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FEASIBILITY STUDY OF A RAILWAY PASSENGER COACH PRODUCTION PLANT IN EGYPT

Final Report

June 1977

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FEASIBILITY STUDY OF A RAILWAY PASSENGER COACH PRODUCTION PLANT IN EGYPT

FINAL REPORT

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SECTION I - INTRODUCTION AND SUMMARY

This report presents the results of an engineering economic feasibility study of a new factory to build railway passenger coaches in Egypt. The study was performed, under contract to the United States Agency for International Development (USAID) with the cooperation of the Societe Generale Egyptienne de Materiel des Chemins de Fer (SEMAF), to provide information to evaluate the proposed plant. The plant would be capable of building all types of railway passenger coaches used in Egypt and of producing or assembling streetcars, metros and underground trains. While the primary purpose of the plant would be to satisfy domestic demand, it could also produce railway coaches for export. The proposed plant would be located about 120 kilometers from Cairo and 80 kilometers from the existing SEMAF plant at Helwan, as shown in Figure I-1. It is proposed that the plant be operated by a new company which would be a joint venture of SEMAF and the private sector.

This section of the report presents a summary of the commercial, technical, financial and economic aspects of our study, and it is concluded with a summary of our findings in regard to feasibility of the project.

COMMERCIAL ASPECTS

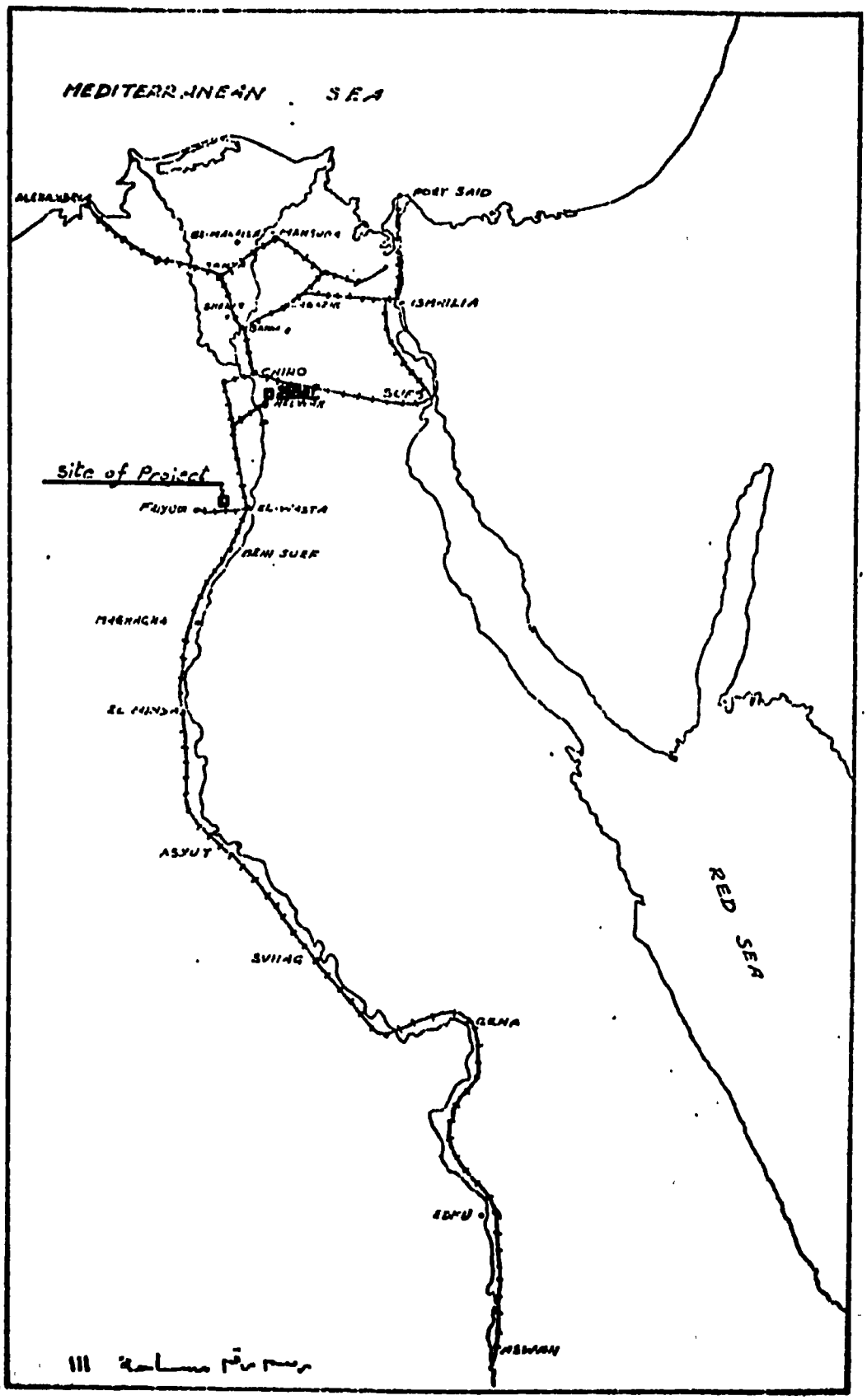
The existing SEMAF plant produces both goods wagons and passenger coaches. It is the only such facility producing passenger coaches in North or Central Africa and the Middle East. The only known potential competition in Africa is a plant in Algeria which produces goods wagons but not passenger coaches. This area is expected to have significant railway expansion in the next 25 years and is believed by SEMAF to present a good market opportunity for an Egyptian producer. SEMAF has access to a low cost supply of both skilled and unskilled labor, it is close to the market, and it is in a position to take advantage of any preferential terms of trade which might be established among African or Arab nations.

Our research indicates that there will be a domestic market which at least until 1990 will substantially exceed the production capacity of the existing SEMAF plant. This market includes not only the Egyptian Railways, but also substantial expansion of urban rail lines ranging from streetcars to underground metro lines. Future needs of Egyptian Railways for goods wagons may well place additional strains on SEMAF's productive capacity, and it appears that removal of current passenger coach production would not leave under-utilized capacity for a long time.

TECHNICAL AND ENGINEERING ASPECTS

The project is sound on a technical and engineering basis such that dependable operation of a reliable manufacturing process and

FIGURE I-1



PROJECT LOCATION

is expected. Important specific conclusions regarding technical and engineering soundness are:

- The efficient operation of the existing SEMAF plant indicates the availability of suitable staff for operation of the new plant.
- The existing operation, including fabrication, assembly and finishing operations is soundly conceived. No dramatic improvement could be expected from re-engineering those operations, although some improvements could result from having more space for efficient storage and in-plant movement of raw materials and work-in-process.
- The increased space to be provided at the new plant is needed for the proposed level of production, and there is not sufficient space to expand the existing facility.
- With additional labor and machinery, the existing methods are suitable for reasonably foreseeable levels of production.
- The existing bogie shop at the SEMAF plant can, with additional machinery, meet projected bogie requirements for both plants.
- Existing machine tools and other equipment in use now for coach fabrication are in good condition, have many years of potential life, and should be used in the new facility. Many of the machines used in fabrication of coaches are not needed for goods wagon production. Those machines are basic types with the flexibility needed for producing a varied mix of types of railroad passenger coaches.
- The existing SEMAF management has the technical capability needed for the new plant.
- Sources of the necessary workforce are available within the design and construction lead time.
- Production management systems and controls in use at SEMAF are sound and adequate, and their use should be extended to the new plant.

The estimated capital costs of the project are summarized below by foreign and local cost components:

Cost Components	Capital Cost (Thousands of $) Foreign	Local	Total
Land Purchase	--	$ 1,157.0	$ 1,157.0
Civil Works - On Site	$1,232.6	1,862.5	3,095.1
Road Construction (SEMAF Equity)	--	312.0	312.0
Buildings	132.6	4,583.8	4,716.4
Additional Equipment for SEMAF Bogie Shop*	2,463.1	276.7	2,739.8
Equipment for New Plant*	3,455.3	399.1	3,854.4
Purchase of Equipment from SEMAF by New Company	--	932.5	932.5
Design and Construction Supervision	475.0	393.3	868.3
Provision for Costs of In-Plant Training	--	143.0	143.0
Capitalized Interest	--	1,072.5	1,072.5
Working Capital		750.0	750.0
Total	$7,758.6	$11,882.4	$19,641.0

*Includes 5 percent contingency for price estimates

The projected time of project execution (from establishment of the new company and beginning of the design contract process) is estimated to be 37 months.

FINANCIAL ANALYSIS

The project is financially feasible. The following are specific findings resulting from our financial analysis.

- After-tax net cash flow for the 3-year development period and a 10-year operating period totals $26.3 million, or about 13 percent of the ten-year gross revenues of $203 million:

	Total Cash Flow ($ Thousands)
Sources of Funds	
Gross Revenues	$203,471
Borrowings	
Long-Term Foreign Loan	7,759
Line-of-Credit	3,727
Subtotal	11,486
Equity	11,882
Total Sources of Funds	$226,839

	Total Cash Flow ($ Thousands)
Uses of Funds	
Capital/Development Costs	$ 17,819
Initial Supplies & Materials	2,308
Operating Costs & Expenses	143,887
Interest Payments	
Long-Term Foreign	6,721
Line-of-Credit	3,512
Subtotal	10,233
Principal Payments	
Long-Term Foreign	3,843
Line-of-Credit	3,727
Subtotal	7,570
Profits Tax	18,698
Total Uses of Funds	$200,515
Net Cash Flow	$ 26,324

- In addition to the $7.76 million for foreign capital costs, $11.88 million in local currency is required to implement the project (the analysis assumes these funds are from equity contributions).

- An additional $1.7 million is required to fund negative cash flow during the development period. This negative cash flow results from the purchase of local materials and supplies needed for the initial production inventory. A line-of-credit agreement is assumed to be available for these working capital requirements.

