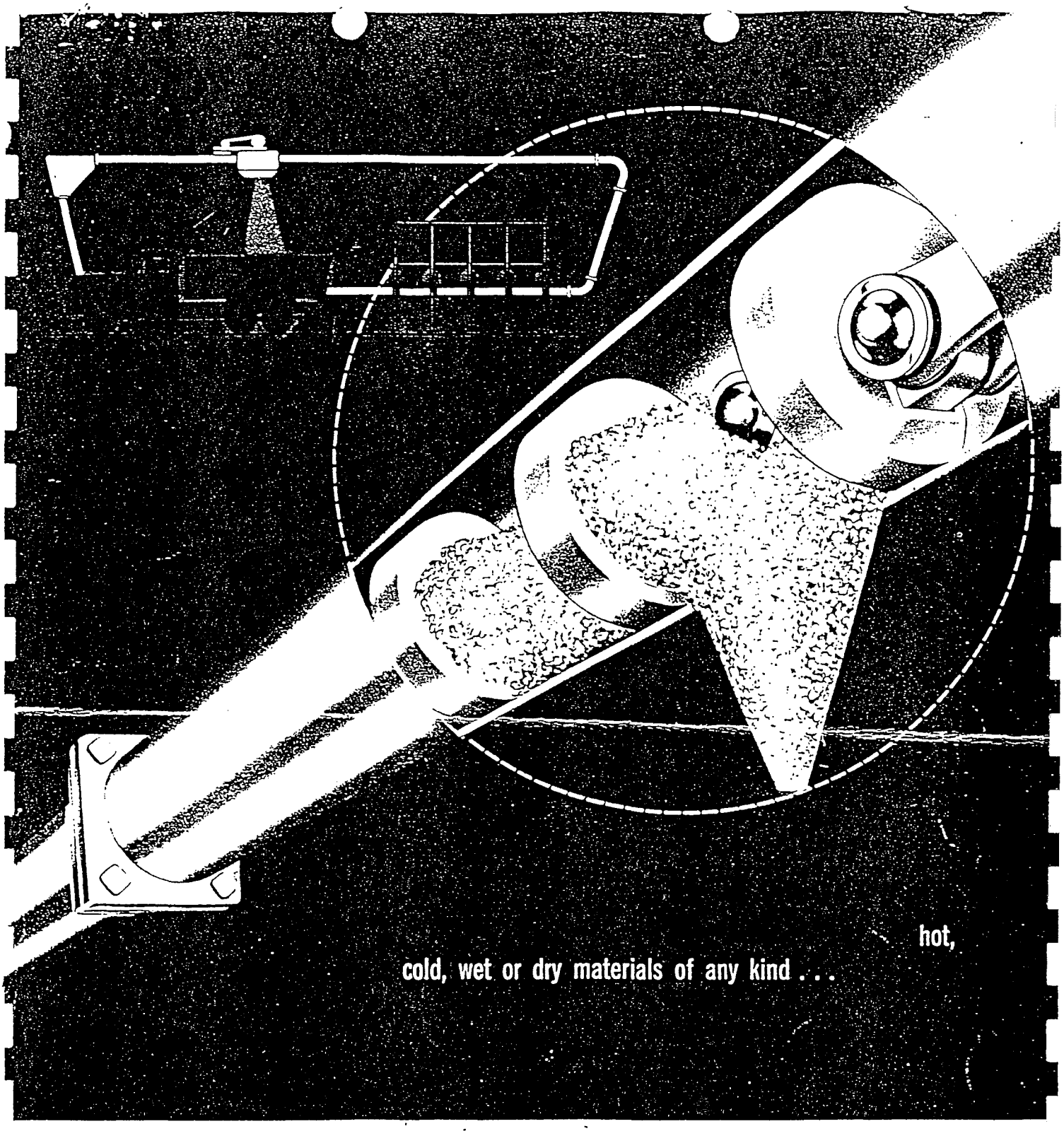
Example 2 – Belt spillage

The tube chain conveyor can also be used in a housekeeping application. For instance, if a belt conveyor is being used to transport large quantities of material, there is often some spillage. At best, material adhering to the belt has to be scrapped off and this can be lost as waste. An innovative use of the tube chain conveyor is to tidy this up. By extending the inlet along the length of the tube, the tube chain conveyor can run open underneath the belt. Any material falling from the underside of the belt is then collected into the tube chain conveyor and returned back onto the belt. Figure two illustrates this concept.

To summarise, to achieve a radical reduction in wear rates and spillage, the Schrage Rohrkettensystem tube chain conveyor is the answer.



Belt spillage

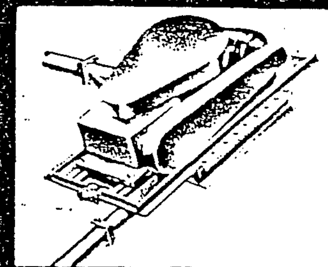


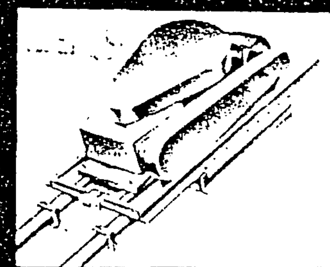
HAPMAN

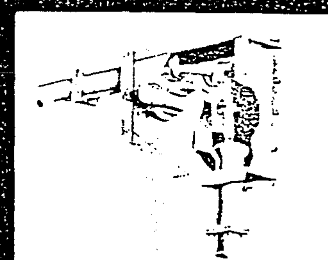
Tubular Conveyor

Hapman Tubular Conveyors

Installation of a Hapman Tubular Conveyor System is fast and easy — requiring only simple hangers or supports to secure the system at any point along its path. The conveyor chain itself is completely factory-assembled, and tubing is shipped match-marked to insure proper installation and alignment. Complete operation and maintenance instructions are furnished.







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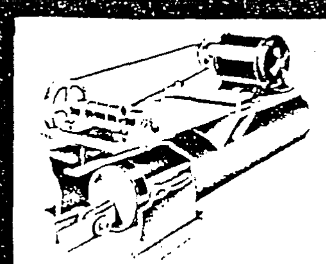

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SPECIFICATIONS

CASINGS: low carbon steel, schedule 40, or 304 stainless steel pipe standard; other thicknesses and materials available; 2, 3, 4, 6, 8, 10 and 12-inch I.D.; gasketed and bolted flange joints; self-supporting vertically. CHAIN: steel linkages protected at pivotal points against wear and corrosion by Neoprene or plastic washer seals. FLIGHTS: solid circular discs in polyurethane, polyethylene, cast iron, Neoprene, or other materials as required; open frame flights for induced flow optional. TURNS: ball-bearing sprocket; case-hardened pipe bends. DRIVE: located at 180° or 90° turns; unit driven through heavy-duty gear type speed reducer by motor of desired hp; variable speed optional; synchronized, load balanced multiple drives where required. TAKE-UPS: screw type, integral with drive or located at idler turn.

UNITRAK CORPORATION LIMITED

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TELEX 06 981419

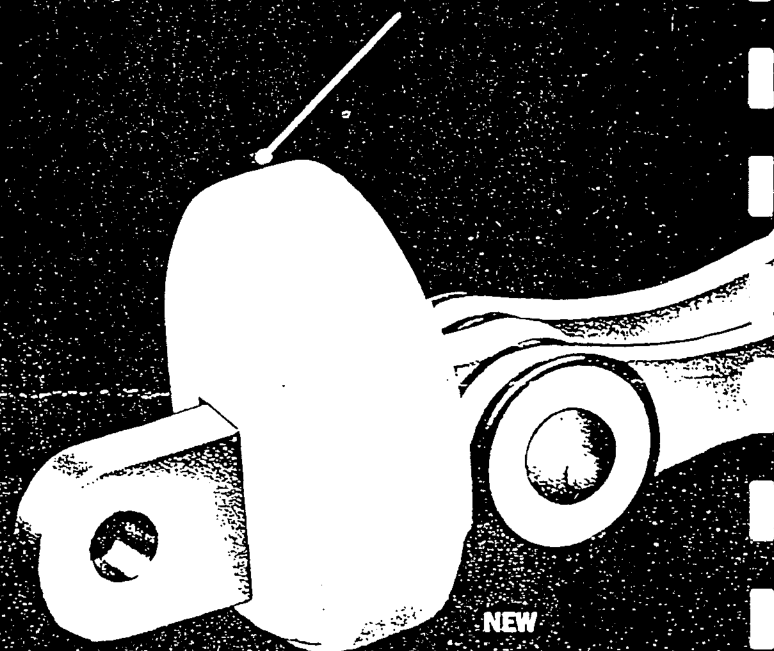
The Conveyor in a Pipeline!

WHEN IT COMES TO MOVING ABRASIVES, CORROSIVES, POWDERS, SEMI-LIQUIDS . . . wet or dry bulk materials of many kinds, no other conveyor can equal a Hapman Tubular for efficiency and economy. This totally-enclosed, self-contained system operates within tubes to move materials smoothly and positively between any desired points, while providing a high degree of protection, isolation and cleanliness.

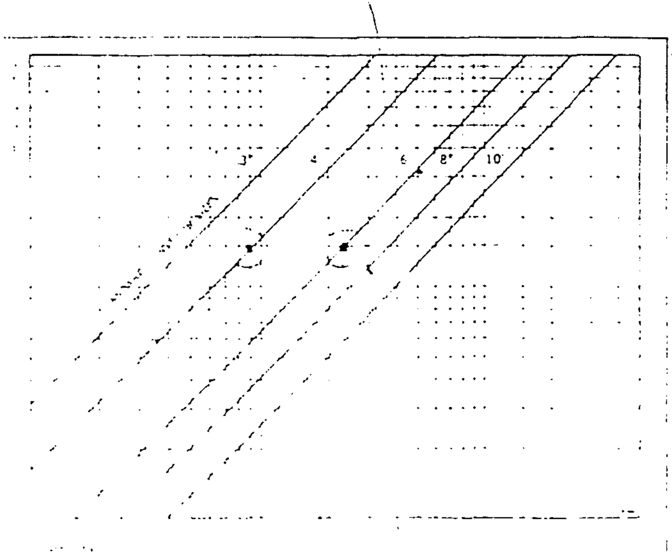
Flexible.

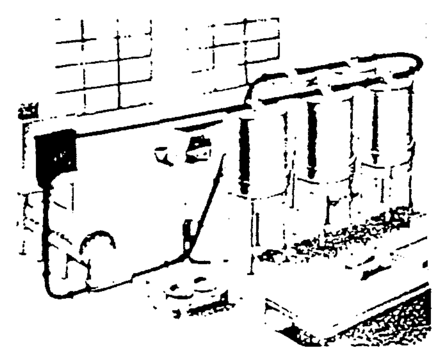
Space-Saving Design.

Dust, Dirt and Odor-Free.



CAPACITY CHART for 3", [illegible] and 10" diameter tubular [illegible]





FOOD PROCESSING [illegible] This Hapman [illegible] Co[illegible] is carrying raw crushed [illegible] pro[illegible]cessing stations. Odors are [illegible]ned dust and dirt [illegible] used in the [illegible] grains, flour [illegible] etc

Hapman

SALES FEATURES OF THE HAPMAN TUBULAR CONVEYOR

The Hapman Tubular Conveyor manufactured under Hapman patents is a custom designed conveyor system made to fit the individual materials handling or processing problem of the customer. Being by nature costlier to produce than mass produced items such as screw conveyors and bucket elevators, it is never bought on price. Nevertheless, the price of the Hapman Conveyor is justified when it meets one or more requirements that cannot be met as well or at all by other conveyor types.

FUNCTIONAL ADVANTAGES:

1. Patented Chain Construction Minimizes Wear
2. Self-Cleaning
3. Degradation is Minimized
4. Works on Wet or Dry Material
5. Self-Feeding
6. Functions as a Volumetric Feeder with Variable Speed Drive
7. Will handle Gummy Materials when Fitted with Special Feeder and Scraper

MECHANICAL ADVANTAGES:

1. Tightness of Casing Will Hold Dust, Pressure, Vacuum, Fluids or Odors
2. Convenience and Economy of Multiple Inlets and Outlets
3. Flexibility of Circuit, Permits Avoidance of Obstacles and Conveying from One Plane to Another
4. Self-Supporting - Requires Few, If Any, Structural Supports
5. Requires a Minimum Amount of Space for a Given Capacity

By bringing out the above points in any sales presentation involving Hapman Conveyors, we are protecting the customer from the possibility of overlooking the importance of one or more of these factors to his project. A good many Hapman Conveyors go in to replace conveyors which were selected without proper attention to the above factors. Here are some specific examples to show the value of these features.

FUNCTIONAL ADVANTAGES:

1. Patented Chain Construction

   The patented "sealed-pin" construction of the Hapman chain seals off the bearing areas of contact between the pin and link so that abrasive materials do not have a chance to enter. The efficiency of this sealing action has been demonstrated in many applications beyond doubt. In some sewage grit conveyors where underground waters are salty, the plain steel parts of the conveyor chain lose a considerable amount of size due to corrosion before replacement.

   When replaced sections of chain are examined, it is very easy to see that the sealed-pin construction has even kept corrosive water out of the bearing area to a degree that you can actually see raised bosses on the chain links and pins.

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We have actually sold Hapman chain to replace chain made by other manufacturers for tubular conveyors, because the competitors chain would wear rapidly and increase in pitch length to an extent that it made it impossible to fit over the sprockets properly. Due to the fact that the material is conveyed in intimate contact with the conveyor chain in the tubular type of conveyor, the sealed-pin features is the fundamental design features that makes the tubular conveyor a practical device.

2. Self-Cleaning Properties

No conveyor is 100% self-cleaning, but there is a marked difference in degree between types of conveyors. The tubular conveyor, if properly designed for self-cleaning operation, will contain a minimum of recesses or dead spots where a residue of material can collect. Due to the circular design of the casing, this material naturally falls to the bottom of the casing where the chain flights will scrape it away.

The Hapman Conveyor is made with a substantial clearance between the inside diameter of the casing and the outside diameter of the flight, thus with sticky materials it is possible for residue to collect on the casing walls. In such cases, it is possible to devise scrapers which may be applied temporarily from time to time to clean out the casing.

3. Particle Degradation is Minimized

In many food and chemical applications the customer desires to hold the particle size of this material constant during transportation from one process to another. Gentle handling of individual particles is possible with a tubular conveyor to a degree that is hard to equal in screw conveyors, bucket elevators and especially pneumatic conveyors.

Pneumatic conveyors, on the other hand, involve high velocities and will ordinarily pulverize fragile materials in transit. We have replaced a number of pneumatic conveyors for this reason alone.

4. Works Wet or Dry

Screw conveyors and bucket elevators frequently will malfunction if condensation develops and creates wet area of material inside of the conveyor. Ordinarily, moisture improves the operation of the Hapman Tubular Conveyor. Many of our best applications such as machine tool chips, filter cake, quench tank scale, sludge, sewage grit, etc., are in connection with wet materials.

5. Self-Feeding Properties

In many types of conveyors it is necessary to have a feeding device to introduce material into the conveyor in a uniform manner to prevent overloading. This is obvious in the case of belt conveyors, for instance, as the material would over-flow the edges if the infeed were not controlled. Screw conveyors and pneumatic conveyors also are affected in a similar manner.

While it is true that some kinds of material will jam up a Hapman Conveyor if fed in too rapidly, it is almost always possible for us to devise baffles for the hopper at the point of entry to give the conveyor the desired self-feeding characteristics.

