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INDUSTRIAL WASTE DIVERSION PROGRAM

EXPANDABLE POLYSTYRENE RECYCLING

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EXPANDABLE POLYSTYRENE RECYCLING

Report prepared for:

Waste Management Branch
Ontario Ministry of the Environment

Report prepared by:

PLAST - EX INC.

DISCLAIMER

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ABSTRACT

This report summarizes the findings of Plast-Ex Inc's expanded polystyrene (EPS) pilot recycling program at both the industrial and post commercial levels. It draws some preliminary conclusions on the economic efficacy of EPS recycling. And also highlights some future requirements that will enable a comprehensive program across Ontario.

INTRODUCTION

Plast-Ex Inc. has been operating a pilot expanded polystyrene (EPS) recycling project over the past four months. During this time period, both post-industrial and post-commercial EPS waste were studied. The findings are presented in this report.

Plast-Ex has always maintained that EPS recycling is economically viable. The objective of the pilot project was to back up this conviction with some operating data. The critics have to be satisfied before the company can successfully launch a comprehensive EPS recycling program across Ontario.

The main thrust of the pilot project was to source a technology to reduce (ie densify) the high volume to weight ratio of the material. The low weight of EPS, coupled with its bulk make it costly to transport. Consequently, very little of the material was being recycled in the past.

The technology that Plast-Ex eventually chose originated from Japan. It employs a wet steam process to reduce or collapse the cell structures within the EPS, making it very dense and economical to transport. The product is a rigid polystyrene lump, which finds a ready market in the Far East.

The scope of this report encompasses both technical and practical considerations. Conclusions have been drawn based on the data obtained. Where conclusions could not be drawn, an explanation is offered. For example, the post-commercial segment was conducted under a very controlled environment, thus the results may not reflect the reality of the matter.

Ultimately, this report would have achieved its objective if it successfully conveys the positive findings of Plast-Ex's pilot EPS recycling project.

TECHNOLOGY

Equipment

The densifier employed was the Jet Steam Packer, Model #500S from Japan. It consisted of a heat chamber, a gas burner, an electric motor driven auger, and an exhaust group. Ancillary equipment included a staging platform, and a water bath system. (Technical information provided in Appendix A)

Installation

Five connections are required to make the densifier operable. There is a electrical power (115VAC, 15 Amp), fuel feed, a water feed, the exhaust, and a water drain.

Process

The heat chamber was brought to a median temperature of approximately 250 degree celsius. The heat was a combination of wet steam and hot air, both generated by the burner. EPS scrap was fed into the heat chamber through a hopper. Contaminants in the scrap were previously sorted out on the staging platform. Once inside, the heat reduced the EPS into a molten form and it dripped settled to the bottom. The auger, located at the base of the heat chamber, pushed the molten sludge through an opening into a rectangular collection pan. The pan was then deposited into a water bath for cooling. The rate of production was approximately 60 Kg/Hr.

End Product

The end product is no longer expanded polystyrene, but rather rigid polystyrene. It assumes the form of the collection pan, and in the case of the pilot, it was a rectangular block of approximately 13 Kg.

POST-INDUSTRIAL SEGMENT

The post-industrial segment is characterized by clean EPS scrap, in substantial volumes, and on a regular basis. The scrap is delivered to Plast-Ex by the generators at their cost. Plast-Ex accepts the scrap without charging a tipping fee.

Source

The following is a list of companies that had provided industrial EPS scrap to the pilot project. They are listed alphabetically by name. Their respective industry's are also provided.

Company	Industry
Canada Cup Inc.	Food packaging
Conference Cup	Food packaging
Fibracan Inc.	Food packaging
Honda of Canada Mfg.,Inc.	Auto assembly
Mitsubishi Electronics Inc.	Television assembly
PlastiFab Ltd.	Form packaging
Polyform Ltee.	Form packaging

Issues

Two main issues emerged from the pilot; logistics and materials. The former arose from the lack of coordination between different departments. In many instances, a dependable estimate of volume was unavailable. This resulted in either of two scenarios; Plast-Ex being swamped with material one week, and sitting idle the next.

Unit production costs would correspondingly increase due to these fluctuations. However, this problem should be tractable over time, as companies begin to view scrap EPS as a commodity, rather than as a waste stream.