- Another $1.98 million is borrowed on the line-of-credit during the first year of operation (1981) to cover negative cash flow, increasing the line-of-credit principal balance to its peak level of $3.73 million. The borrowings are repaid as cash flow becomes available with $812,000 in 1982, $1.73 million in 1983 and the remaining $1.19 million in 1984.

- After repayment of the line-of-credit principal in 1984, net cash flow totals $2.8 million. Then,

annual net cash flow increases to $3.89 million in 1985 and remains near that level unitl export sales increase annual net cash flow to about $4.0 million beginning in 1988.

- Direct foreign exchange requirements for imported mechanical parts exceed foreign exchange earnings from export by slightly more than $13.8 million through 1987. After 1987, with 10 percent of production being export sales, foreign exchange earnings exceed requirements by $393,000 per year.

- The $11.88 million in equity is totally recovered by the end of the sixth year of operations (1987), or nine years from start of development.

- By treading the local capital costs of $11.88 million as equity, the internal rate of return on investment (ROI) is calculated to be 16.6% percent. This ROI is based on a twenty year operating period for the plant.

In general, the financial analysis was conducted in a manner which minimizes the risk of the financial return being significantly less than projected. In many cases where the situation was unclear, we used conservative assumptions about revenues and costs. In addition, we performed sensitivity tests to evaluate possible effects of different conditions on the financial performance. Sensitivity analyses were conducted by altering the principal analysis assumptions and measuring the impact of these changes on project ROI. The sensitivity tests included:

- Reducing the export price from $100,000 to $85,000,
- Reducing the domestic price from $75,000 to $67,000,
- Applying an average annual inflation rate of 5 percent to all costs and revenues,
- Decreasing the sales and production rate from 300 to 200 coaches per year,
- Increasing the sales and production rate from 300 to 400 coaches per year,
- Devaluing the Egyptian pound by 10 percent, and
- Allocating 10 percent of production for export beginning in 1982 rather than 1987.

Results of the sensitivity tests are as follows:

Alternative	Internal ROI	Ten-Year Total Cash Flow (Thousands $)
Base Case	16.6%	$26,324
Reduce Export Price	16.0	25,367
Reduce Domestic Price	10.5	13,457
Inflation	24.0	45,005
Decrease Sales	9.8	13,721
Increase Sales	21.6	39,949
Devaluation	15.6	24,126
Export Sales in 1982	17.0	27,328

Three of the sensitivity tests had an insignificant impact on project performance. Two tests, inflation and an increase in sales had a positive impact on the project financial results, while two tests, the domestic price decrease and a reduction in sales had a negative impact on the financial results. The two cases with negative impact represent very unlikely extreme situations. All of the sensitivity tests showed the project to be financially viable with the worst cast having an ROI of 9.8 percent and ten-year cash flow of $13.4 million.

ECONOMIC ANALYSIS

The economic feasibility of the project was evaluated by calculating the project internal ROI in relation to the national economy. Product and factor prices were modified from values used in the financial analysis to more closely reflect economic costs. Financing, taxes, duties, and other income transfers were excluded from the analysis. After these changes are made, project profits or cash flow provide a reasonable measure of net economic benefit in relation to the Egyptian economy.

Project cash flow on the economic basis for a 30-year project life is summarized as follows:

	30-Year Project Cash Flow ($ Millions)
Sources of Funds	
Coach Sales	$668.0
Scrap Metal	2.0
Salvage Value (Land only)	1.1
Total Sources	$671.1
Uses of Funds	
Capital/Development Costs	$ 28.2
Initial Supplies and Materials	2.3
Operation Costs	486.0
Total Uses	$516.5
Net Cash Flow	$154.6

Capital investment requirements (negative cash flow) total $22.7 million. Cumulative net cash flow turns positive in 1987, increases to $28.4 million by 1990, and continues to increase to $154.6 million by 2010.

The economic internal ROI was computed using the annual net cash flow values from the revised statement of cash flow. This return is estimated to be about 18 percent for the project.

SUMMARY OF FINDINGS

In general, we have found the project to be technically, financially and economically feasible. Specific findings are:

- There is an Egyptian domestic market for railway passenger coaches, streetcars, metros and underground trains which is large enough to support an economically efficient production facility.

- There is export market, primarily in Central Africa, in which the proposed plant could sell third class coaches at competitive prices.

- The existing SEMAF plant does not have the capacity to satisfy the domestic market demand between now and 1990 while continuing to satisfy the needs of Egyptian Railways for goods wagons.

- The management capability and both skilled and unskilled labor necessary to operate the proposed plant are available within Egypt.

- The proposed plant site is satisfactory, given the Government of Egypt plans for general development of that area.

- The total capital requirements for design, construction and equipping the proposed plant together with initial working capital is in the range of $19 to $20 million of which about $8 million would be foreign currency and $11 to $12 million local currency.

- The project is financially sound. Profits after taxes are projected to grow from $598,000 in the second year (1982) of project operation to $3.78 million in the tenth year (1990). The after-tax net cash flow over the ten-year period is projected at $26.3 million, comprised of:

	$ Millions
Sources of Funds	
Investment Capital	$ 19.6
Other Borrowing	3.7
Sales Revenues	203.5
Total Sources of Funds	$226.8
Uses of Funds	
Plant Construction and initial working capital	$ 20.1
Interest and Amortization of debt	17.8
Operating Costs	162.6
Total Uses of Funds	$200.5
Net Cash Flow	$ 26.3

- The after-tax internal rate of return on investment is estimated to be in the range of 16 to 17 percent. The $11.88 million in equity capital is totally recovered by the end of the sixth year of operations (1987), or nine years from start of project execution.

- Tests of sensitivity to reasonably expectable changes in price, production volume, production mix, inflation and foreign exchange rates indicate that the project is highly likely to have a return in the range of 15 to 20 percent.

- The project is feasible on an economic basis with an internal rate of return on investment estimated at 18%.

SECTION II - COMMERCIAL ASPECTS

The primary objective of the proposed plant is to satisfy the domestic market for railway passenger cars and electrically propelled cars for urban transportation in Egypt. A secondary objective is to supply coaches for export. These objectives lead to a three way segmentation which is followed through the analysis of market and competitive position, i.e.:

- Domestic market for railway passenger coaches,
- Domestic market for streetcars, metros and underground trains, and
- Export market in Africa and the Middle East.

For each of those three market segments, we set forth below the following information:

- Review of market trends over the past five years,
- Estimate of future market demands,
- Preliminary determination of the type of rolling stock which should be produced, and
- Analysis of the competitive position of the proposed plant.

Finally, we present a summary of the firm's expected position including forecasts of sales volume and justification of proposed capacities. The impact of local laws, regulations, etc. which affect market conditions is presented under financial aspects in Section IV.

DOMESTIC MARKET - RAILWAY PASSENGER COACHES

This market consists entirely of the passenger coach needs of Egyptian Railways (ER). The basic factors in this market are the existing number and age of railway coaches, number of coaches required to provide adequate service, and expected railway traffic increases. The data presented below are as of January 1, 1977.

Recent Market Trends

Purchases within the last ten years consist primarily of second class coaches from East Germany and third class coaches from SEMAF and East Germany. These acquisitions are estimated as follows:

	SEMAF*	East Germany**		
	Third Class	Third Class	Second Class	Total
1969-70	10			
1971-72	25		129	
1973	35			
1974	44	71		
1975	60			
1976	91			
1977/3 months	27			
	292	71	129	465

* By information from SEMAF deliveries and Table II-1

** Provided by Egyptian Railways

These data reconcile with a distribution of rolling stock age obtained from Egyptian Railways and presented as Table II-1.

Projected Market Trends

Future market trends are estimated from two sources of data. The first is the current acquisition program of ER. The second is based on needs for cars to provide adequate service and projected long-run traffic growth.

As of May 17, 1977, the four year program for acquisitions was as follows:

	SEMAF	Import	Total
1977	120	--	120
1978	150	130	280
1979	150	170	320
1980	150	--	150
	570	300	870

The projected car orders from SEMAF are for third class cars based on the assumption that they will succeed in increasing productive capacity. The imported cars are to be first and second class coaches of a higher standard of comfort.

As shown in Table II-1, there currently exist 1607 passenger cars, of which 153 will be overage by 1980 and can be expected to be scrapped. Thus, the number projected to be available by 1980 can be calculated as:

TABLE II-1

STATEMENT OF PASSENGER CARS AVAILABLE PROVIDED BY EGYPTIAN RAILWAYS

Description.	No Avail.	Age From 1-5 Years	5-10 Years	10-15 Years	15-20 Years	20-25 Years	25-30 Years	30-35 Years	35-40 Years	40-45 Years	45-50 Years	Over 50 Years
(Dining) Passenger Cars A.C	11	-	-	11	-	-	-	-	-	-	-	-
Dinning Cars	2	-	-	-	-	-	2	-	-	-	-	-
Sleeping Cars A.C.	50	-	-	50	-	-	-	-	-	-	-	-
Sleeping Cars	10	-	-	-	-	-	-	-	-	-	10	-
1st Class Cars A.C	22	-	-	9	-	6	4	3	-	-	-	-
1st Class Cars	43	-	-	-	26	8	-	-	-	-	9	-
2nd Class Cars	256	99	30	13	5	55	-	-	-	-	34	20
3rd Class Cars	772	356	9	-	39	188	144	-	20	-	11	5
Combined 1st & 2nd	10	-	-	-	-	-	-	-	-	-	10	-
Combined 2nd & 3rd	335	-	-	130	200	-	-	-	-	-	4	1
Break Vanes.	96	-	-	-	29	9	20	-	1	-	14	14
Total.	1607	455	39	213	299	266	179	3	21	-	92	40

Total No. of overaged cars 153.

