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TENEMENT:

TENEMENT HOLDER: SLOANES SAND DEPOSIT PTY. LTD

REPORTS:

Plans:

amdel
The Australian Mineral Development Laboratories
Flemington Street, Frewville, South Australia 5063
Phone Adelaide 79 1662, telex AA 82520

Winner of Award for Outstanding Export Achievement, 1975
Pilot Plant: Osman Place, Thebarton, Sth Aust
Phone Adelaide 43 8053
Branch Offices: Perth and Sydney
Associated with: Professional Consultants Australia Pty Ltd

Please address all correspondence to Frewville.
In reply quote:
1/1/226

22 August 1978

Sloanes Sand Depot Pty Ltd,
539 Churchill Road,
KILBURN Sth Aust. 5084

262 1240
380 9086

Attention: Bill Sloane

Dear Bill,

Cyclones

Based on data for Krebs cyclones running at 10 psi with a vortex finder diameter $\frac{1}{4}$ to $\frac{1}{3}$ of the cyclone barrel diameter and 25% solids:

Cyclone Diameter inches	D95* mesh	Flow Rate g/m	Sand Input t/h	Spigot Dia. inches
16	240	375	30	$2\frac{1}{4}$
12	270	250	20	$1\frac{7}{8}$
9	300	125	10	$1\frac{1}{8}$
6	400	53	4	$\frac{1}{2}$

* D95 is mesh for which 95% goes to spigot product.

At 20 psi the cyclone will put through 40% more volume than for 10 psi.

At 20 psi the topsize of sand in the overflow will be 80% of the topsize for 10 psi i.e., higher pressure gives a finer cut.

For different throughputs of sand the product size will change, a higher throughput gives a coarser overflow from the cyclone. For a 12-inch cyclone and 250 g/m it would be approximately:

Sand Rate t/h	D95 mesh	Required Spigot Diameter inches
35	200	$2\frac{3}{8}$
20	270	$2\frac{1}{4}$
%0	325	$1\frac{1}{8}$

The overflow sizing is also affected by the amount of clay in the water and this depends on the clay in the sand and the tonnage rate. The clay content of the water can be measured with a density balance (Marcy scale) or a hydrometer 1.000-1.100 range.

.../2

The pump horsepower can be calculated easily as:

$$\frac{(\text{t/h solids} + \text{t/h water}) \times (\text{feet lifted} + \text{feet inlet head to cyclone})}{8.84 \times \%\ \text{efficiency of pump from curves.}}$$

$$\frac{(30\ \text{t/h solids} + 70\ \text{t/h water}) \times (15 + 30)}{8.84 \times 35\ \text{(allowance for wear and solids in water also)}}$$

$$= \frac{100 \times 45}{8.84 \times 35}$$

$$= 14.5$$

So if you want more tonnage:

(a) you must have large enough cyclone spigots,

(b) the pump horsepower must be enough,

(c) the cyclone overflow will become coarser,

(d) you must also review the size of your conditioner tanks.

Note that $2\frac{3}{8}$ in. diameter is about the maximum size spigot that anyone uses for a 12 in. cyclone.

Unfortunately I did not see your plant operating but I think that:

1. Your product sizing is controlled by the amount of fines which you bleed off as conditioner overflow.

2. Probably (I did not see it) your feed hopper is quite small, requiring frequent topping up with the end loader. A 10 ton bin is the smallest you should use for 10 tons per hour. I can supply a good design for one if necessary.

3. Your circuit could be rearranged slightly to make more efficient use of water.

4. Ammeters for the pump motors would be useful.

5. Your conditioning tank sizes need to be reviewed.

I could add a lot more but really before attempting this I should have all the details of the plant and how it operates, i.e., all conditioner sizes, pump sizes, motor sizes, pump speeds, pipe diameter, and lengths, heights of cyclones, etc. etc. including water pump details.

.../3.

The main point of this note is that I suspect that the main limit on your throughput is the size of your cyclone spigots; and not the size of your pumps or motors. However, you may have other difficulties at higher throughputs in getting the correct grading of product due to the size of your conditioners.

Finally, I must say that I enjoyed your hospitality very much, and was most impressed with the production you are achieving with a lot of hard work, ingenuity and amazingly simple equipment.

Yours sincerely,
The Australian Mineral Development Laboratories

Dave Allen

D. Allen
Senior Consultant.

CC: R. Wildy SADME

DWA:fmf

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In reply quote: 1/1/226

23 August 1978

Mr W. A. Sloane, Manager,
Sloanes Sand Depot Pty Ltd,
539 Churchill Road,
KILBURN, Sth Aust. 5084

Attention: Trevor Bromley

Dear Bill and Trevor,

Drying and Cooling

I calculated the oil which you would need to give the same amount of heat as 7.39 kg of L.P.G. per ton and got an answer of 1.95 gallons per ton. This corresponds to either quite wet sand like 8% moisture, or inefficient drying.

In the recent job in Ceylon we drained a much finer sand to 2% moisture before drying it. If you drain the sand to give 5% less moisture then you will require 3.0 kg less of L.P.G. per ton of sand. The secrets of good drainage are :

(a) drain from right across heap. In the beach sand industry various methods are used for drainage. One operator uses ACI-Nylex pipe called 'Garnite Brown PVS65' which is a corrugated, slotted, plastic, soil drainage pipe. This is set at a good angle for drainage, one pipe every 3 feet and is covered with coarse sand or gravel to a depth of 2 or 3 ft. Resting on the coarse sand is a deck of timber strong enough to support endloader operation, I think 6 in. × 2 in. on edge with 1 in. or 2 in. between each plank and the whole lot bolted together through spacers.
Possibly you could make such a system work without the timber deck if you were very careful with the endloader. If the coarse sand bed is too shallow the pressure from the end loader wheels will crush the slotted drainage pipes.

(b) work with three heaps built up by one or more cyclones. One way to do this is to set one cyclone on a pipe or tower quite high and to have a long, swivelling launder set at 30° to carry the cyclone underflow to each of three heaps. For 20 tons per hour, 7 hours per day, 5 days per week and a drainage time of 1 week then each heap must contain 20 × 7 × 5 = 700 tons. For a 40° angle of repose and a bulk density of 100 lb per cubic foot, the stockpile size would be 33 feet diameter and 14 feet high. The bottom of the cyclone would have to be set 26 feet above the ground. The stockpiles would occupy an area 80 feet in diameter. Your operation is in an area which gets only 17 inches of rain per year. On a 700 ton stockpile,

(b) contd. 007

one inch of rain represents 2 tons of water or 0.3% moisture. Because this figure is so low I don't see any good economics in putting a roof over your stockpiles, just a few troublesome days in the winter months.
You could of course put the three stockpiles in a line with one cyclone for each and set at a height of 14 feet, simultaneously you would save 3.5 horsepower on the pump for the stockpiling cyclone.
This system allows you to make changes to your washing plant while, say, a hired loader driver feeds the dryer from your large stockpiles. Alternatively it allows you to make changes to the dryer while a hired loader driver feeds the washing plant.

An alternative system which is also used by beach sand operators is to continuously filter the sand and feed this straight to the dryer at about 8% to 10% moisture. This has the advantage of only requiring the endloader to feed the washing plant but has the disadvantage of putting high moisture feed into the dryer. The power requirements of cone filters for 20 t/h would be 40 hp total and the purchase price around $100,000. A final installed price could be up to three times the purchase price depending on how elaborate the setup was made.

I favour the simple, open stockpiles even though they require double handling by endloader.

Assuming that the large stockpiles are adopted, then your dryer should have a capacity of 10 tons per hour as follows:

	L.P.G., kg/h		
Item	Countercurrent	Co-current	
10 t/h dry sand 60°F to 260°F	20.0	(200°F discharge)	14.0
2.5% moisture	15.0	(1.0% moisture product)	9.0
exhaust gases at 260°F	2.5		2.5
radiation losses etc.	10.0		8.5
	47.5		34.0

I estimate roughly from your statements that your burner and dryer currently handle around 45-50 kg of L.P.G./h. (You probably have details on the burner which you could let me have.)

Some of the options you have are:

(a) instal a second dryer similar to the first one;

(b) instal a second dryer of similar type with double the capacity of the first one;

(c) instal a completely new type of dryer, for example, a fluosolids or flash type.

(d) instal the 30 ft - 0 in. × 3 ft-9 in. Rotary Kiln from Cawte Industries Ltd, Murray Bridge, S.A.

Because of its low purchase price item (d) is very attractive. Problems with the unit are:

1. Speed is too low, $2\frac{5}{16}$ rev/min suits about 2 tons per hour.

2. Drive is only via the trunnion rollers and this means:

   2.1 horsepower is limited to that transmitted by steel-to-steel friction.

   2.2 the trunnion rollers cannot be lubricated as this would reduce the friction and hence power transmissible.

   2.3 no lubrication means high wear rate on trunnions.

   2.4 the burner capacity is probably too low, as even for well drained sand you will require at least 1.0 gallon of oil per ton.

In comparison with the existing dryer of 20 ft-0 in. × 3 ft-0 in. or 141 ft^3 the 30 ft-0 in. × 3 ft-9 in. shell with 331 ft^3 has 2.35 times as much volume and for the same drying rate would handle 20 tons per hour where 8.5 tons per hour represents the existing dryer capacity. However, the existing dryer has a different firing arrangement with a long flame which permits a higher drying rate than is normally achieved with a firebox heated dryer.

I consider that the Cawte Industries dryer should be regarded as a second 10 ton per hour unit. It should be speeded up to 10 rev/min which would be achieved by driving two or more support rollers at 54 rev/min. To transmit 5 hp at 54 rev/min through a steel-to-steel contact with 0.58 coefficient of friction the weight supported by the steel driving roller would need to be greater than 1150 lb. For a $\frac{5}{16}$ in. shell and 1000 lb of lifters the average weight per roller would be 1310 lb so it is feasible to drive the dryer in this way.

Preferably the drive arrangement should be:

- motor, 5 hp 1440 rev/min
- fluid coupling
- gearbox 54 rev/min output
- flexible coupling
- roller shaft.

For a low temperature product the direction of drying should be changed from counter-current (solids moving in opposite direction to the flame) to co-current. That is both the existing dryer and the Cawte dryer (if used) should be fired from the opposite end, that is fired from the end where the solids are fed in. If this is done you should be able to reliably get a sand product at about ½% to 1.0% moisture and 200°F. This could then be screened at 16 mesh and the undersize simultaneously cooled, further dried and elevated by a fan and cyclone system similar to that used for collecting sawdust in a timber mill. The dry, cool sand would gravitate to a bin to suit its sizing. A series of bins could be arranged in a line or a group which allowed access for the trucks.