6. Functions As A Volumetric Feeder
In many production processes it is desirable to pace the movement of material with some other process, and have the means to vary the rate of delivery to fit other circumstances. This can be done over quite a wide range with the Hapman Conveyor by merely fitting it with a variable speed drive. Such an arrangement has found several applications in the paper industry where a small Hapman Conveyor is used to feed a special additive into the production process.

7. Will Handle Gummy Materials
Some kinds of sludge, filter cake, etc., are very difficult to handle in any known conventional type of conveyor. By devising positive displacement feeders to actually pack the material into our Hapman Conveyor, and then mechanical scrapers to remove the material from the flights at the discharge point, we find it possible to handle such materials very efficiently, still retaining the advantages of the basic conveyor.

MECHANICAL ADVANTAGES:
In many cases, the physical form and nature of the conveyor will have an important effect on cost, possibility or convenience of installation.

1. Casing Tightness
The ability to seal the Hapman Conveyor against dust, pressure, vacuum, or fluid multiplies the possibilities of its application many times. In sinter dust applications in steel mills, the Hapman Conveyor picks up from a number of dust collectors and discharges through a rotary airlock or star feeder. If it were not for the pressure holding characteristics of the Hapman Conveyor, it would be necessary to have a rotary airlock at each one of the dust collectors. Thus, the tightness characteristics of the conveyor has provided a low cost application in this case.

This characteristic makes the Hapman Conveyor odor free, an important factor in sewage plant installations, and also with respect to health hazards in chemical applications.

Fluid tightness, of course, permits operating quench tank scale conveyors below the fluid level. Chip Conveyors where lubricant oils may flood the system also benefit from this characteristic.

2. Circuit Flexibility:
A noteworthy advantage of the Hapman Conveyor is the ability to take bends from one plane to another and avoid obstacles which break up an ordinary conveyor system. This advantage should not be over-played by permitting too many bends to be installed in the conveyor circuit. On the other hand, it generally has the effect of simplifying a conveyor system and reducing the number of drives.

3. Convenience of Multiple Inlets and Outlets
Due to the self-feeding nature of the Hapman Conveyor, it is possible to locate inlets or receiving points, and outlets for discharge points almost any place in the conveyor circuit. Recirculation is also frequently desired and easily obtained by providing a gravity discharge from the carry run back to the return run, short-circuiting the drive box.

The Tubular Conveyor lends itself to the self-cleaning gate which permits feeding a variety of materials through the same conveyor to different discharge points without entrapping a residue of material at each gate which would result in cross-contamination.

4. Self-Supporting
As the conveyor casing of the Hapman Tubular Conveyor is the equivalent of standard pipe, the structural rigidity and strength is high. It is not necessary to support the Hapman Tubular Conveyor to the same degree required with a screw conveyor, belt conveyor, etc. The conveyor is merely located where desires and secured in position. This is usually a very simple matter by making use of simple ceiling hangers, sway braces, etc.

5. Minimum Space Requirements
Where space is at a premium, the Tubular Conveyor can often be installed so inconspicuously that its presence is not even apparent. It is quite a problem solver in existing situations where a materials handling device has to be added. It is often found that overall height, width, etc., is limited to a point that no other kind of conveyor will fit.

The Hapman Tubular Conveyor will be selected over other materials handling devices where the combination of function and form of the tubular conveyor provide an economic advantage over other types. In such considerations, the yearly value of the conveyor in the application is ordinarily a much bigger factor than the purchase cost. Thus, it often works out that a Hapman Tubular Conveyor costing 3 or 4 times as much as the cheapest substitute will be the best money saver for the customer.

Hapman

CONVEYOR COMPARISON CHART

This comparison chart compares the Hapman with other conveyor types. It is based on desirable characteristics which are inherent in the conveyor or attainable with only slight modification.

CHARACTERISTICS	HAPMAN	BELT	PNEUMATIC	SCREW	VIBRATING
Can have multiple inlets	5	5	3	5	5
Can have multiple outlets	5	2	2	5	5
Is virtually self-supporting	5	2	4	2	2
Exact alignment unnecessary	5	1	5	2	2
Has relatively low HP requirements	4	5	1	4	3
Has minor lubrication requirement	5	2	5	2	2
Capacity can be changed easily	4	4	2	4	4
Can be run out of doors w/o special enclosure	5	1	5	3	2
Multi-Plane operation possible with 1 unit	5	1	5	1	1
Conveyor can elevate	5	2	5	3	3
Can do volumetric feeding	4	3	2	4	2
Adapts easily to existing equipment location	5	2	4	2	2
Has small space requirement	5	2	4	3	2
Can perform other operations while conveying	5	3	4	5	4
Gives little lubrication contamination	5	5	5	3	5
Can carry abrasive materials	4	5	4	2	4
Can carry material at relatively high temperatures	5	3	4	4	5
Can convey slurries	5	2	1	5	1
Can be run partly empty	5	5	5	5	5
Is self-cleaning	5	5	5	2	4
Is dust tight	5	1	5	3	1
Has minimum product degradation	4	5	1	1	1
Has minimum cross-contamination problem	5	5	5	1	4
Can work wet or dry	5	4	1	4	1
Can be pressurized or evacuated easily	5	1	4	3	1
Can collect sediment from settling tank	5	1	1	4	1
Can act as a de-watering device	5	1	1	5	4
TOTAL	130	78	93	89	76

Very good - 5. Good - 4. Fair - 3. Poor - 2. Very Poor - 1.

Hapman

APPLICATIONS OF THE HAPMAN TUBULAR CONVEYOR

Hapman Conveyors are inherently closed, are versatile as to layout, are relatively small in cross section, and self-feeding, and are readily adaptable to existing equipment.

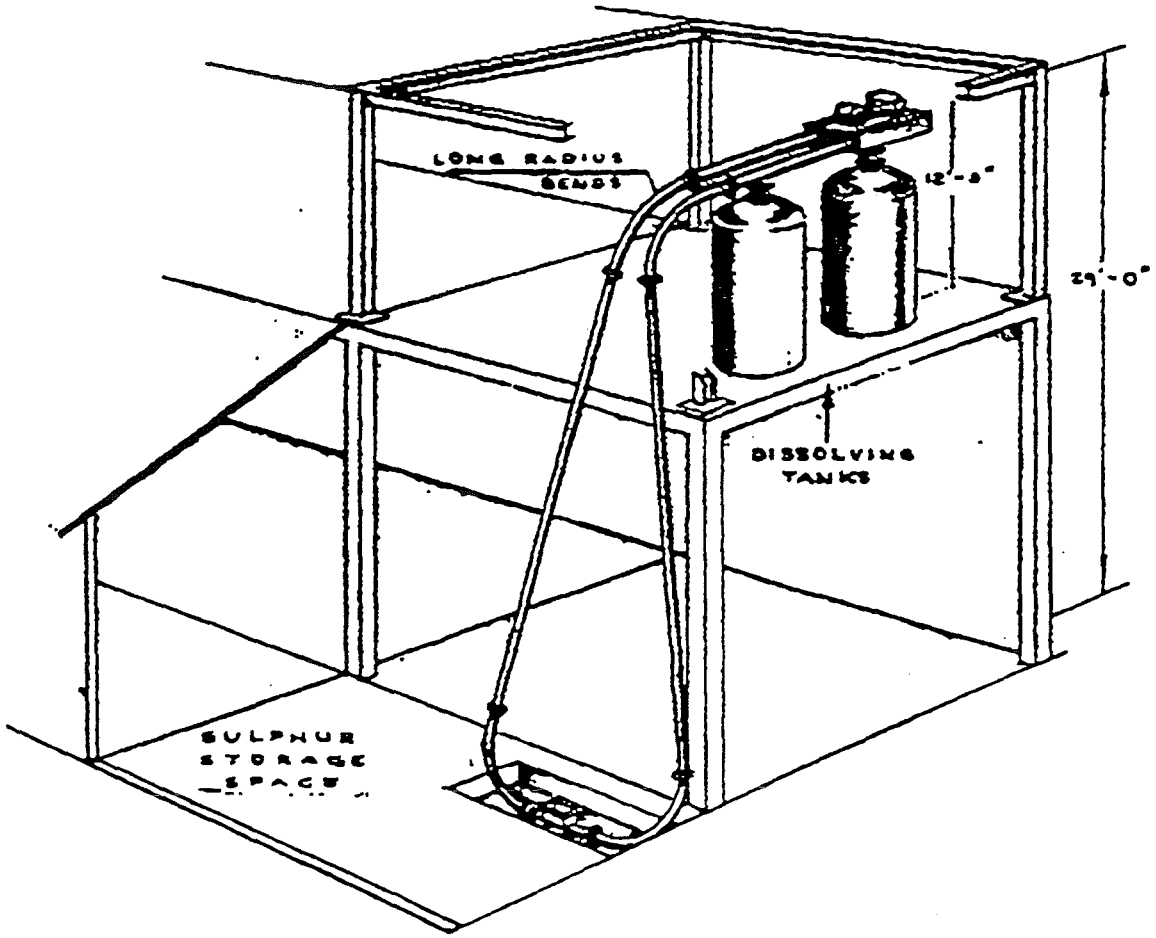
Whenever a conveying problem calls for tightness against leakage of dust, liquids, or gas, Hapman Conveyors should always be considered. Foundries, refractories, ceramic tile and pottery manufacturers strict to eliminate dust conditions that contribute to the industrial hazard of silicosis to employees. Atomic energy plants must have dust tightness in the conveyance of their various salts. Lead oxide manufacturers also strive to eliminate dust conditions that contribute to the industrial hazard of lead poisoning to the employees. Conveying of insecticides and many dry materials require dust tightness to minimize toxic dust and irritation to employees. Semi-solids and sludges removed from waste treatment and quench tank operations require liquid tight construction.

Whenever the arrangement is difficult or space is limited, Hapman Conveyors will often provide the best and sometimes the only feasible layout solution. As the Hapman Conveyor is well suited to multi-plane operation, it is often possible to replace two or more straight line type of conveyors (belts, screws, bucket elevators).

Following is a partial list of successful Hapman installations, arranged alphabetically by customer. A list grouped by industry showing the materials carried in a Hapman Tubular Conveyor is also provided.

FROM HAPMAN CONVEYORS' CASE STUDY FILE

EXAMP
C-151



ELEVATES GRANULATED SULPHUR TO TANKS

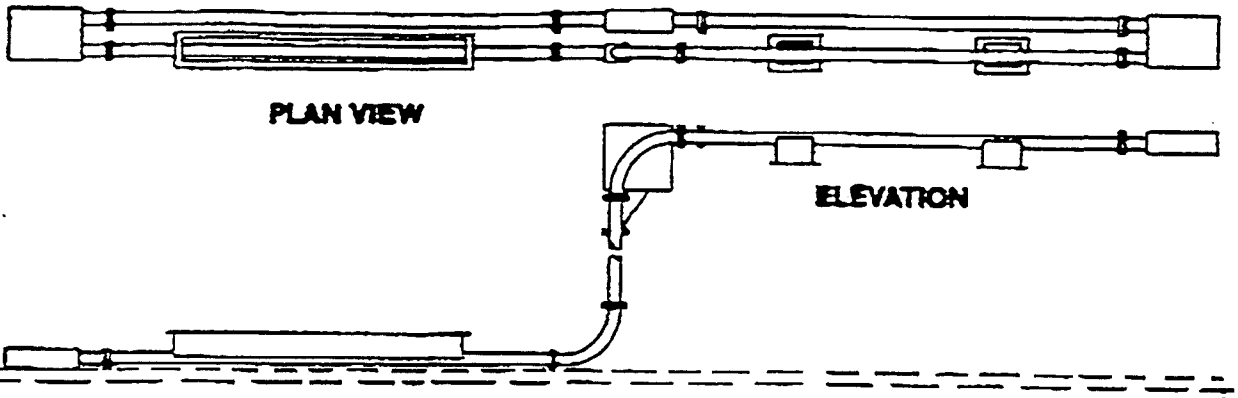
PROBLEM: Carry granulated sulphur, 2000 lbs. per hour, from floor storage space to two dissolving tanks about 29 feet above the floor. The receiving hopper, complete with screen, was to be hand loaded. Slide gates were required for the two discharge hoppers above.

SOLUTION: Series No. 25 Hapman sealed-pin chain, running in 3" pipe, at chain speed of 20 FPM. Chain flights were made of bronze instead of standard Neoprene to meet the customer's requirements.

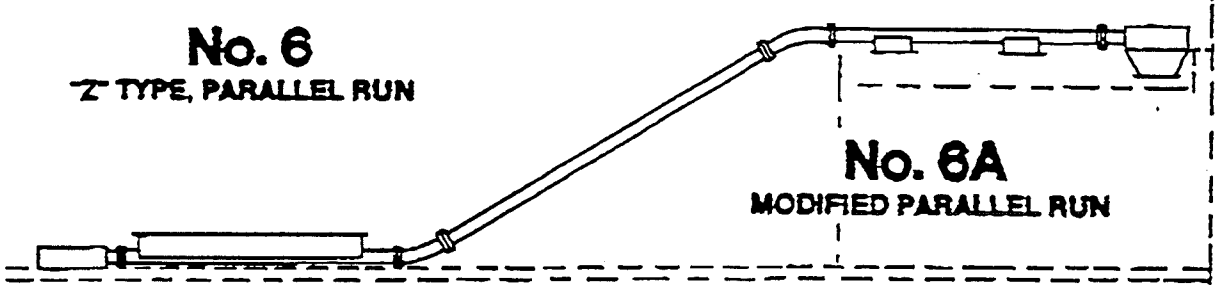
RESULT: A dust-tight handling system with minimum space and support requirements. An explosion-proof motor of only 1 HP was required... a typical example of Hapman operating economy.

Hapman

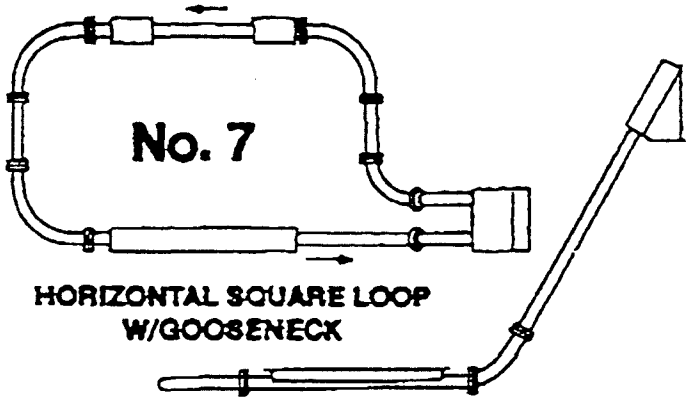
ENGINEERED MATERIAL HANDLING SYSTEMS



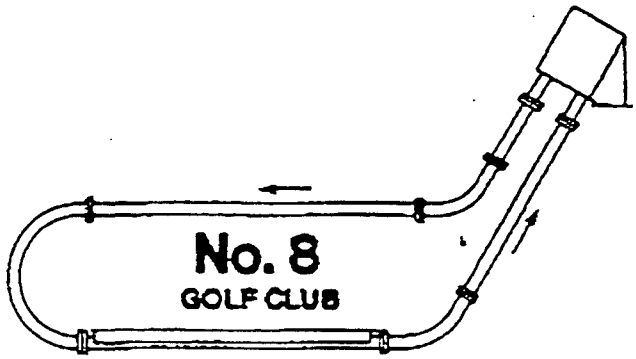
No. 6
"Z" TYPE, PARALLEL RUN



No. 6A
MODIFIED PARALLEL RUN



No. 7
HORIZONTAL SQUARE LOOP W/GOOSENECK



No. 8
GOLF CLUB

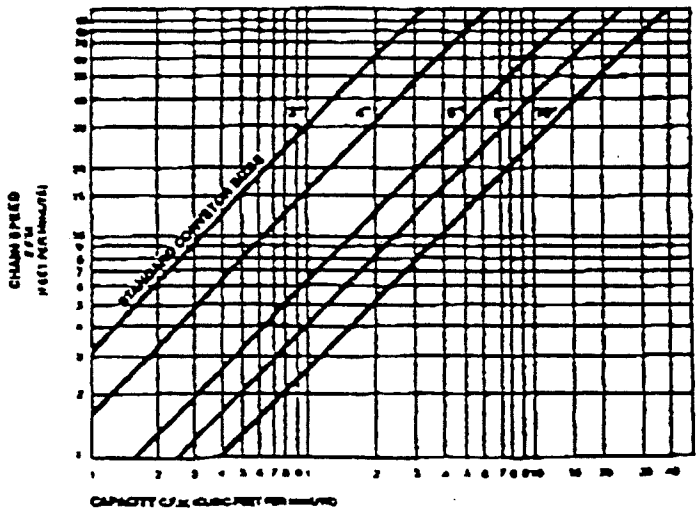
GENERAL DESIGN INFORMATION

STANDARD PIPE SIZES	STANDARD BEND RADII
2"	12"
3"	18"
4"	24"
6"	36"
8"	48"
* 10"	60"

Additional receiving and/or discharge hoppers may be specified. Location and details of construction to meet requirements.