Cars on Hand (3/31/77)		1,607
1977-1980 Program	870	
Less three months 1977 from SEMAF	(27)	
		843
		2,450
Less expected retirements		(153)
On Hand - End of 1980		2,297

Future replacements of overage stock are estimated at:

1982 - 86	3 coaches
1987 - 91	179 coaches
1990 - 96	266 coaches

Actual requirements of ER for coaches can be estimated from the current stock, existing deficit in relation to requirements and projected traffic growth. It is currently estimated by ER that to satisfy the existing demand would require two to three times the number of coaches now in service (that number currently being about 1,200 because of the large number of coaches out of service for maintenance.) The rate of traffic growth is estimated at 5 percent per year. This is based upon data in the draft report of the Egypt National Transport Study and discussions with World Bank staff in Washington. In addition, an improvement of the out of service ratio to 10 percent from the current 20 percent is assumed.

The end of year requirements shown in Table II-2 are based on the annual growth rate of 5 percent of the current requirement[1/], a conservative assumption of a factor of 1.5 times coaches in service to estimate requirements, and addition of a number to allow 10 percent out of service. From that data, a demand for coaches to satisfy traffic growth and to replace retirements can be projected as shown in columns (3) through (5) of Table II-2. The demand begins at 150 coaches in 1981 and varies between 105 and 200 coaches in the ten years through 1990.

Recommended Local Production

It is recommended that local production be concentrated on third class coaches and progressively upgraded to second and first class coaches as capacity becomes available. This strategy takes full advantage of existing capabilities and will facilitate the maximum total volume of coaches produced locally.

1/ A constant annual (linear) growth rate has the effect of reducing the percentage growth in later years, thus avoiding the extremely large and often unrealistic numbers in later years. Our experience with similar situations of passenger demand estimation indicates that in the long run, particularly as economies mature, the linear estimate tends to be more accurate.

Competitive Position

It is clear that third class coaches can be produced economically in Egypt in comparison with imports. There is no reason to believe that production facilities in other countries are significantly more efficient, and local labor is plentiful. In addition, there is the advantage of no transportation cost to place the cars on Egyptian Railway tracks.

TABLE II-2

PROJECTION OF EGYPTIAN RAILWAYS
PASSENGER COACH REQUIREMENTS

	End of Year Requirement (1)	Actual Projected (2)	Demand: From Traffic Growth (3)	Demand: From Retirement (4)	Demand: Total (5)
1977	2100				
1978	2207				
1979	2310				
1980	2415	2230			
1981	2520	2380	150		150
1982	2625	2580	200		200
1983	2730	2730	150		150
1984	2835	2835	105	1	106
1985	2940	2940	105	1	106
1986	3045	3045	105	1	106
1987	3150	3150	105	36	141
1988	3255	3255	105	36	141
1989	3360	3360	105	36	141
1990	3465	3465	105	36	141

DOMESTIC MARKET - STREETCARS, METROS AND UNDERGROUND TRAINS

This segment of the market is composed of cars with electric motors and control systems designed to run as independent units. They include:

- Streetcars for the Cairo Transport Authority (CTA), referred to as "town trams".
- Cars for the proposed "urban metro" line to be operated by CTA.

- "Regional metro" cars for the Helwan suburban line and its proposed extension over the Egyptian Railways line to El Marq.

- "Surface metro" cars for:

  - CTA lines under construction in Helwan
  - Traffic growth on lines of the Heliopolis Company
  - Traffic growth on lines of the Alexandria Passenger Transport Authority (APTA)

Background information on the lines mentioned above and their future requirements is provided in Appendix A.

Recent Market Trends

The current equipment status of the electrified lines, including recent orders is shown in Table II-3.

Projected Market Trends

An estimate of future requirements for which data are available is presented in Table II-4. This includes cars required for town tram, surface metro, regional metro and urban metro for the Cairo area and for Alexandria. It does not take into account the following future possibilities:

- Extension of town tram or surface metro lines in Alexandria,

- Surface metro in new towns such as Sadat City, and

- Surface metro in the development of existing cities, particularly Port Said, Suez, Ismailia, Tanta and Benha.

To the extent that requirements for electric railways may develop in such instances in the future, our estimates may be said to be understated. Also, there could be requirements for additional cars if the goals for improvement of maintenance, as discussed in Appendix A, are not met.

Recommended Production

We recommend that local production of these cars begin with assembly of imported cars in knocked down condition. This will minimize the learning curve required for initial production. In the future, SEMAF should strive to add to the local component as much fabrication and assembly of electrical components as possible short of incurring the expense of setting up high technology specialized production facilities which cannot be justified at the level of electric vehicle requirements foreseeable in Egypt.

TABLE II-3

RECENT MARKET TRENDS AND EQUIPMENT STATUS - ELECTRIFIED LINES

(Multiple Unit Sets are Expressed in Terms of Total Number of Cars)

Line Equipment Type	CTA Town Trams	Helwan Regional Metro	Heliopolis Surface Metro	APTA Surface Metro
Recent Deliveries				
1972	--	75		
1973	--	--		
1974	--	--	32	
1975	--	--	28	66
1976	--	--	36	
Previously Owned	421	72	154	284
Total On Hand	421	147	250	350

Competitive Position

An Egyptian construction facility can be expected to be fully cost competitive with foreign assembly. This is due to both low costs for skilled labor and to the lower ocean freight cost for a shipment of a given weight and value with lower cube, as is the case with unassembled railway cars.

EXPORT MARKET

The export market for railway cars has not yet been tapped by any Egyptian manufacturer, and it thus represents a new marketing venture. Therefore, no market history data is available. There is, however, data for estimating the potential market.

Marketing Projection

The potential export market is clearly in the African and Middle Eastern countries. There are political differences among countries in the area which could affect market penetration. Since the political situations are very fluid and we are making projections for sales at least five years in the future, the political factors are not considered. The market can be described in terms of five segments.

TABLE II-4

PROJECTED REQUIREMENTS FOR ELECTRIFIED ROLLING STOCK

	Town Trams	Surface Metro 7/	Regional Metro	Urban Metro	Total
1977	--	--	--	--	--
1978	100 2/	50 3/	--	--	150
1979	60 2/	120 10/	--	--	180
1980	100 4/	131 10/	--	--	231
1981	--	20	--	--	20
1982	--	50 10/	180 5/	--	230
1983	--	20	183 5/	--	203
1984	--	50 10/	--	--	20
1985	30 11/	52 8/	--	--	82
1986	-- 11/	20	30 9/	--	50
1987	20 11/	20	--	--	40
1988	--	20	--	232	252
1989	--	20	30 9/	--	50
1990	--	20	--	--	20

1/ Cars fabricated by Hitachi to be assembled at SEMAF.

2/ Assembly at SEMAF of cars from current tender offers to CTA (only if the trams selected are compatible with the assembly line for surface metro cars.

3/ Including Current Mitsubishi order for Helwan lines (30 in 1978 and 70 in 1979).

4/ Additional cars required to meet 1980 CTA objective.

5/ Assuming total requirement spread over two years.

6/ Including 81 cars for Cairo lines.

7/ Including 20 cars each year for normal expansion of Heliopolis.

8/ Including 32 cars for Airport line.

9/ Assuming 2 percent annual traffic growth.

10/ Includes 30 cars for Alexandria

11/ Alexandria cars

- Standard gauge railways,
- Narrow gauge railways in the Middle East,
- African narrow gauge railways in areas of French influence,
- African narrow gauge railways with independent purchasing policy, and
- Railways proposed or under construction.

The basic market facts regarding passenger coaches in the first four categories (existing railways) are displayed in Table II-5. The table shows the gauge of each railway and the number of passenger coaches currently owned.

North African/Middle East Standard Gauge

These railways generally use equipment built to European standards, and European suppliers are well established. The estimated replacement market of 54 cars annually is not a likely market area for Egypt, particularly since Algeria and Tunisia are reported to be considering building their own coaches.

North African/Middle East Narrow Gauge

These lines have a number of cars which are barely significant from a replacement point of view.

African Narrow Gauge - French Influence

Those railways are all listed in international directories as having the same purchasing agent (Office Francais de Cooperation pour les chemins de Fer et les Materiel d'Equipement) in Paris. All recently reported purchases of goods wagons and passenger coaches are from French companies. Therefore, those railways are not considered to be a likely market for Egypt.

African Narrow Gauge - Independent

This group of railways appears to offer the best potential market for Egypt. Replacement demand is estimated at about 90 cars per year assuming a 40 year life. With one minor exception, they are 1.000 or 1.067 meter gauge. Thus, they present a reasonable potential for series production of a standardized third class coach with only accessories being changed to suit individual railroads. Recent delivered prices of Eastern European coaches to this market are reported to be priced at about $100,000. At this price level, Egypt can be highly competitive. For the purpose of this study, it is assumed that Egypt would obtain one third of the market or 30 coaches annually.