Cooling, elevating, drying calculation:

Product rate 20 t/h		or	747 lb/min
Moisture content 1.0%		or	7.5 lb/min
Product temperature			200°F
Required final temperature			110°F
Temperature drops			90°F
Heat in sand	747 × 0.19 × 90	=	12 774 Btu/min
Heat in water	7.5 × 1.0 × 90	=	675
Total heat to be removed			13 449
Air required for transport			10 000 cfm
Air temperature start			80°F
Air temperature finish			110°F

Heat taken by air $\frac{10\ 000}{14} \times 0.25 \times 30 = 5357$ Btu/min

Heat taken by evaporation 7.5 × 1000 = 7500

Total heat taken from damp sand 12 857

Hence, the hot, slightly moist sand can be cooled, dried and elevated in one step.

This requires:

1. 10 000 cfm fan, 10 in. water gauge, 25 hp.
2. Pipeline size for 50 fps is 2 ft diameter.
3. High capacity cyclone 3 ft 6 in. dia. 17 ft 6 in. overall height.

Automatic control of the dryer would be achieved by measuring the gas temperature and using this to vary either the gas flow or the solids feed-rate to the dryer. This method has a very rapid response as a change in feed moisture gives a change in exhaust gas temperature a few seconds after it occurs.

Rapid wear of the air conveyor pipes will occur at bends and also in the collection cyclone if these are not rubber lined.

Five products are produced by Sloanes but the relative annual tonnages are not known. To some extent these tonnages will determine:

(a) wet stockpiles,

(b) tonnage for dry storage.

One operating method would be to have a series of bins of 18 tons capacity which exactly suits 2 bubbles or 1 truckload.

Obviously automatic flow of sand from bin to bin would be required to avoid hourly changing. Six bins of 18 tons capacity are available at Thebarton.

Another method is to have a large bin for the main tonnage plus subsidiary bins for minor production runs on other sizes.

Thus a 140 ton bin could be used for the main volume of product to give one days storage while smaller bins were used to hold special production runs on minor tonnages.

Assuming a bulk density of 100 lb per cubic foot a 140 ton bin would be 3136 cubic feet or 116 cubic yards. For height equal to diameter a cylindrical bin would be 16 ft diameter and 16 feet high. A shallow conical bottom would allow it to empty completely.

For a truck filling height of 14 feet, bin clearance 1 foot, bin gate 1 foot, bin height 16 feet the top of the bin is 32 feet above ground level and the top of the cyclone another 27 feet higher at 59 feet above ground level.

An alternative setup would be to have two 10 ton per hour systems each comprising:

Wet sand bin (1 hour capacity)

Feeder

Dryer

Screen ($\frac{1}{16}$ inch mesh)

Pneumatic cooler/dryer/elevator

Cyclone and fan

Drysand bin.

In this case the main production tonnage would always run and the minor production unit would operate as required on minor production batches as well as some main production.

Assuming 18-20 ton bins each cyclone could feed 3 or 4 bins. For diameter equal to height, each bin is 8 ft diameter and 8 ft high. For half the flow volume of 5000 cfm, each pneumatic pipeline would be in the range of 14 in. - 18 in. diameter and the cyclones 2 ft-4 in. diameter by 11 ft-6 in. overall height. The overall product storage height would be 14 ft for truck, 1 ft clearance, 1 ft bin gate, 8 ft bin, 5 ft to base of cyclone, 12 ft for cyclone, height to top of cyclone 41 ft.

I put these concepts forward to you for consideration and discussion.

Major factors in developing these concepts have been:

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(a) the need to keep capital costs low,

(b) a requirement for unsophisticated automatic control systems,

(c) plant operation by one man.

Obviously there is no point in developing in detail an overall concept which is unacceptable to you.

Summing up the Concept:

1. Large mass flow feed bins for the washing plant and dryers.

2. 700 ton stockpiles with excellent drainage to give low moisture, even feed for the dryers and low fuel consumption.

3. 2 dryers 10 ton/h each with parallel flow drying and simple automatic exhaust gas temperature control of LPG flow to burner.

4. separate vibrating screens on the dryer discharge, 3 ft × 6 ft with $\frac{1}{16}$ in. mesh thermodecks to cope with a hot slightly moist product.

5. ventilation hood with 5000 cfm fan to remove dryer exhaust and screen dust. Approximate fan cost with 10 hp motor is $1700.

6. pneumatic conveying, cooling, final drying systems, one per dryer, 16 in. diameter pipe rubber lined on bends, rubber lined cyclone 2 ft-4 in. diameter high capacity type, 20 hp 5000 cfm blower $2000 with motor, exhaust stack.

7. product storage bins each of 18 to 20 ton capacity, arranged in clusters of 3 or 4 per cyclone, mounted to allow truck access underneath and with simple manual truck filling valves rated at 150 ton per hour.

8. Road system to allow trouble free movement of trucks.

I have not attempted to cost this out accurately as a variable amount of the work could be done by yourself over a period of time. However, it is easy to add up $100,000 for purchases even allowing for things like second hand product storage bins.

The Amdel draftsman is preparing some sketches of the concept for your consideration and these will be forwarded later.

Sincerely,
The Australian Mineral Development Laboratories

D.W. Allen
~~Senior~~ Consultant.

Mr R.W. Wildy.
11.20.0466
Advice & Assistance to Sloan's Sands Pty. Ltd. 012

R
28/8/78

1/1/226

25 August, 1978.

The Manager,
Sloan's Sands Pty. Ltd.,
539 Churchill Road,
KILBURN SA 5084

Attention: Bill Sloan and Trevor Bromley

Dear Bill and Trevor,

Drying and Cooling

I suppose you are wondering why I did not discuss the fluosolids drying and cooling to date.

There are two reasons basically, and they are :-

(a) Cost
(b) Complexity

Looking at cost first, we have:-

Item	Cost $
Fluotherm Dryer	84,000
Fluotherm Cooler	33,000
Total	117,040

To this must be added :
Feeding system - bin and conveyor
Discharge system - conveyor and/or bucket elevator
Water supply for cooling, 250 gpm at 70°F
Floor and foundations
Building
Electrical supply
Design fees for specialised equipment
Commissioning which could easily be 2 days or 2 weeks.

The range of these extra costs would normally be $62,000 to $316,000 to give you a total somewhere in the range $179,000 to $433,000. $300,000 would be an average sort of figure.

To this has to be added:
Screens - if product needs scalping
Storage bins and foundations
New office/workshop/spare parts store.

One way and another I quickly guessed that you could easily spend $500,000 if you go for a brand new deluxe system.

The Development Bank normally only lends up to $300,000 (although there is no firm rule on this) and interest on loans over $100,000 is 13% p.a. reducing. If you got up to $500,000 at 13% over 10 years initially your payments would be $115,000 p.a. or $5.75 per ton of sand at 20,000 tons per year. Put another way, it would require 7,700 tons of sand p.a. to pay for your new installation. You would be forced to achieve high sales to stay in business.

Operating costs would be an additional amount, approximately as follows:

Item	cents/ton	$p.a.
Fuel for drying 2.5% moisture sand	60.0	12,000
Power 100 kw for drying & cooling	17.6	3,520
Maintenance for drying & cooling	7.0	1,400
Total	84.6	16,920

This is equivalent to another 1128 tons of sand p.a.

If you changed over to using furnace oil you could save approximately $5000 per year on fuel purchases. This would require preheating and extra power for blowers amounting to some $500 p.a. for extra power and a much more complicated system.

As regards complexity, the fluosolids system has a lot more instrumentation than you are accustomed to, and it could be a hassle for a while.

Please don't get the idea that I am against fluosolids dryers, I am not. I have spent many years with fluosolids roasters and have watched fluosolids dryers in action and heard excellent reports of their performance. I do however think that you would be better off with a system which you could put together and maintain with the minimum of outside help. This is why I initially put up for your consideration a scheme which is not highly instrumented and to the construction of which you can make a major contribution.

As yet I haven't attempted to work out your overall costs, but I think it is easy to see that you can get in a situation of having to sell an extra 10,000 tons per year just to achieve the same annual profits as at present, due to capital repayments, extra fuel, power and maintenance and extra mining costs completely using up the value of the extra production.

I have not allowed for collection of fine dust in the previous proposal with pneumatic conveying. Depending on the wind direction, dust could be a problem requiring a wet dust scrubber. The elimination of extra fines may of course be beneficial to your sales.

Another thought which occurred to me was to elevate the sand to your bins with a bucket elevator or conveyor and then cool the sand by pneumatic recycling overnight. This would cater for cooling problems in midsummer and may also be required on hot days for the previous scheme.

I will leave any further discussion until after you have seen the sketch. In order to better assess the economics I would like you to provide data on your other cost centres of mining, wet processing, end loader operation, transport of raw sand, transport of product sand and overheads.

Sincerely,

D.W. Allen
Senior Consultant.

DA:pd

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Pilot Plant: Osman Place, Thebarton, Sth. Aust.
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Branch Offices: Perth and Sydney
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Please address all correspondence to Frewville.
In reply quote: 1/1/226
Your Ref.: 11/20/0466

1 September 1978

The Director-General,
Department of Mines and Energy,
PO Box 151,
EASTWOOD, SA 5084

Attention: Mr D. Watkins
Mr R. Wildey

Dear Sir,

Furnace Oil Combuster

Enclosed is a copy of a letter sent to the following manufacturers:

The Manager,
Hamworthy Engineering Aust. Pty Ltd,
Combustion Division,
12 Alban Street,
LIDCOMBE, NSW 2141

The Manager,
Ward E.J. & Co.,
5 Wanda Avenue,
FINDON, SA 5023

The Manager,
Wessberg Martin Engineering Pty Ltd,
820 Port Road,
WOODVILLE SOUTH, SA 5011

The Manager,
D.C.I. Instrumentation Co. Ltd,
27 Neptune Terrace,
ROSEWATER, SA 5013

The Manager,
Major Furnace & Combustion Engineers
(S.A.) Pty Ltd,
30 Jervois Street,
ALBERT PARK, SA 5014.

As mentioned in the letter the information is sought on behalf of Sloans Sand Depot Pty Ltd.