*Conveyor circuitry limited.

Capacity Chart



HAPMAN
Hapman Conveyor
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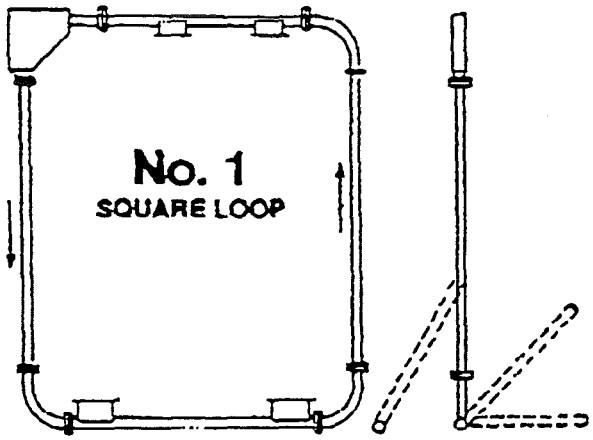
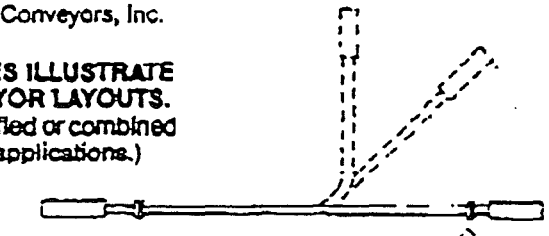
HAPMAN

A Division of Prab Conveyors, Inc.

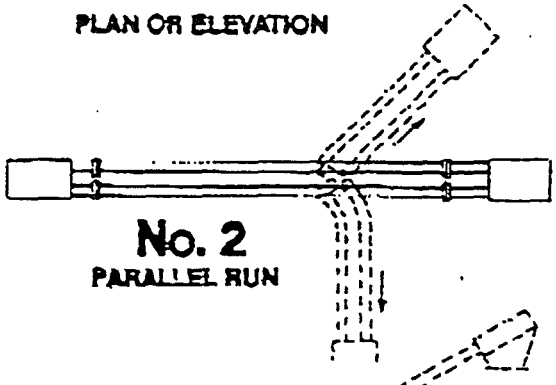
THESE SKETCHES ILLUSTRATE TYPICAL CONVEYOR LAYOUTS.
(They may be modified or combined to suit specific applications.)



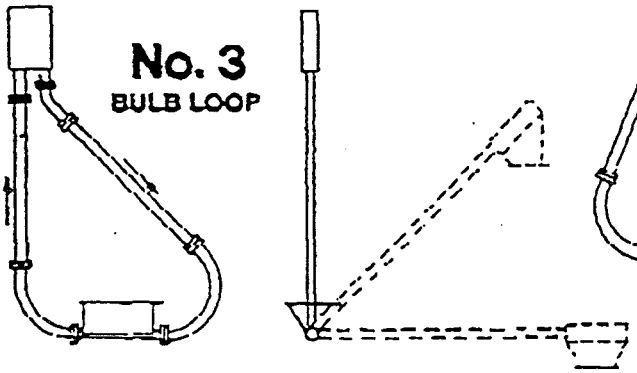
No. 1
SQUARE LOOP



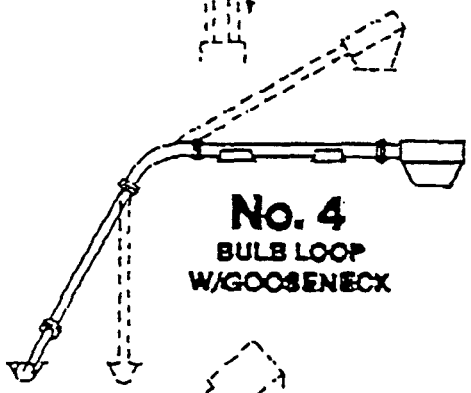
PLAN OR ELEVATION



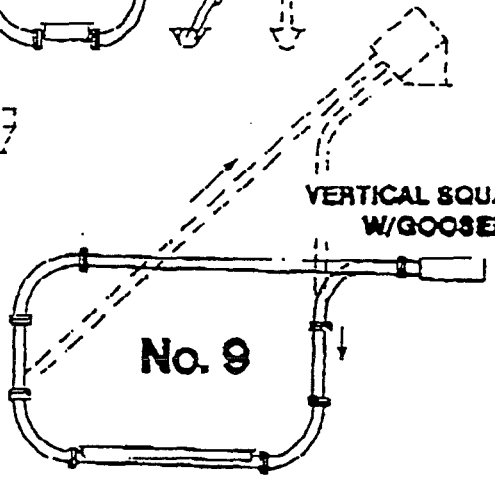
No. 2
PARALLEL RUN



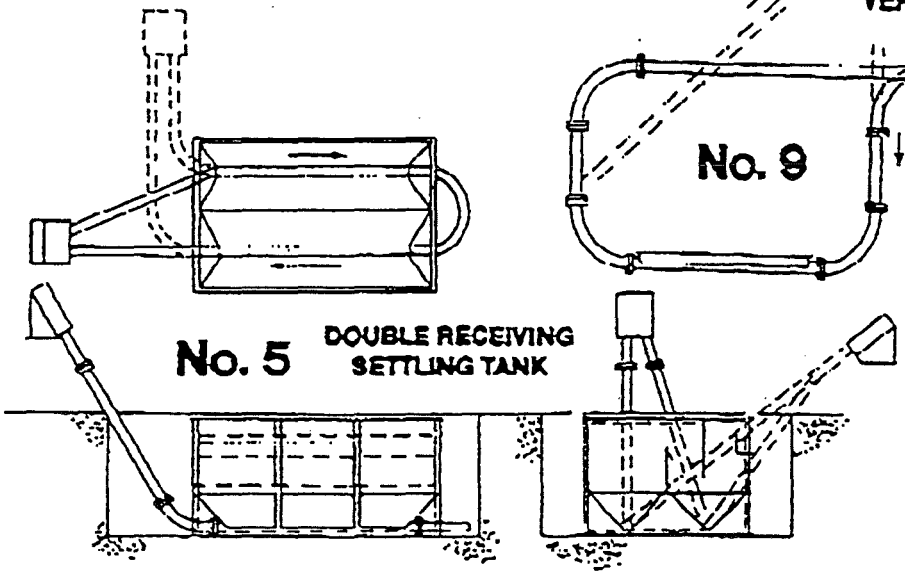
No. 3
BULB LOOP



No. 4
BULB LOOP
W/GOOSENECK



No. 9
VERTICAL SQUARE LOOP
W/GOOSENECK



No. 5 DOUBLE RECEIVING SETTLING TANK

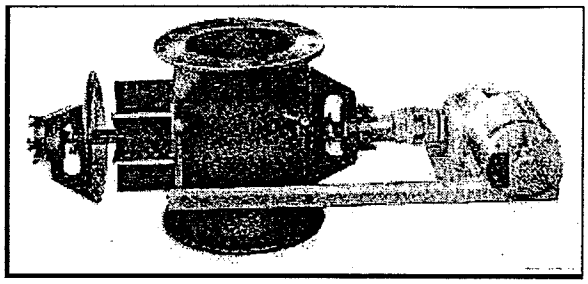
OVER

APPENDIX K

Vacuum Systems Equipment For The Food Industry

SANITARY PNEUMATIC CONVEYING SYSTEMS

CHICAGO CONVEYOR CORPORATION



Sanitary Rotary Feeder

SANITARY PNEUMATIC CONVEYING SYSTEMS

The handling of certain food, chemicals and pharmaceuticals require the ultimate in practical cleanliness and cleanability in all the equipment in contact with the product. Since the dairy industry was the forerunner in setting standards for this type service, we have established our designs of components and systems on the basis of these standards. Both vacuum and pressure systems can be used based upon application requirements. Typical features are 304 stainless steel construction with a 2B finish. All welds are ground smooth to a No. 4 finish with no pits or crevices.

SANITARY ROTARY FEEDERS

Designed for handling...

- **Dairy Products**
- **Food Products**
- **Pharmaceuticals**

Chicago Conveyor has been manufacturing the Sanitary Feeder since 1970 and dozens of them are now in service; it has been approved by the U.S. Department of Agriculture for use on milk powder and similar products.

THE MAJOR REQUIREMENTS FOR A SANITARY FEEDER ARE:

- **NO PITS OR CREVICES ANYWHERE IN THE PRODUCT CONTACT AREA.**

The Chicago Conveyor Sanitary Feeder has a smooth finish on all product contact surfaces; there are no pits or crevices.

- **ALL PRODUCT CONTACT SURFACES EASILY CLEANED.**
  Chicago Conveyor Feeder is easily dismantled making all internal surfaces readily accessible.

FEATURES:

- 304 or 316 stainless steel product contact.
- Smooth finish on all contact surfaces; no pits or crevices.
- Endplate and rotor easily removable without the use of special tools; housing interior is then fully exposed for cleaning. Drive remains in place.
- No endplate gasket to become contaminated or require replacing; finely machined surfaces provide an excellent seal.
- Solid teflon shaft seal packing.
- Sealed outboard bearings.
- Direct drive with easily disconnected coupling; no greasy or oily sprockets and chain.

Need a **Budget Quotation** on a Pneumatic Conveying System?
Complete this request form.

Need a **Budget Quotation** on a Rotary Feeder?
Complete this request form.

Manufacturers Representative

J. L. Horst, Inc.
P. O. Box 1286
Mars, PA 16046
Phone: (724) 935-1590
Fax: (724) 935-1591
E-Mail: jhorst@nauticom.net

You can reach us by e-mail at: jhorst@nauticom.net

Back to *J. L. Horst Inc. Home Page*.

■ Back to Chicago Conveyor ■ Pneumatic Conveying Request Form ■ Dust Collectors ■

■ Diverter Valves ■ Blower Packages ■ Bag Dump Stations ■ Inline Filters ■

This page was revised by Joseph L. Horst on August 25, 1998.

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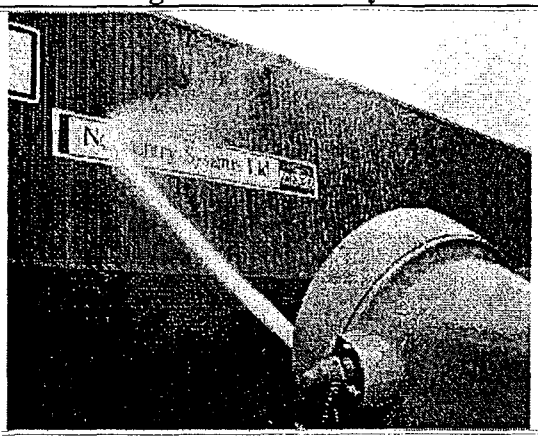
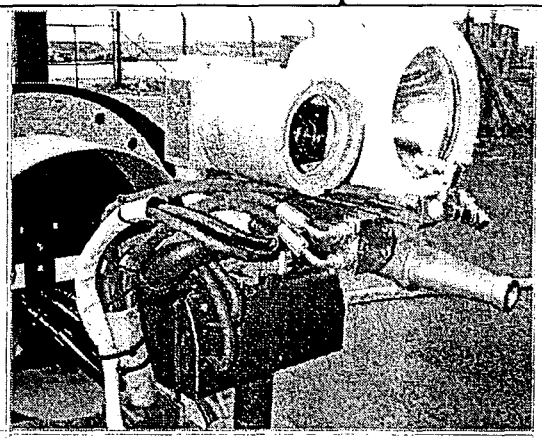
APPENDIX L

High Pressure Washers

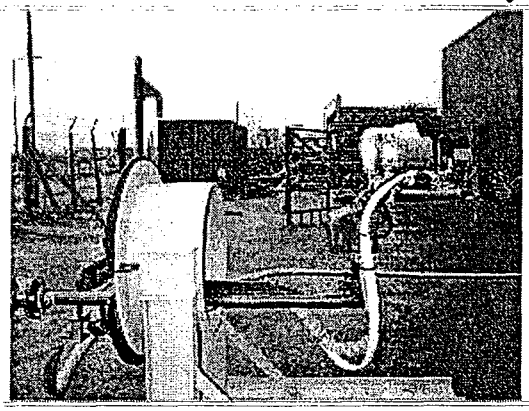
TCT Tank Cleaning Picture Gallery 8 MANWAY CANNON with remote operation