The materials issue was more problematic. The densifier was designed to handle the lower density packaging foams. Once the higher density foams, found in food packaging, were introduced into the machine, clogging and sticking occured. The situation arrived to the point whereby the heating vents were being sealed. The operating temperature dropped accordingly, and the rate of production fell. The worst offender was the polystyrene paper(PSP) found in hamburger clam shells.

The problem was finally rectified when packaging foam was mixed with the denser foam. This gave the sludge more liquidity, albeit the rate of production fell.

A more efficient method of solving this problem would be to introduce more volume of heat into the heat chamber to increase the speed of densification, and adding an extra auger. Plast-Ex is designing just such a machine at the moment.

Competitive Edge

Most large generators of scrap EPS haul it to landfill via their own tractors. And given the geographic proximity of the landfill and the EPS recycling centre are approximately equal, it will always be cheaper to choose the recycling option. In the least, the tipping fee is eliminated. However, if the landfill is closer to the source and their tipping fees are still fairly low, recycling remains a non-option. Simple economics dictate whether EPS is recycled or not.

POST-COMMERCIAL SEGMENT

The post-commercial segment is characterized by contaminated scrap, in low volumes, and on an infrequent basis. Examples of these generators are cafeterias, importers, retailers, excetera. Plast-Ex usually charges a tipping fee (ie. $100.00 per 22' truckload) to offset the higher production unit costs of densifying this supply stream. Two reasons exist; first, because of the low volumes, no economies of scale can be achieved during production; and second, the scrap is usually contaminated with foreign items.

The scrap is usually picked-up by Plast-Ex. A pick-up charge is levied on top of the tipping fee.

Source

The following companies participated in the pilot project. Their respective industrys' are also listed.

Company	Industry
Canada Cup Inc.	Cafeteria & office
Capital Records	Importers
I.B.M.	Computer assemblers
Mattel Canada	Toy distributor
Tectrol Inc.	Electronic assembly

Issues

The following issues emerged from the pilot project:

1) Collection infrastructure

2) Contamination

Eventhough the post-commercial pilot was limited in scope, the issue of collection arose. Commercial scrap, more often than not, occurs in small quantities. The questions, "How do you economically collect small quantities of material over a large geographic area?" and "Are the generators willing to store the EPS scrap until a significant quantity is accumulated before pick up?", becomes key to the recycling equation. Further complicating the issue are the volume variances between generators, and the timing of the scrap's availability within the same geographical region. These factors discourage regularly scheduled pick-ups, and increases the transportation cost component.

Contamination take two forms; contamination from non-plastic items and contamination from other plastics. Both forms result in higher unit production costs, and potential difficulties further down the reprocessing stream.

The contaminants have to be manually sorted, thus reducing the rate of production and increasing the labour cost component. Food contaminants also create a health risk problem, not to mention odors, rodents and insects.

In terms of the actual densification process, contaminants are coincidental. They cannot damage the densification equipment, nor alter the process. The contaminants merely become imbedded in the styrene lumps.

Of greater concern is the processing of the lumps further downstream. Metal objects would definitely present a problem to a grinder or an extruder. All contaminants alter the physical characteristics of the re-extruded styrene pellets one way or another, and may render the batch unusable. Thus contamination is more a concern for the end markets rather than the initial densification process.

Caveat

The post-commercial results as they relate to the reycling of cafeteria waste may be unrealistic. The pilot project was undertaken in a highly controlled environment, and the test subjects were relatively knowledgeable in terms of identifying EPS from other materials in the waste stream.

Competitive Edge

There is and there isn't a competitive edge in post-commercial EPS recycling. For minute generators of this material, such as restaurants, the most cost effective method of disposal is still the regular garbage system. However, for companys' such as IBM, the recycling option is definitely cheaper than using a 40 cubic yard bin to transport the EPS scrap to landfill. The bins are simply more expensive and carry less material than a 22' truck.

END MARKETS

Sales to Date

To date, Plast-Ex has sold two 40 foot containers of densified EPS lump to the Far East. This constitutes approximately 40 metric tons of material diverted from landfill. It represents only a fraction of the potential EPS market. The standing order of 800 metric tons per month in hand is a long way from being filled.

The majority of the densified EPS will be destined for the Far East in the near future. Canada simply does not have the non-critical end product manufacturing base to absorb the volume of recycled material. This situation is unlikely to change due to Canada's small population.

Downstream Processing

The densified lumps are shipped to the Far East for further processing. They are first shredded, then grounded and finally compounded with additives form reprocessed polystyrene pellets. These are used as feedstock in the manufacture of items such as cassette and audio casings, picture frames, toys, pots, excetera.