Yours faithfully,
The Australian Mineral Development Laboratories

D.W. Allen
Senior Consultant.

COPY 015

amdel
The Australian Mineral Development Laboratories
Flemington Street, Frewville, South Australia 5063
Phone Adelaide 79 1662, telex AA 82520

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Please address all correspondence to Frewville
In reply quote: 1/1/226

1 September 1978

Dear Sir,

Furnace Oil Combuster

Amdel is providing consulting advice to Sloan's Sands for their intended plant modifications.

Currently, part of their operation involves drying damp foundry sand at the rate of 8 t/h in a counter-current rotary dryer. The fuel used is L.P.G. with a consumption of 7.4 kg per tonne of product sand. This equates closely to 8.9 litres (2.0 gal) of furnace oil per tonne.

Sloanes are interested in the cost savings indicated by the use of Furnace Oil instead of L.P.G.

Two similar capacity dryers are involved and each would consume oil in the range 25 to 125 litres per hour depending on Sand feed-rate and moisture content. A design average rate would be 60 litres per hour.

A burner is required which will avoid any possibility of the sand becoming filmed with traces of oil as such an event would render the sand useless for its intended use. Hence, long flame burners and short flame burners which throw intermittent unatomised drops of oil are both unacceptable. A very reliable hot gas generator is required.

The estimated savings per burner are approximately $2500 per annum, which has to be equated with the extra capital and operating costs of the Furnace Oil burning equipment.

If you manufacture a suitable combustor please reply to:

The Manager,
Sloan's Sands Pty Ltd,
539 Churchill Road,
KILBURN, SA 5084

Attention: Mr Trevor Bromley.

Yours faithfully,
The Australian Mineral Development Laboratories

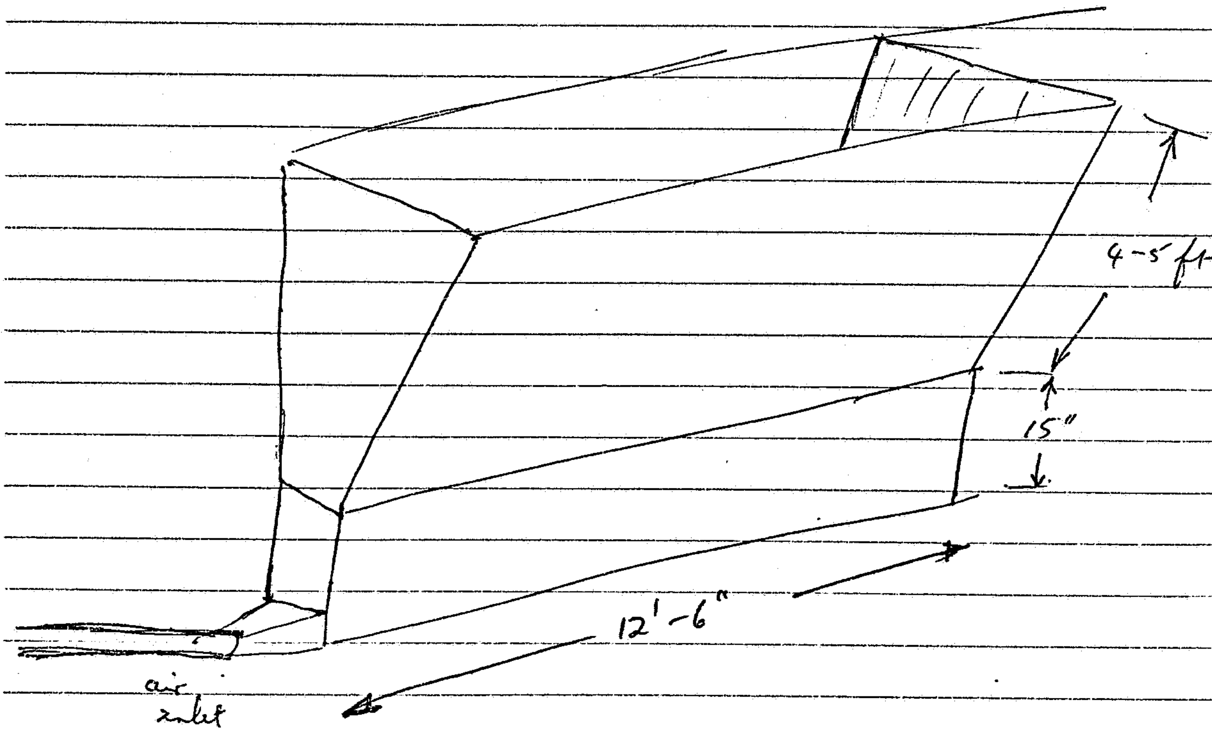
D.W. Allen
Senior Consultant.

FLUOSOLIDS

COOLER CONVEYOR

MARK I DESIGN.

[signature]
3/9/78.



Sketch of fluosolids cooler/conveyor

Design Criteria

Capacity	10 t/h	(tonnes per hour)
Contact time	1 minute	(based on steam filter adiabatic cooling time.)
Air pressure	minimum possible	(low power & also will be coolest.)
Feed moisture	1.0 % nominal	

Design Calculations

Fluidising superficial velocity

From experiences and various references the lowest safe superficial velocity is about 2 feet per second for sand with 1/8" topsize.

Commercial dryers commonly operate at 4 feet per second.

Select 2.5 fps or 150 cfm per squarefoot.

Conveyor dimensions

Bed depth	12"	as this is commonly used for dryers.
Width allow	6"	to keep size & weight down.
Length calculate as follows		

Bulk density of fluidised sand take as 60 lb per cubic foot.

Weight of sand per foot run is

width (feet) × depth (ft) × 1 ft × 60

$\frac{6}{12} \times 1 \times 1 \times 60 = 30$ lb per foot run.

Rate of sand is 10 t/h

$= \frac{10 \times 2240}{60} = 373$ lb per minute

For 1 minute contact need

$\frac{373}{30} = 12 \cdot 6$ feet.

Say 12' 6" or 12·5 ft

Fan capacity

Volume required is area × flow per square foot

$= \frac{6}{12} \times 12 \cdot 5 \times 150 = 937$ cubic feet per mi

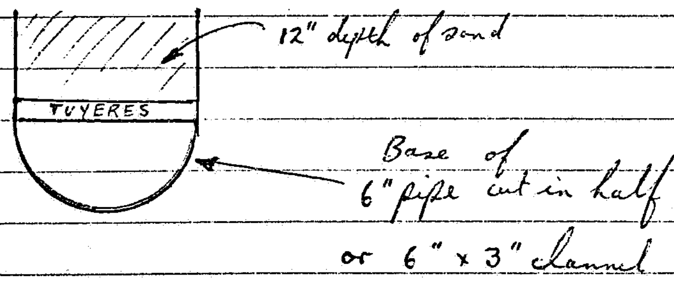
Pressure — to supply
(a) duct losses
(b) tuyere losses
(c) bed losses

Duct losses.

Allow for 1000 cfm.

Allow 10 feet of 6" pipe from fan discharge to cooler/conveyor.
Loss is 0·3" Water Gauge per 100 feet (pipe X^n 0·2 ft²)
0·03" WG for our 10 feet. (85 feet/second.)

Design conveyor cooler like this



The pressure loss along the conveyor will reduce with the length if a fixed size base is used.

Assume the friction in a 6" x 3" channel as being the same as a pipe with the same circumference

Channel 6" + 3" + 6" + 3" = 18"

Circle $\pi D = 18"$ $\therefore D = \frac{18}{\pi} = 5{\cdot}7"$ diameter.

Check for circle of same cross section

$6 \times 3 = 18$ square inches

equivalent area circle $\frac{\pi d^2}{4} = 18$ $d = \sqrt{\frac{18 \times 4}{\pi}}$

$= 4{\cdot}8"$ diameter

Friction for 5" diameter pipe is 0.4" WG/100 ft
So friction in base of conveyor is about 0.04" WG.

Total of duct losses 0.03 + 0.04 Say 0.1" WG.

Tuyere losses.

The air distributors or tuyeres need to have appreciable pressure loss across them to give a stable air flow pattern.

For roasters the tuyere loss is around $\frac{1}{4}$ to $\frac{1}{3}$ of the total of tuyere plus bed loss.

Bed loss is normally about 1" WG per 1" of bed & we selected 12" fluidised depth.

So if 12" is $\frac{3}{4}$ of bed + tuyere then tuyere loss is $\frac{1}{3}$ of 12 = 4"

Tuyere loss 4.0" WG.

Bed loss

As above 12.0" WG

Total fan pressure 12.0 + 4.0 + 0.1 = 16.1" WG.

Obviously we could try running at 6" bed depth & use 8.1" WG.

~~Go~~ we could run at 4" bed depth and use 5.3" WG.

If we take 6" bed depth & we still want 1 minute cooling contact then the conveyor needs to be 25 feet long. The advantages would be less fan horsepower and cooler air from the fan & longer conveyor if we wanted it.
The disadvantages are a heavier, more costly conveyor.

<u>Tuyere design.</u>

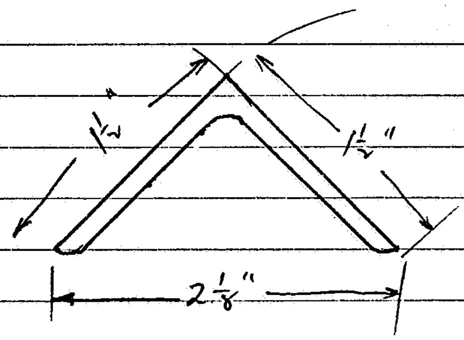
Selected pressure drop 4" WG
Selected flow volume 150 cfm per square foot which means 75 cfm per foot run of 6" wide cooler.

The sand must not run back when the fan is off, base the geometry on 30° repose for dry sand.

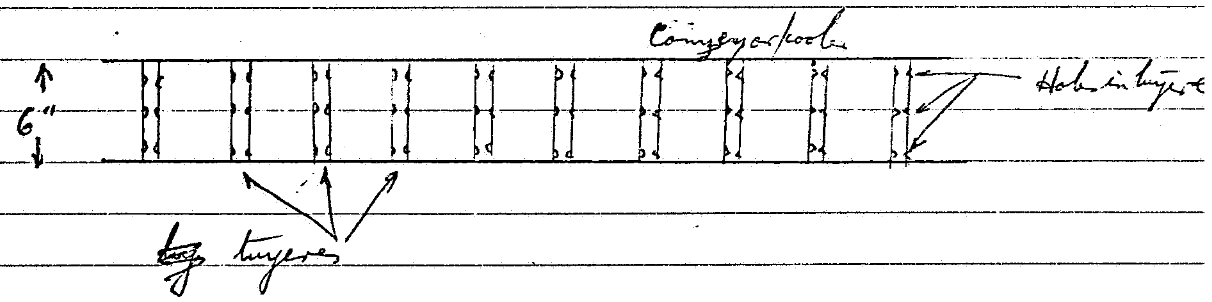
Preliminary calculations show pipe and orifice tuyeres are too clumsy for this job.