Railways Proposed or Under Construction

There are numerous plans for new railway construction in the developing countries. While passenger coach requirements are not yet

TABLE II-5

THE PASSENGER COACH MARKET IN AFRICA AND THE MIDDLE EAST

RAILROAD	GAUGE	PASSENGER COACHES OWNED IN 1974	
North Africa/Middle East Standard Gauge			
Morocco	Standard	304	
Algeria	Standard	386	
Tunisia	Standard	150	
Syria/Lebanon	Standard	163	
Iraq	Standard	244	
Saudi Arabia	Standard	21	
Total			1,268
North Africa/Middle East Narrow Gauge			
Tunisia	3 ft. 6 in.	n.a.	
Jordan	1.050 meter	52	
Syria/Lebanon	1.050 meter		
Iraq	3 ft. 6 in.	366	
Total			418
Africa Narrow Gauge - French Influence			
Benin	1.000 meter	29	
Cameroun	1.000 meter	94	
Congo	3 ft. 6 in.	66	
Ethiopia (D-AA)	1.000 meter	59	
Ivory Coast/Niger	1.000 meter	134	
Malagasy	1.000 meter	86	
Mali	1.000 meter	28	
Senegal	1.000 meter	93	
Togo	1.000 meter	63	
Total			652
African Narrow Gauge - Independent			
Angola	3 ft. 6 in.	134	
Ethiopia	.950 meter	24	
Gabon	Standard		
Ghana	3 ft. 6 in.	253	

TABLE II-5 (continued)

RAILROAD :	GAUGE	PASSENGER COACHES OWNED IN 1974	
Guinea	1.000 meter	36	
Kenya	1.000 meter	*	
Malawi	3 ft. 6 in.	23	
Mozambique	3 ft. 6 in.	152	
Nigeria	3 ft. 6 in.	655	
Sudan	3 ft. 6 in.	632	
TanZam	3 ft. 6 in.	100	
Tanzania	1.000 meter	*	
Uganda	1.000 meter	*	
Zaire	3 ft. 6 in.	562	
Zambia	3 ft. 6 in.	70	
*Total East Africa	1.000 meter	824	
Total			3,465

Railways Proposed or Under Construction

Libya	Standard	Four lines in design or feasibility study
Syria/Jordan	Standard	Under construction Homs to Damascus - feasibility study Damascus to Amman.
Iraq	Standard	Extensive network under construction
Saudi Arabia	Standard	Feasibility studies - Dhahran to Iraq, Jedda to Mecca, Medina and Riyadh
	1.050 meter	Proposed reconstruction of Hedjaz Railway
Nigeria	Standard	Proposed replacement of narrow gauge network
Sudan	3 ft. 6 in.	Proposed extensions to the south

known, it may reasonably be assumed that Egypt could be a competitive supplier in this market. Three countries of particular interest, since funds are readily available, are Nigeria, Libya and Saudi Arabia. The current SEMAF third class standard gauge coach could be considered excellent by Nigerian standards and may be very cost competitive.

Recommended Production and Competitive Position

It is recommended that Egypt initiate development of a standardized narrow gauge coach for use on African railways. Such a coach, with local option for accessorial equipment, could easily become the most cost effective means for those railways to replace their overage coaches. Egyptian labor is cost competitive and the proposed plant would operate at a level of efficiency which would make it a strong competitor.

In evaluating this market, we visited the railway administrations in Jordan and Sudan. No explicit market data was available for other countries in the area. Therefore, the total number of cars currently owned was used as the basis for estimating future demand. An average 40 year life was assumed with a level replacement rate. While most of the countries in the area are growing in population, other factors, such as highway improvement, are working to reduce rail market share. Therefore, in the absence of contradictory evidence, it was assumed that the market would be basically the replacement of 2½ percent of the fleet each year.

SUMMARY OF FIRM'S EXPECTED POSITION

The total estimated future market is summarized in Table II-6. It is evident from the table that the peak demand would be in the 1978 to 1983 time period. This, however, assumes that projects would be completed on schedule and that the complete needs of Egyptian Railways (ER) would be met by 1983. Given past experience, some projects are likely to be delayed and the resultant demand deferred. Additionally, it might be considered reasonable to extend the time before which ER demand is not satisfied to the level of current requirements. Since the alternative is use of additional foreign exchange for demand which could be satisfied subsequently in Egypt, it seems reasonable to assume that moderate delays would be accepted to ensure local production.

TABLE II-6

SUMMARY OF PROJECTED DEMAND

	Egyptian Railways	Electric Cars	Export	Total	Capacity	Backlog
1977	120	--	--	120	120	--
1978	150	150	--	300	180 1/	20 4/
1979	150	180	--	330	220 2/	70 4/
1980	150	231	--	381	180 3/	271
1981*	150	20	--	170	150	291
1982	200	230	--	430	200	521
1983	150	203	--	353	300	574
1984	106	50	--	156	300	430
1985	106	82	--	188	300	318
1986	106	50	--	156	300	174
1987	141	40	15	196	300	70
1988	141	252	30	423	300	193
1989	141	50	30	221	300	114
1990	141	20	30	191	300	-5

*First year of production in new plant

1/ Assuming railway coach capacity increased to 150 and production of 30 surface metro cars (power cars).

2/ Assuming surface metro capacity increased to 70 cars (all unpowered)

3/ Assuming 1978 trained electrical assemblers available for 30 tram cars.

4/ 160 cars for Cairo tram lines not included in backlog because of possibility of foreign assembly.

It is evident from Table II-6 that if the full physical capacity of 300 cars annually were used the backlog would be eliminated by 1990. But, if the work force is stabilized and production is held to the value added equivalent of 300 cars, then there would be a substantial backlog extending into the years beyond 1990. The impact of such a policy is illustrated in Table II-7. For illustrative purposes, it is assumed that the value added of an electric car is 150 percent of that of a third class passenger coach and thus each car equates to 1.5 such coaches. The recommended capacity of 300 cars annually is reasonable for either scenario. As shown later in Section IV, the project is financially viable even if annual production is less than 200 cars per year. If significantly more production were required by 1990, the plant can be easily expanded.

The actual production level for the plant does not need to be more specifically determined at this time. The most critical decision, related to work force size, is whether to expand production from 200 cars in 1982 to 300 cars in 1983. This decision should be based upon a reassessment of the market in 1981, by which time the status of future development of the railways, metros and tram lines should be much more clear. Another decision which can be made several years in the future is the timing of beginning of export sales. This can potentially be moved forward to 1983 if it appears that production capacity will be available.

TABLE II-7

DEMAND IN VALUE ADDED EQUIVALENT UNITS

	Total Demand Table II-6	Electric Cars	Value Added Equivalent	Revised Demand	Capacity	Backlog
1978	20 1/	20	30	30	--	30
1979	50 1/	50	75	75	--	105
1980	201 1/	201	300		--	405
1981	170	20	30	180	150	435
1982	430	230	345	545	200	780
1983	353	203	304	454	300	934
1984	156	50	75	181	300	825
1985	188	82	123	229	300	754
1986	156	50	75	181	300	635
1987	196	40	60	216	300	551
1988	423	252	378	549	300	800
1989	221	50	75	246	300	746
1990	191	20	30	201	300	647

1/ Backlog cars only

SECTION III - TECHNICAL AND ENGINEERING ASPECTS

This section discusses technical and engineering aspects of the proposed project. It includes the preliminary design of a technically feasible railway passenger car production plant. The following subjects are presented in this section:

- o A description of the proposed manufacturing process including:
  - manufacturing aspects of the product
  - characteristics of present and proposed manufacturing processes
  - manufacturing process flow
  - patent and license requirements
  - recommended output rates, and
  - selection and description of the proposed plant.
- o Resource requirements for the proposed plant,
- o Plant layout and infrastructure,
- o Environmental Impact,
- o Plans for project execution and plans for project operation.
- o Estimated cost of physical facilities.

A summary of our conclusions as to the technical soundness of the project is presented at the end of this section.

MANUFACTURING PROCESS

The following paragraphs discuss the manufacturing process characteristics associated with rolling stock production.

Manufacturing Aspects of the Product

Potential products of the new plant would include railway coaches, such as currently produced at SEMAF, and electric multiple unit or tram cars. A description of these products, from a manufacturing viewpoint, is provided below.

Railway Coaches

The railway coaches being produced by SEMAF and others in use by Egyptian Railways have the same basic underframe, same bogie

and exterior sides and roof, generally the same sheathing, and the same buffers and couplers. Most coaches have similar external dimensions and, except for door and window sizes and spacing, have the same appearance.

There is an axle-mounted mechanical power take-off for generation of current for the operation of electrical equipment and battery recharging on the railway coaches except for third class coaches such as those now in production at SEMAF. The third class coaches presently receive AC current supply by intercoach cable connected with the locomotive to provide general lighting. Their batteries (used for emergency lighting only) are recharged at railway yards. Eventually, third class coaches also will have axle powered generators.

The inside ceiling of non air-conditioned coaches closely follows the outside contour of the roof, the space between the ceiling and the roof containing the wiring for light fixtures. The inside ceiling of air-conditioned coaches is flat at about the level where the roof curved profile begins, the space between it and the outside roof containing air-conditioning ducting, more thermal insulation, lighting wiring and piping.

Coaches currently used by Egyptian Railways can be mostly categorized as:

- Third Class Passenger Coaches
- Second Class Passenger Coaches
- First Class Passenger Coaches
- Sleeping Cars
- Dining Cars

The difference between the three classes of passenger coaches other than air-conditioning mainly are the seating, furniture ranging from wooden slat seats in the third class coach to progressively more comfortable seats in the second class and first class coaches.

The structural differences between air-conditioned coaches and non air-conditioned coaches lie mainly in the amount of thermal insulation, with the air-conditioned coaches having double paned windows and insulated doors.

All coaches have two toilet/wash basin equipped compartments at one end of the coach with sleeping coaches having also wash basins in each sleeping compartment. All third class coaches have "Asian" toilets in both of these compartments while other coach classes have one compartment equipped with a "European" toilet and the other with an "Asian" toilet.

