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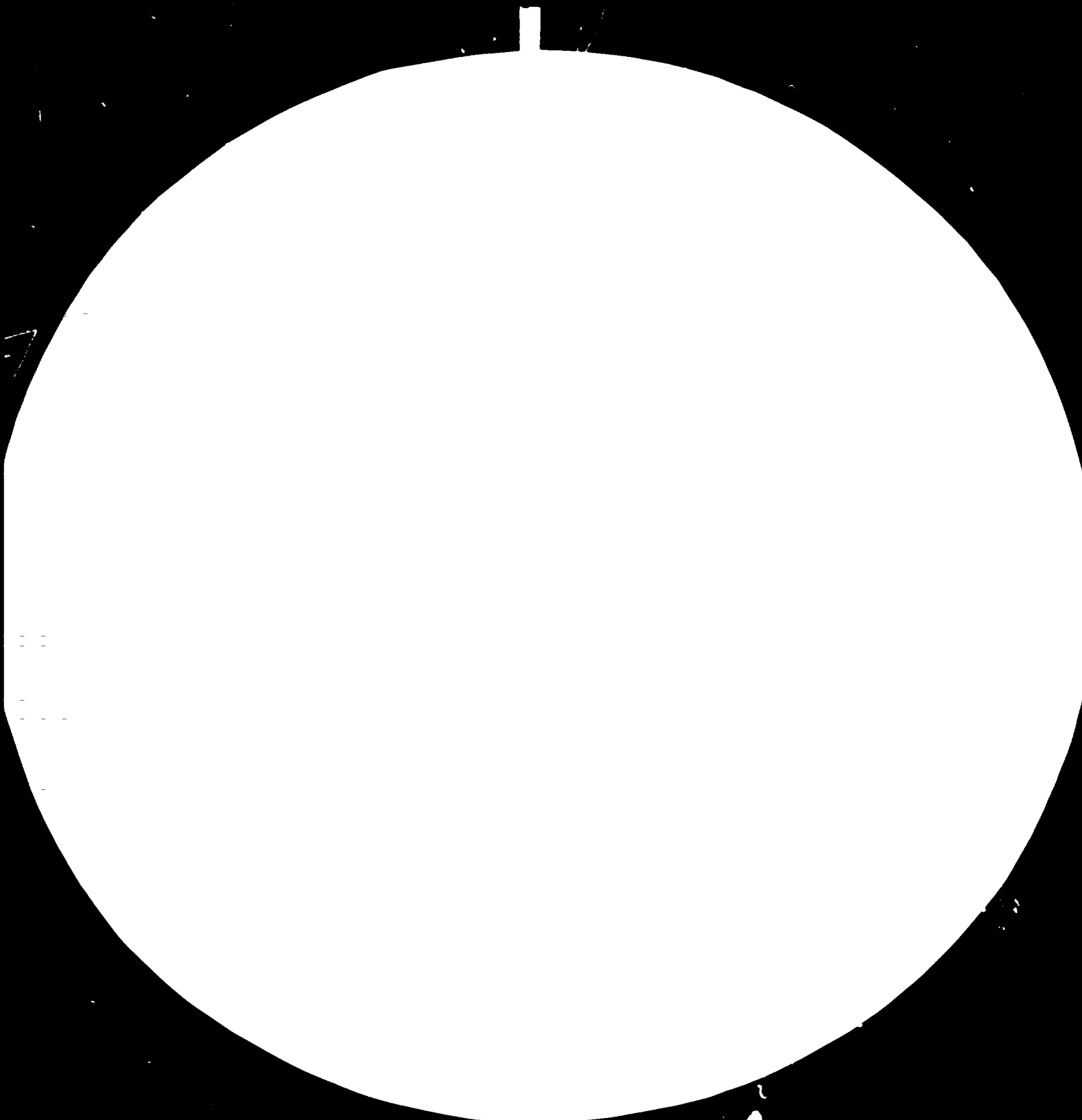
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UNITED NATIONS INDUSTRIAL
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Distr.
LIMITED

UNIDO/IO.402
7 January 1980

English

(12)

CONSULTANT IN BRICK MAKING INDUSTRY

UF/ETH/78/172

ETHIOPIA

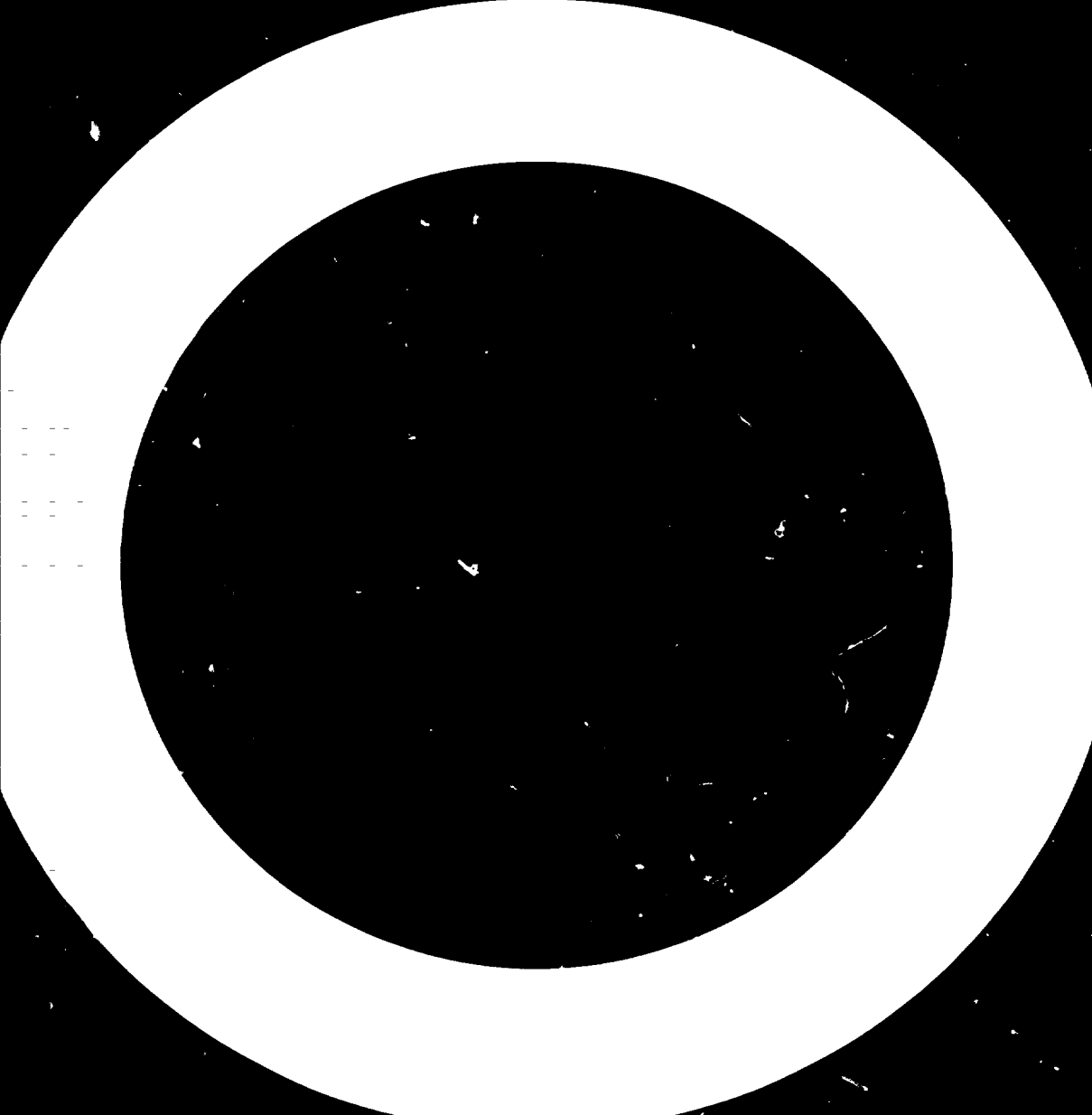
Terminal report

Prepared for the Government of Ethiopia
by the United Nations Industrial Development Organization