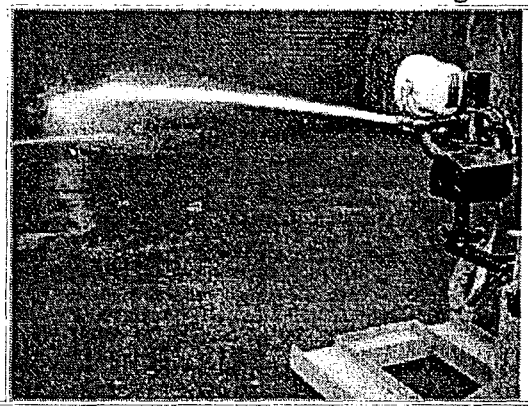
Wash that Tank with Non Man Entry



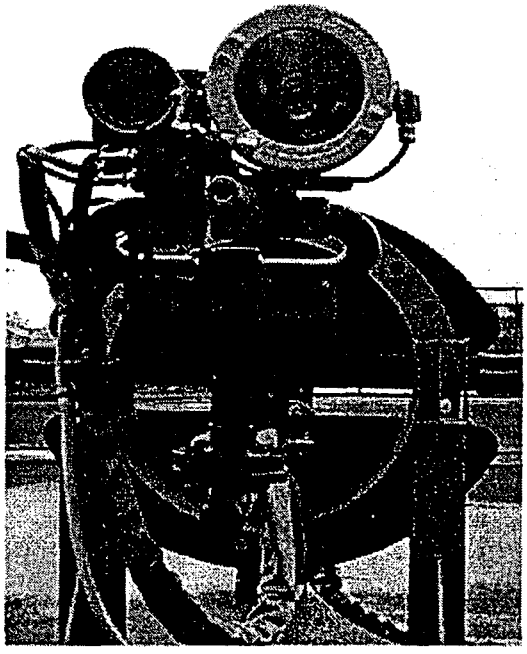
Cannon Head Camera and Light



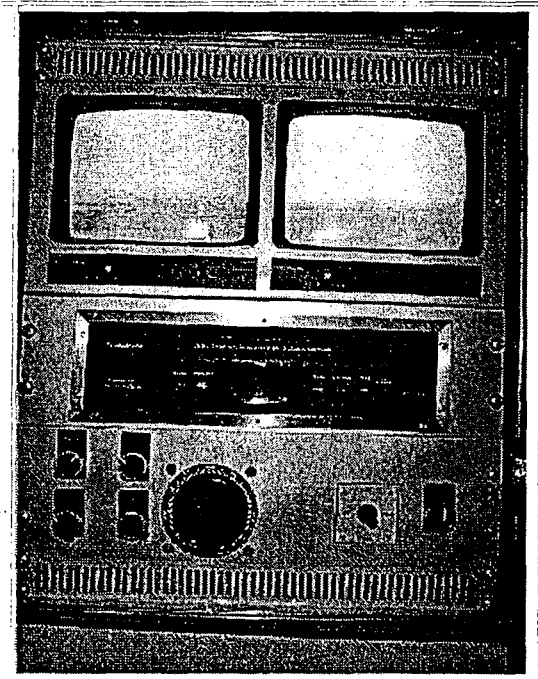
Side View in dummy manway



Rear View

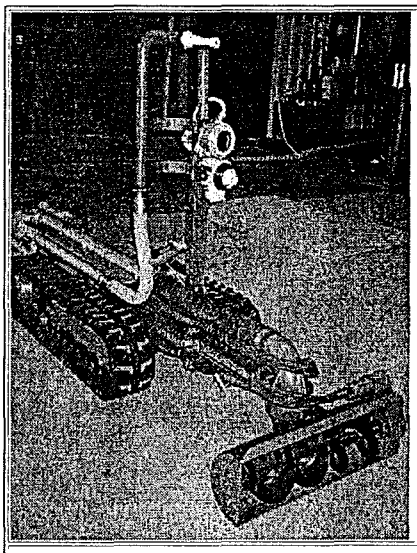


Front View



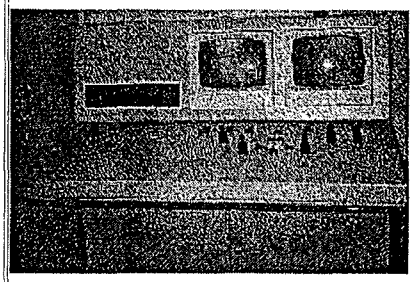
Blackbox Remote Control and Video Panel

TCT Tank Cleaning Picture Gallery 2 ROBOTIC REMOTE CONTROL KIT



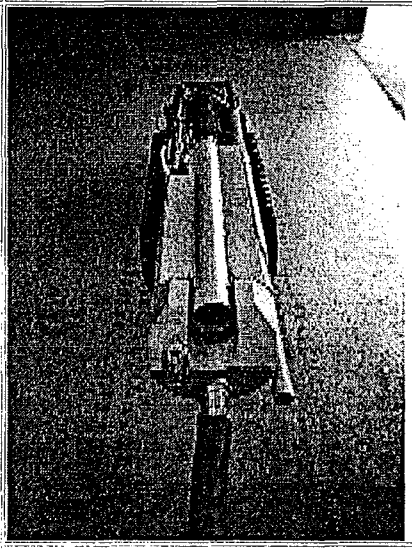
Tracks open and canon raised

Tracks closed canon lowered



Operator Control Panel

Front View Tracks Closed



Rear View Tracks Closed

BACK

Contact us now tankcleaning@technologist.com

Contact us now tankcleaning@technologist.com

APPENDIX M

PROTECTIVE ENCLOSURES

Martin Cab

High Visibility Steel Cabs®

News-Specials
Company Profile
Product Information
Steel Cabs
Panel Cabs
Fabric Cabs
Customized Cabs
Support Information
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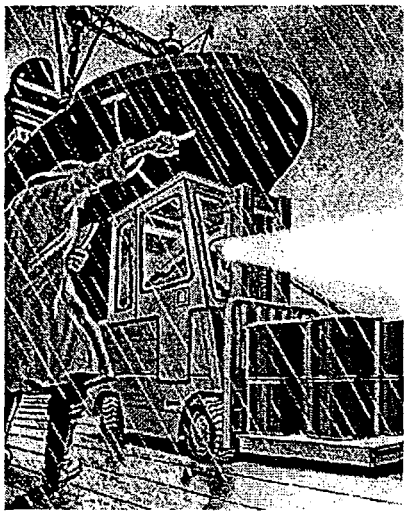
MARTIN CAB enclosures are on the job in unheated warehouses, aviation, and foundry operations, in forestry and mining applications, and in all types of hazardous materials handling situations around the world. Indoors they allow the economical heating of just the cab, not the entire warehouse. Outdoors they protect the operator against extreme heat and cold and other adverse weather conditions.

The Martin Cab approach to individual equipment enclosure designs provides for extremely fast and easy installation. Modification of the truck or enclosure is seldom needed. No expensive drilling or welding are required to achieve a permanently secure attachment. Many cabs can be completely installed in approximately one hour so there's little or no interruption of your operations.



OVER 70 YEARS OF EXPERIENCE

Martin Cabs are the product of more than 70 years of design and manufacturing experience.

SINGLE SOURCE CONTROL

Perhaps the most important factor in the Martin Cab quality equation is the total control of all design, fabrication and assembly aspects under one roof. We maintain a thorough and current familiarity with all lift truck, towing tractor and materials handling equipment. This allows our engineering team to design an enclosure which meets a unit's physical and functional requirements without complex and costly mounting problems.

Martin Cab

Customized Cabs

News-Specials
Company Profile
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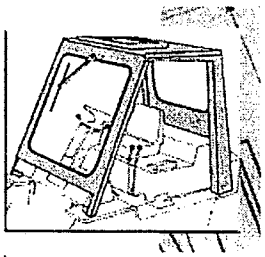
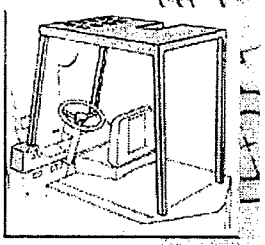
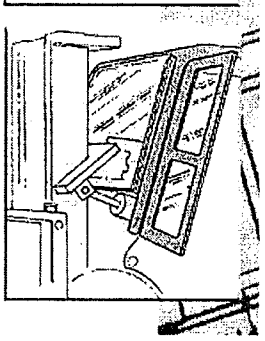
CUSTOMIZE YOUR CAB







DRIVE-In Rack Guards: Specially engineered for various drive-in and drive-thru rack applications. Electric truck guards are designed with openings in roof for easy battery removal.

Partially Enclosed Cabs: Steel front / rear / roof top panels with laminated glass can be incorporated with vinyl curtains to allow you to design a cab to suit your operator's needs.

Blast Furnace and Foundry Cabs: Steel panels and special glass allow us to design enclosures to your requirements at various temperatures.

Whatever your operators' needs, MartinCab can design and build a cab to do the job. We have designed thousands of cabs for virtually every type of lift truck and materials handling vehicle, and offer rapid development from new design to finished product. We also encourage our customers

APPENDIX N

Giant Mine Arsenic Trioxide Safety Procedures

ARSENIC TRIOXIDE

SAFETY PROCEDURES
AND
GENERAL INFORMATION

FOR MINE AND MILL PERSONNEL

GIANT YELLOWKNIFE MINES LIMITED

ARSENIC TRIOXIDE
SAFETY PROCEDURES
AND
GENERAL INFORMATION
FOR
MINE AND MILL PERSONNEL

ORIGINAL - NOVEMBER 1986
REVISION 1 - DECEMBER 1986

GIANT YELLOWKNIFE MINES LIMITED

TABLE OF CONTENTS

GIANT YELLOWKNIFE MINES LIMITED

ARSENIC TRIOXIDE SAFETY PROCEDURES AND GENERAL INFORMATION FOR MINE AND MILL PERSONNEL

1. ARSENIC TRIOXIDE GENERAL INFORMATION

General Description

White powder, odorless.

Solubility in Water

3.7 g per litre.

Chemical

Contact with acids or acid substances in combination with certain metals, for example, galvanized sheet metal, may cause formation of toxic fumes. When heated over 200°C gas is emitted.

Toxicity

Less than 5 mg per kilogram of body weight.

Protective Equipment

Goggles, (give protection to the eyes), suitable respiratory protection, plastic or rubber gloves, plastic or rubber aprons, boots.

Emergency Action

Spillage Small amounts should be collected in a simple way, that is by vacuum cleaner. Large quantities must be handled by personnel in protective coveralls with rubber boots, gloves, dust respirator and close fitting goggles. Large spillages are cleaned, where possible, by Cottrell Operators using the vacuum truck. Otherwise, spillages should be contained in dust-proof drums or other suitable packing.

Fire Keep containers cool by spraying with water, gas is emitted over 200°C, do not inhale the gas. Use gas masks working in gas area.

First Aid

If ingested, cause vomiting by using water, milk or milk of magnesia and take victim to physician immediately. If inhaled, remove victim from the contaiminated area, keep breathing passages open and keep him warm. If powder is on his clothes, take a shower using soap and water, and change clothing.

.....2

Sanitary Demands

Change work clothing often as necessary, wash regularly, smoking should not be allowed in places where there is a risk of contact with arsenic trioxide.

2. SAFE HANDLING OF ARSENIC TRIOXIDE

2.1 Toxicity

Arsenic trioxide is a poisonous substance, and if taken by mouth, may cause severe illness and death. Suitable precautions must always be taken, to avoid accidental contamination of foods and beverages.

The dust of arsenic trioxide is irritating to the skin and mucous membranes. If dust gets on the skin, especially on skin moist with perspiration and in areas where clothing rubs on the skin, irritation will develop. The skin will become reddened and sore.

If some dust is inhaled repeatedly, a sore spot may develop inside the nose, on the septum (the partition between the nostrils). Or, if dust is inhaled by mouth, there may be irritation of the throat.

Probably because arsenic trioxide dust is irritating, it is unlikely that anyone would ever inhale enough dust to cause poisoning of the whole body like the poisoning caused when arsenic is taken by mouth. At least such poisoning by inhaling dust has not been reported in all the years arsenic trioxide has been used in industry.

2.2 Dust Control

Mechanical conveying and mixing equipment used for arsenic trioxide should preferably have hoods with powered exhaust ventilation at points of dust dispersion. The decision as to dust control equipment will depend on many local factors and conditions of use and no detailed rules can be stated. In cases where the arsenic trioxide will be used in wet processes, addition of water to it as early as possible in the production procedures, will prevent dust problems. Add mixture of a small percentage of a high flash point oil with the dry trioxide, if traces of oil are permissible in the final product, will greatly reduce dusting.

.....3

2.3 Personal Protective Equipment

To keep dust off the skin, long cotton underwear, coveralls, cotton gloves and high shoes or boots should be worn. The sleeves and legs of the coveralls should be tied around wrists and ankles respectively. Rheulecream or Calamine lotion (without phenol) or zinc oxide powder or suitable commercial protective creams afford some protection to the face and other exposed areas of skin. Workmen should have showers after removing their work clothes and before donning their street clothes. Also, anytime during shift, should shower and change work clothes if contaminated.

To prevent dust inhalation, workers should use dust masks with Racal hoods. Respirators with rubber face pieces rub on the skin and encourage perspiration and skin irritation. The extent of personal protective measures will depend on the amounts of dust to which workmen are exposed and on the length of time of such exposure. Skin and nose irritations, even minor ones are a signal that protective measures are not good enough and that greater care should be taken.

2.4 First Aid and Medical Attention

In case of accidental swallowing of arsenic trioxide, vomiting should be induced, if possible, and a physician should be called at once.

Irritations of the skin, nose or throat, except for the mildest case which disappears in a day or two, should have medical attention. Again, such irritations are a warning that preventative measures are not adequate.

2.5 Storage

Arsenic trioxide must be kept out of places where children or animals might get at it. Warning labels and/or signs should always be prominently displayed in storage areas and on containers. Old unlabeled containers, such as tin cans or buckets, which might later be employed for foodstuffs or drinking water, should not be used.

Arsenic trioxide together with an acid, such as battery acid, and iron or zinc (a galvanized bucket is zinc-coated) may produce arsine, a highly poisonous gas. This combination of substances is to be avoided.

.....4

3. PROTECTIVE EQUIPMENT FOR CLEAN-UP PERSONNEL

A wide variety of protective equipment is available to minimize the exposure of clean-up personnel to arsenic bearing dusts stirred up during the clean-up activity. The major types of protective equipment available at Giant are as follows:

3.1 Protective Coveralls made of cotton, nomex or synthetic water tight materials. The cotton coveralls are adequate when dealing with smaller spills or for short exposure periods. Coveralls made of synthetic water tight materials are recommended for use in dealing with larger spills where exposure periods to arsenic bearing materials is likely to be of a longer duration. Coveralls currently in use are from Reynolds Manufacturing Co. Ltd., Edmonton, Alberta. They are 6112F-11 zipper coveralls with rear pocket and 4 front pockets, no hoods, no side openings and no belt.

3.2 Paper Particulate Masks are not adequate as a final level of protection from fine baghouse dust. These masks are useful as secondary forms of protection when used in conjunction with other forms of respiratory protection. 3M disposable respirator No. 8710 is commonly used.

3.3 Racal Airstream Filtering Helmets are basically a hardhat with a face visor, air circulation fan and filtering system. Dust laden air is drawn into the rear of the helmet by a small axial fan. Large dust particles are removed by a coarse pre-filter which also serves to protect the fan. After leaving the fan the air is passed through a filter bag located in the crown of the helmet. This filter bag is designed to remove more than 95% of the dust particles 0.5 microns or larger in size. The filtered air is then passed downward over the user's face along the inside of the visor. A positive pressure is maintained in the region of the user's nose and mouth which continues even when the helmet is being used by a manual worker with heavy requirement for air. The air is exhausted at the bottom of the visor. The low air flow resistance in the system makes possible the use of a small fan powered by a portable rechargeable battery pack. The low voltage light-weight battery is connected to the fan motor via a flexible cable. The battery pack may be clipped to a belt or carried in a pocket.

.....5

The Racal airstream helmet is intended for use in low risk exposure situations or for short exposure durations. They are not adequate protection for tasks requiring ongoing exposure to arsenic dust or in areas where dust is being stirred up. Baghouse dust has an extremely low particle size so more dust particles would tend to pass through the filter bag than for other dust types.

They are useful in protecting an employee for short periods such as shutting down a piece of leaking equipment or for cleaning up spills where dust is not being stirred up or becoming airborne through other means such as cleaning up small spills using vacuum equipment (assuming no wind).

3.4 Gas Masks - Following components make up mask and filters from Survivair Division, U.S.D. Corporation, Santa Ana, California, U.S.A.

- respirator half mask face piece, series 2000, in large, medium and small sizes.
- filter retainer code 1400-76.
- pre-filter for dust and mists code 1010-00/TC-21C-232.
- chemical cartridge for vapours and gases, MSHA/NIOSH approved, code TC-23C-318.