Compounding and repelletizing could take place in Canada. But the processors in the Far East prefer to receive the styrene in lump form. This allows them to tailor the repro pellets to their specific needs. Moreover, their cost of reprocessing is cheaper.

RECOMMENDATIONS

Post-industrial Segment

The recycling of post-industrial EPS scrap can be improved by :

1) Locating the densification equipment at source, thus eliminating the transportation component altogether.
2) Recognition by management that EPS is a commodity and not a part of the waste stream. Communicating this fact to the rank and file.
3) Imposition of an industrial EPS ban at landfill, or raising the tipping fee for EPS disposal to a sufficient level to prompt its recycling.
4) Modification of the existing equipment to suit the Canadian EPS materials situation.

Post-commercial Segment

Viable longterm post-commercial recycling can only take place with proper public education. The mechanism to communicate the recycling message is still in its infancy. It is the joint responsibility of government and industry to promote recycling.

In the short-term, we recommend engaging in another pilot project dedicated strictly to post-consumer food waste. However, it would require the full commitment and financial support government and the coalition of EPS producers and users.

At issue is not whether Plast-Ex's densification technology is viable; we have proven it to be already. The issue is whether an appropriate collection and segregation infrastructure can be set in place. To make this work, longterm commitments must be extracted from all the interested parties. Plast-Ex would be the preferred vehicle to execute this new project.

CONCLUSION

Recycling in general must be market driven. Without end markets, the output of the recycling effort ends up in stockpiles, much like the ill-fated PET project. The illusion created over the collection period is that the material is being recycled, but what do you do with it after? As the volume of material begins to accumulate, it becomes more and more difficult to manage. Desperation sets in, and irrational behaviour result. Good intentions are not good enough in a market driven industry such as recycling.

To preclude the foregoing scenario, Plast-Ex first determined the demand for EPS lumps before it sought the technology and the source of the material. The company is now ever more convinced that EPS recycling is economically viable, especially at the industrial level. However, further studies have to be done to adapt the program to cover all segments of the waste stream.

More specific to the just completed pilot project, the average overall cost of producing one kg of EPS lump came in at $0.515/kg At this level it would appear that EPS recycling is non-viable. However, on closer examination of the data, several factors emerge:

- The process management cost would not exist once the EPS recycling segment is integrated into the rest of Plast-Ex's operation. It would become part of the responsibility of an existing manager.

- The labour component for the pilot project was not maximized due to the low capacity of the test machine. The capacity of the machine can be increased three times without an incremental increase in the number of operating man hours. Also with a larger capacity machine, your storage space requirements are reduced due to the increase through-put.

This all adds up to a lower per unit production cost. (ie. less than one third (1/3) of the existing cost)

APPENDIX A

Technical Information on Equipment

Machinery: Jet Steam Packer - 501S

- 60 kg/hr production rate
- 0.6 kw/hr electrical consumption
- 8 - 12 L/hr kerosine fuel consumption (avg. = 10)
- 115 VAC 15 amp electrical supply
- 400 W, 13 cubic meter/min. exhaust blower
- 400 W, variable speed auger driver
- Approx. 1.35M (H) x 1.28M (W) x 1.73M (L)
- Approx. 1000 kg. weight

Conversion: Conversion from kerosing burner to natural burner. The original plan was to have the conversion done in Japan, however, engineering and modification would mean indefinite delay. As well, additional upgrades would still be required to conform to the Canadian Gas Association's requirment for natural gas appliance.

- Eclipse model #236-JIB-G, 1 million BTU/hr.
- Conversion was made to reduce fuel cost and ease of operation.

Staging Platform: To facilitate sorting prior to densification.

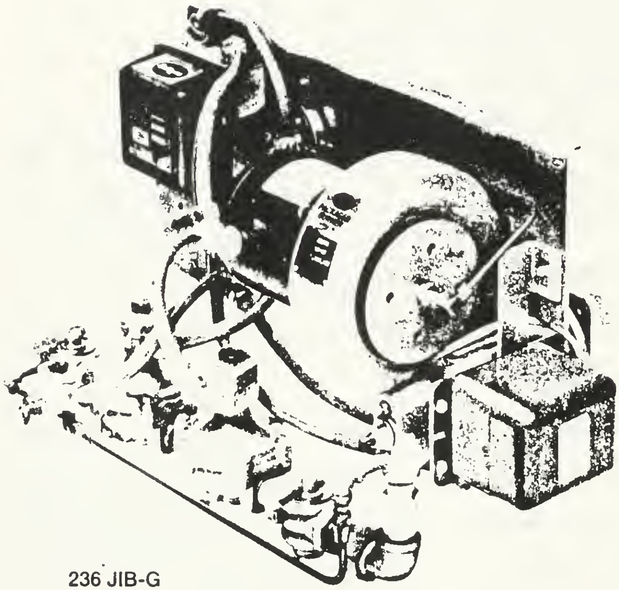
- Custom built
- All steel construction on wheels