Based on the work of Hans G. Enius

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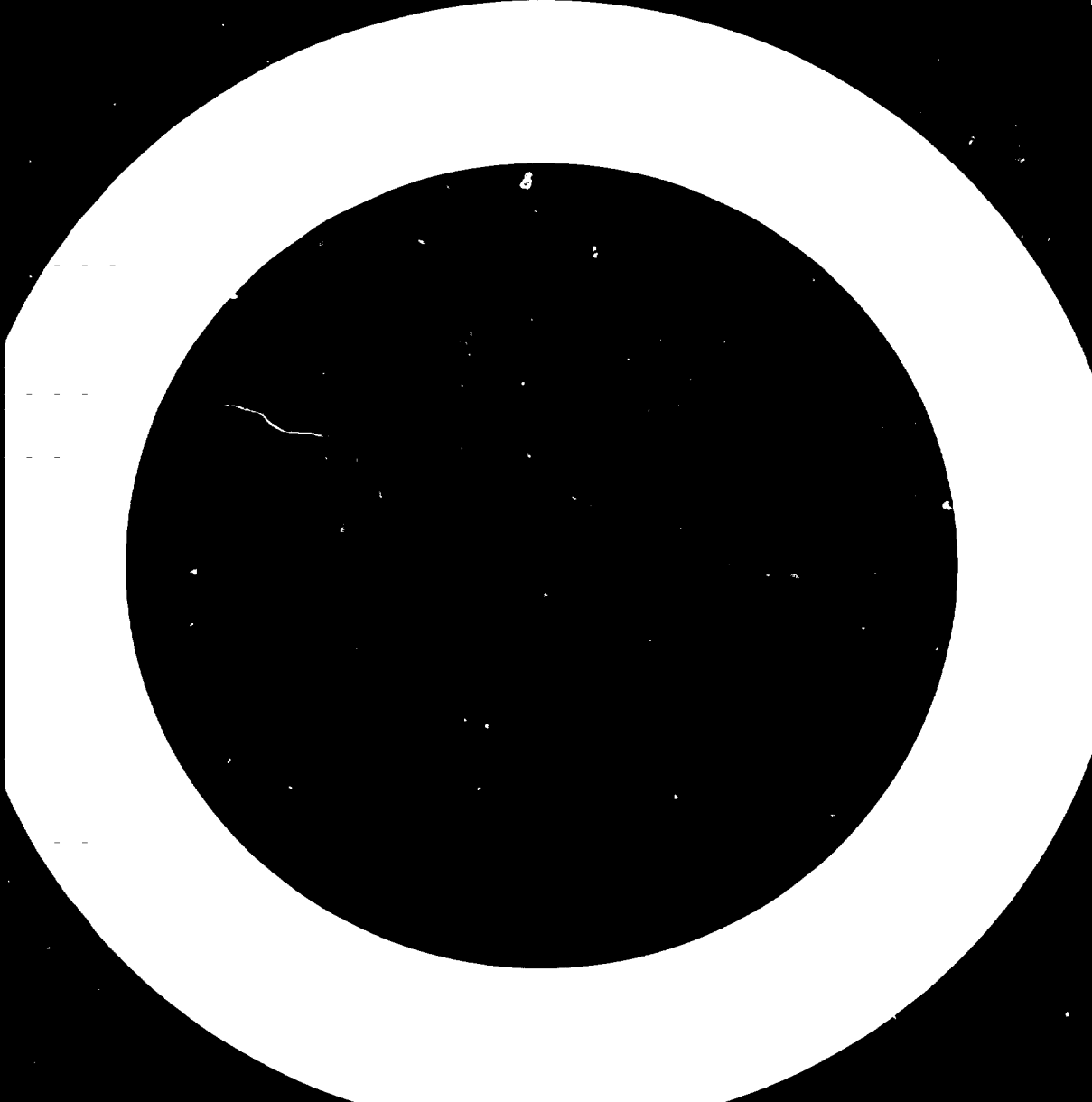
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INTRODUCTION

Ethiopian Building Materials Corporation (EBMC) has three mechanized brick factories, Addis Shekla, Ceramical and Ethio-Brick. Ever since their inception, these factories have had technical and financial problems. Before any decision on a programme of action that would ensure their quick recovery EBMC and the Ministry of Industry requested the assistance of a brick making expert that would examine the problems, explore the possibilities to improve the present situation and recommend the measures to be taken in order to make the plant a viable undertaking.

I. ADDIS SHEKLA FACTORY

Summary

The whole factory is run down. To repair the building and to overhaul the machinery would cost almost as much as to build a new plant. Because of frequent operation stoppages, the production is far below the production capacity of 12 million bricks per year. The clay deposit at the site would probably last only for four years.

The plant is operating at a loss, and at present the revenue collected from sales is not covering even the operating costs. There is no possibility to settle the accrued debts of the plant.

Therefore, it is recommended that the Addis Shekla factory be closed down and a new plant on a new site be erected.

Findings

At present, the Addis Shekla brick work is not functioning, although some very poor bricks are produced, because of the following:

(a) A poor working discipline. The supervisor is disobeyed and the orders are neglected;

(b) A total unbalance of the dryer, some fans of which have been renewed. The green bricks get a heat shock and nearly the whole car load cracks when it is pushed into the dryer;

(c) The kiln's arch in the middle of the firing zone is swaying so much that no fuel feeding can be done in this part of the firing zone (see figure I);

(d) The clay production is not continuous because either the excavator is not in order or the clay transport is not functioning ;

(e) The production machinery is nearly worn out.

Addis Shekla is a tunnel kiln-tunnel dryer brick work. The green bricks from production line are placed directly on the tunnel kiln cars, which should pass through the dryer and the kiln continuously. The cars must be pushed into the dryer and the kiln according to an exact time schedule, otherwise the system will be in an unbalance and the quality of the fired bricks will be bad. Such a factory is very sensitive for stops and disturbances in the processline. It has no flexibility. Therefore it is recommended that another type of firing process, with more flexibility, should be used.