A novel design has been conceived which appears to
(a) be simple to manufacture
(b) will not block up
(c) will not run back
(d) has the correct flow rate
(e) has the correct pressure drop.

Select a spacing between tuyeres of about 6"
& use a $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$" angle cut as follows:–



Allow 3 holes each side ~~across~~ along the tuyere length
of 6"



Put tuyere centrelines at 8".

So every 8 inches we have 6 holes.

The area is $\frac{8 \times 6}{12 \times 12} = 0.33\ ft^2$

The flow rate is 150 cfm/ft^2

that is $150 \times .33 = 50$ cfm per 8" or per 6 holes

Each hole must deliver $\frac{50}{6} = 8.3$ cfm.

The formula for an orifice is

Volume = orifice factor × area × velocity

$8.3 = 0.6 \times A \times V$

Velocity is $4005\sqrt{"WG}$ for air — feet per minute

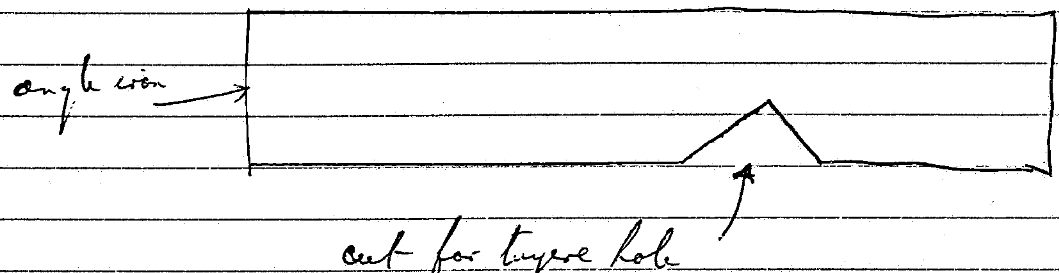
Allow 0.5" WG for feeding air into tuyeres

Allow 3.5" WG for air flow through orifices

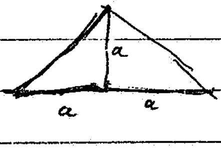
Hence $8.3 = 0.6 \times A \times 4005\sqrt{3.5}$

Therefore $A = 1.846\times10^{-3}$ square feet
$= 0.266$ square inches.

Select a triangular cut into the angle



Area of triangle is $\frac{\text{base} \times \text{height}}{2}$

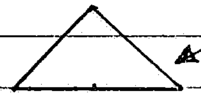
Select 

$\frac{2a \times a}{2} = a^2 = \text{area}$

$a^2 = 0.266$ square inches

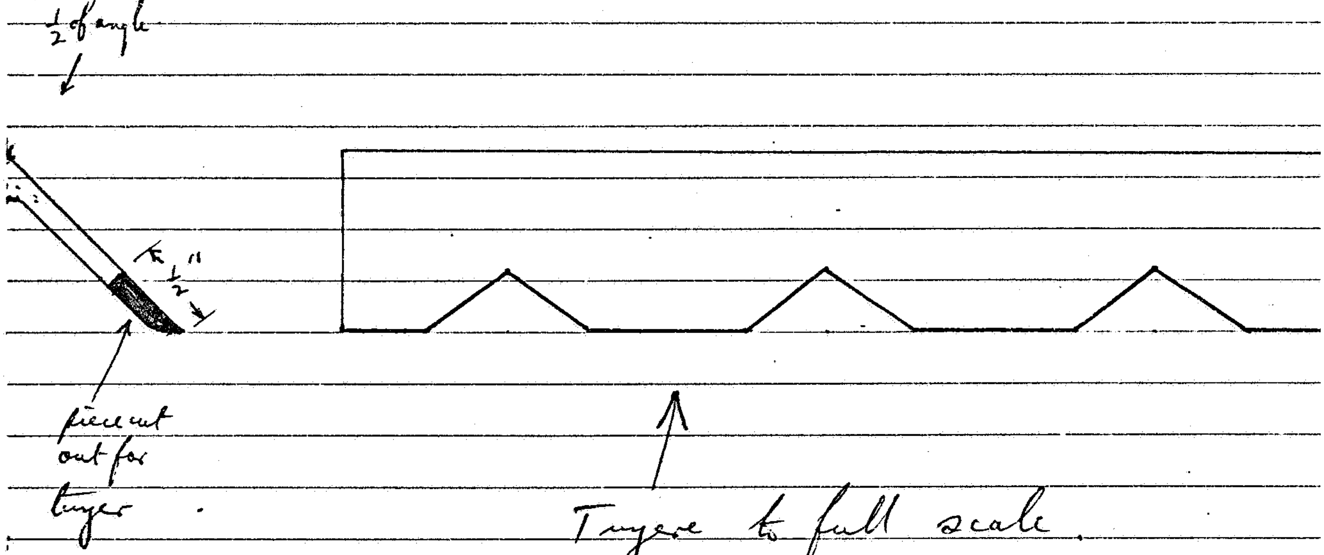
$a = 0.51$ inches.

This gives holes about 1" wide × ½" high like so



These look a bit big but should be OK under 12" of sand.

(If you would like twice as many holes then $a^2 = .133$ & $a = \frac{3}{8}"$ ie. $\frac{3}{4}"$ wide × $\frac{3}{8}"$ high.)



Tuyere to full scale.

for 12'-6" & one tuyere every 8" we need 19 of these.

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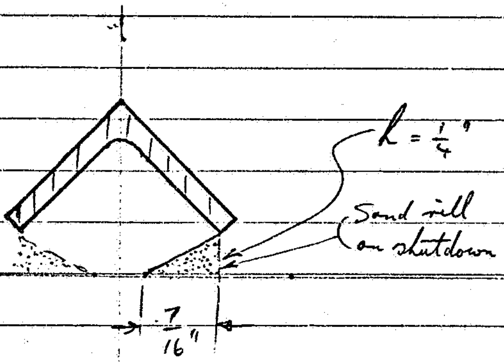
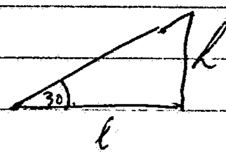
Sand run back at 30° repose.





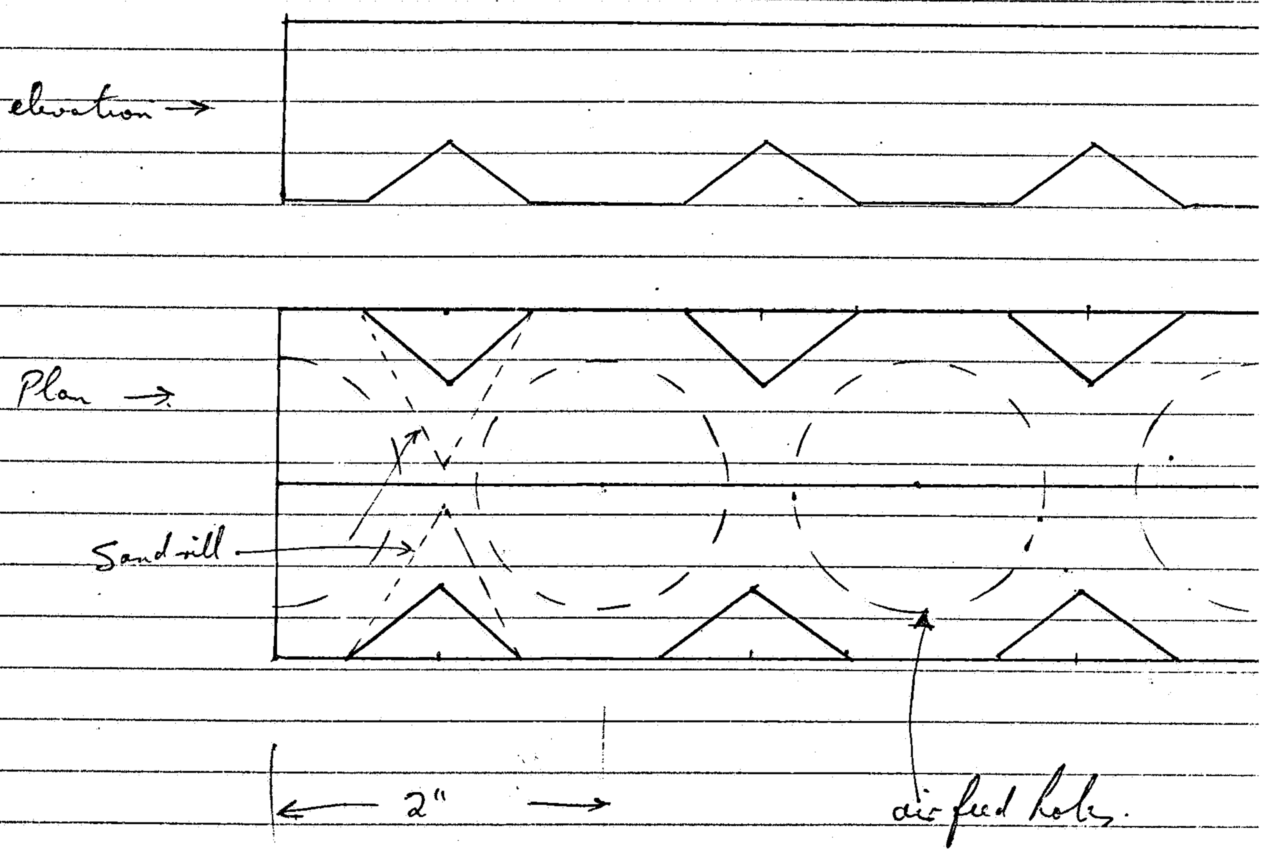
$\tan 30 = \frac{h}{l} = \cdot 577$

if $h = \frac{1}{4}$"

$l = \frac{h}{\cdot 577} = \frac{\cdot 25}{\cdot 577} = \cdot 4$

$= \frac{7}{16}$"

Hence the maximum width of the centre air feed holes can only be $\frac{1}{4}$", or else set the air feed holes in between the tuyere holes.