3.5 Skin Protection - various forms of skin protection are available ranging from water tight coveralls through gloves, disposable paper coveralls and hoods to various barrier creams.

3.5.1 Barrier creams used are as follows and may be obtained through the Safety Supervisor:

- Barriere A&H/Silicone Skin Cream
- Atrixo/Triple Action Hand Cream
- Nivea Cream/Softens and Protects
- Ply #6/Skin Protection Cream
- Fend/Protection From Contact Irritants.

3.5.2 Rash Relief Creams are:

- Rhuli Cream/Relieves Skin Irritations
- Collyrium/Soothing Eye Lotion
- Ozonol Ointment/Burns and Rashes.

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3.6 Self Contained Suits

- TD2768 Dust Hoods with kwik clip air line, velcro to match suit.
- TD1881 Polarmate Dust Suits with velcro to match hood. L/XL.
- TD2788 Visors.
- Polarmate material to patch hoods.

All from Safety Supply Co., Edmonton.

Air Supply from 100 p.s.i. air, filtered through Del Monox System. Consists of:

- Air Prefilter #150E
- Final Filter #C-20
- Catalyst Purifier #BA-12.

Headers located:

- By Cottrell fan on Del Monox System
- Bottom floor Cottrell
- Top floor Cottrell
- Outside Cottrell for sandblasting
- Baghouse bottom floor
- Baghouse North and South sides
- Inside As Silo
- Inside As loadout building.

3.7 Welding Helmets

3M Welding Helmet #W-5003 which includes liftable faceshield, Nomex inner shroud, leather outer shroud, and head suspension, all from Safety Supply, Edmonton. For use with compressed air supply as described in 3.6.

4. CHEMICAL SAFETY DATA SHEET

4.1 Properties

Physical properties of Arsenic Trioxide:

Molecular Symbol	As_2O_3
Physical State	Odourless Powder
Colour	White
Melting Point	315°C
Specific Gravity	3.43

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Solubility	Soluble in glycerine, acids and alkaline solutions; slightly soluble in water
Chemical Reactivity	Contact with acids or acid substances in combination with certain metals for example galvanized sheet or light metal, may cause the formation of toxic fumes. Gas is emitted over 220°C when heated
Flammability	Non-Flammable

5. HEALTH HAZARDS

5.1 Properties

Arsenic trioxide is poisonous if swallowed or by dust inhalation. Dust may cause irritations on the skin and mucous membranes. Arsenic may cause cancer.

Toxicity - 5 mg/kg body weight.

5.2 Personal Protective Measures

5.2.1 Avoid direct skin contact by wearing goggles, gloves, disposable boots, and disposal coveralls.

5.2.2 Avoid inhalation of the dust by dust respirators.

5.2.3 Change work clothes often, wash skin regularly, and avoid smoking where there is a risk of contact with arsenic trioxide.

5.3 First Aid

5.3.1 If Ingested, cause vomiting by using water, milk or milk of magnesia, and take victim to a physician immediately.

5.3.2 If Inhaled, remove victim from the contaminated area, keep breathing passages open, keep him warm and take the victim to a physician immediately.

5.3.3 Skin Contact, change clothing and wash powder off with soap and large volumes of water as soon as possible.

.....8

5.4 Arsenic Trioxide Leaks

5.4.1 Personnel required to handle arsenic trioxide shall be trained in the proper actions to be taken in the event of a leak or spill. They shall be instructed to use the proper equipment in the event of an emergency. Cottrell Operators are trained to clean up leaks and spills.

5.4.2 If a leak occurs personnel shall:

i. See that persons not required to deal with the problem are kept clear of the area.

ii. Put on suitable personal protective equipment.

iii. Tape the leak.

iv. Shovel up the product, putting it into a plastic bag and placing it inside the trailer.

v. Remove protective equipment and put it into a plastic bag and place it in the trailer.

vi. Wash thoroughly with soap and water.

vii. The Manager or his designated deputy is responsible for reporting the spill.

5.5 Arsenic Trioxide Spills

5.5.1 See that persons not required to deal with the emergency are kept well clear of the contaminated area and up wind.

5.5.2 Contact the nearest emergency departments informing them of the problem as outlined in the Emergency Spill Action Plan Report Sheet.

5.5.3 Prevent the arsenic trioxide from contaminating waterways.

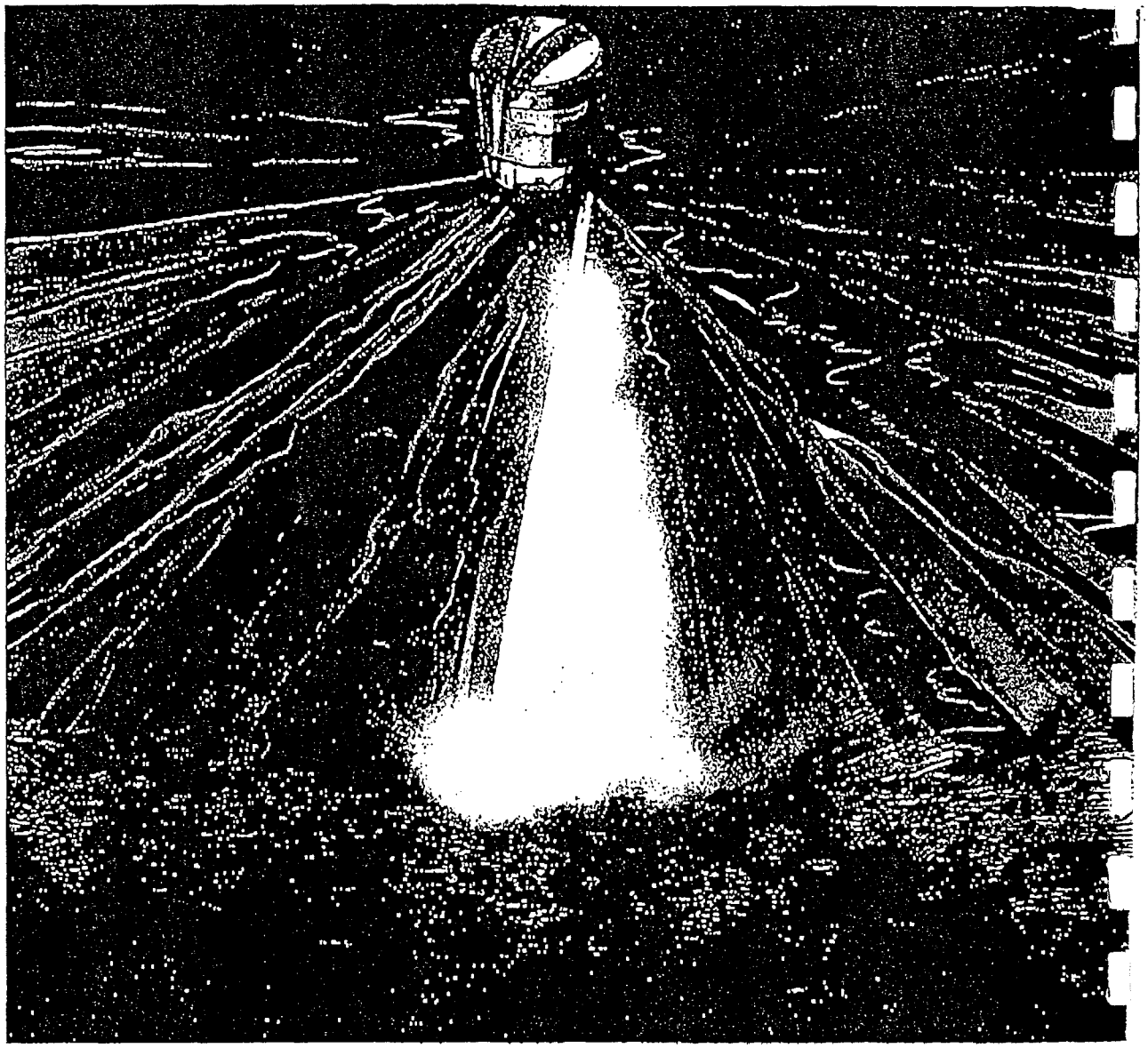
.....9

Appendix O

Marconoflo Slurry Systems

SVEDALA

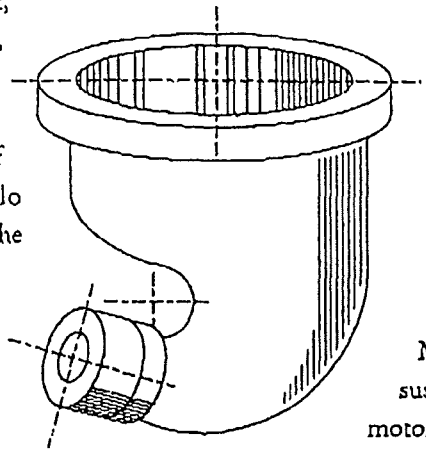
MARCONAFLO®
SLURRY SYSTEMS



SVEDALA
PYRO SYSTEMS DIVISION

VERSATILITY BY DESIGN

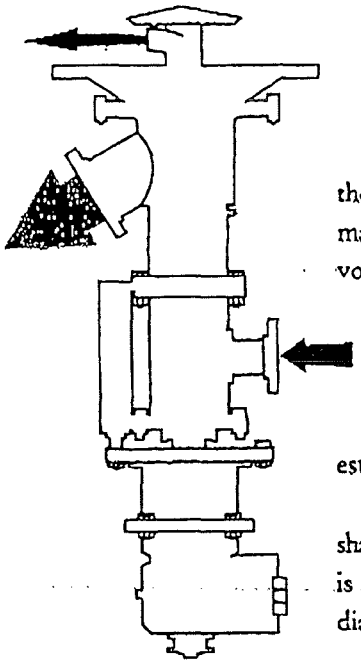
No matter what the containment, and no matter what the material, the efficiency of a repulping operation depends on the velocity and volume of water hitting the settled mass of material. Success of the Marconaflo Systems is based on the versatility of the MARCONAJET nozzle in creating a jet stream of appropriate diameter and intensity in a variety of situations.



The problem of maintaining that stream is compounded by the fact that the nozzle must incorporate a right angle, rotate and still present a minimum cross section against the settled solids in the impoundment as it rotates.

A simple elbow would have served to direct high-pressure water horizontally into an impoundment, but it would have permitted water along the inside radius of the elbow to pick up speed relative to the water on the outside radius. The result would have been turbulence, breaking up the jet stream and reducing power and efficiency in the repulping operation.

An extensive program of nozzle development resulted in the patented MARCONAJET gooseneck design. By lengthening the inside radius to approach as nearly as possible that of the outside of the curve, the design reduces turbulence and preserves jet stream integrity.

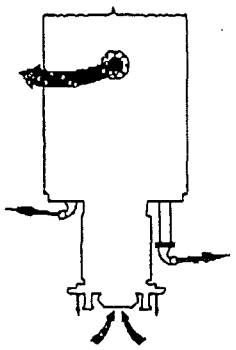


This design provides the energy to repulp settled masses with a relatively small volume of water, achieving the maximum possible solids density for slurry, and maintaining that density within closely established parameters.

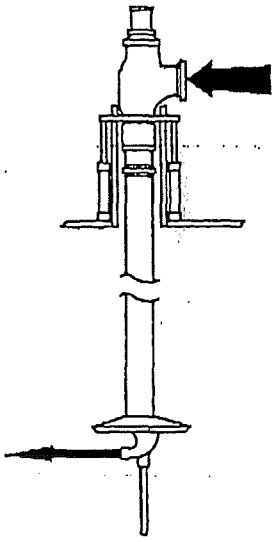
While the basic gooseneck shape of the MARCONAJET is standard, variations in the diameter of the nozzle stem, and in the design of the replaceable orifice control the volume and intensity of the st and thus the solids density of the slurry. most of the nozzle wear takes place at the c the replaceable plate also cuts maintenance c

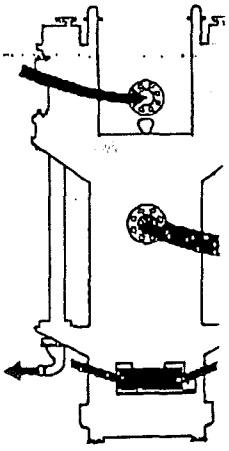
A MARCONAJET alone can signific improve recovery of material from ex feed bins or thickeners where material tendency to compact and bridge or co MARCONAJET on a long stem m suspended from a bridge and rotated by a motor to repulp the contents of the entire tank

The following pages outline basic configurations with Marconaflo System, and provide examples of their applic



Page 5





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Shaded arrows – *slurry flow.*
Black arrows – *high pressure water.*

MAKING SLURRY PRACTICAL

Traditionally, slurry technology has been oriented toward long-distance pipeline transportation of suspended solids. Yet the rising cost of conventional materials handling over even the shortest distances has prompted consideration of every alternative. One of the most logical is slurry. Marconaflo makes it practical.

Marconaflo Systems, in essence, are designed to efficiently and economically pulp either dry or wet solids, converting them to a suitable form for slurry transport. In every case in which they have been applied (and the range of applications is extremely broad) Marconaflo Systems use less labor and power per ton of material moved than conventional handling systems. They are also simpler, and easier to maintain.

At the heart of the Marconaflo System is the MARCONAJET®, which generates a concentrated, high intensity water stream to undercut stored solids, causing them to collapse into the stream and form a high-density slurry. The jet is effective whether materials are deposited dry or as a slurry, exist in place as an unconsolidated overburden or lie compacted in a tank or basin, or even lie submerged as a settled mass.

It is this flexibility which permits Marconaflo Slurry Systems to be used in place of thickeners, agitated storage vessels or other conventional labor-intensive materials handling methods, at substantial savings.

Materials currently handled by Marconaflo Systems al coal, ore tailings, uranium, ilmenite, potash, sand, silt, sl slimes and mineral concentrates such as iron and nick

Containments for which the system is suitable range landfill, ponds, excavations, reservoirs and lakes t bins, bunkers, silos, ships and barges.