Miscellaneous Items:

- Barrel Truck (to handle fuel drums)
- Manual hand pump (fuel)

ECLIPSE
JUNIOR INDUSTRIAL BURNERS

Models 210 & 236 "JIB"



236 JIB-G

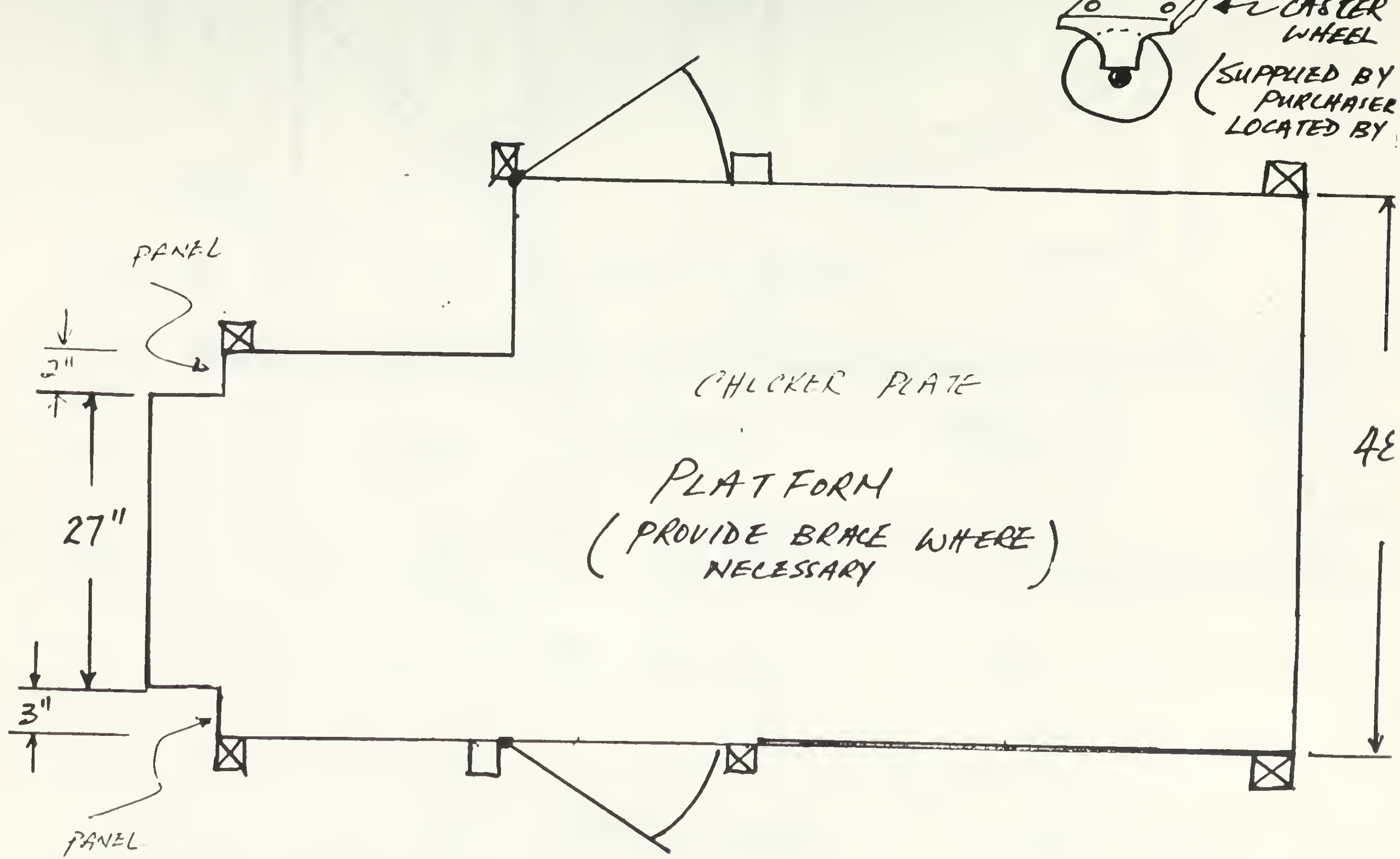
- Easy to install and operate.
- Rugged construction for long life in industrial environments.
- Protection against overheating from residual oven heat.
- Electronic flame monitoring.
- Two automatic gas shut-off valves.
- Air flow proving switch.
- 100% factory tested and adjusted.