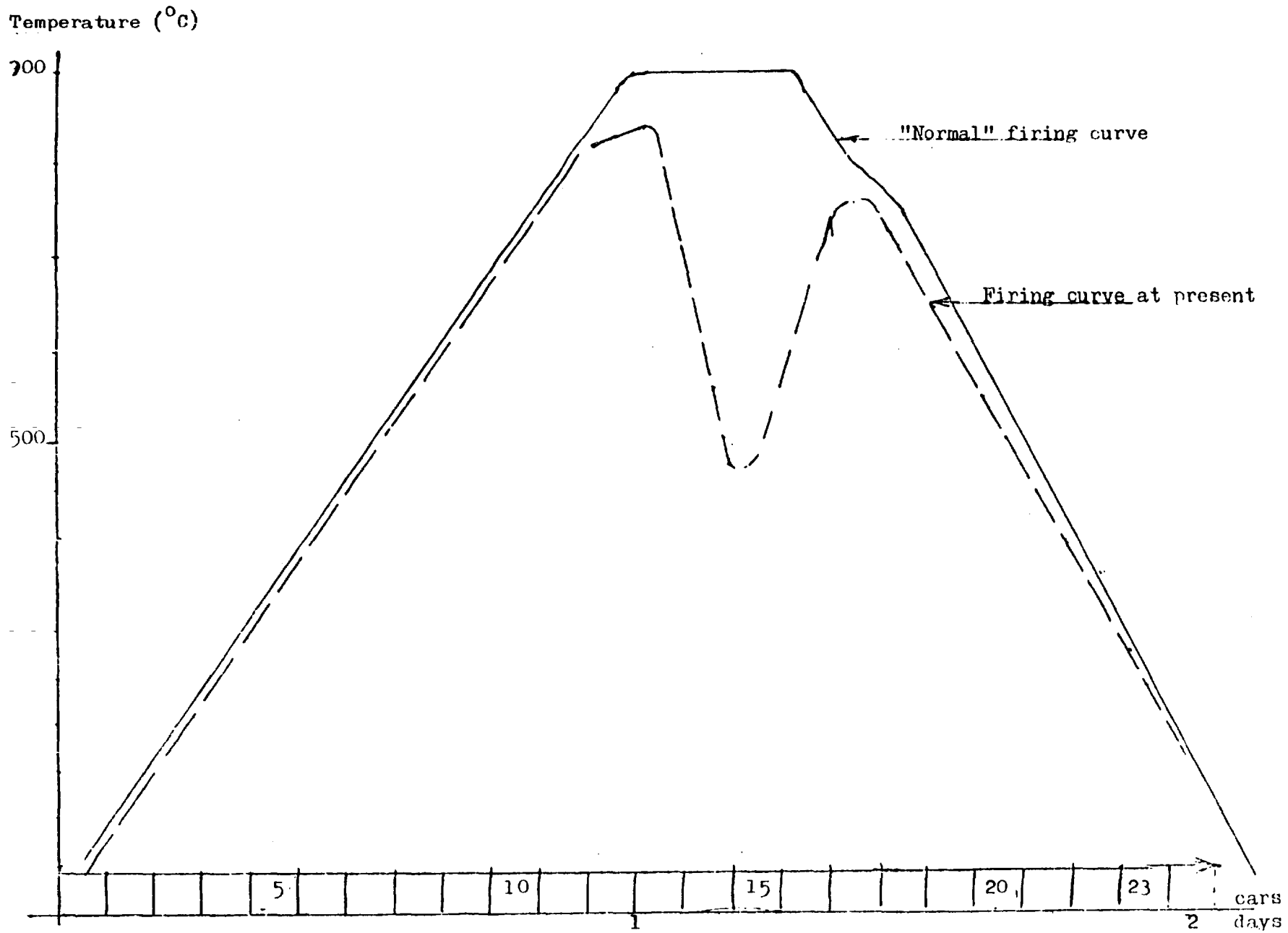


Figure I. Addis Shekla: Firing curve (firing time of 48 hours)

To remedy the present situation three alternatives should be considered:

1. To repair the tunnel kiln.
2. To change the kiln or the type of firing process.
3. To close the Addis Shekla factory.

The three alternatives are discussed in detail under Technical aspects.

Financial and technical aspects

Financial aspects

Addis Shekla Factory was organized and established as a share company with an initial paid up capital of Birr 1,077,200 contributed by five shareholders (founders). The technical and economic feasibility of the project was carried out by Interkiln Engineering Inc. The construction agreement between Interkiln Engineering and the shareholders was signed in January 1968. In the agreement the costs for the plant were estimated at \$US 695,000. The preliminary site work of the factory was started in June 1968 and the basic factory construction was completed in April 1970. Unfortunately right from the start of the project the financial position and the technical aspects of the plant were not healthy. The present financial losses and the technical problems of the plant are attributable to the failures and deficiencies at its inception.

In the feasibility study the planned production capacity was as follows:

Daily production	84,000 bricks
Annual production	24,000,000 bricks
Breakeven point	51.1% of production capacity.

However, the production facilities installed could produce maximum 12 million bricks a year, i.e. 1.1% below the breakeven point of the production plan. Worse still, the real production is 5.7 million bricks a year (30 June 1979). This is only 24% of the planned production.

The financial position and the production of the factory are shown in tables 1 to 7.

Table 1. Addis Shekla: Financial position, 1971-1979 ^{a/}
(Birr)

Year	Capital	Capital addition (deduction)	Loss	Accumulated loss	Capital vs. loss
1971	1 346.600	-	495 075	(703 955.99)	641 914
1972	1 357.200	10 600	566 576	(1 081 212.57)	275 987.43
1973	1 727.200	370 000	400 398.75	(1 481 977.92)	245 222.08
1974	1 727.200	-	361 693.00	(1 844 216.00)	(117 016.00)
1975	996.470	(730 730)	398 014.13	(1 018 958.10)	(22 488.10)
1976	996.470	-	479 805.00	(1 498 763.00)	(502 293.00)
1977	996.470	-	513 610.71	(2 012 374.20)	(1 015 904.20)
1978	996.470	-	539 102.19 ^{b/}	(2 551 476.39)	(1 555 006.39)
1979	996.470	-	348 387.88 ^{b/}	(2 899 864.27) ^{c/}	(1 903 394.27)

^{a/} As reported by external auditor Getachew Kassay & Co.

^{b/} Draft accounts.

^{c/} Loss adjustment of Birr 12 302.92 is reflected in balance sheet statement.

Table 2. Addis Shekla: Bank loans, as of 30 June 1979
(Birr)

Date granted	Expiry date	Granted by	Amount			Loan number
			Principal	Interest	Total	
8/12/60	22/4/75	AID Bank	803 793.46	261 861.19	1 065 654.65	10101-001
4/5/67	24/4/72	AID Bank	515 468.48	71 354.32	586 822.80	10101-055
		ADDIS Bank	39 318.55 ^{a/}		39 318.55	O/D-11313
1969		ADDIS Bank	575 321.03 ^{a/}		575 321.03	O/D-10372
Total			1 933 901.52	333 215.51	2 267 117.03	

Note: All loans were fully utilized except an active overdraft facility of Birr 50,000 granted by Addis Bank.

^{a/} Interest included.

Table 3. Addis Shekla: Other debts, as of 30 June 1979
(Birr)

Payable to	Amount	Remarks
Ceramical Factory	129 393.26	Borrowed to pay salaries
Ethio-Brick Factory	52 005.34	Borrowed to pay salaries
Inland Administration	341 017.02	Taxes not paid
Pension Administration	24 556.82	Pensions not paid
Sundry creditors	212 759.07	Various outstanding items
Total.	759 731.51	

Table 4. Addis Shekla: Production, 1971-1979

Year	Production (pieces)	As percentage of installed capacity	As percentage of planned capacity
1971	1 722 000	14.4	7.7
1972	814 000	6.8	3.4
1973	3 329 000	27.7	13.8
1974	3 016 000	25.1	12.6
1975	2 096 000	17.5	8.7
1976	2 815 000	23.5	11.7
1977	3 569 000	29.7	14.8
1978	3 829 000	31.9	15.9
1979	5 728 000	47.7	23.8
Total	26 918 000		

Table 5. Addis Shekla: Cash flow

Item	30 September 1978 (12 months)	30 June 1979 (9 months)
CASH IN		
Sales	397 999.55	382 294.10
Other income	1 083.46	36 657.65
Cash borrowed from other plants	149 914.76	30 026.61
Total	542 997.77	448 978.36
CASH OUT		
Total expenses	938 185.20	767 339.63
(Depreciation)	(251 207.16)	(189 044.03)
(Corporation Supervision fee)	(3 441 45)	(7 939.08)
(Bank interest)	(131 811.98)	(121 378.16)
(Licence fees and sanitation tax)	(8 726.84)	
Total	(395 187.43)	(318 361.27)
Total	542 997.77	448 978.36

Note: Corporation supervision fee, bank interest, licence fees were not paid because of shortage of funds.