Allow first try of 3 only 1" diameter holes to feed the tuyere.

Flow 50 cfm for 3 holes or 16.7 cfm each.

$$16.7 = 0.6 \times \frac{\pi}{4} \times \frac{1 \times 1}{12 \ 12} \times 4005 \sqrt{\text{"WG}}$$

$$\therefore \sqrt{\text{"WG}} = 1.27$$

$\therefore$ "WG = 1.6   But we only allowed 0.5.

Try 1.5" diameter holes

$$16.7 = 0.6 \times \frac{\pi}{4} \times \frac{1.5}{12} \times \frac{1.5}{12} \times 4005 \sqrt{\text{"WG}}$$

$\therefore$ "WG = 0.32   = OK.

Dust escape.

The superficial velocity of 150 cfm / ft² or 2.5 feet per second will carry over sand of 100 mesh and finer.

This represents a major proportion of your sand.

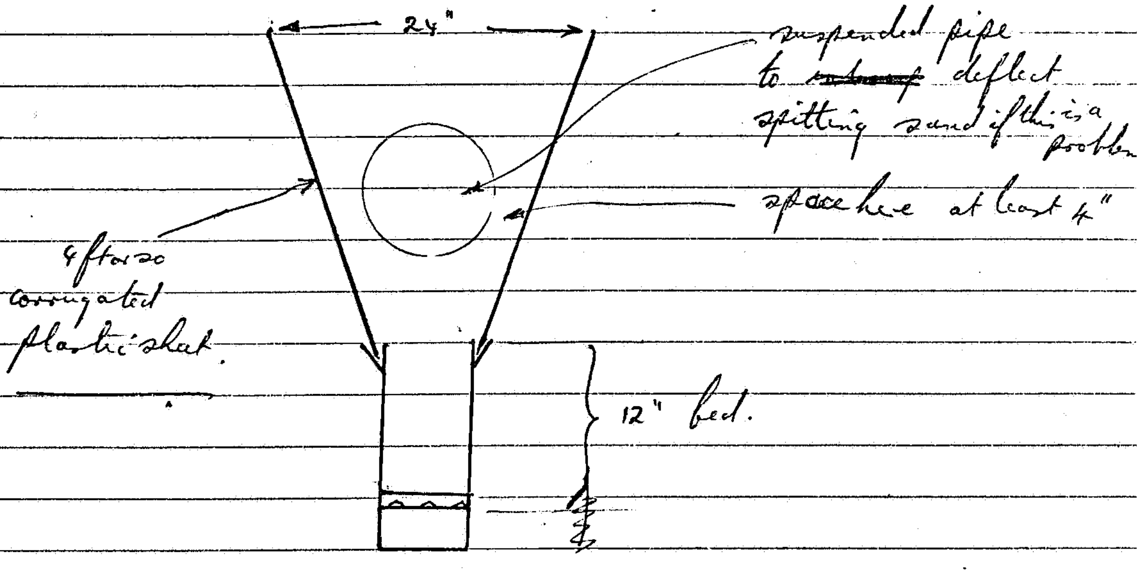
Hence arrange to reduce the carry over to − 300 mesh if possible.

Require 0·6 fps superficial velocity from 2·5 fps in the bed.

Hence cross section must be 4 times ie width 4 times.
ie. instead of 6" wide go to 24" wide.

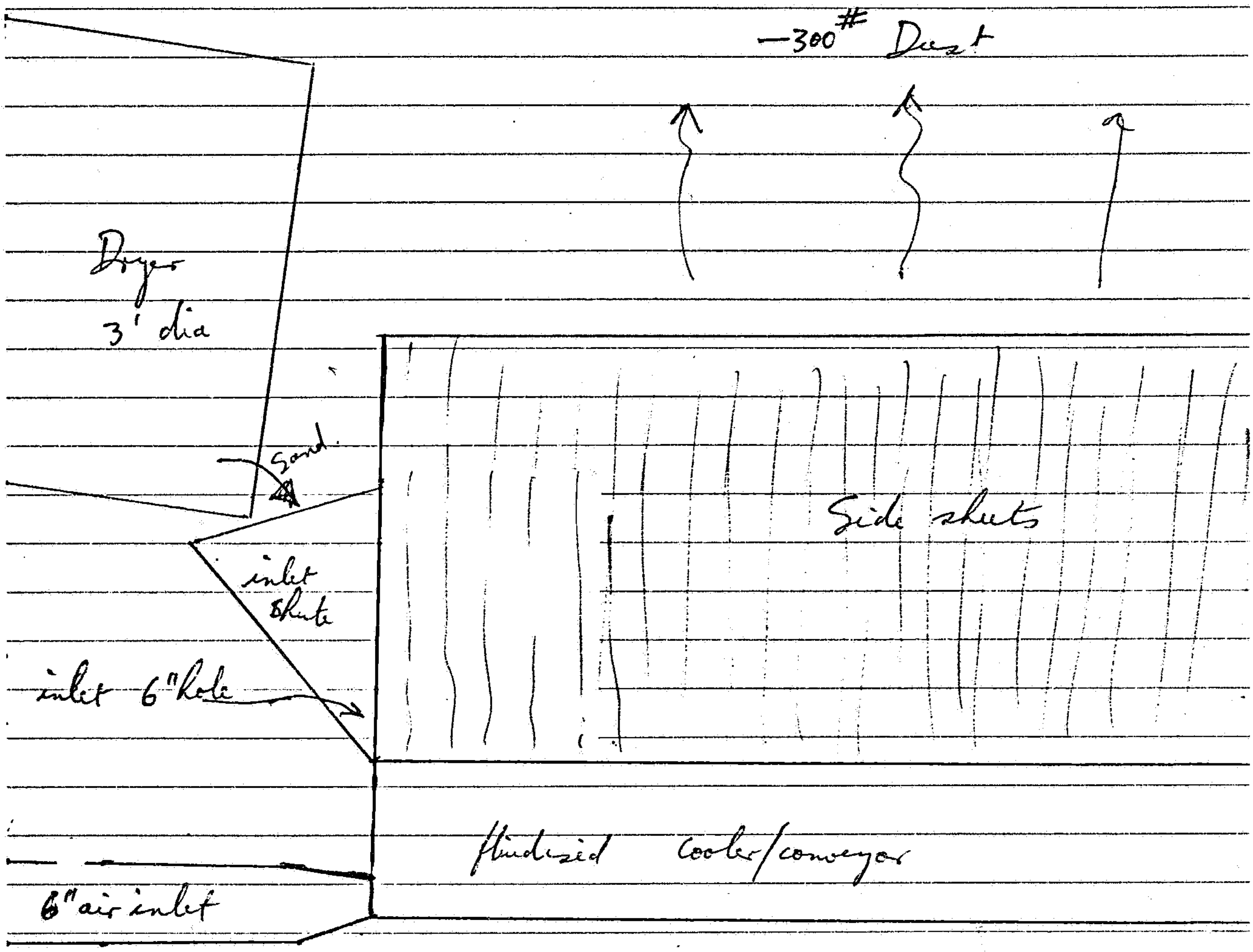
The side angle need to be steep enough to let the sand fall ~~tha~~ back, so the sides need to be at least 45° or 18" long.

As the sand will spit up quite a bit 4 ft or 5 ft plastic corrugated sloping sides could be used.

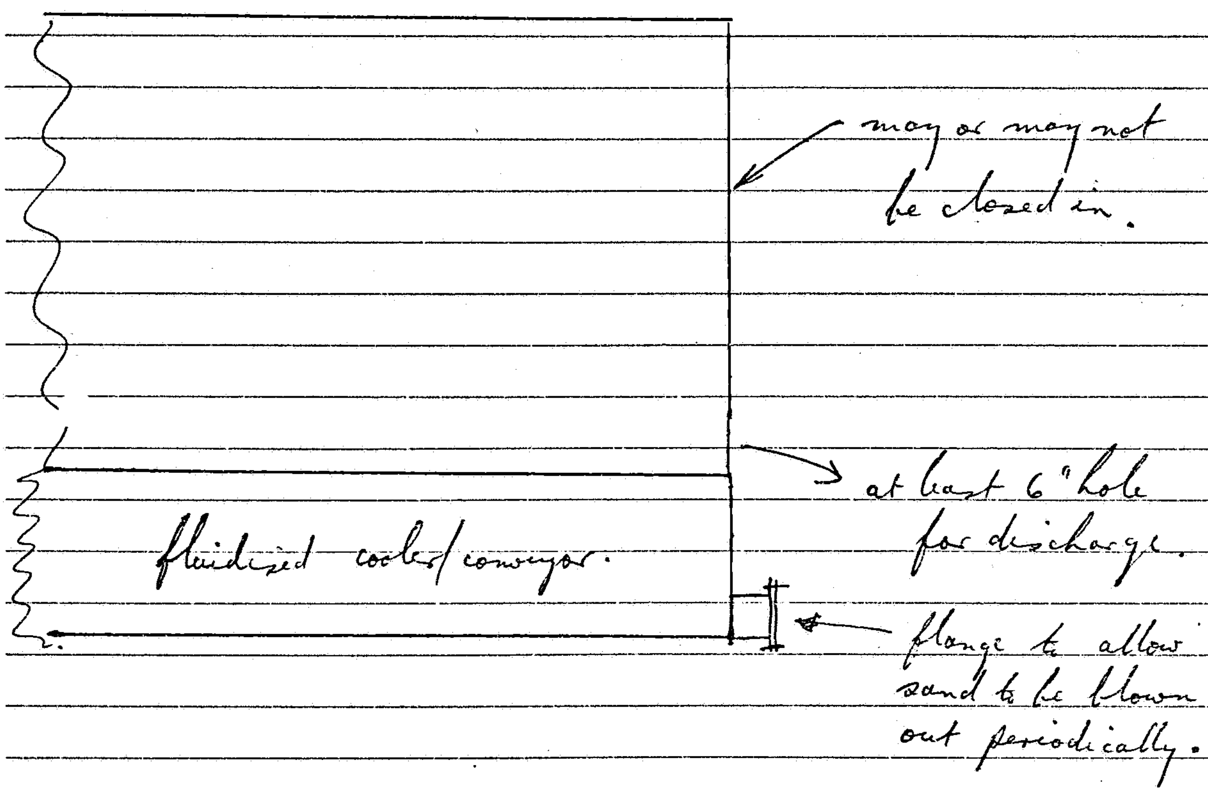


N.B. Condensation on the suspended pipe (if it is used) could be a problem.