Coach parts and materials imported from abroad comprise:

- Wheel and axle sets
- Axle boxes with roller bearings
- Brake sets
- Dampers
- Asbestos (insulation)
- Flooring (mastic)
- Electrical equipment
- Air-conditioning equipment (other than ducting)

Raw materials, components and parts procured from Egyptian manufacturers include:

- Carbon steel sheets, plates and rolled sections (structural shapes such as I-beams, angle iron, channel iron, etc.
- Cast steel and cast iron parts, some as-cast, some machined
- Forged parts other than steel parts requiring only hot bending and shaping from flat stock
- Bogie springs
- Common fasteners (nuts, bolts, screws, rivets)
- Aluminum moulding
- Handles, locks and similar hardware
- Laminated phenolic sheets (for inside walls and ceilings)

In summary, the various kinds of coaches listed above represent small differences in their fabrication and assembly of structural components. With the exception of air-conditioning differences in structural wall and ceiling construction, the main differences among coaches, sleeping cars and dining cars are the substitution or addition of the interior components and the attachment to the underframe of various additional equipment such as air-conditioning compressors, drains and piping and the generator/alternator on the bogie axle. This means that no major changes are required in fabrication or assembly of the basic coach body. The significant changes occur in the "finishing" operations and these require little or no basic equipment for their execution other than extra space to accommodate the longer times required to "finish" the more luxurious or specialized models.

Electric Multiple Unit or Tram Cars

These vehicles, which include streetcars, metros and underground trains, are from the viewpoint of manufacturing expected to be little different from railway coaches insofar as the fabrication and assembly of the vehicle bodies are concerned. The vehicle bodies usually are smaller in all three dimensions, and their construction is of lighter design. The same machinery and skills are required for building those vehicle bodies as for coach bodies.

The main differences are in the bogies, both powered and trailer, and in the installation of traction motor control equipment. It is contemplated that motors and related gearing and control equipment will be imported and require only installation and testing. SEMAF has manufactured, on an experimental/pilot basis, two bogies for the Heliopolis line, and these were satisfactory. These bogies include imported motors. There seems no reason why SEMAF should not produce at its present plant, the bogies required for the different kinds of electric cars.

The manufacturing of traction motors, gears and related electrical control equipment requires specialized machinery and skills not available presently at SEMAF. Projected annual quantities of the different kinds of such motors, gears and control equipment are so small over the forecast period that their manufacture by SEMAF would be uneconomic both as to capital investment and cost of production.

The condition that there are different track gauges in use in Egypt presents no significant problem. The assembly of the car body to its bogies is the last stage of assembly. It is only for the movement of the total car from the final work station through one of the transfer tables to the test track and on the test track itself that additional rails must be provided for multiple gauges. This comment is also applicable to railway coaches for export to countries with different gauges.

PROCESS CHARACTERISTICS AND SKILL REQUIREMENTS

The SEMAF facilities for coaches, including those for manufacture of bogies, were selected for the particular coaches now being built. There are, however, no production equipment units that are especially built for manufacturing these cars. All equipment units are standard machine tools found in most metal-working factories producing products of similar weight and functional use. There are differences between the facilities for production of coach bodies and the facilities for manufacture of bogies. Diagrams of SEMAF facilities together with lists of machine tools are included as Appendix B.

Coach body facilities comprise, mainly, equipment for fabricating parts from steel structural shapes, light steel plate and heavy steel sheet and strip and for welding these parts into static assemblies with especially built fixtures being used to hold pieces (and subassemblies) in the proper positions for welding them together. Equipment used for fabrication comprise metal cutting cold saws, semi-automatic flame cutting units (with some hand torch flame cutting) power shears, large and medium sizes of reciprocating punch presses, friction screw type coining presses (for hot forming of plate steel parts), spot welders (both stationary and large portable units) automatic welders (to join steel sheets and light steel plate), electric (shielded arc and non-shielded) welding units for manual welding of fixture-held subassemblies, and similar equipment. A complete listing is included in Appendix B.

Except for the manual (hand-held electrode holder) welding operation which requires high skill, these operations do not require the skills normally associated with the various kinds of metalworking craftsmen, as the use of dies, jigs and fixtures almost entirely control dimensional and locational quality of the operator's output.

The manufacture of bogies, on the other hand, may be likened to that of producing medium heavy machinery, wherein, the operator of the particular metalworking unit must have and apply a relatively high degree skill and constant attention if the parts he works on are to be of acceptable dimension and finish. Machinery used in fabricating bogie parts, compared to that used for fabricating coach body parts, is heavier in capacity and capable of close tolerance work on plate steel parts and weldments. Typical of these heavier units are the shears capable of shearing 16 millimeter thick by 275 millimeter wide steel plate, the 500 ton hydraulic press and the radial drill presses. Typical of the close tolerance machine units are the large four head planer type milling machine, the several table type horizontal boring mills, a centerless grinder, engine and turret lathes and the smaller universal milling machine. Other machinery includes a fairly large slotter (vertical shaper) several conventional mechanical shapers, and two medium large planers, one of which is of the open-side type. A complete listing of this equipment also appears in Appendix B. No facilities are provided in the bogie shop for the production of axles or wheels or their assembly together as the special alloy steel for axles is not available from Egyptian sources and there are no Egyptian facilities for rotary forging of the wheels.

The manpower skills required in bogie production are those of the typical production machinist which are not as demanding as those of the general machinist who must, himself, decide how and with what equipment and standard tools he will use to make one or a small quantity of a part or how he should assemble the machinery he has been assigned to produce or recondition.

The sides, ends and roof of the coach are produced as subassemblies from parts made in the coach parts fabricating shop. After the construction of the underframe, it is placed upon shop bogies for the assembly (welding, mainly) of the sides, ends and roof. The shop bogies are used for moving the coach through the balance of the work required to complete the coach and are replaced with new bogies as the last operation before delivery of the coach to the customer. A small locomotive is used in conjunction with a transfer table to shift the coach body within and between the production buildings and after assembly of the final bogies to the railway siding for delivery to the customer.

Auxiliary or satellite shops make the wooden seat and baggage rack parts, bend piping and tubing, preassemble bearings and their

housings to the axle-wheel sets, assemble doors, and make or assemble other items used in the assembly of the coach body or in "finishing" the coach. Parts and subassemblies which require painting before assembly are hand spray-painted in water curtain booths and carried through the booths and on through the radiant heated drying ovens by and overhead continuous chain conveyor. Rust and weld scale are removed by hand wire brushing, an inadequate practice in our opinion. There are pickling tanks installed but not currently used. Pickling is a better way of preparing metal parts for painting as, properly carried out, it makes the skin of the part chemically clean and provides a grain to assure better paint adhesion.

The last step in assembly of the coach body before its painting and "finishing" is the straightening of any unevenness in the side panels. This is performed with heating and cooling with solid and perforated plates followed by hand torch and hammer straightening. After the side panel straightening and the currently omitted "leak testing" operation, the car body is moved to a closed building area where the entire body other than the underframe is "grit blasted" down to the shiny bare steel surfaces thus removing all rust or other material and providing a "grained" surface for primer adhesion.

Also prior to painting of the coach body is the provision for checking and correcting of possible leakage of rain into the inside of the coach. This checking is usually not done on coaches for the Egyptian Railways as rainfall is nil or practically nil along its entire rail system and it is believed by SEMAF that the hand lathering on by trowl of the thick "putty" over the primer coat will seal any leakage. It will be necessary that rain leakage be checked and corrected on coaches built in the future for export, particularly to those countries where there is rainfall.

After the application of the "putty" coat and its sanding by handheld machines, the coach body is hand brush painted with the final color coats. It is questionable whether spray-painting would be less costly or produce better finish quality. We believe that the present hand brush painting should be continued and have not provided for any method change in the new plant.

The coach body shell then is passed through a number of "finishing" work stations in which the body shell is fitted with wiring, piping, windows, insulation, the interior walls, ceiling and partitions, the sanitary facilities, baggage racks, lighting fixtures, seats and all other components to complete the coach including the removal of the shop bogies and the installation of new bogies, and leveling of the body, thus making the coach ready for delivery to the customer.

The skills involved in painting and finishing the coach are numerous and overlapping in terms of the general lines of demarcation

between crafts and as the work is repetitive, the full knowledge and skills usually associated with a craft are not required. Within these limitations, the crafts required include electrical wiremen, pipe fitters, painters, carpenters, millwrights and glaziers plus helpers and trainees in these occupations.

Quality control is effected by in-process inspection of parts, various inspection check points during subassembly and in the finishing operations plus a final inspection before releasing the coach for delivery to the customer. The required skills for inspection work range considerably from those easy to acquire to those requiring craft knowledge and high degrees of judgment as to acceptance and possibility of reworking questionable items.

Other current skill requirements are those in the operation of cab type bridge cranes, fork lift trucks, a small shunter locomotive, a transfer table, plus those of the helpers to these operators.

It should be remembered in considering skill requirements that, except for jig and fixture construction, tool making and plant maintenance, all of which require high degrees of craft skills, the typical craft skills required for production operations are reduced considerably by the production engineering and planning staff's determination of "how" and "with what" and the provision to production operations of dies, jigs, fixtures, templates and gauges.

Manufacturing Process Flow

The existing SEMAF manufacturing process flow, as described below, is well suited to the scale of production recommended for the proposed facility. We recommend a basically similar flow with modifications in spatial relationships to improve efficiency. The plant layout described in a later subsection is designated for such a process flow.

Basically, two separate manufacturing plants produce the SEMAF passenger coach. Their separate products, bogies and bodies, are completed with no integration between the two plants until the completed body is mounted on the completed bogies and the brake system components of the body are connected to the brake system components of the bogies.

There is, however, some integration of the passenger coach bogie production plant with SEMAF goods wagon production. There is one shop which assembles roller bearings and housings to axle-wheel sets for both passenger coach bogies and goods wagon bogies. Also, the passenger coach bogie plant performs some work for goods wagon production requiring about 20 hours of work load monthly on two of its machinery units, i.e., the 500 ton hydraulic forming press and the 16 millimeter by 275 millimeter wide capacity shear. (An increase to 50 passenger coach bogies per month would not, in the opinion of SEMAF supervision, affect the availability of these equipment units for current goods wagon production requirements.)

A process flow chart, provided by SEMAF, showing the separate process flows of bogies and coach bodies is duplicated as Figure III-1.