Table 6. Addis Shekla: Profit and loss, as of 30 June 1979
(Birr)

NET SALES		352 294.10	
OTHER INCOME			
Transport recovery	33.00		
Scrap sales	866.00		
Fines	141.90		
Service charge	35 597.85		
Others	18.90	<u>36 657.65</u>	<u>418 951.75</u>
COST OF SALES			
Salaries, wages and allowances	110 775.65		
Pension contribution	5 321.23		
Uniforms	5 007.84		
Medical	293.49		
Transport allowance	1 690.35		
Furnace oil	101 766.17		
Fire wood	79 262.06		
Electric power	54 836.31		
Maintenance			
Machinery	12 861.20		
Industrial	6 595.61		
Factory building	633.00		
Equipment	86.00		
Fuel and lubricants	7 373.09		
Workshop and other supplies	10 082.95		
Insurance	5 767.65		
Depreciation			
Building	40 326.14		
Machinery	133 147.89		
Motor vehicles	15 570.00		
Miscellaneous	346.49		
Maintenance	1 869.10		
School fees	120.00		
Laboratory expenses	83.84	<u>593 816.06</u>	
ADMINISTRATIVE AND GENERAL EXPENSES			
Salaries, wages and allowances	24 020.92		
Uniforms	382.33		
Medical	88.07		
Transport allowance	1 898.78		
Stationary	1 976.62		
Telephone and telegrams	739.63		
Postage and revenue stamps	181.95		
Electricity and water	227.83		
Legal expenses	175.26		
Corporation supervision fee	7 939.08		
Bank interests and charges	123 519.55		
Sanitaries	1 297.51		
Insurance	4 200.48		
Miscellaneous	6 127.80		
Motor vehicles maintenance	522.51		
Furniture and other building maintenance	196.25	<u>173 493.57</u>	<u>767 339.63</u>
Net loss			(348 387.88)

Table 7. Addis Shekla: Balance sheet, as of 30 June 1979
(Birr)

Item	Value	Depreciation	Value
FIXED ASSETS			
Building	1 071 107.57	479 294.26	591 813.31
Plant and Machinery	1 479 421.09	1 313 650.26	165 770.83
Motor vehicles	103 799.98	103 799.98	
Furniture and fittings	13 528.46	8 559.26	4 969.20
Tools	6 592.32	4 190.81	2 401.51
Total	<u>2 674 449.42</u>	<u>1 909 494.57</u>	<u>764 954.85</u>
CURRENT ASSETS			
Stock at cost	10 615.37		
Goods in transit	158 772.01		
Debtors and prepayments (202 150.70)			
Less: Provision for doubtful debts (27 579.45)	174 571.25		
Cash on hand	<u>2 237.87</u>		346 196.50
Total			<u>1 111 511.30</u>
CURRENT LIABILITIES			
Creditors and accrued charges	305 485.49		
Taxes payable	454 246.02		
Addis Bank overdraft (active)	39 318.55		799 050.06
LONG TERM LIABILITIES			
AID Bank loan	1 652 477.45		
ADDIS Bank overdraft (inactive)	575 321.03		<u>2 227 798.48</u>
Total			<u>3 026 848.54</u>
EXCESS OF LIABILITIES OVER ASSETS			<u>(1 915 697.19)</u>
SHARE CAPITAL			
Preference shares	974 880.00		
Ordinary shares	21 590.00		
Profit and loss (prior years)	(2 563 779.31)		
Profit and loss (current year)	(348 387.88)		
EXCESS AND LOSS OVER SHARE HOLDER EQUITY			<u>(1 915 697.19)</u>

The production costs in Addis Shekla are very high. Table 8 compares the production costs of Addis Shekla with two other brick factories.

Table 8. Comparison of production costs, as of 30 June 1979

(Birr)

Item	Total production			1 000 Bricks		
	CERMICAL ^{a/}	ADDIS SHEKLA ^{b/}	ETHIO-BRICKS ^{c/}	CERMICAL	ADDIS SHEKLA	ETHIO-BRICKS
Fuel costs						
Furnace oil	107 507.22	129 205.46	48 592.20	17.72	22.55	14.51
Wood	27 920.00	103 927.50	2 825.00	4.60	19.01	0.83
Electricity	<u>57 214.65</u>	<u>83 857.65</u>	<u>40 960.20</u>	<u>9.43</u>	<u>14.65</u>	<u>12.23</u>
Total	192 641.87	321 990.61	92 377.40	31.75	56.21	27.57
Labour costs						
Basic salary	132 796.10	154 095.39	19 899.71	21.89	26.90	5.94
Wages	27 379.61	5 238.57	25 144.40	4.51	0.72	7.49
Overtime	35 054.52	15 432.87	7 496.52	5.78	2.68	2.23
Pension	20 258.39	7 094.97	1 138.73	3.34	1.24	0.34
Leave	6 405.44	4 961.92	-	1.05	0.87	-
Medical	469.17	508.75	347.20	0.08	0.08	0.12
Uniform	<u>3 337.40</u>	<u>7 185.56</u>	<u>1 794.97</u>	<u>0.55</u>	<u>1.25</u>	<u>0.54</u>
Total	225 700.63	194 518.03	55 821.53	37.20	33.94	16.66
Other costs						
Maintenance	51 886.22	35 927.91	14 754.23	8.55	6.28	4.41
Gas oil and petrol	17 692.26	10 485.72	6 439.39	2.92	1.83	1.88
Bank interest	58 626.70	123 519.55	5 700.00	9.66	21.56	1.70
Insurance	11 803.96	9 968.13	727.76	1.94	1.74	0.21
Taxes	44 534.82	41 305.69	17 215.91	7.33	7.21	5.14
Depreciation	110 223.44	188 405.37	46 366.68	18.17	32.89	13.84
Transport allowance	1 625.83	4 785.50	524.71	0.27	0.84	0.16
Stationery	1 142.78	2 635.49	3 557.25	0.19	0.46	1.00
Telephone, telegram, postage	136.90	1 228.77	190.00	0.02	0.21	0.06
Corporation supervision fee	6 979.10	7 939.08	3 129.72	1.15	1.38	0.93
Miscellaneous	<u>5 600.00</u>	<u>10 867.87</u>	<u>3 188.23</u>	<u>0.92</u>	<u>1.89</u>	<u>0.95</u>
Total	310 252.01	437 069.08	101 593.98	51.12	76.29	30.28
Total cost	728 594.51	953 577.72	249 792.91	120.07	166.44	74.51
Total revenue	667 070.00	630 080.00	368 390.00	110.00	110.00	110.00
Profit(loss)	(61 554.51)	(323 497.72)	118 597.09	(10.07)	(56.44)	35.49

^{a/} 6,064,000 bricks.^{b/} 5,728,100 bricks.^{c/} 3,349,000 bricks.

Technical aspects

The following summary illustrates technical situation at Addis Shekla factory.

1. The clay pit is flooded and must be drained.
2. There is only one rather poor lorry for the clay transport. A new and reliable lorry is needed.
3. Clay preparation is poor. The high speed roller is uneven and can not crush stones and other hard particles sufficiently. The clay feeding is not at its best.
4. Clay forming machine (Bradley and Craven 16 FMT auger machine, extruder) breaks down frequently. It produces up to 30,000 bricks a day. It seems that new spare parts are not available.
5. The cutter is worn out and causes too many stops.
6. Taking off conveyer to the tunnel kiln cars is in working condition.
7. The dryer is in total unbalance and destroys whole car loads of green bricks by heat shocks. The dryer could be adjusted, but first a new production scheme should be developed.
8. The kiln is in a very bad shape and cannot be fired much longer. Six sections of the arch of the kiln in the firing zone are sagging and neither firing nor fuel feeding can be done in these sections.
9. The quality of the bricks is very bad. A tunnel kiln - tunnel dryer work is based on a continuous running. That is, at a certain time (say every 3 hours) a car with fired bricks should come out of the kiln. At the same time a car with dried bricks just out of the dryer tunnel, should be pushed into the kiln; and a car with green bricks should be pushed into the drying tunnel. If the time schedule is not kept, the drying and firing will be in unbalance and the products will be poor.