Feed end.


-300# Dust
Dryer
3' dia
sand
inlet
shute
inlet 6" hole
Side sheets
fluidised cooler/conveyor
6" air inlet

Discharge end.



Speed along conveyor.

1 minute contact for 12.5 feet
that is 12.5 feet per minute
or 2.5 inches per second.

This is quite slow & the cooler should not require much tilt, if any.

Heat balance.

Assume sand enters cooler at 200°F & 1% moisture

Heat in sand above 100°F is

$(200-100)$ × 0.22 × 373 = 8206 BTU/min.
temp diff — specific heat — lb/min

Heat in moisture on sand above 100°F is

$(200-100) \times 1.0 \times 373 \times \frac{1}{100}$ = 373 BTU/min.

Total heat in = 8579 BTU/min.

Heat taken by the water as it evaporates

3.73 × 1006 = 3752 BTU/min.
lb/min — BTU/lb
(1% of solids)

Remainder = 4827 BTU/min

Hence the sand will be at $\frac{4827}{373 \times .22} + 100 = 159$°F
when the water has all evaporated.

The air at 937 cfm represents

937 ÷ 14 = 67 lb per minute.

Specific heat of air is 0.25

If air & sand are just mixed thoroughly then we have

$$67 \times 0.25 \times x = 373 \times 0.22 \times y.$$

$$16.7x = 82y.$$

& if the air starts at 79°F and the sand at 159°F then $x + y = 80$

$$16.7(80-y) = 82y. \qquad 1336 = 98.7y.$$

$$y = 13.5$$

The sand temperature would fall to 159 − 13.5
= 145.5°F.

However the time effect is different as there is a progressive cooling effect!

Also the side wings of the conveyor/cooler will let out some heat.

Also if the moisture is allowed to be 2% at the dryer discharge then the cooler discharge should be about 100°F

This would save fuel to the dryer.

By proper drainage to say 3% moisture
drying to 2% moisture
cooling to 0.2% moisture

The dryer only has to heat the sand & drive off 1% water.

Dryer

Sand feed 10 t/h = 373 lb/minute

Heat from 70°F to 210°F = 140°F rise.

Heat required = 373 × 140 × 0·22 = 11 488 Btu/min.
= 689,280 Btu/hr
= 68,928 Btu/tonne.

1 kg LPG is 47,070 BTU

Hence LPG to heat up sand = $\frac{68928}{47070}$ = 1·46 kg/tonne

---

Water with the sand is 3% = $\frac{3}{100}$ × 373 = 11 lb/min.

Heat from 70°F to 210°F = 140°F rise

Heat required to heat up water = 11 × 140 × 1·0 = 1540 Btu/min

LPG = 0·20 kg/tonne

Heat to evaporate 1% of water = 3·73 lb/min.

3·73 × 1006 = 3752 BTU/min

LPG = 0·48 kg/tonne.

Heat lost to combustion air & excess air heated & sent up ~~st~~ as exhaust

Allow 70 lb of air per kg of LPG.

Exhaust gas at say 300°F

(300 − 70) × 70 × 0.25 = 4025 BTU/kg LPG lost

say 10% of LPG used.

Radiation & convection losses from dryer shell

Allow 1.5 BTU / hr ft² °F

Shell area = 20 × π × 3 = 188 square feet.

Heat loss rate 1.5 × 188 × (200 − 70) = 36757 BTU/hr

= 3676 BTU/tonne

LPG = 0.1 kg/tonne.

Allow convection ~~as~~

Velocity say 18 rpm

= 18 × π × 3 = 170 fpm = 2.8 fps.

Allow convection losses as for radiation losses

LPG = 0.1 kg/tonne.

LPG			
	To heat sand	1.46	Kg/tonne
	To heat 3% water	0.20	
	To evaporate 1% water	0.48	
	Shell losses of dryer	0.20	
	Sub total	2.34	
	Add 10% for exhaust gases	.23	
	Total	2.57	

So there is a big prize to be gained from

1 Well drained sand

2 Using cooler/conveyor to evaporate 2% of water while cooling the sand.

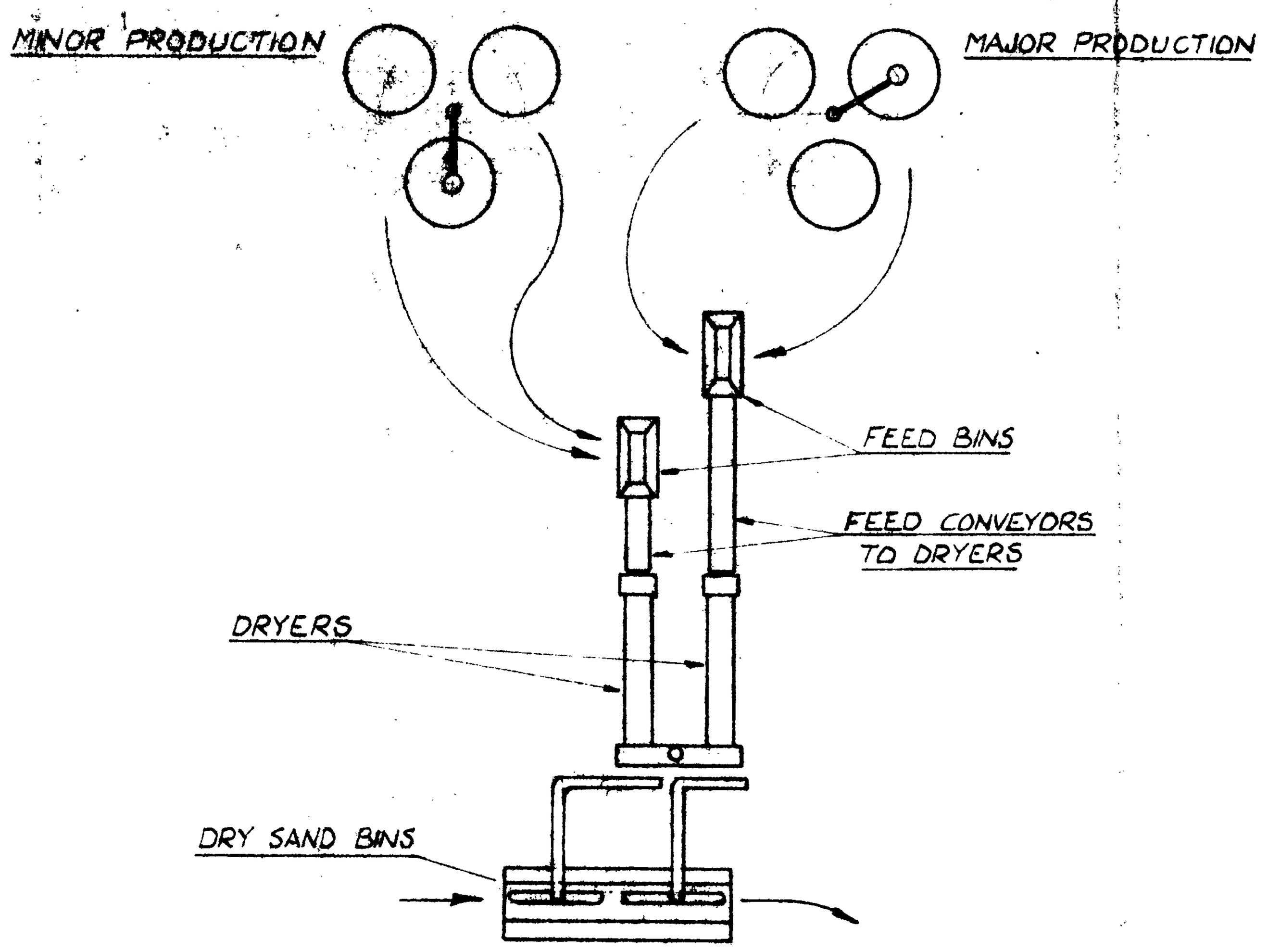
It will be important to have steady feed rate and steady moisture (large stockpiles) to achieve low fuel consumption reliably.

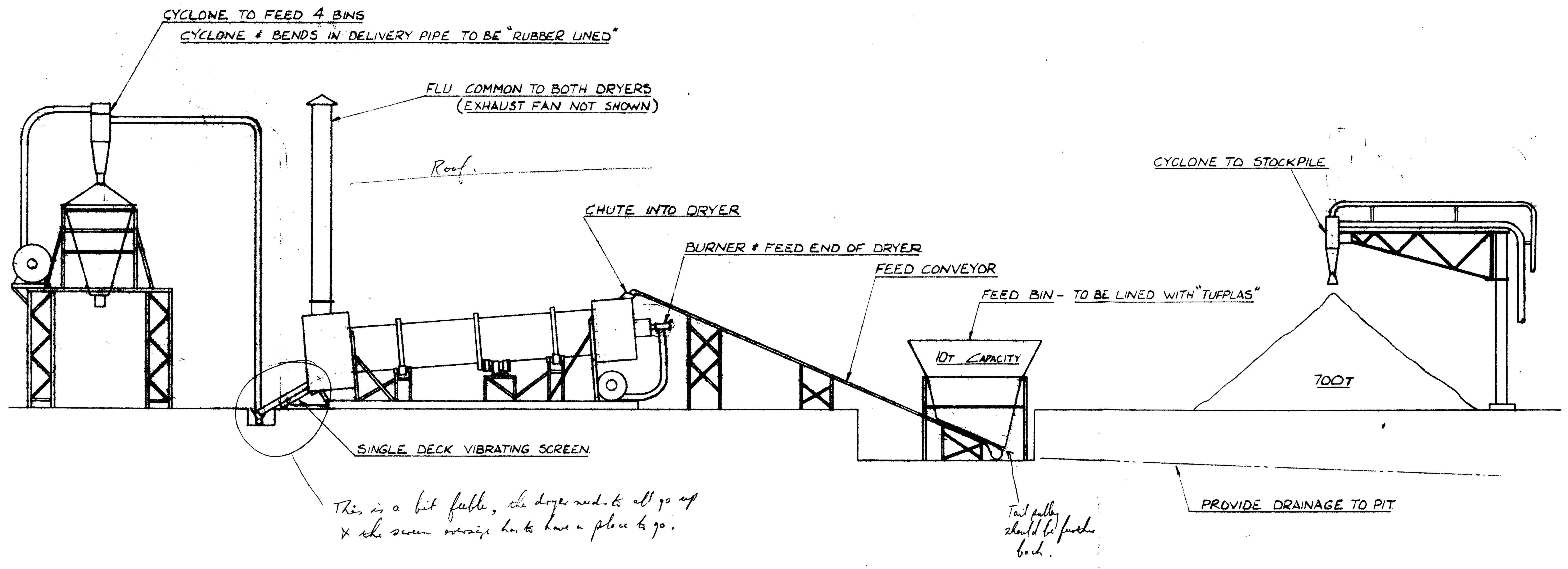
Plus several instruments.
Plus co-current firing!