Patents and Licenses

There are no essential differences between the present and proposed plants which would affect patent and licensing considerations. Therefore, the following description of patent and license effects on the existing plant also applies to that which is proposed.

With one possible exception, all of the equipment in place and its operation is and has been for many years in the public domain and, thus, outside the question of patent infringement or license requirements. This one possible exception, the Union Melt welding unit, in our opinion based on experience with similar equipment, carried with its purchase (1961) the right to use it. In any case, SEMAF does not pay any license fee for its use.

All patents concerning the railway coach design are understood to have expired. Some of the coach components may be patented but as all of these items are purchased directly or indirectly from the manufacturers, there should be no liability on the part of SEMAF or its customers.

Equipment for electrically propelled units would be affected by additional patents. These effects can be determined only in the process of tender and negotiation with individual suppliers of such equipment.

Output Rates

From the commerical analysis, it is evident that a production level of 300 coaches per year is readily justifiable and that there could be reason for future expansion of the plant to an annual production level of 500 units. As shown below, the annual level of production of 300 coaches would be difficult to achieve in the existing plant. Additionally, such production would limit capacity for goods wagon production.

The SEMAF passenger coach plant was originally designed to produce four coaches per month on a one shift basis. Current output is now 10 coaches per month. Although attempts are being made to increase this output to 12½ coaches per month, the constraining factor is the bogie shop. Methods studies are in process to determine how to relieve this constraint. To reach the present monthly output of 10 pairs of bogies, key equipment units are being manned on two 10 hour shifts each workday. While the methods studies will probably be successful, it is improbable that it would be possible to produce 25 pairs per month as required in this project. The only practical means of increasing

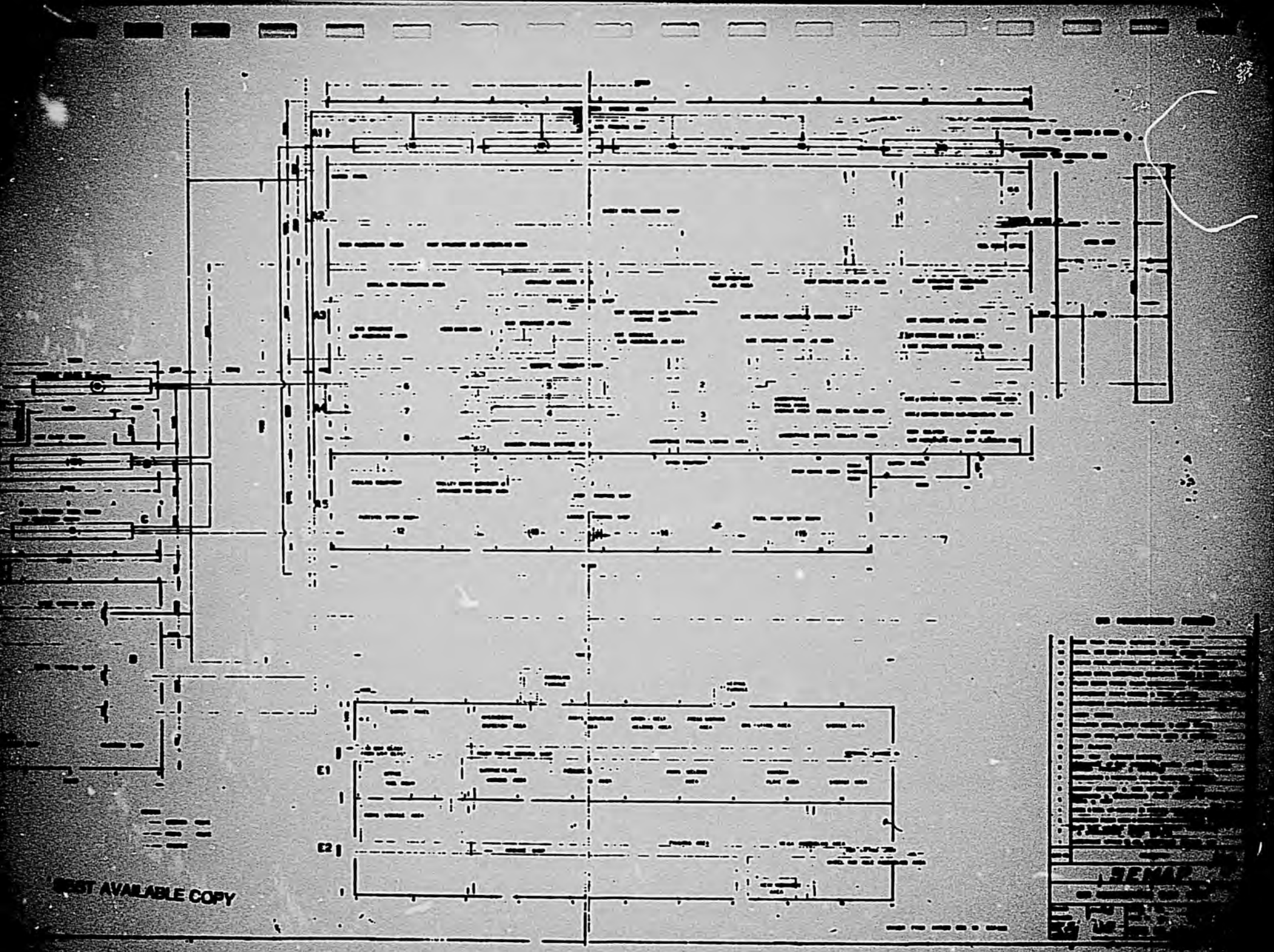


FIGURE III-1

the present output rate to the projected rate is, in our opinion, to install additional units of the equipment types now constraining output.

The current coach body assembly output of 10 bodies per month is now achieved on a single shift. This increase from the 4 coaches per month, for which the original facilities were designed and equipped, has been attained by encroaching upon the areas originally allowed for material movement and in-process materials and parts storage. Theoretically, the present output rate could be doubled to 20 coach bodies per month simply by adding a second shift. Possibly by extending the length of each shift 25 percent (from 7 to 9 hours per shift) a rate of 25 coach bodies per month could be reached. Practical experience rebuts this theoretical calculation. Multi-shifting of assembly and finishing operations requires turnover from the departing shift of information as to the status of each work assignment to the on-coming shift if errors are to be avoided and a minimum of time is wasted in picking up from where the previous shift left off. Multi-shifting parts fabrication also has this problem but to a much lesser degree than assembly work. A practical answer is to work both parts fabricating and assembly operations two shifts with each of the two shifts of the assembly operations being provided with separate jigs, fixtures and gauges plus separate floor areas. This would allow each of the assembly workers to pick up at shift start where he left off at the end of his last shift.

All of the above means that for economic output of 25 coaches per month the entire manufacturing workforce would be split into two shifts but that each of the two body assembly shifts would have its own work area and its own set of jigs, fixtures, gauges and tools. It follows that each of these shifts would have its own area for storage of required parts, subassemblies and production supplies. The feasibility of such an arrangement in the existing plant is questionable.

Selection of the Proposed Facility

A number of different approaches were considered as means to attain an efficient monthly output of 25 third class passenger coaches (or their value-added equivalent) with the lowest practical investment. These included:

- Building and equipping of an entirely new plant producing passenger vehicles in their entirety, using no existing SEMAF equipment.

- Building a new plant and moving to it all of the equipment now used at SEMAF for coach building including the manufacture of bogies and adding such equipment as required to produce 25 coaches per month.

- Building a new plant and equipping it to assemble and finish coach and other vehicle bodies while obtaining its requirements of body parts and bogies from SEMAF, and adding the necessary additional equipment at SEMAF to enable it to produce 25 pairs of coach bogies per month.

- Building a new plant for the fabrication of coach body parts and the assembly and finishing of coaches, moving to it all or practically all equipment now at SEMAF that is used in these operations, obtaining its requirements for bogies from SEMAF, and adding additional equipment at SEMAF for building bogies.

In each of the above alternatives, it was assumed the new plant would be built on property now owned by SEMAF and that SEMAF would supply bogies to the new plant on a normal commercial basis. The additional equipment for the increased production of bogies would be purchased by the new company. It would be installed at SEMAF and title to the equipment would pass to SEMAF. The cost of the new equipment would be considered as a down payment against future delivery of bogies from SEMAF to the new plant. SEMAF would pay for the equipment through a reduction in price for delivered bogies. The price reduction would continue until the new company was fully compensated for its investment. Also included was the condition that all present SEMAF equipment and other facilities moved to the new plant would become the property of the new plant with fair compensation to SEMAF. It was also assumed that the railway wagons needed to transport bogies to the new plant would be the property of SEMAF and that SEMAF would sell bogies to the new plant on a delivered price basis.

It was also assumed that, until adequate housing is available for the workforce and staff, the new plant would operate buses for these personnel for their transport to and from the plant. Consideration of providing such housing was not included in this project study as it is understood that other agencies of the Government of Egypt are responsible for the development of adequate housing and are planning housing near the proposed plant site.

It was recognized that the building of the new plant and the additional equipment required provided opportunities for improvements in production methods, particularly in material storage and handling and in flexibility of movement of vehicle bodies as they progress through their construction.

The last approach described above was selected as the most desirable both as to financial requirements, and as to meeting requirements for increasing output rates and for the flexibility required to produce electrically propelled rail vehicles. More specifically, this approach includes:

- In addition to the new machine tools required to increase the output of bogies at the SEMAF plant, the inclusion of four rotary tables (attachments) for the three present and the one new horizontal boring mills so that all four of these machines may be operated more of the time in cutting metal. Discussions were held with SEMAF as to the installation of radial drill presses so that two of them could drill large work pieces beyond the reach of one and thus not require shifting and reseting the work pieces.