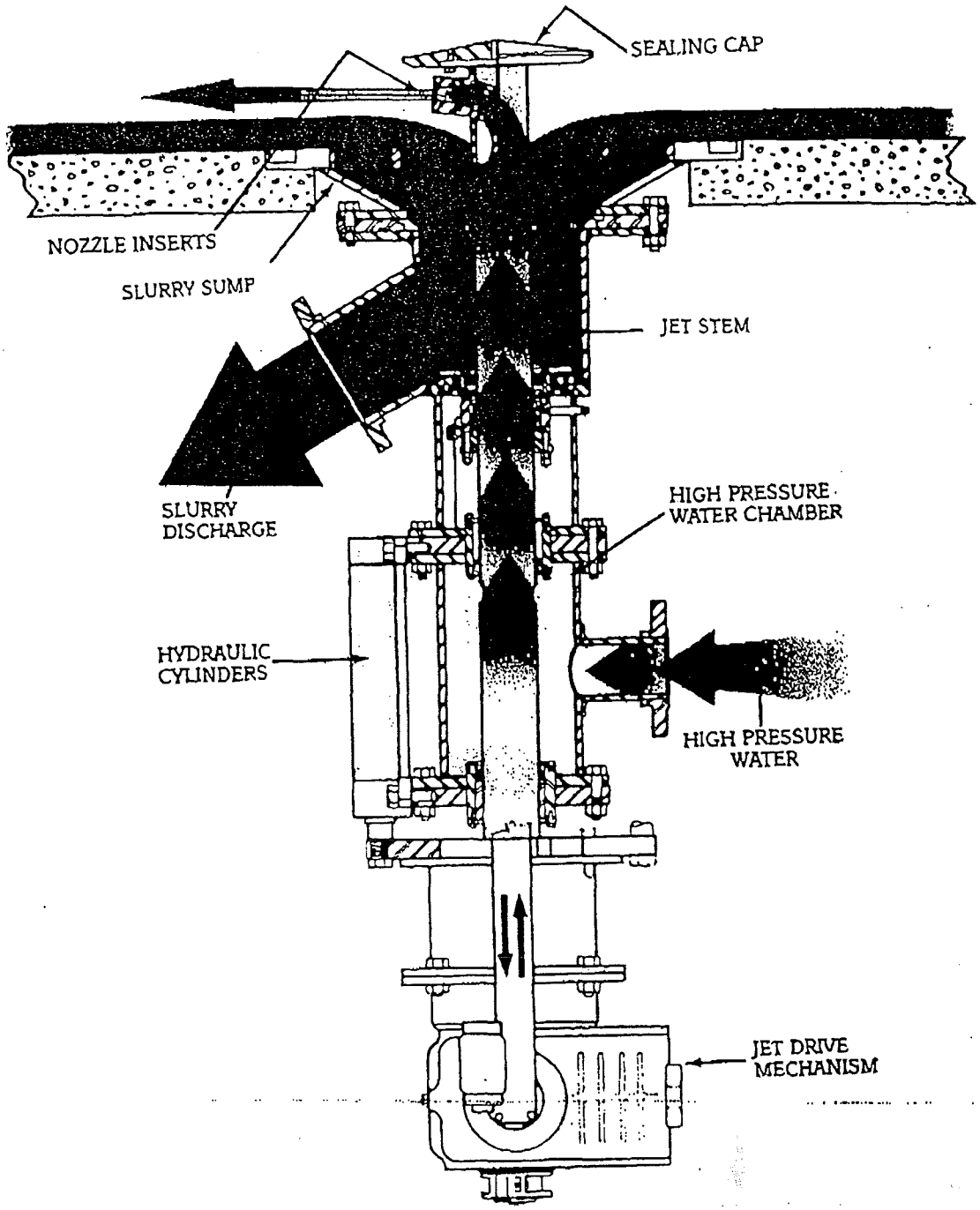
THE ORIGIN OF A CONCEPT

Marconaflo Slurry Systems were born in 1969 of a move iron and other mineral concentrates at a lower co ton. Marcona Corporation, a mining and shipping c first implemented a slurry load and discharge system a own SS Oread. The term Marconaflo, and the specialized technology for materials handling, originated there.

Commercially applicable slurry systems grew fro recognition that each application would involve a dif combinations of materials and operating conditions. constants were the needs to generate a high density slu demand, without pollution, minimize energy cons and capital investment.

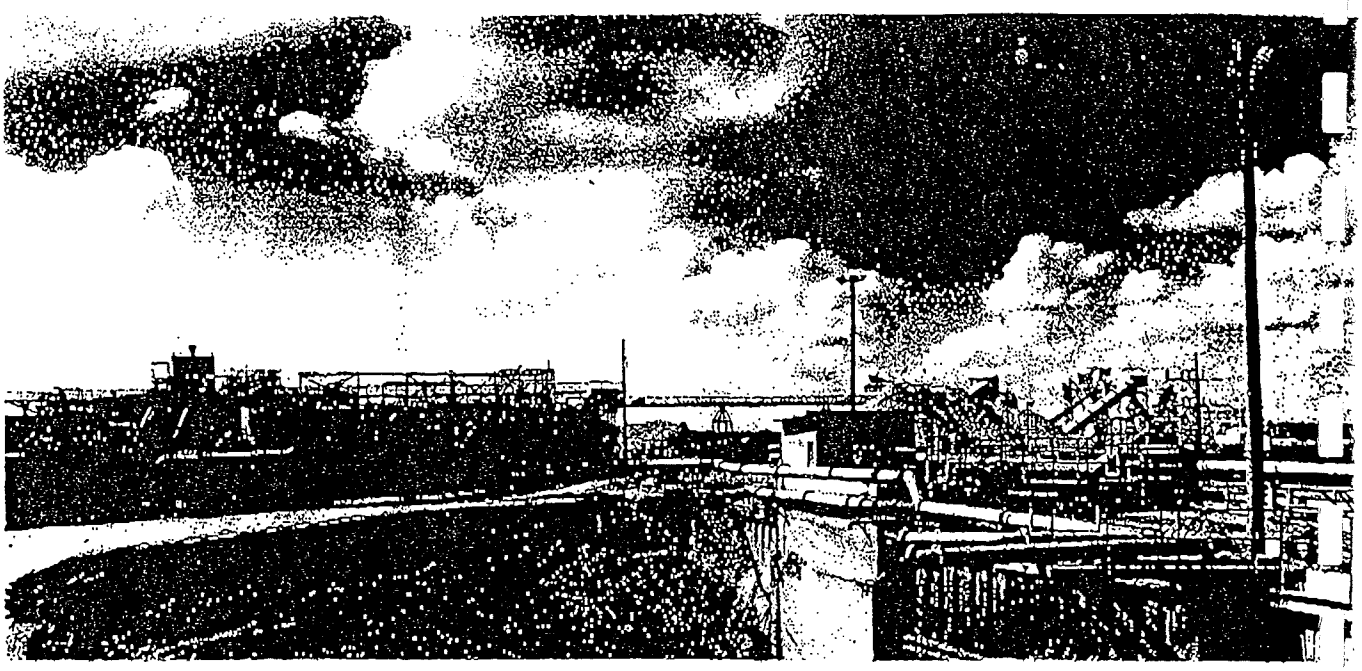
With these parameters established from the outset, Marc Slurry Systems have evolved to meet the needs of power g plants, pelletizing industry, mining, marine transport an

MARCONAJET — SELF-SEALING



GENERAL SPECIFICATIONS			
Size*1	MJ-04	MJ-08	MJ-14
Height (Ft.)	8	10	21
Weight (Lbs.)	2,500	5,000	12,000
Nom. Slurry Cap. Range (GPM)	500-1400	1300-4000	3000-8000
High Pressure Water (GPM)	270-700	600-2000	1800-6000
High Pressure Water Horsepower Based On (250 PSI)*2	75-150	125-450	400-1250
Short Tons Per Hour (STPH)*3	90-260	240-550	530-1450

**1 All values are nominal - will vary with each application.*
**2 MARCONAJETS' stream energy is a function of pressure - will vary with reach and compaction.*
**3 Assumed: Specific gravity of solids = 2.5, 50% solids by weight.*



MARCONAJET—Self-Sealing handles phosphate slurry for International Minerals and Chemical Corp.

The MARCONAJET—Self-Sealing is designed specifically for ponds, bunkers or tanks where it is possible to locate the unit beneath the bottom of the containment, and provide an access tunnel for maintenance. It offers the advantages of continuous discharge even while the containment is being refilled from above, and of close control of slurry density.

The nozzle is cast into a stem, raised and lowered by hydraulic rams. A cap above the nozzle serves as a valve to cut off material flow when the mechanism is lowered, preventing solids from entering and plugging the nozzle, and permitting maintenance of the unit without emptying the containment.

The jet stream always operates at the bottom of the containment, and material collapses into the stream to provide a high-density, uniform slurry which flows to the sump for removal. A hydraulic drive motor rotates or oscillates the jet as it operates. Sides of the containment may be either vertical or sloped. The bottom may be constructed with a slope to provide flow-back to the sump. Because the unit operates at the bottom of the containment, there is no practical maximum depth. As long as there is a minimum of one or two feet of settled material above the jet, new material may be introduced to the containment while the MARCONAJET is operating.

The volume of material which flows to the sump is easily controlled by the height to which the jet with its sealing cap is raised. Dilution water may be added in the slurry sump to control density either automatically or on an operator-controlled basis.

Jets can have a stem diameter of 4", 8" or 14" to suit client requirements for throughput, and can be manufactured of special steels to suit chemical qualities of certain slurri have effective operational radii of up to 200 feet.

APPLICATIONS

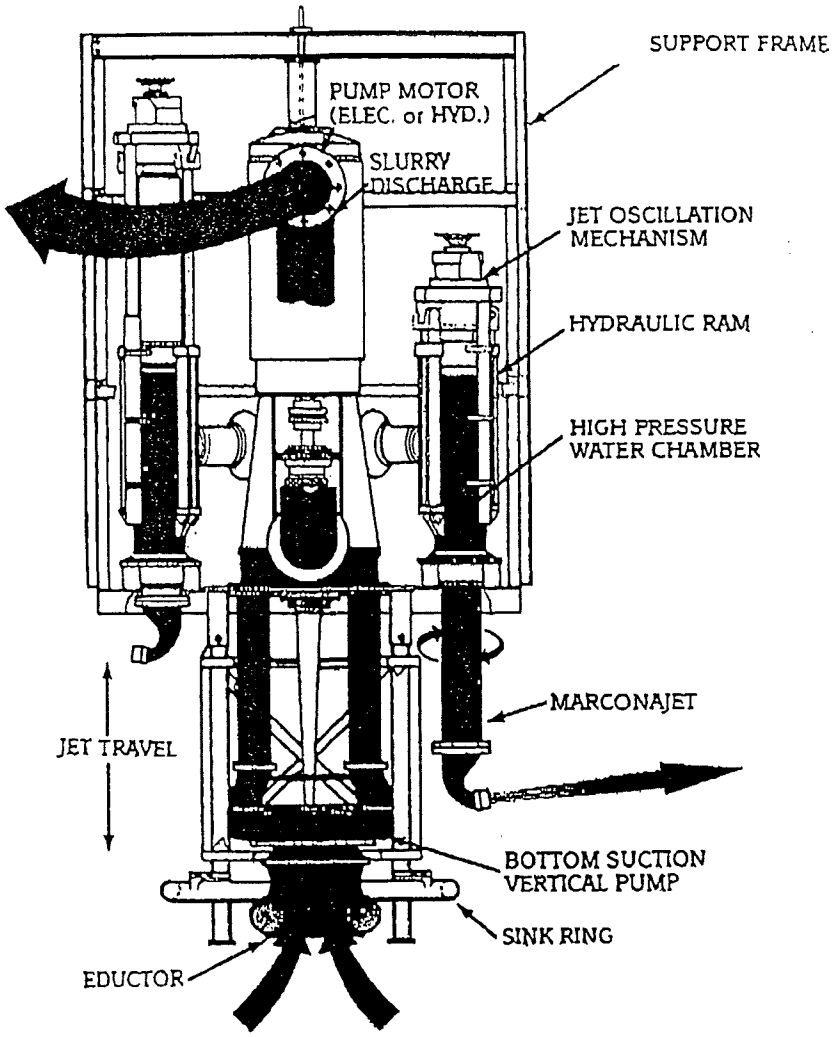
The MARCONAJET—Self-Sealing is currently ha such diverse materials as phosphate rock, iron ore pe sands and pyrrhotite.

Among these installations are four major slurry transfer s at one International Minerals and Chemical Corp. flota in Florida. The systems, two in each of two storage pc separate mines, have resulted in a reduction of 25% requirements for transport of phosphate slurry from was flotation plant, due to constant feed and consistent den addition, they have increased the active storage capacity by repulping material previously left in storage, and desliming due to the high pressure jet wash of phosphate ro

Systems are installed in two-section ponds, approxin feet in diameter and 25 feet deep, with storage capacity o tons of plant material.

A similar MARCONAJET—Self-Sealing installatic Metals Company, Thompson, Manitoba, delivers s underground backfilling operations at a constant densit solids, plus or minus 2%. The system provides an accura over the amount of cement used, with a constant mix, greatly reducing cement costs. It also reduces slimes, wat pumping requirements, in addition to employing the fu of the storage tank in which it is installed. A previous sys operated effectively only if the tank was at least half full.

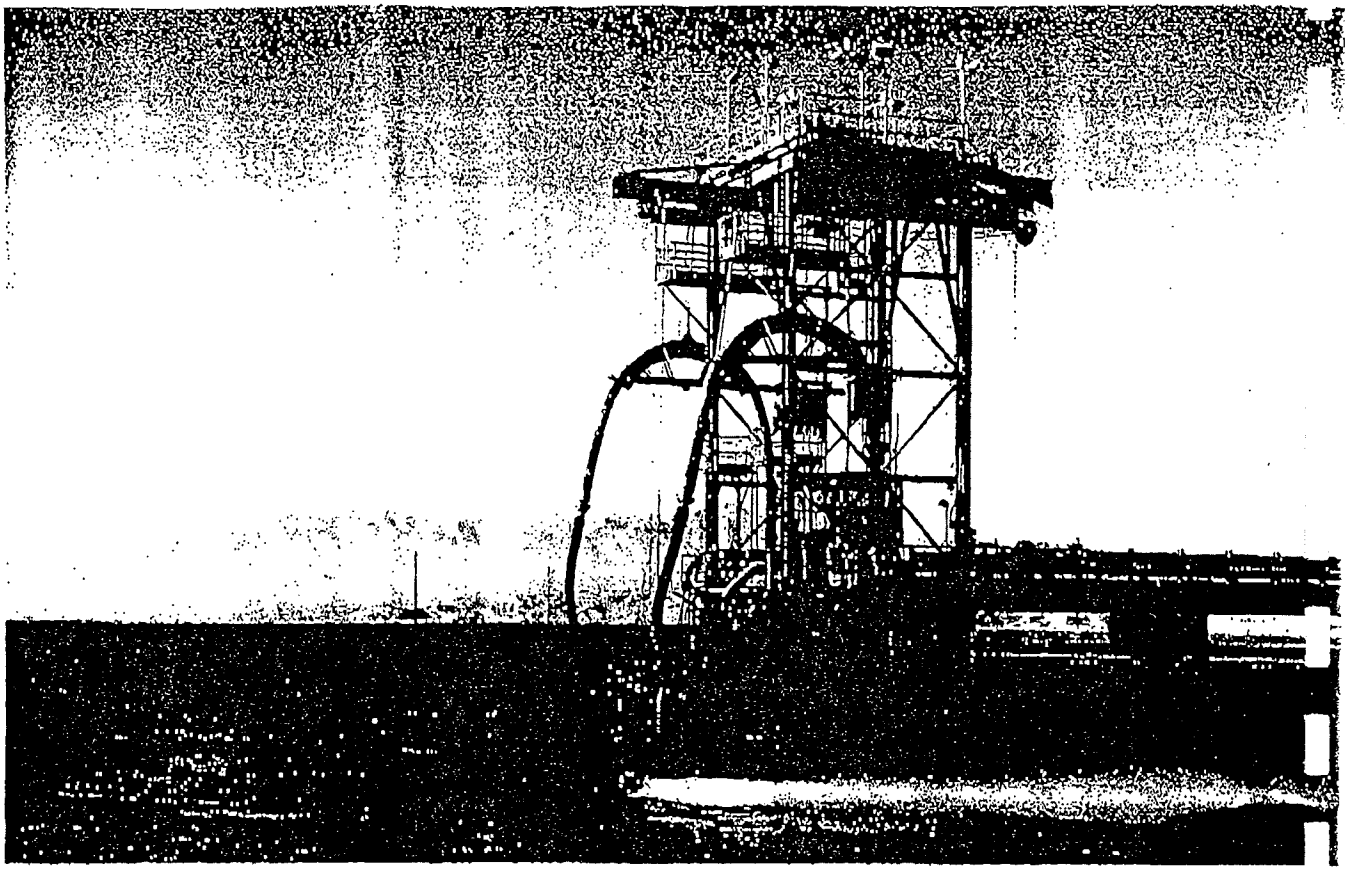
DYNAJET — CANTILEVERED SHAFT



GENERAL SPECIFICATIONS

Size*1	DJ-03	DJ-04	DJ-05	DJ-06	DJ-08	DJ-10	DJ-12	DJ-14
Height (Ft.)	9-10	7	9	11	14	16	19	22
Weight (Lb.)	2,500	6,000	7,000	10,000	13,000	15,000	22,000	28,000
Nom. Slurry Cap. Range (GPM)	200-350	300-450	350-700	600-1500	1200-2200	1500-2500	2000-4000	3000-50
Total Discharge Range In (Ft.) (Of Water)	40-120	40-120	40-120	40-120	40-120	40-120	40-120	40-12
High Pressure Water In (GPM)	100-250	100-350	250-500	400-1000	700-1500	1000-2000	1500-3000	2000-40
Dynajet Slurry Horsepower (HP)	15-30	20-40	25-50	50-100	75-100	100-200	150-350	250- 5
High Pressure Water Horse-Power Based on (250 PSI)*2	25-75	25-100	50-125	100-250	200-350	250-500	350-750	500-10
Total System Horsepower (HP)	40-105	45-140	75-175	150-350	475-450	350-700	500-1100	750-15
Short Tons Per Hour (STPH)*3	25-65	35-80	60-100	125-260	200-390	260-440	350-700	550-11

**1 All values are nominal - will vary with each application.*
**2 MARCONAJETS' stream energy is a function of pressure - will vary with reach and compaction.*
**3 Assumed: SPG of solids = 2.5, slurry concentration 50% by wt. depending on application.*
All DYNAJET models available in Ni-hard or PH55A or 28 CR steel slurry pump construction.