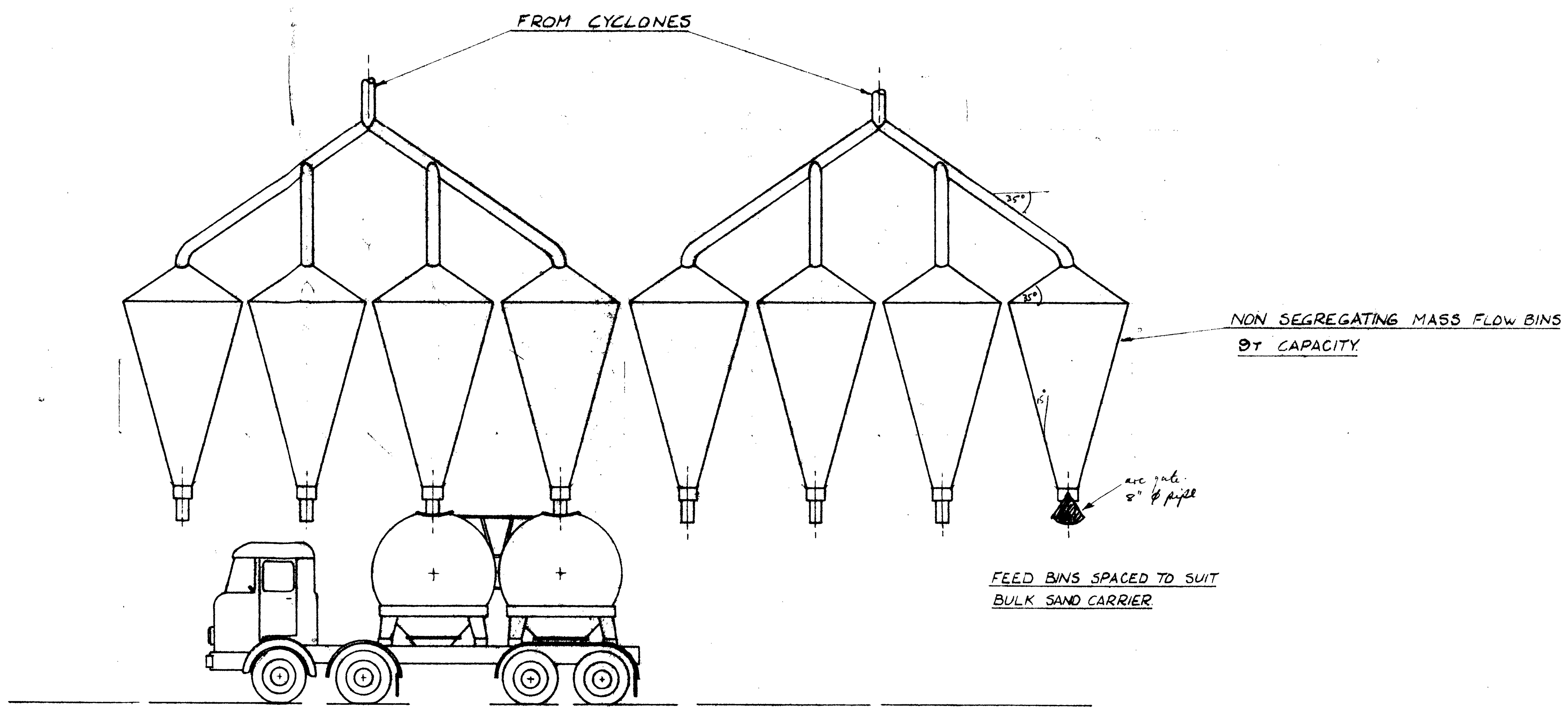
7.4 − 2.6 = 4.8 kg/tonne
× 12.5
60 ¢/tonne
× 10 000
$ 6 000 pa. or $12 000 pa on 20,000 t/a.

It's worth chasing this one carefully.

Weight of sand	12.5 × 0.5 × 1.0 × 60	=	375 lb.
Weight of conveyor			
Channel 6" × 3"	12.41 lb/ft × 12.5	=	155 lb.
¼" plate Construction plate & sides	12.5 (1 + 0.5 + 1) × 10	=	312.5 lb.
Tuyeres	19 × 0.5 × 1.22	=	11.6 lb.
Side sheets	4' × 12.5 × 2 × 1 lb/ft²	=	100.0 lb.
Sundry bits & pieces		=	50.0 lb.
		Total	1004.1 lb.