In order to rehabilitate the factory three alternatives should be considered:

1. To repair the kiln.
2. To change the kiln (clampfiring or Hoffmann or similar kiln).
3. To close the factory.

1. The first alternative does not seem practicable. The inspection of the kiln showed that the carrying iron beams and refractories sagged by 12-14 cm and that the insulation is worn out. A temporary repair could be made but it is not certain how long it would last. The costs for a complete and lasting repair of the kiln are estimated at Birr 500,000. But even then the problems of production schedule, flooded clay pits, machinery, tunnel kiln cars, unbalanced dryer would remain. The total costs for repairing the kiln and solving all the other problems are estimated at Birr 1.3-1.5 million. (For the plan of the tunnel kiln see figure II.)

2. The firing could be done by clampfiring. In this process the clay is mixed with the coal dust. The coal would have to be imported. The bricks could be dried outdoors. For drying during the rainy season, the old tunnel dryer could be changed to chamber dryer. For transportation of formed bricks to the drying area pallets or barrows should be used instead of tunnel kiln cars. The estimated investments would be as follows:

	<u>Birr</u>
Beds for clamps	100,000 (including roofs and side walls)
Drying stacks	50,000
Changing the dryer	60,000
Transport equipment	10,000
Contingency	<u>20,000</u>
	240,000 say 250,000

Clampfiring appears to be the cheapest and easiest temporary solution. The only problem would be to find a competent clamp-firer. For the start only one minor bed could be installed in which case the costs would not be higher than the salary for the clamp-firer.

The tunnel kiln could be replaced by a Hoffmann kiln or similar (Zig Zag, Buhrer or Habla). The annual capacity of any of those kilns would be 6-8 million bricks.

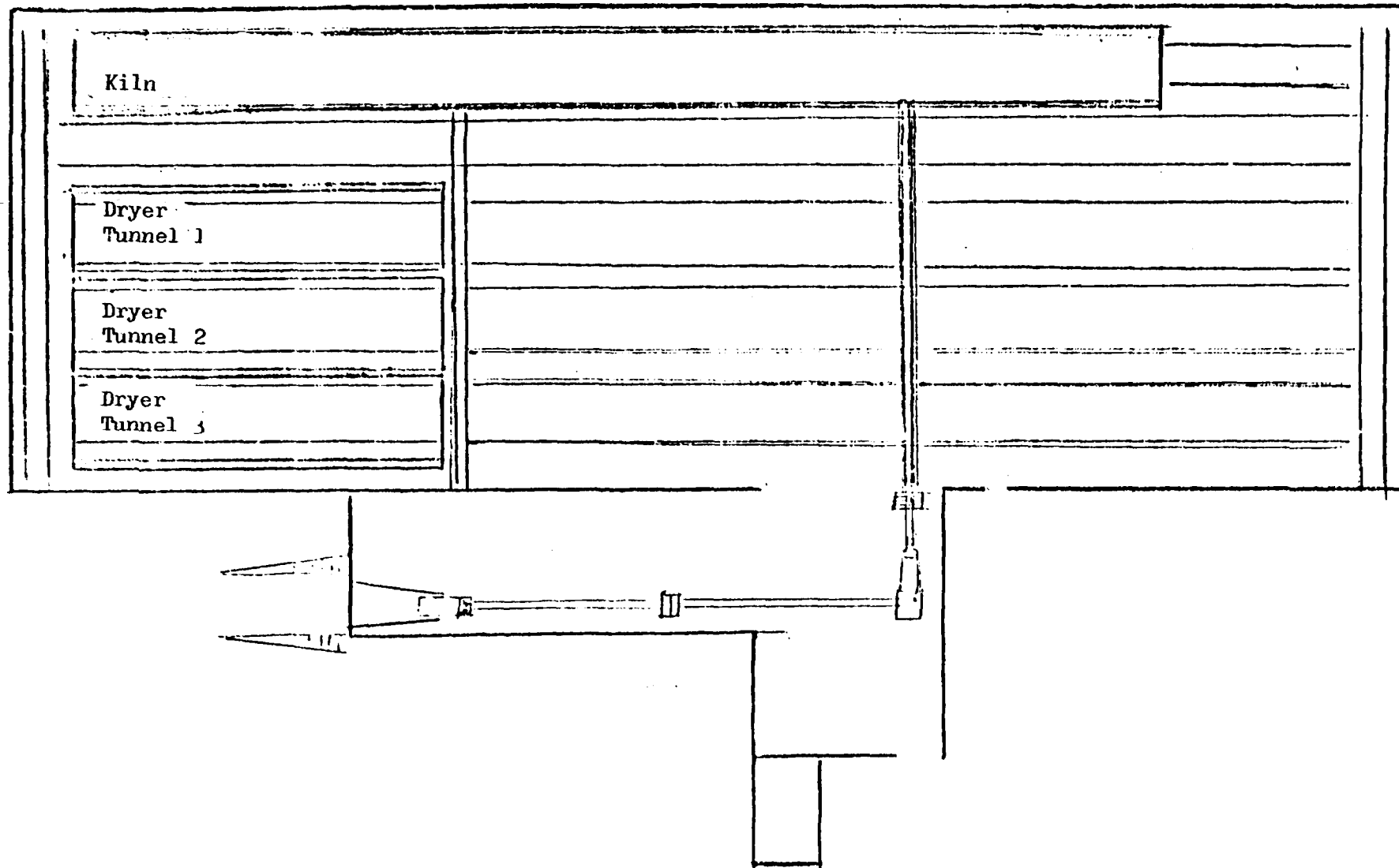


Figure II. Addis Shekla brick work: tunnel kiin

Some equipment from the tunnel kiln could be used, the rest should be bought. The estimated costs would be for Hoffmann kiln, Birr 450,000 (figure III); for Zig-Zag kiln, Birr 400,000-450,000 (figure IV); for Habla kiln, Birr 350,000 (figure V); and for Habla kiln without top, Birr 250,000.

The bricks could be dried outdoors. For drying during the rainy season the tunnel dryer could be changed into chamber dryer. For that a heater should be installed because the waste heat from the kiln would not be sufficient.

During the first stage of the operation the old and repaired machinery could be used. During this time a new production plant should be erected (figure VI). The missing components for the new not used machines (Shoa's) must be bought. The cost for the components is estimated at Birr 200,000-300,000.

Some small transportation equipment such as hand carts for green bricks should be bought also. The estimated costs would be Birr 10,000-20,000. The investment costs for this alternative would vary depending of the kiln chosen. For a Hoffmann kiln they are estimated at:

	<u>Birr</u>
Kiln	450,000
Dryer	60,000
Heater	50,000
Machines	200,000
Transport equipment	20,000
	<hr/>
	780,000

To this must be added the costs for excavator, lorries, and building roofs etc. In total Birr 1.0 to 1.1 million will be required. Table 9 compares the investment costs for a new kiln with the costs for the repair of the old tunnel kiln.

However, two major problems, i.e. lay-out and clay deposit, would remain. It is estimated that at an annual production of 8 million bricks the clay deposit will be exhausted in four years. This period is too short for a large investment.