DYNAJET—Cantilevered Shaft, one of three units employed by Southern California Edison to reslurry inventory coal.

The DYNAJET® is a self-contained, portable unit containing from one to four MARCONAJETS, sink jets, flushing jets and a slurry pump. It is designed for use in material removal or reclaim operations which are intermittent, or which involve a number of separate containments. The unit can be furnished with a top or bottom suction pump.

To enhance portability, the slurry pump unit is closely coupled to its motor. Thus the portable DYNAJET, a limited submersible unit, is designed to be lowered by cable from any support mechanism such as a crane or bridge, into the material to be repulped.

Flexible hoses are used between the portable unit and its fixed high-pressure water supply, and to connect with slurry pipework. Units may also be provided with a pendant control box and long cable for freedom of movement by the operator.

Sink jets create a slurry pocket into which the unit is lowered, and high pressure jets begin operation to break down the surrounding settled mass. From one to four jets can be incorporated, and oscillation of each jet can be controlled through drive mechanisms in the self-contained unit.

The DYNAJET may also include an educator jet s assure continuous suction at the slurry pump intake, eve slurry level falls temporarily below the intake. Th p virtually complete vacuuming of material from containr r as ship and barge holds, and eliminates additional cleanr which can be expensive and damaging to the containme

APPLICATIONS

Southern California Edison employs three DYNAJI to reslurry inventory coal previously transported by pipeli Mohave generating station near Laughlin, Nevada. The c units are used in eight storage ponds at the generating st 440 feet in diameter and containing 75,000 tons of coal.

Stored coal is repulped at a density of 50%, solid: f ponds, and pumped at a designed rate of 440 DTPH to t slurry feed system, although rates have exceeded 500 DT extended periods.

The portable DYNAJET currently is employed to barges, ships, tanks, leach vats and other similar containr addition to emptying tailing ponds and storage p removing natural deposits or storage piles.

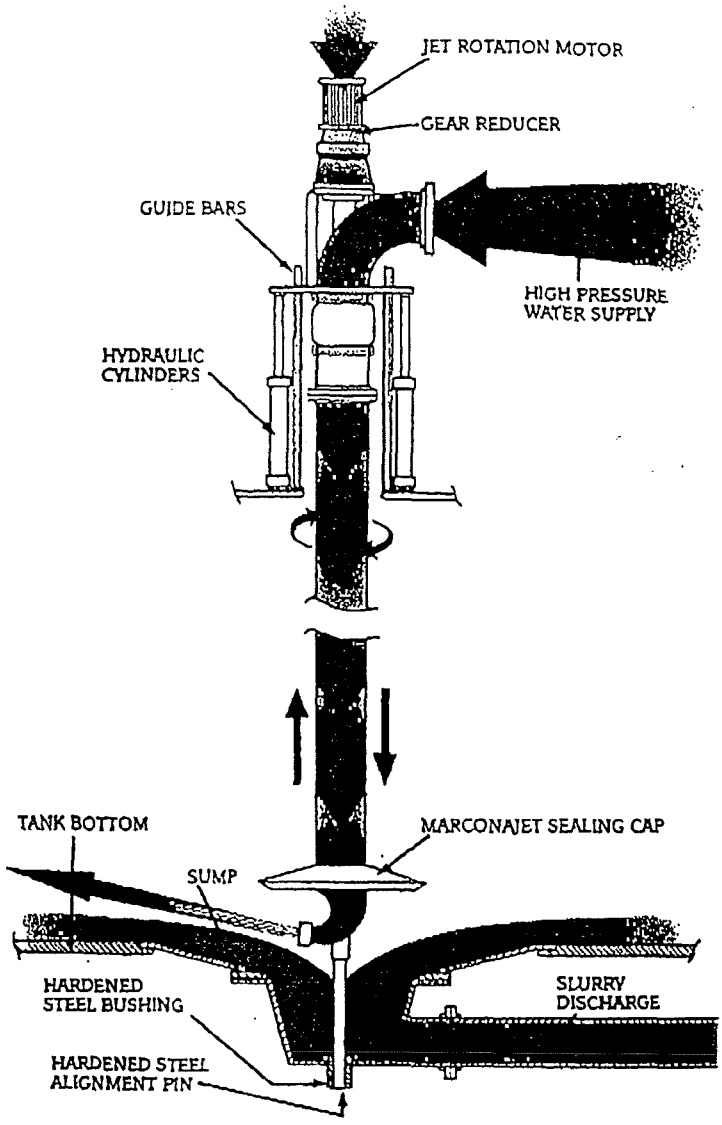
MARCONAJET — TOP MOUNTED

MARCONAJET—Top-Mounted employed in thickeners, agitated tanks and storage tanks, replace agitator mechanisms or paddles in assuring a ready supply of high quality slurry for further processing.

In conventional containments of this type, a bridge structure supports some mechanical means of agitation to prevent slurried materials from settling out. The operation is continuous and, therefore, expensive both in terms of power requirements and in terms of down time and direct maintenance costs. Additionally, power outages or other failures may allow material to settle out and create serious re-start problems.

The MARCONAJET—Top-Mounted involves no operational cost until there is a demand for slurried material for processing. Materials in the containment are allowed to settle out, then reconstituted on demand using a minimal amount of electrical power and virtually eliminating mechanical wear and tear.

There are two types of MARCONAJETS—Top-Mounted. The first is mounted in the containment,with a specially constructed sump which permits the jet to retract along with the sump cap on its own shaft. This type is illustrated at left, and permits the jet to be shut down entirely when not in operation.



A second type of top-mounted jet employs the existing containment outlet and valve. It rotates or oscillates in a manner identical to the first type, and slurries settled materials which in turn flow to the existing drain. A minimum quantity of water may be required to prevent clogging of the exposed jet orifice by settled solids.

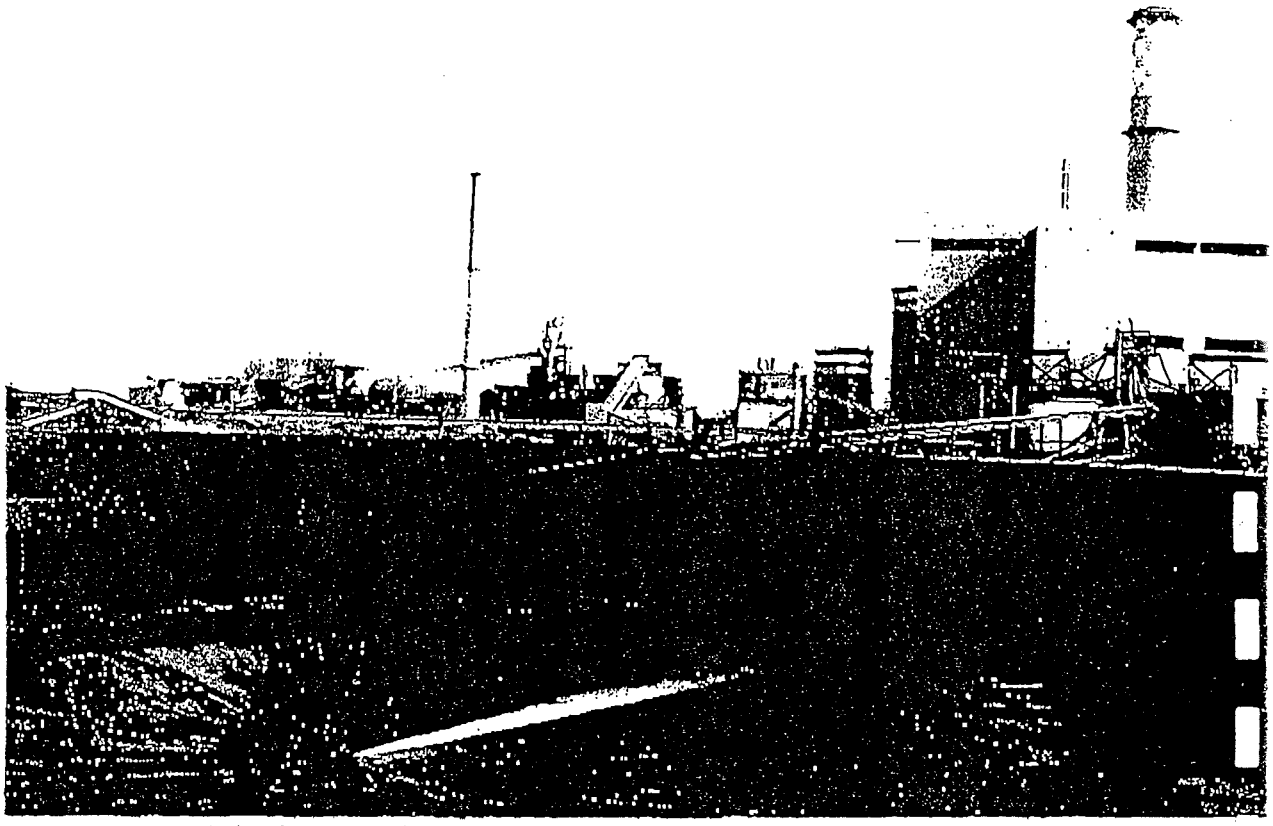
Both systems can have a density control system conn between the sump or outlet and the slurry pump systems offer substantial advantages in operation conventional constant agitation procedures.

GENERAL SPECIFICATIONS

Size*1	MJ-04	MJ-06	MJ-08	MJ-10	MJ-
Height & Weight*2	*2	*2	*2	*2	*2
Nom. Slurry Capacity	200-500	450-1500	1200-2200	1500-2500	2000-
High Pressure Water (GPM)	100-350	350-1000	700-1500	1000-2000	1500-
High Pressure Water Horsepower Based On (250 PSI)*3	25-100	100-250	200-350	250-500	350-
Short Tons Per Hour (STPH)*4	35-80	80-260	200-390	260-440	350-

*1 *All values are nominal - will vary with each application.*
*2 *The height and weight of top -mounted MARCONAJETS are determined by application parameters such as depth of tank.*
*3 *MARCONAJETS' stream energy is a function of pressure - will vary with reach and compaction.*
*4 *Assumed: Specific gravity of solids = 2.5, 50% solids by weight.*

MARCONAFLO SYSTEMS



MARCONAJET-Self-Sealing, for iron ore reclaim.

Will Marconaflo Systems work for you? The range of application for Marconaflo Slurry Systems is so broad that, in all likelihood, you will not find precisely your set of requirements represented here. How can you be sure a Marconaflo System will work for you?

First, you can take assurance from the fact that each Marconaflo System installed has been designed and engineered to the individual specifications of the client. Each has been based on detailed laboratory analysis of variables affecting the design, and on extensive study in the realm of practical application.

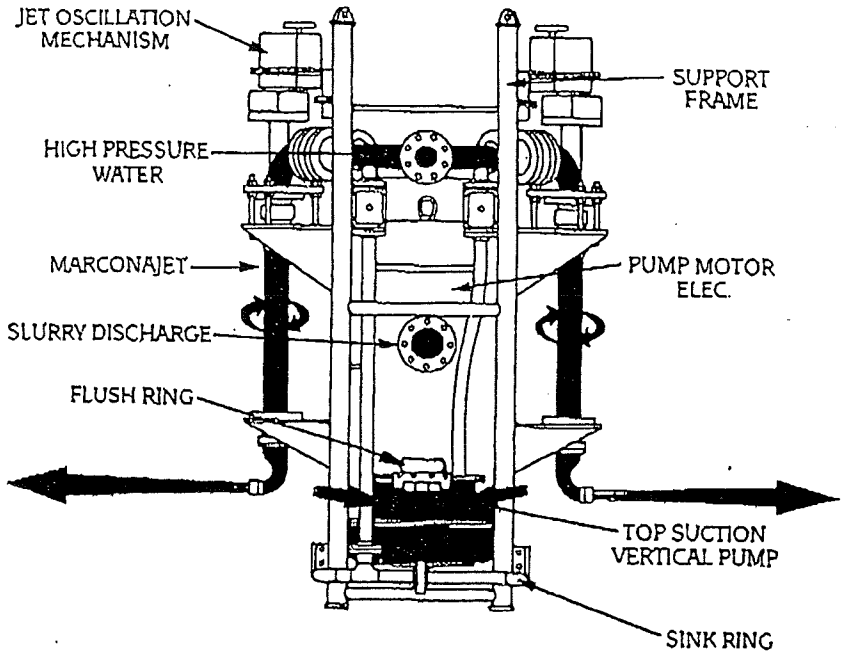
Second, you can take assurance from the Marconaflo track record. Installed systems are successful in a variety of applications from ship loading and discharge to tailings pond recovery, from coal slurry to phosphates. In each case, the Marconaflo System is meeting or exceeding design specifications. In each case, the Marconaflo System is providing operational improvements and cost savings over the previous system.

You needn't guess, though. Provide us information on your needs on the form shown at the right. We'll have a Marconaflo System specialist respond in detail.

DYNAJET – SUBMERSIBLE

Designed to operate when totally submerged, the DYNAJET—Submersible meets the requirements of reclaiming materials at depths up to 85 feet. A submersible slurry pump with either top or bottom suction forms a main part of the unit.

The MARCONAJETS, one to four, are located above the pump intake. They are oscillated hydraulically to undercut the material, thereby creating slurry from settled solids. Sink jets at the bottom of the unit are used to create a cavity beneath the DYNAJET to allow the unit to be lowered to operating depth. Flush jets are directed toward the pump intake to clear debris if necessary and are also used for slurry dilution when required.



A hydraulic power unit is mounted on the unit to open/close valves and to oscillate the MARCONAJETS. Flexible hoses connect the unit to the high pressure water supply and the slurry pipeline. Power and control cables and a control pendant or panel are provided.

The DYNAJET—Submersible can be supported from bridges, barges or cranes to reclaim material beneath a layer of water. The close coupling of motor to pump results in a compact, easy to handle unit where a portable system is required.