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REF 1-1-226

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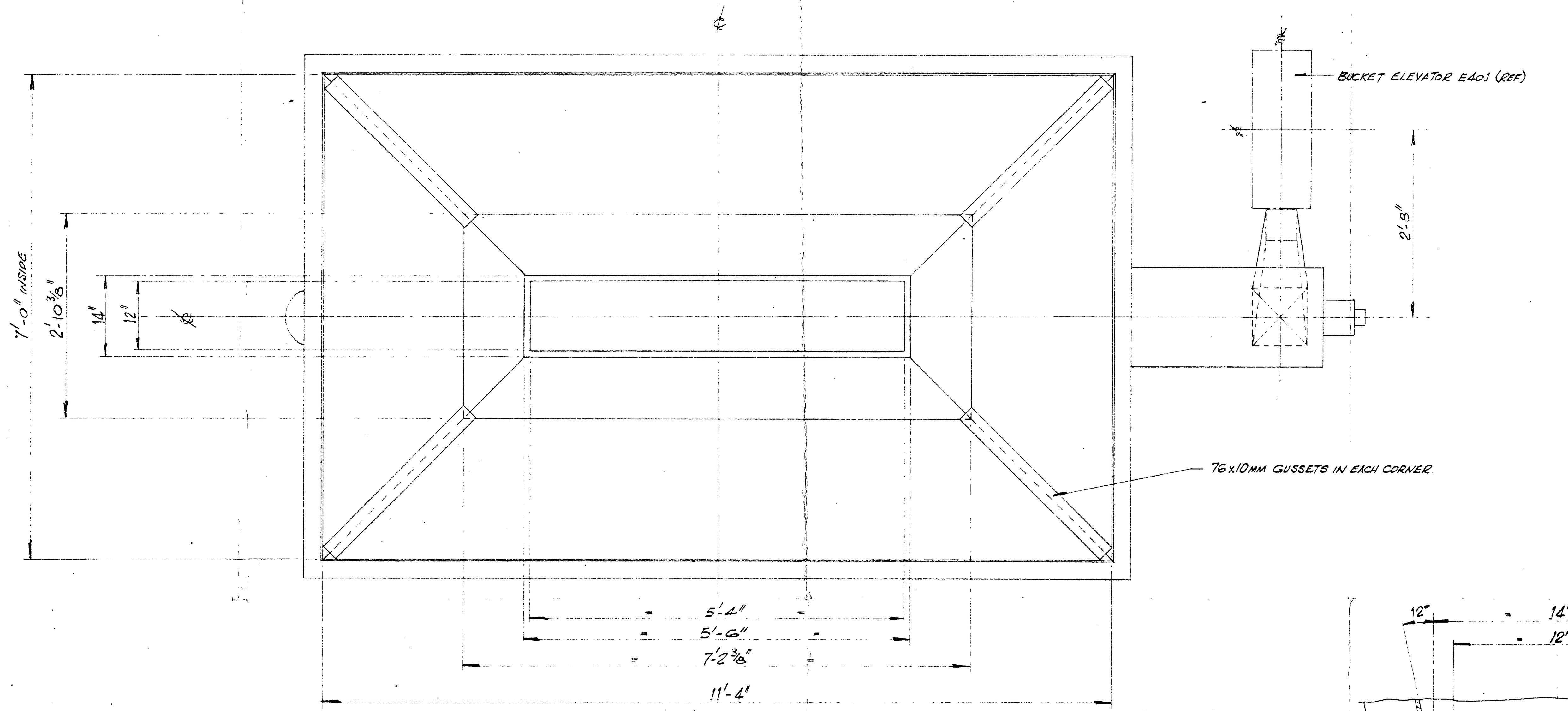
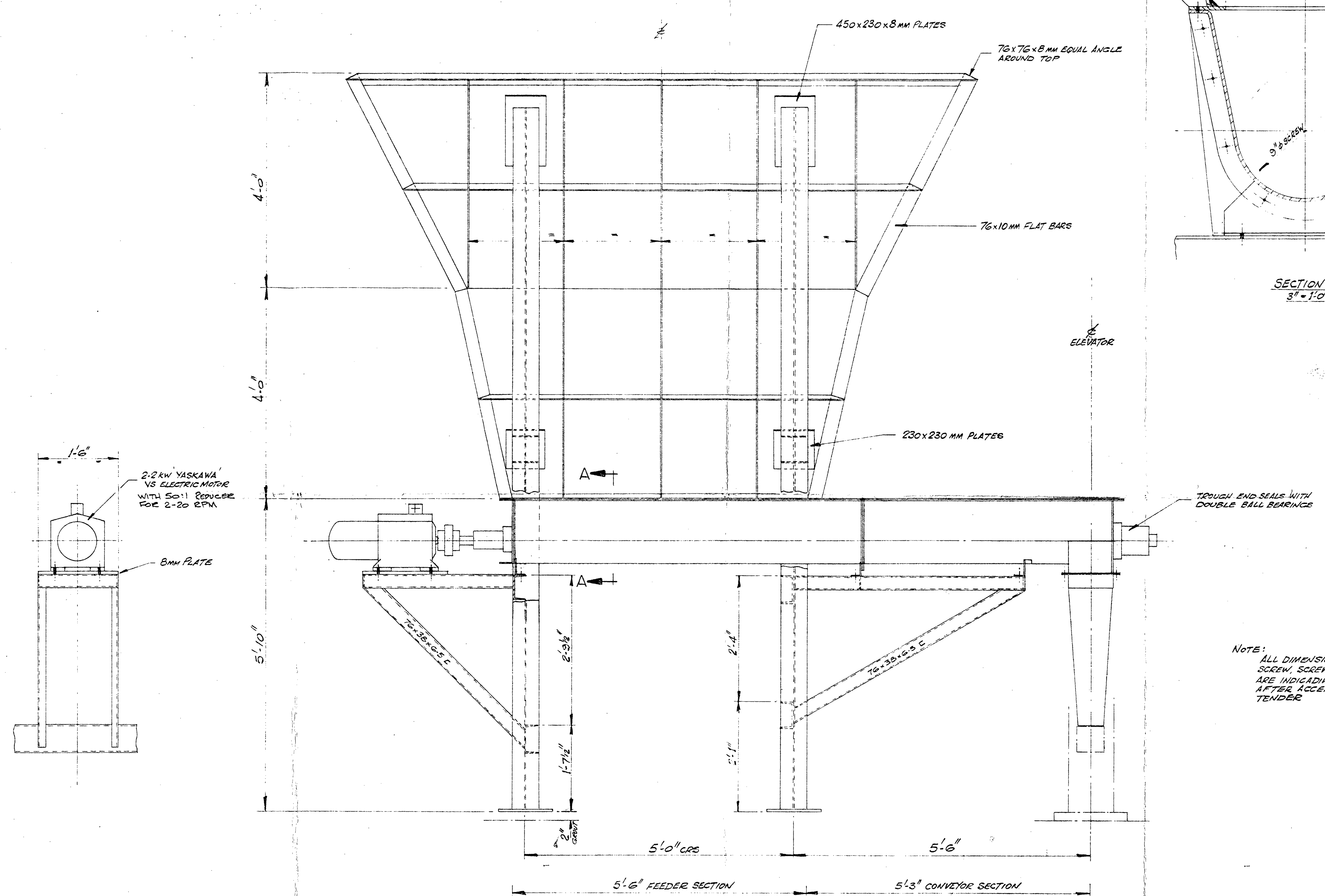
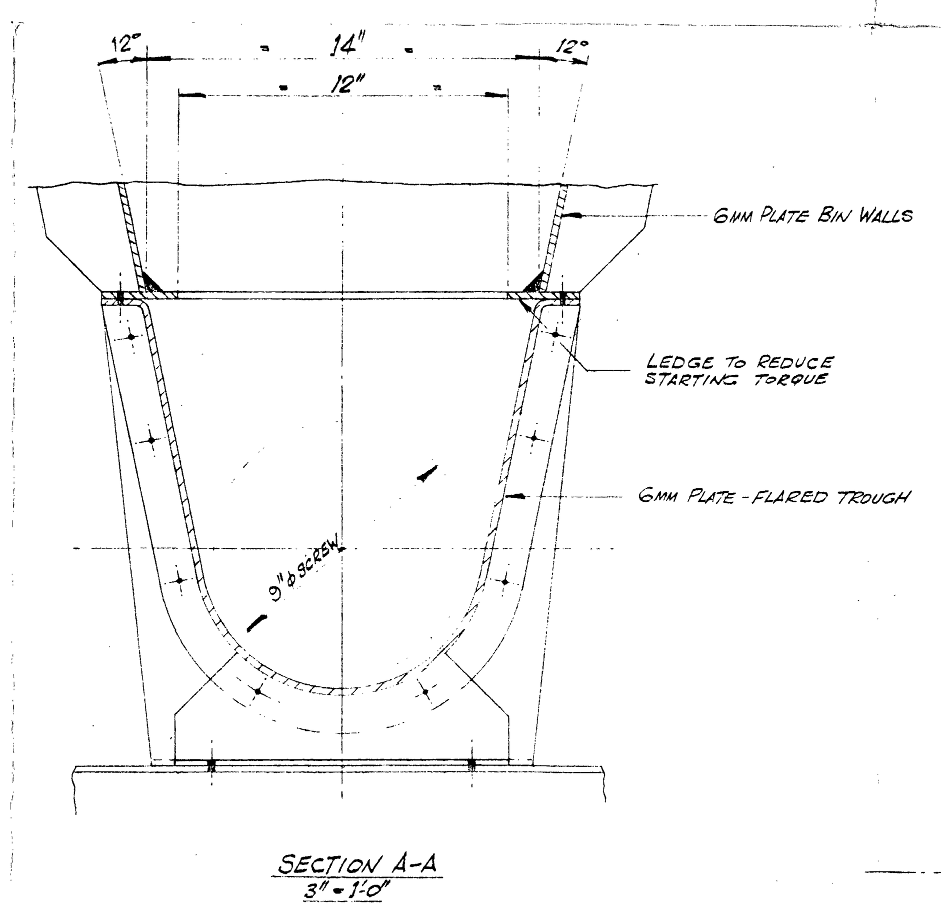
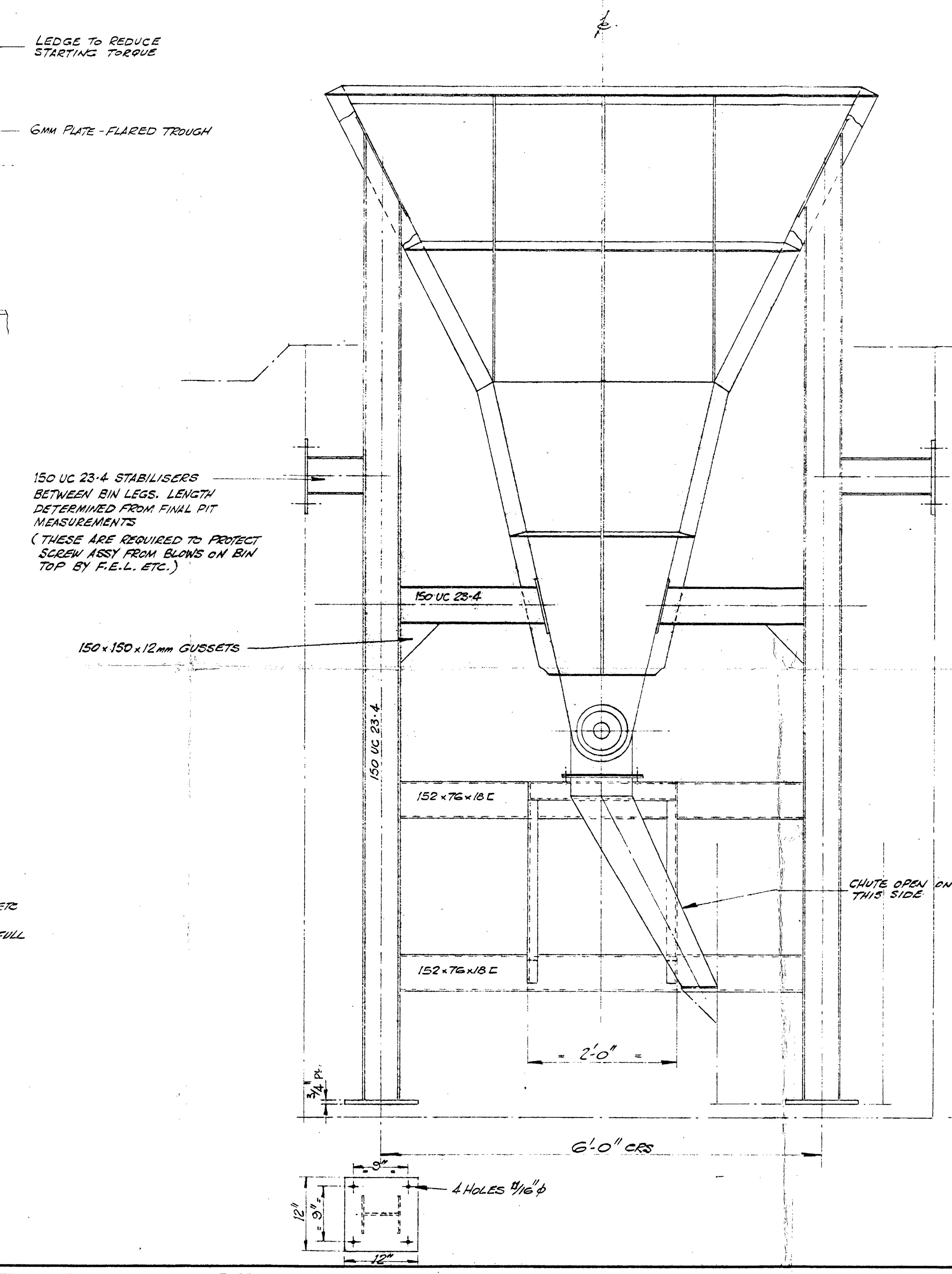
Client	DEPARTMENT OF MINES
Title	FIRST CONCEPTS FOR SLOANS SANDS EXPANSION
Drn	G THOMAS
Appd	M Eng
Date	25-8-78
Drg No	5178









NOTES:

1. ALL WELDED CONSTRUCTION WITH CONTINUOUS FILLET WELDS - UNLESS NOTED
2. SUPPORT FRAME WELDED TO BIN
3. PIT FLOOR TO SLOPE TO 2'x2'x2' DEEP SUMP — Slams loose bulk density possibly ½ this.
4. SCREW CAPACITY 120 ft^3/HOUR OF SAND ~~150 lb/ft³~~ AT 4-10% MOISTURE
   SCREW TO HAVE VARIABLE PITCH & SPEED
5. BIN CAPACITY ~~20~~ 10 TONS OR ~~4~~ 1 HOURS

This bin has been designed to give "mass flow" on damp sand.

A Conveyor 18" (460 mm) wide could be used instead of a screw to pull sand from the bin. In this case, the slot over the conveyor should be 9" at the rear and 12" wide at the front of the bin. For 20 tonnes per hour the belt speed should be 66 feet per minute for 1½" depth of sand. A drive pulley of 18" diameter operating at 14 rpm would give 66 fpm belt speed.

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NOTE: ALL DIMENSIONS RELATING TO SCREW, SCREW MOUNTING, DRIVE ETC. ARE INDICATIVE ONLY & MAY ALTER AFTER ACCEPTANCE OF SUCCESSFUL TENDER

3301-2

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ASSOCIATED DRAWINGS	No	No	AMENDMENT	BY	DATE	No	AMENDMENT	BY	DATE