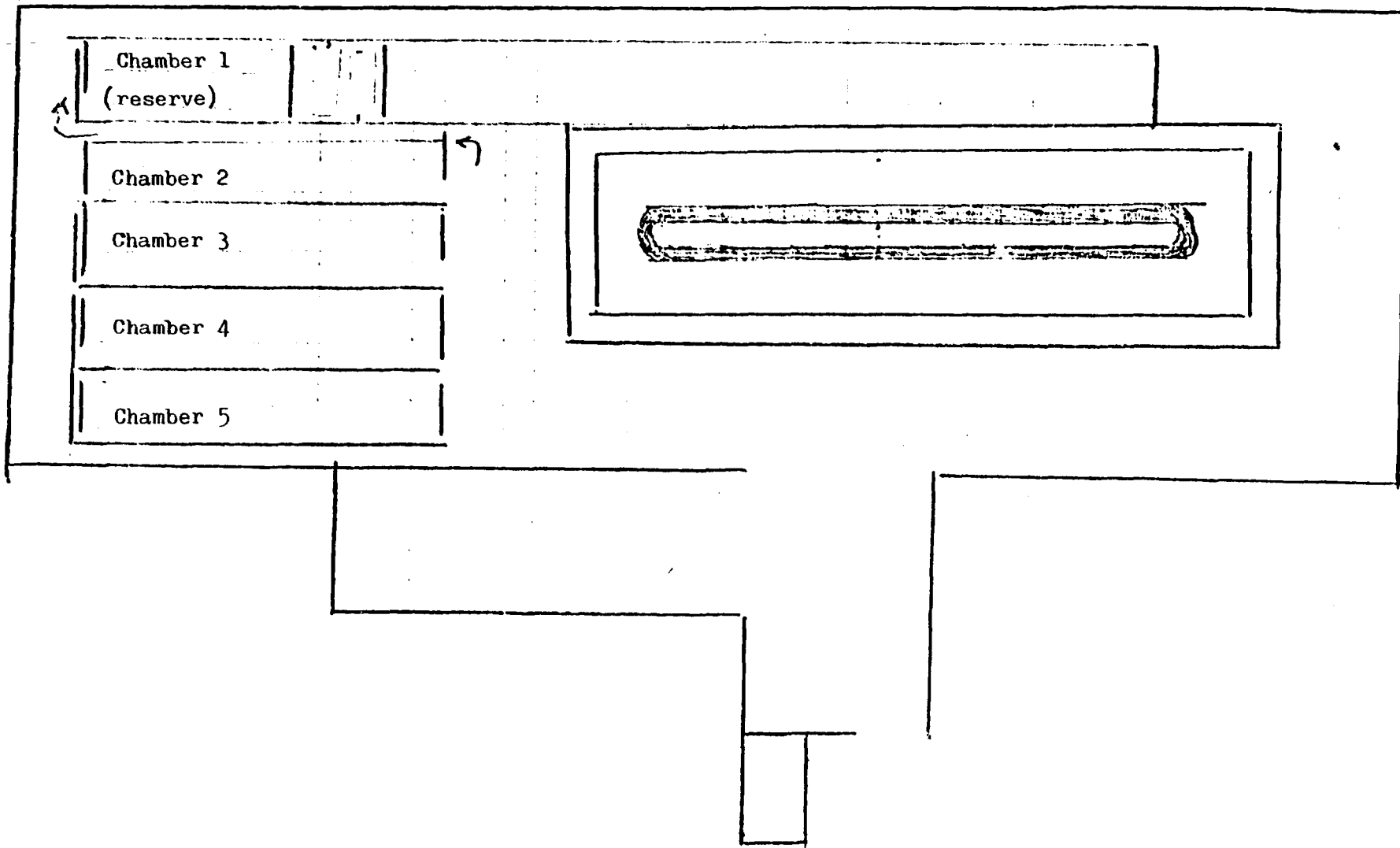


Figure III. Addis Shekla brick work: Hoffmann kiln.
 (The tunnel dryer changed to chamber dryer additional heater)

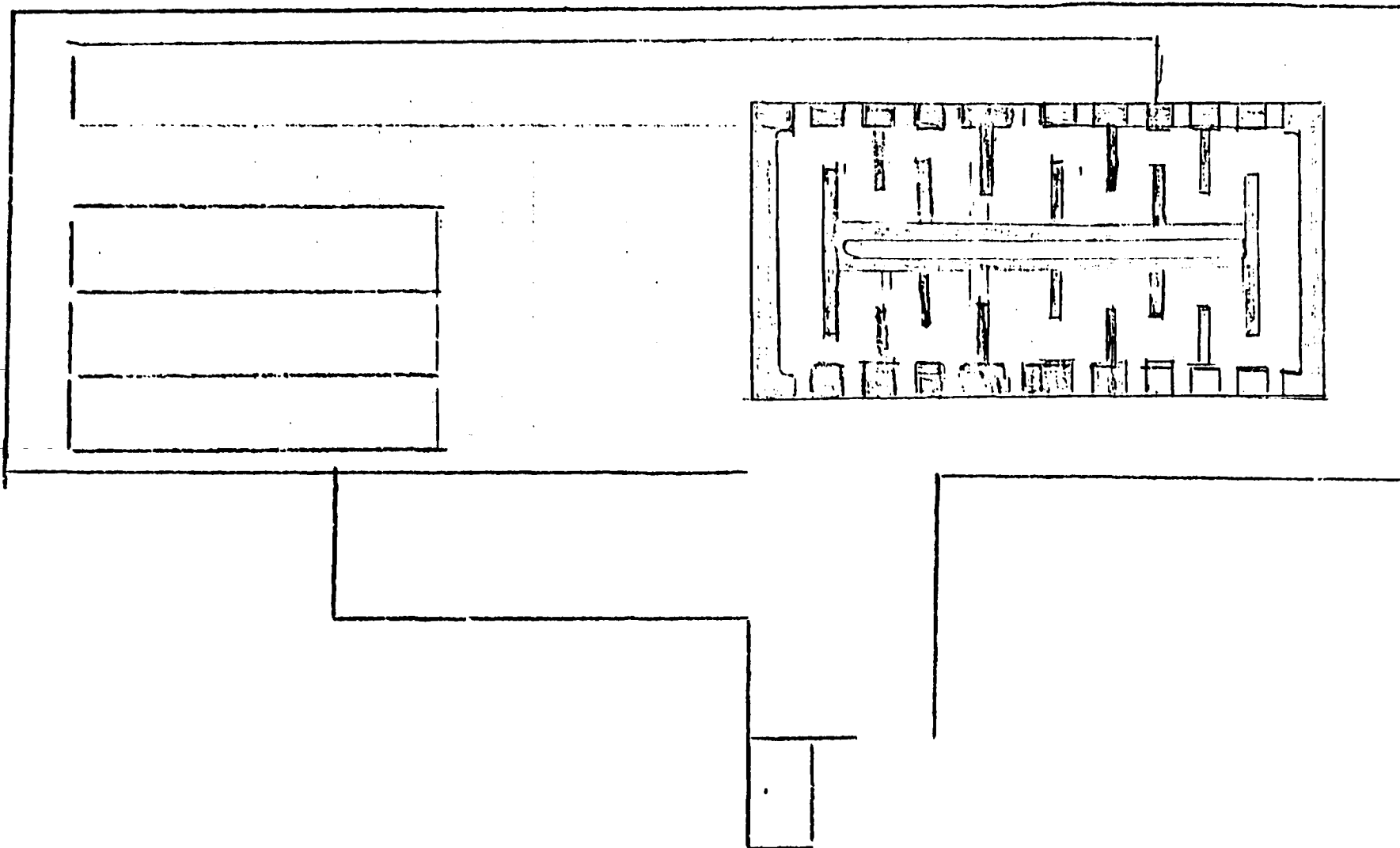


Figure IV. Addis Shekla brick work: Zip-Zap (Bührer) kiln
(Dryer arrangements as for the Hoffmann kiln)