The DYNAJET—Submersible can also be appl recovery from tailings ponds or similar types of stored m where significant depths are encountered. In this mode t can be designed for electric operation of all functions.

APPLICATIONS

Two submersible DYNAJETS were provided to r sand as a slurry from a mobile arctic caisson at the rate DTPH and a density of 45% solids by weight. The c has been ballasted with medium sand to resist the fo ice during the arctic winter. Removal of the sand is re to allow movement of the caisson to new drilling locat

GENERAL SPECIFICATIONS

Size*1	DJ-02.5	DJ-04	DJ-05	DJ-08	DJ-10	DJ-
Height (Ft.)*2	6	7	8	10	10	1
Weight (Lbs.)	2,400	3,600	5,600	12,000	12,500	17,
Nom. Slurry Cap.Range (GPM)	150-250	200-400	400-1000	800-2500	1500-3500	2500-
Total Discharge HD Range In (Ft.) Of Water	40-120	40-120	50-150	50-150	50-120	70-
High Pressure Water In (GPM)	100-200	100-300	150-800	300-2000	600-2500	1500
Dynajet Slurry Horsepower (HP)	7.5-15	15-40	40-100	40-180	100-180	150
High Pressure Water Horsepower Based On (250 PSI)*2	20-50	20-65	35-175	65-450	125-600	350
Total System Horsepower (HP)	27.5-65	35-105	75-275	105-630	225-780	500-
Short Tons Per Hour (STPH)*3	30-50	40-80	80-200	160-500	300-700	500-

**1 All values are nominal - will vary with each application.*
**2 MARCONAJETS' stream energy is a function of pressure - will vary with reach and compaction.*
**3 Assumed: SPG of solids = 2.5, slurry concentration 50% by wt. depending on application.*
All DYNAJET models available in Ni-hard or PH55A or 28 CR steel slurry pump construction.

MARCONAFLO MATERIAL HANDLING QUESTIONNAIRE

Company _____ Name _____
Address _____ Title _____
_____ Telephone No. _____
City _____ State _____ Facsimile No. _____
Zip _____ Country _____ Job Site Location _____

We are interested in a Marconaflo System and request a technical evaluation for handling _____ under the following conditions:

A. MATERIAL IMPOUNDMENT AREA

Length: _____ feet
Width: _____ feet
Depth: _____ feet
Estimated total quantity of materials: _____ dry short tons
Depth of surface water (if any): _____ feet

Please include sketch or drawing of impoundment area if available.

B. PHYSICAL CHARACTERISTICS

Material bulk density (dry basis): _____ lb./cu.ft.
Specific gravity of solids: _____
Particle size distribution (top size): _____% _____
Particle size distribution (bulk of mtl): _____% - _____+ _____ mesh
Particle size distribution (slimes): _____% - _____ 200 mesh
In-situ moisture content of material: _____ % by weight
pH of material: _____
General nature of material
(abrasiveness, shape, factor, porosity, etc.): _____

Please include a complete screen analysis if available.

C. MATERIAL FLOW REQUIRED

Dry short tons per hour: _____ DSTH
Dry short tons per year: _____ DSTY
Slurry density control required: YES _____ NO _____
Elevation slurry to be pumped: _____ feet
Distance slurry to be pumped: _____ feet

Please include process flow sheet if available.

D. GENERAL

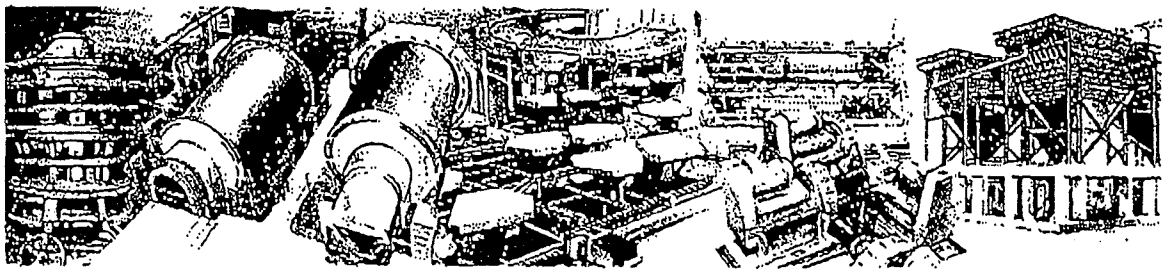
Available Water Supply:

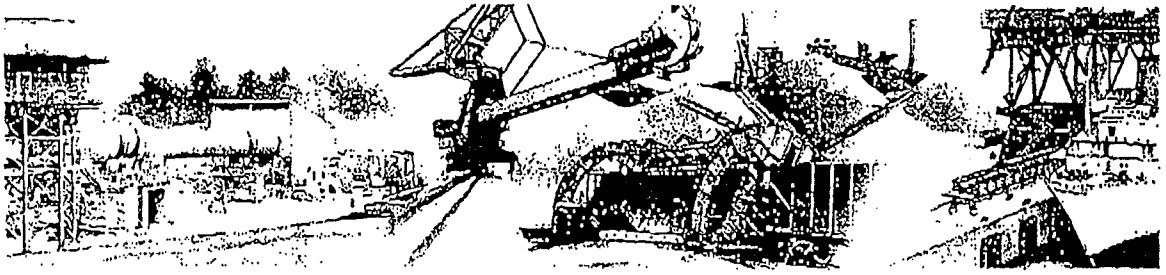
Volume: _____ GPM
Pressure: _____ PSI
pH: _____
Distance from installation site: _____ feet

Available Power Supply:

Phase/Hertz/Volts: _____/ _____/ _____
Distance from installation site: _____ feet

SVEDALA





Svedala supplies the systems and equipment for three core sectors:

- Construction
- Mineral Processing
- Materials Handling

Many well-known brandnames are today part of the Svedala Group, Such as Allis Mineral Systems, Altairac, Marcy, Svedala-Arbå, Balatros, Goodwin Barsby, Braham Millar, Tidco, Barmac, Denver Sala, Dynapac, MPSI, Faço, Conrad-Scholtz, Hardinge, Interconsult, McNally Wellman, Weda Robot, Stephens-Adamson, Kennedy Van Saun and Flexowell.

With headquarters in Sweden, Svedala operates world-wide through about 200 subsidiaries and a comprehensive network of agents and distributors.

SVEDALA
PYRO SYSTEMS DIVISION

350 Railroad Street ■ Danville, PA 17821-2046 ■ Phone: (717) 275-3050 ■ Fax: (717) 275-6789

MARCONAFLO Installation List
Printed - March 16, 1995

COMPANY	LOCATION	MATERIAL SLURRIED	SYSTEM TYPE	MODEL NO.	YEAR
AHMSA	MONCLOVA, MEXICO	IRON ORE CONCENTRATES	DYNAJET	DJ10TS2	1989
AMAX COAL CO.	CENTRAL CITY, KENTUCKY	COAL REFUSE FROM PONDS	DYNAJET	DJ500	1980
AMERICAN CAN COMPANY	HALSEY, OREGON	PAPER MILL SLUDGE FROM POND	DYNAJET	DJ1000	1978
AMERICAN CAN COMPANY	HALSEY, OREGON	PAPER MILL SLUDGE FROM POND	DYNAJET	DJ1000	1980
ATLAS CONSOLIDATED MINING & DEVELOPMENT CORP.	PHILIPPINE ISLANDS	COPPER TAILINGS	DYNAJET		1972
BAMANGWATO CONCESSIONS LTD.	BOTSWANA	PYRRHOTITE	BOTTOM MOUNTED MARCONAJET	4 INCH	1976
BECHTEL NATIONAL, INC.	OAK RIDGE, TENNESSEE	RADIOACTIVE SLUDGE	DYNAJETS	DJ03BC1	1983
CALAND ORE MINING COMPANY	ANTIKOKAN, ONTARIO, CANADA	SAND & SILT	DYNAJET	DJ1000	1976
CANADA MINES LTD.	COBALT, ONTARIO, CANADA	SILVER TAILINGS	DYNAJET	DJ03TC1	1980
CYPRUS METALLURGICAL PROCESSES CORP.	TUCSON, ARIZONA	COPPER	(3) MARCONAJETS		1973
ENVIRONMENTAL LIME COMPANY	DENVER, COLORADO	SPENT LIME	DYNAJET		1972
EXXON DISPUTADA	CHILE	COPPER TAILINGS	DYNAJET	DJ03BS1	1991
FALCONBRIDGE COPPER MINES LTD.	IGNACE, ONTARIO, CANADA	COPPER/SILVER TAILINGS	DYNAJET	DJ1000	1980
FALCONBRIDGE NICKEL MINES LTD.	TORONTO, ONTARIO, CANADA	SAND BACKFILL	BOTTOM MOUNTED MARCONAJET		1980
FERMCO	FERNALD, OHIO USA	RADIOACTIVE WASTE FROM BUNKER	DYNAJET	DJ02.5	1994
FMC CORP.	KANSAS	WASTE POND CLEAN-UP	DYNAJET	DJ03TC1	1984
GILMORE STEEL CORP.	PORTLAND, OREGON	SHIP UNLOADING	DYNAJET	DJ4000	1977
GREAT CANADIAN OIL SANDS	FORT McMURRAY, ALBERTA, CANADA	TAILINGS	DYNAJET	DJ2000	1974
GULF CANADA RESOURCES, INC.	CALGARY, ALBERTA, CANADA	SAND	(2) DYNAJETS	DJ08TS2	1982
HUDSON BAY MINING	FLIN FLON, MANITOBA,	SAND BACKFILL	(3) BOTTOM MOUNTED	MJ04SCH	1981

MARCONAFLO Installation List
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COMPANY	LOCATION	MATERIAL SLURRIED	SYSTEM TYPE	MODEL NO.	YEAR
HUDSON BAY MINING	CANADA		MARCONAJETS		
HUDSON BAY MINING	FLIN FLON, MANITOBA, CANADA	SAND BACKFILL	BOTTOM MOUNTED MARCONAJET	MJ04SCH	1986
INCO METALS CO.	COPPER CLIFF, ONTARIO, CANADA	NICKEL AND/OR COPPER CONCENTRATES	(2) DYNAJETS	DJ05TC2	1983
INCO METALS CO.	COPPER CLIFF, ONTARIO, CANADA	NICKEL AND/OR COPPER CONCENTRATES	MARCONAJET		1978
INCO METALS CO.	COPPER CLIFF, ONTARIO, CANADA	SAND BACKFILL	DYNAJET	DJ06TC2	1990
INCO METALS CO.	COPPER CLIFF, ONTARIO, CANADA	SAND BACKFILL	DYNAJET	DJ06TC2	1992
INCO METALS CO.	THOMPSON, MANITOBA, CANADA	SAND BACKFILL	BOTTOM MOUNTED MARCONAJET	4 INCH	1978
INTERNATIONAL MINERALS & CHEMICAL CORP.	BARTOW, FLORIDA	PHOSPHATE	(4) BOTTOM MOUNTED MARCONAJETS	14 INCH	1974
INTERPACE CORPORATION	IONE, CALIFORNIA	KAOLIN ORE FROM PONDS	DYNAJET	DJ500	1980
IRON ORE COMPANY OF CANADA	CAROL LAKE, NEWFOUNDLAND	IRON CONCENTRATE FROM LAKE BOTTOM	DYNAJET	DJ2000	1977
J.R. SIMPLOT COMPANY	POCATELLO, IDAHO	PHOSPHATE	DYNAJET	DJ04BS2	1991
J.R. SIMPLOT COMPANY	POCATELLO, IDAHO	PHOSPHATE	TOP MOUNTED MARCONAJET	MJ06SCH	1982
KAISER STRONTIUM	NOVA SCOTIA		RAIL CAR UNLOADER		1974
KERR McGEE CHEMICAL CORPORATION	HAMILTON, MISSISSIPPI	CALCINE	MARCONAJET	MJ01DCE	1982
KIDD CREEK MINES LTD.	TIMMINS, ONTARIO, CANADA	SAND BACKFILL	MARCONAJET	MJ04SCH	1981
KIENA GOLD MINES, LTD.	VAL d'OR, QUEBEC, CANADA	SAND BACKFILL	MARCONAJET	MJ04SCH	1983
LOCKHEED MISSILES & SPACE CO.	SUNNYVALE, CALIFORNIA	OCEAN NODULE RECLAIM	(2) DYNAJETS		1978
LORNEX MINING COMPANY	LOGAN LAKE, B.C., CANADA	COPPER TAILINGS	DYNAJET	DJ1000	1973
M & T CHEMICALS, INC.	CARROLLTON, KENTUCKY	TIN SLUDGE	DYNAJET	DJ2BC01	1979
OCCIDENTAL CHEMICAL COMPANY	WHITE SPRINGS, FLORIDA	PHOSPHATE	MARCONAJET		1975

MARCONAFLO Installation List
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COMPANY	LOCATION	MATERIAL SLURRIED	SYSTEM TYPE	MODEL NO.	YEAR
PENA COLORADA	MANZANILLO, MEXICO	IRON ORE CONCENTRATES	(3) BOTTOM MOUNTED MARCONAJETS	4 INCH	1979
PENNSYLVANIA POWER CO.	SHIPPINGPORT, PENNSYLVANIA	LIME SLUDGE	DYNAJET	DJ1000	1979
PHELPS DODGE CORPORATION	MORENCI, ARIZONA	LEACH TANK CLEANOUT	DYNAJET	DJ1000	1975
RIDGEWAY FUEL CORP.	PAINTSVILLE, KENTUCKY	COAL SLUDGE	DYNAJET		1980
SICARTSA	LAS TRUCHAS, MEXICO	IRON ORE	BOTOM MOUNTED MARCONAJET	4 INCH	1975
SICARTSA	LAZARA, CARDENAS, MEXICO	IRON ORE	MARCONAJET	MJ04	1993
SICARTSA	LAZARO CARDENAS, MEXICO	IRON ORE	(2) MARCONAJETS	MJ08SCH	1982
SICARTSA	MEXICO	IRON ORE	(2) MARCONAJETS	MJ08SCH	1985
SOUTHERN CALIFORNIA EDISON CO.	LAUGHLIN, NEVADA	COAL	DYNAJET	DJ3000 (12")	1977
SOUTHERN CALIFORNIA EDISON CO.	LAUGHLIN, NEVADA	COAL	DYNAJET	DJ3000 (12")	1979
SOUTHERN CALIFORNIA EDISON CO.	LAUGHLIN, NEVADA	COAL	DYNAJET	DJ3000 (12")	1988
STAUFFER CHEMICAL CO.	MT. PLEASANT, TENNESSEE	PHOSPHOROUS FROM POND	DYNAJET	DJ2000	1979
TAMPA ELECTRIC COMPANY	TAMPA, FLORIDA	FGD SLUDGE	DYNAJET	DJ06TC2	1981
WESTMIN RESOURCES	VANCOUVER ISLAND, B.C., CANADA	MINE TAILINGS/BACKFILL SYSTEM	(2) MARCONAJETS	MJ03SMH	1985
WESTMIN RESOURCES	VANCOUVER ISLAND, B.C., CANADA	MINE TAILINGS/BACKFILL SYSTEM	DYNAJET	DJ04TS1	1985
WEYERHAEUSER CANADA LTD.	KAMLOOPS, B.C., CANADA	PAPER SLUDGE	DYNAJET		1979
ZELLIDJA S.A.	MOROCCO	TAILINGS	(3) DYNAJETS	DJ1000	1976