- The provision of transfer tables at both ends of the production halls to provide more flexibility in moving coaches between production halls. They would be long enough to transport a trackmobile coupled to a coach and have carrying capacity to move road locomotives so that the new plant could rebuild locomotive upper bodies.

- The use of trackmobiles in movement of coach bodies between work stations and buildings and also in yard movements of railway wagons, thus eliminating the need for track switches in the plant yard.

- The length of the production halls being sized so as to handle the longer (26.4 meter) length "European International" UIC coach as well as present Egyptian (23.03 meter) coaches. These 210 meter halls provide for either 8 Egyptian coaches or 7 UIC coaches with about 3 meters working space between either type coach.

- The use of a "cherry picker" (a highly mobile rubber-tired crane) for unloading materials (mainly raw steel plate, sheet, bars and shapes) from incoming goods wagons and trucks for storage anywhere outside the warehouse and for selective pickup and movement of these materials to production.

- The provision of a track into the warehouse so that goods wagons may be crane unloaded without intermediate handling.

- The provision of more space and fixtures for coach body assembly so that the crews on two different

shifts can work on separate fixtures and, thus, be able to pick up where work was left when that shift went home on the previous day.

- Two shift operation of all production work at the new plant.

- Inclusion of a test track with overhead catenary for electrically driven self-propelled rail vehicles.[1]

RESOURCE REQUIREMENTS

Resource requirements for the new plant can be split into the two categories of 1) those required for production in the plant, and 2) the plant infrastructure. The production resources, which are described here, are:

- Machinery and equipment,
- Tooling,
- Labor, and
- Materials.

Machinery and Equipment

The required machinery and equipment units are listed in Table III-1 and III-2 showing, respectively, the items to be installed at the new plant and those to be installed at the SEMAF bogie shop.

Prices are estimates from manufacturers, not firm quotations. Prices and delivery times are based on present price levels and supplier work backlogs resulting from our requests for such information from suppliers of machine tools. Our specifications were reasonably specific but open enough for an estimate to be based on either or both of usual relationships of dimensions and the next larger standard dimension configurations.

Caution should be exercised before considering the most expensive machinery item of the group listed for installation at the SEMAF bogie manufacturing shop, i.e., the planer-mill and its universal vertical attachment. These represent an investment of about $1.7 million plus about EGL 14,000. This equipment is needed to increase SEMAF's output of coach bogies to 300 pairs per year. Communication with a builder of such equipment indicated that, under present conditions, an order placed now would require about 22 months including ocean shipment time for arrival at the SEMAF plant ready for installation. This would mean that there are about seven months after the overall project has

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1/ It should be noted that we have made no financial or physcial provision for loading and shipping of these vehicles to the customer. We suggest that these facilities be developed after the vehicle design is known and the method of shipping is determined. The cost of such facilities should be included in the pricing of [illegible]

TABLE III-1

COST ESTIMATE OF EQUIPMENT TO BE INSTALLED AT NEW PLANT

	Delivery Months*	U.S. $ Cost Source**	U.S. $ Est. Ocean Freight & Insurance	U.S. $ Installation Supervision	U.S. $ Total	F.O.I. Cost	F.O.I. Inland Freight Ins.	F.O.I. Subsist-ence***	F.O.I. Total
Transmission (Whiting)									
Model [illegible] 3 @ $[illegible] FAS	n.a.	161,000	12,700	See Below	194,200	-	1,000	See Below	1,000
Spare Parts		10,000	2,000	*	20,000	-	300	*	300
Transfer Tables (Whiting)									
100 Ton 24 meters long 2 @ $200,000 (pits included in construction cost estimate)	n.a.	400,000	20,000	See Below	420,230	-	4,000	See Below	4,000
Spare Parts		13,000	1,000	*	14,000	-	500	*	500
Bridge Cab Controlled Cranes (Whiting)									
7½ metric ton, 10 meter lift 6 @ $70,000	n.a.	000,000	30,000	See Below	000,000	-	6,000	See Below	6,000
30 metric ton, 10 meter lift 10 @ $80,000		000,000	56,000	See Below	056,000	-	9,000	See Below	9,000
Spare crane parts for above items		43,000	2,000	*	46,000	-			
All Above Whiting Items				20,000	20,000	-		40,000	40,000
"Cherry Picker" type Mobile Industrial Crane Grove Model 36	10	43,000	5,000	-	48,000	-	400	200	600
Spare Tires and Parts for above		2,000	1,000	-	3,000	-	150	-	150
Fork Lift Trucks (to supplement those now in SEMAF coach body shops)									
Pneumatic-hydraulic-gasoline powered									
2 Ton Lift 4 @ $15,000 FOB- Battle Creek,	6	60,000	3,000	-	63,000	-	800	400	1,200
5 Ton Lift 3 @ $30,000 FOB- Michigan	6	84,000	6,000	-	90,000	-	800	300	1,100
Spare Tires & Parts for above		18,000	2,000		20,000	-	200	-	200
Buses for Transporting Personnel to/from plant - 40 seated, 12 standing 20 @ $18,000 FOB Factory	5	360,000	80,000	-	440,000	-	1,000	2,000	3,000
Spare Parts and Tires		15,000	1,500	-	16,500	-	250		250
Budget for Inspection Equipment & Testing Laboratory	5	18,000	4,000	-		3,000	300	2,000	
Measuring Tools & Gauges		3,000	500	-	25,500	2,000	150	-	7,450
Budget for Maintenance Shop									
Machinery	10	90,000	6,000	-		10,000	1,150	3,000	
Hand Tools & Measuring Tools		4,000	500	-		2,000	100	-	
Consumables - Initial Supply		--			100,500	1,000	--	-	17,250
Budget for Jig & Fixture Shop									
Machinery & Welding Equipment	10	100,000	7,000	-			8,000	7,000	
Hand Tools & Measuring Tools		12,000	1,500	-		1,000	100	-	
Consumables - Initial Supply		-	-	-	120,500	1,000	100	-	17,200
Budget for Drawing Room									
Equipment	5	1,000	100	-		4,000	200		
Fixtures & Furniture					1,100	3,000	150		7,350
Budget for Office & Timekeeping									
Equipment (ex: telephones)	3					6,000	300		
Fixtures & Furniture						5,000	250		11,550
Budget for Canteen									
Refrigeration & Cooking	8	4,000	800	-		500	100	200	
Pots, Pans, Cutlery		-	-		4,800	400	50	-	1,250
Budget for Fire Fighting (other than water supply to hose points)									
Hose & Nozzle		5,000	350	-		-	50	25	
Extinguishers		6,000	400	-	11,750	-	100		175
Budget for Mobile Equipment Service & Repair Shop									
Equipment & Fixtures		10,000	1,000				200	500	
Test Instruments		4,000	400	-		-	100	-	
Hand Tools		700	100	-	16,200	-	25	-	825
Grit Blast Equipment (to replace equipment at SEMAF which is not to be relocated to new plant site) complete with recovery system and spare parts		90,000	6,000	8,000	104,000	10,000	1,000	12,000	23,000
Removal of all coach body fabrication and finishing machinery, tools and fixtures plus all coach body sub-assembly, final assembly and finishing equipment, jigs and fixtures except Grit Blast equipment, trackage, bridge cranes and transfer table from SEMAF plant and re-installation at new plant						20,000	12,000	5,000	37,000
Development of floor layout of new plant and supervision of installation						10,000		6,000	16,000
Provision for additional shop begins (20) to cope with increased coach building output rates and transit car body building (made locally)						8,000	400	-	8,400
Provision for additional jigs and fixtures for additional coach assembly output rates						16,000	3,000	-	19,000
Provision for material handling conveyors, skids and "A" frames						20,000	2,000	-	22,000
Automotive Vehicles:									
Maintenance Automobiles		14,000	3,700	-		-	100	100	
Tractor Truck		7,000	1,000	-		-	50	50	
10 Ton Truck		10,000	2,000	-		-	75	100	
Spare Parts & initial supply of replacement tires		3,000	600	-	[illegible]				[illegible]
		Total U.S. Dollars			3,[illegible],700	Total Equipment Costs			[illegible]
Contingency - 5%					[illegible]				[illegible]
[illegible] arrival at site		Total U.S. Dollars			[illegible]	Total Equipment Costs			[illegible]
[illegible]									

TABLE III-2

COST ESTIMATE OF EQUIPMENT TO BE INSTALLED AT SEMAF (HELWAN)

		U.S. $				E.G.L.			
	Delivery Months*	Cost Export**	Est. Ocean Freight & Insurance	Installation Supervision	Total	Cost	Inland Freight Est.	Subsistence***	Total
Planer-Mill (Ingersoll) (2 heads on rail)	22	1,500,000	105,000	45,000		--	5,000	9,000	
Universal Vertical Attachment for above Planer-Mill (Ingersoll)		35,000	Included in above	Included in above			Included in above	Included in above	
Export Packing - Freight to U.S. East Coast both above Ingersoll items		22,000			1,707,000				14,000
Horizontal Boring Mill (Lucas)	9	238,000	Included below with other Lucas item	9,000			2,000	7,000	
Tail Stock (Lucas)		15,000							
Rotary Tables (Lucas) for 3 present plus 1 new horizontal boring mills 4 @ $19,233 each	9	77,000		Included in above		--	500	1,500	-
Export Packing and Freight to East Coast for above Lucas items		8,000	23,000		370,000				11,000
Radial Drill Presses (Carlton) 4 @ $57,765 each		231,000	16,000	10,000	257,000		1,500	2,500	4,000
Holding Positioner (Teledyne-Readco)	6	10,600	1,200	--	11,800		300	1,500	1,800
Equipment relocation to install above items		--	--	--				3,500	3,500
Newly built flat goods wagons with rails to transport bogies to new plant 6 @ EGL 25,000 each	5					150,000			150,000
					2,345,800				184,300
Contingency - 5%					117,290				9,215
					2,463,090				193,515

* From order date to arrival at site
** Including FOB U.S. East Coast
*** Installation and supervision

been approved and funded before an order would have to be placed. This time period should be used to determine the wisdom of ordering this planer-mill equipment. This study should consider:

- Whether the manufacture of bogies for regional metro, urban metro, surface metro and town tram cars will require this planer-mill and together with railway coaches add up to a level at which a second planer-mill will be justifiable,

- The number of years into the future that the present railway passenger coach bogie may be produced before it becomes technologically obsolete and replaced with a bogie of a different design,

- Whether the new horizontal boring mill, together with one of the four rotary tables included in the list of new equipment will allow rerouting of portions of the present bogie and relieve the present planer-mill of enough machine time load to allow it to produce the bogie parts that must be machined by it at output rates high enough to satisfy requirements.