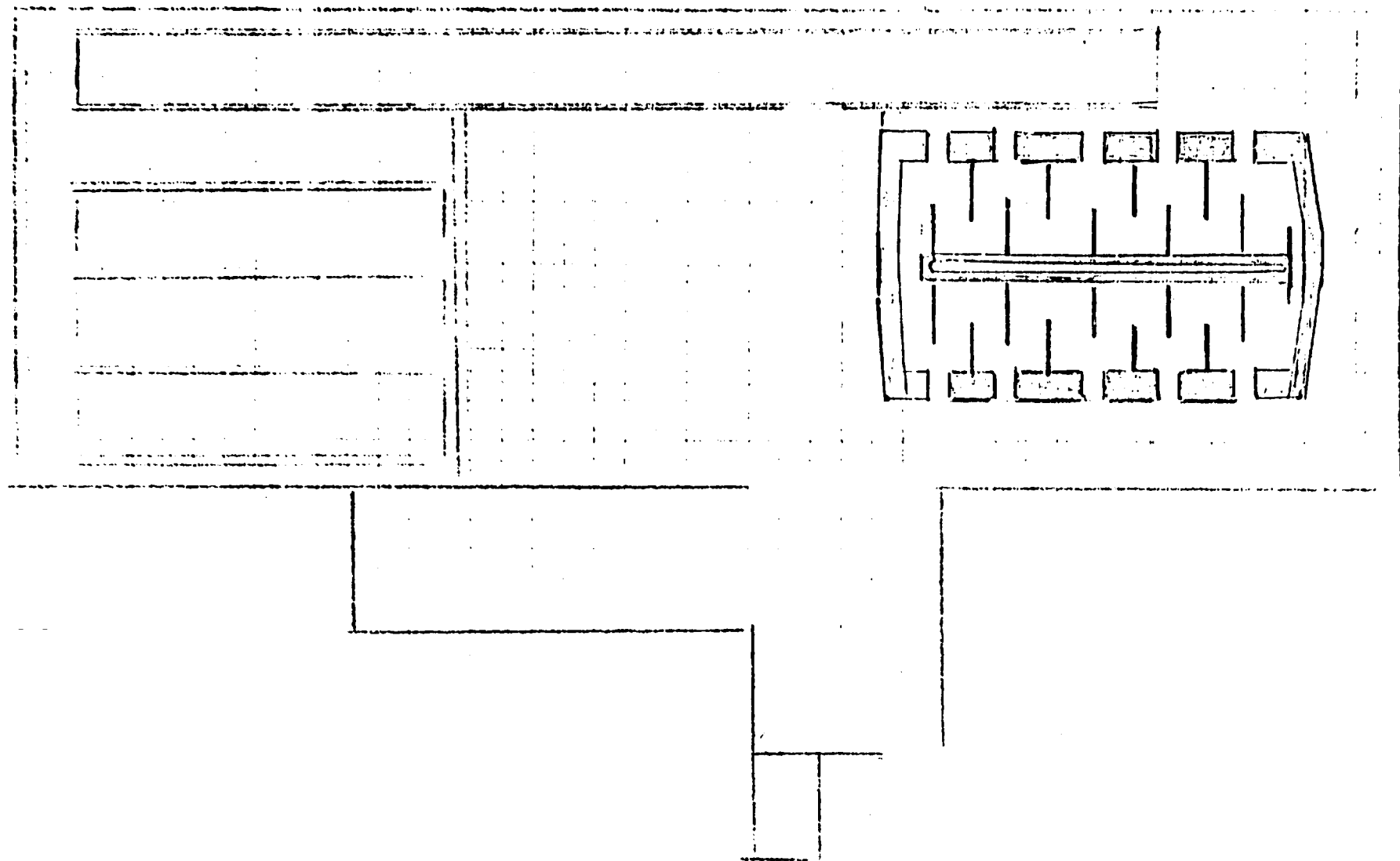


Figure V. Addis Shekia brick work: Habla kiln
(Dryer arrangements for the Hoffmann kiln)

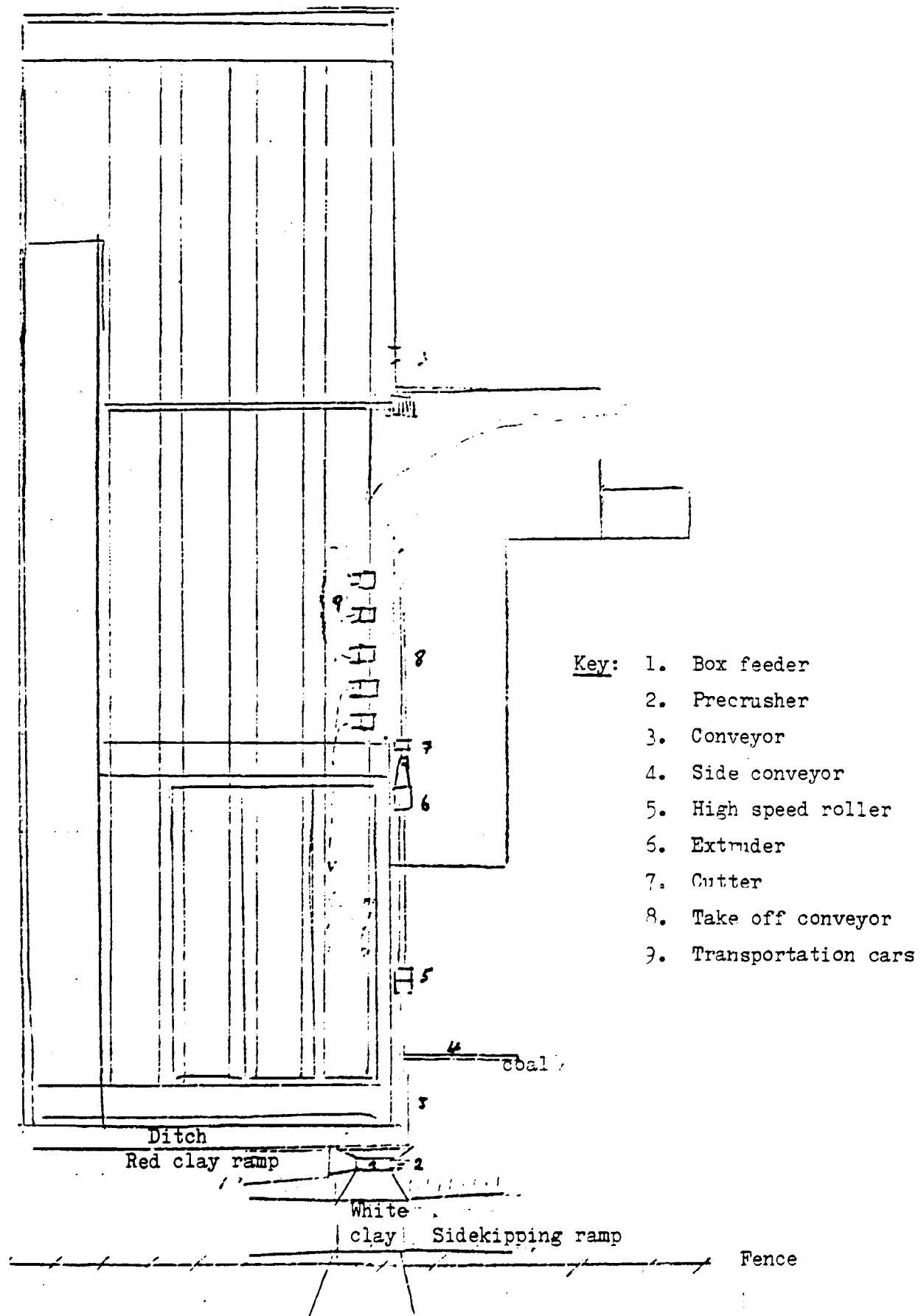


Figure VI. Addis Shekla brick work: new machinery lay-out
(Building costs for roof Birr 45,000 for foundations Birr 5,000)

Table 9. Addis Shekla: Comparison of investment costs
(Birr)

	New kiln (Hoffmann or similar)	Repair of the old kiln
Kiln	450 000 ^{a/}	450 000 ^{b/}
Burners and instruments		200 000
Dryer	160 000 ^{c/}	115 000 ^{d/}
Sheds	200 000	
Heater	50 000	
Machinery	200 000 ^{e/}	400 000
Transportation equipment	20 000	
Building costs	50 000 ^{f/}	50 000 ^{g/}
Lorry for clay transportation	130 000	130 000
Clay pit	70 000	70 000
	<u>Birr 1 330 000</u>	<u>Birr 1 435 000</u>
Production (bricks/year)	6-8 million	8-10 million
Maintenance costs	Low	Very high

^{a/} Utilizing some parts from the old kiln.