Eclipse Junior Industrial Burners (JIB) are packaged burners that are easy to install, simple to operate, and offer long service life in industrial environments. They are fully piped, wired, tested, and adjusted before shipment. To install the burner, simply mount it on the oven or furnace and connect gas and electricity. To operate the burner, just turn the burner switch on or off as required.

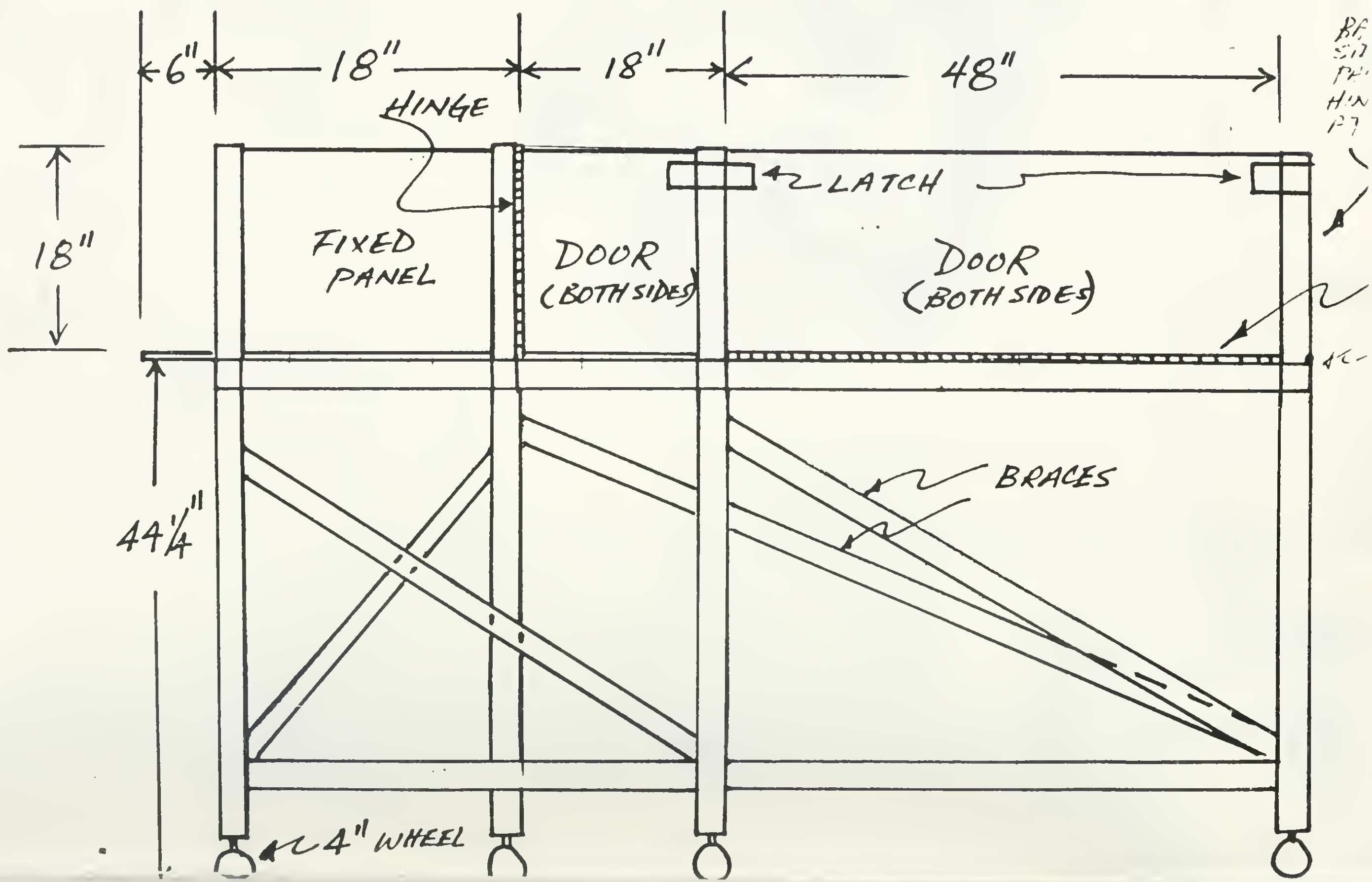
JIB burners feature protection against overheating when the blower is off. Should hot gases flow back into the burner, a thermal switch will start the blower automatically, cooling the burner and preventing damage.

JIB Burners are ideal for use in ovens, furnaces, kilns, or incinerators requiring simple burner operation and easy maintenance.

TOP VIEW


4" CASTER WHEEL
(SUPPLIED BY PURCHASER LOCATED BY
PANEL
CHECKER PLATE
PLATFORM
(PROVIDE BRACE WHERE NECESSARY)
27"
3"
PANEL

SIDE VIEW



6"
18"
18"
48"
HINGE
18"
LATCH
FIXED PANEL
DOOR (BOTH SIDES)
DOOR (BOTH SIDES)
BRACES
44¼"
4" WHEEL

APPENDIX B

Material Information Sheet

Industrial Segments

Volumes are on a per month basis (lbs/month)

Company	Material	Volume	Contaminants
Canada Cup	Cups & trays	18,000	Paper, metal, rubber, other plastics.
Conference Cup	Cups	1,500	Clean
Fibracan	Cups	1,500	Clean
Honda	Pkg trays	16,000	Clean
Mitsubishi	Pkg trays	6,000	Paper, dirt *

*Polyform and PlastiFab bring in Mitsubishi's material on a rotating basis.

Post-commercial segment

Volumes reported are for the full period of the pilot project (lbs)

Company	Material	Volume	Contaminants
Canada Cup	Cups & trays	320	Coffee, food, paper, plastic
Capital Records	Pkg.	500	Paper, scotch tape
IBM	Pkg.	500	Scotch tape
Mattel	Pkg.	1,000	Scotch tape
Tectrol	Pkg.	400	Paper, tape

APPENDIX C

Production Costs Analysis

Industrial Segment & Post-commercial Segments

Note: 1. There is no significant cost difference between the Industrial and the Post-commercial segments of the pilot program except for the additional 0.5 man/hr (1.5 man/hr for industrial and 2 man/hr for post-commercial) required for the Post-commercial segment to separate the extra contaminants (this does not apply to food contaminated waste). Thus, for the purpose of this cost anaylsis 2 man per hour will be the base our calculation.

2. The cost analysis is strictly based on real average cost incurred during the 3 month period of the pilot program. Actual production over time will decline due the integration to the rest of Plast-Ex's operation.

Assumptions : 1) 17 hour production day

less: 0.5 hr for initial warm up.

1.0 hr for lunch and breaks.

1.0 hr for cooling and clean up.

22 days per month = 319 hr/month.

2) The through-put of the densifier is 60 Kg/Hr or 19,140 kg/month (approx.)

3) 2 men were required to operate the machine at approx. $10 per hour per man.

Direct costs ($/month)		
Fuel (@10L/Hr x $0.509/L x 319Hr)	1624	
Utilities (0.4kw/Hr x $0.05/kw x 440Hr)	9	
Labour ($10 x 319hrs)	3190	
Total direct costs	4823	4823
Fixed costs		
Occupancy (15% of total rent + TMI)	825	
Management (1/3 of contract)	3333	
Depreciation (1/12 of 10% of $70000)	583	
Total fixed costs	4741	4741
Repair and maintenance (estimated)		300
Total costs		9864
		=====
Production costs ($/Kg 9864/19140)		0.515

APPENDIX D

Actual vs. Budget

Note: Funding level of 50% is applicable to all costs.

	Budgeted	MOE Max.	Actual
Machine *	105,000	52,500	64,962
Duty and freight **	13,000	6,500	226
Installation ***	11,560	5,780	1,856
Fuel ****			3,511
Labour	28,560	14,280	19,441
Process management	12,000	6,000	10,010
Total			

* Includes: JSP501S & Eclips burner.

** No duty was applicable to this equipment because there is no equivalent Canadian substitute.

*** Includes: Platform and fuel handling equipment.

**** Fuel cost for kerosine burner were neglected on the original application. However, it constitutes a major component of the cost structure.