^{b/} For repair.

^{c/} Changing into chamber dryer.

^{d/} For instruments. The problem of a too small dryer will remain.

^{e/} Utilizing existing machines (Shoa).

^{f/} For roof, foundations etc.

^{g/} For clay intake.

^{h/} including excavator.

3. The best solution to all the problems would be to close the Addis Shekla factory. The parts of the plant that are still in good condition could be used in two other brick factories, Ethic-Bricks and Ceramical Brick. Also, the possibility to build a new factory should be considered.

The ideal site for a new factory would be the old quarry of Ceramical Brick works. The area is level with an easy access from the main road. The clay deposit would last for decades. There would be enough space to plan an ideal lay-out, with new machinery, the production capacity could be increased to 12 million bricks per year. Many components from Addis Shekla could be used in the new factory. It could be built in two stages.

1. Using the Shoa machinery production capacity 7 million bricks per year.
2. Kiln and dryer enlarged, new and heavier machinery, production capacity 12 million bricks per year.

Table 10 shows the estimated costs of a new brick factory and table 11 shows the estimated profits for 1982-1986.

To build a new factory on a new site would cost more than to repair and rebuild the Addis Shekla plant; but that would be soon offset by the advantages of bigger clay deposit, better lay-out of the plant and higher production capacity.

There are 95 employees at Addis Shekla. Some of them could work on erecting of the new plant and the rest could work in the other brick-making plants and replace the daily workers.

It is not expected that supply of bricks to the market may cause a problem. At present, cement is the major constraint for construction. In 1982, when the expansion of cement plants will be completed and the demand for bricks will increase the proposal of organizing and erecting a new brick factory that will be operative after 1982 would seem reasonable.

Table 10. Estimated costs of a new brick factory ^{a/}
(Birr)

Item	Entirely new components	Using some components from Addis Shekla
Pre-investment and preparatory expenses as clay prospecting etc.	50 000	10 000
Clay pit etc.	-	-
Wages, salaries etc. during construction period (1 year)	50 000	30 000
Utilities (electricity, water)	30 000	30 000
Office equipment etc.	10 000	10 000
Land and civil engineering		
Land		
Buildings 3 000 m ³ at Birr 400/m ²	1 200 000	500 000
Sanitary installation	10 000	10 000
Drying sheds 380 m ² at Birr 50/m ²	200 000	200 000
Manufacturing equipment		
Machinery, spare parts etc.	1 300 000	300 000
Hoffmann kiln	500 000	500 000
Erecting costs accessories	60 000	50 000
Engineering supervision	70 000	50 000
Labour, mechanic, electrician etc.	30 000	20 000
Excavator and lorries	500 000	500 000
Total	4 010 000	2 210 000

^{a/} On the site of the old quarry of ceramical brick works. With a Hoffmann kiln and an open air drying.

^{b/} Shoa machinery.

Table 11. Estimated profits of a new brick factory, 1982-1986

Item	1982	1983	1984	1985	1986
	Number of bricks				
Production capacity	7 000 000	8 000 000	8 000 000	8 000 000	8 000 000
	Birr				
Revenue Sales	840 000	960 000	960 000	960 000	960 000
Other	<u>70 000</u>	<u>80 000</u>	<u>80 000</u>	<u>80 000</u>	<u>80 000</u>
Total	910 000	1 040 000	1 040 000	1 040 000	1 040 000
Costs					
Clay	-	-	-	-	-
Furnace oil ^{a/}	164 000	180 000	180 000	198 000	198 000
Electricity ^{b/}	68 000	75 000	75 000	82 000	82 000
Salaries and wages ^{c/}	200 000	216 000	233 000	252 000	272 000
Fuel and lubricants ^{d/}	15 000	16 000	18 000	20 000	22 000
Repair and maintenance ^{e/}	46 000	46 000	70 000	70 000	70 000
Insurance ^{f/}	12 000	12 000	12 000	12 000	12 000
Depreciation ^{g/}	212 000	212 000	212 000	212 000	212 000
Taxes ^{h/}	76 000	86 000	86 000	86 000	86 000
Miscellaneous	<u>20 000</u>	<u>30 000</u>	<u>30 000</u>	<u>30 000</u>	<u>30 000</u>
Total	831 000	873 000	916 000	962 000	984 000
Net profit	97 000	167 000	124 000	78 000	56 000

Note: It was assumed that: (a) Investment fund would be availed from the Government Treasury; (b) income tax would be exempted for 5 years; and (c) the market would not be a problem.

^{a/} 10% increase every two years.

^{b/} 10% increase every year.

^{c/} 8% increase every year.

^{d/} 10% increase every year.

^{e/} 2% of fixed assets for two years and 3% thereon.

^{f/} 0.05% of fixed assets.

^{g/} 5% of fixed assets.

^{h/} 9% of sales.

II. ETHIO-BRICK FACTORY

The factory has a very good well functioning machinery and a high capacity Hoffmann kiln. The capacity of the two channels tunnel dryer, is too low for production of green bricks as well as for the firing capability of the kiln. There is enough space to build two more channels. The hot air production unit could supply hot air for all four channels.

With construction of the two new channels the production line would be in balance and the production could be increased. A work shop and an office building are also needed.

The cost for the above mentioned improvements is estimated at Birr 900,000. It is recommended that these improvements be realized.

III. CERAMICAL FACTORY

The main problems at this factory are:

(a) The road to the white clay pit is in a very bad condition. During the rainy periods the pit could not be reached by a lorry;

(b) The clay pit is partly filled with water and there is no drainage. The deposit contains not only white clay but many other types of clay and some stones that should be crushed. In such a clay deposit a "one bucket" excavator should be used and the clay should be sorted. It is true that bricks could be made from almost any clay mixture but they would require different drying time and their quality would not be high. If properly dried and fired they could be good stock bricks;

(c) The clay feeding is done by a double belt box feeder. One side for white clay the other side for red clay. The clay is fed in the proportions 1:1. The openings of the box feeder must be adjusted and the steel plates repaired in order to obtain the feeding proportions of 3:1, that is 3 parts of white clay to one part of red clay. Even though the white clay is not pure this proportion must be held. The "forks" at the end of the box feeder belts should be repaired;

(d) The conveyor belt leading from the box feeder is beyond repair and should be replaced;

(e) The extruder's column is cut by an automatic cutter cutting 3 bricks at a time. The speed of the column should be increased from 70-72 bricks per minute to at least 100 bricks per minute. In order to obtain that a new driving wheel on the electric motor should be installed.

Because of lack of space the automatic feeding of green bricks to pallets (175 bricks/frame) is not used. From the cutter the green bricks are loaded on one-wheel barrows and stacked on wooden pallets, and on the floor. After a week they are moved outdoors and covered for a day or so and then exposed to the sun. The drying time is long because the clay mixture contains too much of red clay.

At present, the dryer consists of four coupled drying chambers. Four additional chambers are under construction. The hot air generation generates 500,000 Kcal/h. The outgoing air has a temperature of 125°C.

To regulate the drying is difficult. At the beginning of the drying process it should be possible to add fresh air. Inside the chambers thermometers should be installed. In order to control the moisture content hygrometers should be placed at the exhaust. In order to fully utilize the dryers a schedule of

setting and emptying the chambers must be established. The capacity of the dryer is smaller than the capacity of the kiln. Nevertheless, the setting-emptying schedule must be followed, even if the bricks are not dry enough. The brick drying process should be completed in the kiln by a small hot air generator at the top of the kiln.