Costs of the equipment discussed above have been included in the financial feasibility calcuations.

Similar questions should be asked about the other equipment designated for installation in the SEMAF bogie shop.

Tooling

It is assumed that all tools used in the manufacture of bogies will remain at SEMAF and that all tools at SEMAF used solely in the fabrication, subassembly, assembly and final finishing of coach bodies will be transferred from SEMAF to the new plant.

Tools to be relocated at the new plant should include:

- Templates
- Dies
- Fixtures
- Alignment and checking gauges
- Measuring tools - vernier and micrometer calipers, scales, protractors, etc.
- Shop bogies
- Special crane slings
- Jacks
- Air powered riveting guns and bucks
- Portable electric and air powered drills, saws and chipping hammers

- Welder scale hammers and brushes, electrode holders, cables and ground clamps
- Consumable tools such as drill bits, reamers, saw blades, cutters, insertable carbide tips, etc.
- Portable work lamps
- Hand tools such as hammers, screwdrivers
- Gas torches, hose and cylinders
- Tongs
- Pry bars, wedges
- Water hose

Except for certain jigs, fixtures and alignment gauges which will require additional duplication to handle the increased output rates and tools which are now used plant-wide at SEMAF, there should be only minor additional to the tooling now on hand to satisfy the new plant's requirements, mainly due to the anticipated two-shift operation of the plant. A cost for items which could be anticipated is included in Table III-1.

Labor

SEMAF applies measured labor standards to an individual worker's production output or the output of a group, depending on which application is more practical to establish and administer. These standards are expressed in "standard hours", and the worker is paid these hours or his actual hours worked, whichever is greater. The "standard hours" associated with the fabricating of parts and the assembly of a passenger coach is shown in Table III-3. Built into these standards is an incentive allowance of 35 percent. These standards are set on the batch size of 20 coaches, thus, providing for one set-up time to produce the number of parts or operation cycles required for that batch size. Unit direct labor cost to SEMAF becomes constant once all workers produce enough output to earn more than their hourly base rates or consume less time than 74 percent (100 divided by 135) of the labor "standard hours.

The derivation of expected production rates and direct production employment level requirements for the new plant is shown in Table III-4. The calculation is based on a target production level of 300 third class passenger coaches (or their value-added equivalent) per year. The standard manhours per coach is decreased from its current level of 15,300 in 1981 to 15,000 in 1982 and 14,500 in 1983 and thereafter. These reductions are based on economies which should result from additional working and storage space at the new facility and improved plant design.

Average productivity is defined as the ratio of standard manhours to actual manhours. While under optimal conditions productivity could reach 135 percent, average productivity is projected to reach 90 percent in 1981, 100 percent in 1982, and 125 percent in 1983 and thereafter. During the first two years of operation, a significant number of new employees would be in the training stage, thus, yielding a low average productivity rate. However, a large number of employees would still be expected to earn bonuses in the first two years of operation.

TABLE III-3

STANDARD MANHOURS FOR PRODUCTION OF THIRD CLASS PASSENGER COACH BODIES AT EXISTING SEMAF PLANT
(Based on Batch Size of 20 Coaches)

Activity	Standard Manhours/Coach*
Machining of Parts	
Shearing	183
Sawing	31
Flame Cutting	42
Welding	38
Blacksmithing & Straightening	307
Press Operation	196
Bending	161
Drilling	202
Planing	20
Tracing	80
Tapping & Screwing	28
Finishing	54
Subtotal	1,342
Assembly	
Underframe	1,680
Side	1,612
End	400
Roof	336
Final	2,554
Accessories	588
Subtotal	7,170
Finishing	
Inner casing (glass wool, formica, etc)	1,086
Inner erection	1,852
Outer erection	1,182
Electrical installation & wiring	427
Andrulium & asbestos installation	360
Grit blast	90
Putty	405
Painting	553
Wood working	832
Subtotal	6,787
Total	15,299

TABLE III-4

PASSENGER COACH BODY PRODUCTION CAPACITY AND DIRECT PRODUCTION EMPLOYMENT LEVEL REQUIREMENTS
(Based on Target Production Level of 300 Third Class Coaches per Year)

	Year		
	1981	1982	1983*
Standard Manhours per Coach	15,300	15,000	12,240
Average Productivity (related to standard)	90%	100%	125%
Actual Manhours per Coach	17,000	15,000	11,600
Number of Coaches Produced	150	200	300
Manhours Required per Year (Thousands)**	2,550	3,000	3,480
Number of Direct Production Employees***			
Skilled	385	453	525
Semi-Skilled	643	756	877
Unskilled	257	302	351
Total	1,285	1,511	1,753
Paid Manhours per Coach	19,082	17,400	14,500
Paid Manhours per Year (Thousands)			
Skilled (30%)	858	1,044	1,305
Semi-Skilled (50%)	1,430	1,740	2,175
Unskilled (20%)	572	696	870
Total (100%)	2,860	3,480	4,350

* First year of full production.
** Product of actual manhours per coach and number of coaches produced.
*** Based on 1,985 annual hours per employee.

"Actual manhours per coach " is derived by dividing "standard manhours per coach" by productivity. "Manhours required per year" is the product of "actual manhours per coach" and "number of coaches produced". Then, on the basis of approximately 1,985 annual hours per employee, the number of direct production employees is derived, showing the labor force increasing from 1,285 employees in 1981 to 1,511 in 1982 and 1,753 in 1983 and thereafter.

Paid manhours per coach also is shown in Table III-4. Total paid manhours is established by adding actual manhours worked, for those employees assumed to work at less than a 100 percent productivity level, to standard manhours, for those employees assumed to work at greater than a 100 percent productivity level.

In addition to direct production employment, the new plant would require indirect and overhead employment. At the existing SEMF

plant, indirect and overhead employment represents about 39 percent of total employment. At the new plant, this ratio is expected to drop to 35 percent since an effort would be made to eliminate the type of redundant employment which exists at SEMAF. Applying this new ratio yields a total employment level of 2,700, of which 950 are classified as indirect and overhead. About 10 percent of the total plant employment or about 270, would serve in an administrative, technical, supervisory or clerical capacity.

Materials

About 70 percent of the cost of direct materials and parts that SEMAF purchases for the manufacture of the third class coach is for Egyptian sources. Imported material consists of bogie components and brake parts. Because these components are standardized, they may be procured from several countries, thus putting SEMAF in a position to obtain competitive prices and to have alternate sources of supply.

Although some special shapes are not rolled in Egypt, and the local steel mill produces only the lower carbon steels, the kinds, shapes and sizes of steel which are used in volume by SEMAF in building coach bodies and coach bogies are produced within Egypt. A third class coach requires about 28 tons of steel; an annual production of 300 such coaches would require about 8,400 tons per year.

Locally manufactured mechanical special and specialty items plus locally available hardware, fasteners, and welding rod comprise about 45 percent of the value of all direct materials for the third class coach. There should be no difficulty in procuring the additional quantities required of those items.

Sample pages of the complete Bill of Materials for the third class coach are shown in Appendix C.

Production is planned and scheduled through manufacturing in batches of 20 coaches. The cutting of plate and sheet stock is planned on this batch size, and wastage is minimized by using standard layouts for each piece of stock. This batch size seems practical to continue regardless of the projected increase in output as it is well above the cost breakeven batch size (7 sets) often experienced in this type of manufacturing, and it is small enough to minimize in-process storage space requirements, reveal shortages early enough to allow their detection and timely correction, prevent subquality parts production from continuing for any lengthy time before the condition is detected and the cause corrected, and allow good cost control and accurate administration of production incentives.

PLANT LAYOUT AND INFRASTRUCTURE

The plant infrastructure includes:

- A site for the new plant,
- Factory buildings,

- Support buildings, and
- Outside facilities.

The following paragraphs discuss these items and their associated costs.

Site Description and Layout

The land available for the new plant consists of 449,485 square meters. This land abuts and lies north of the single track railway line from El Wasta to Faiyum. The site lies about half way between these towns, which are about 16 kilometers apart. A road is being constructed to connect this site with the present road system. This site is about 80 kilometers from the SEMAF plant at Helwan.

The weather conditions are:

	Summer	Winter
Temperature Average	41°C	7°C
Temperature Max/Min	52°C	0°C
Relative Humidity Average	15-33%	30-60%
Rainfall	nil	nil
Wind Velocities	Data Not Available	

The area has desert characteristics and is subject to sand and dust storms. The topography of the property is relatively flat but grading work will be required for its use as a plant site.

The projected use of this property is shown on the map in Figure III-2. The total land available is more than enough for the plant. Specifications and cost estimates for the civil engineering work to be performed are included as Appendix D. A summary of those costs is given in Table III-5.

Factory Buildings

The proposed layout of factory buildings is shown in Figure III-2. There are two groups of factory buildings: one north, the other south of the "north" transfer table.

The southern building comprises six halls, each running the full length of the building. One of these halls, marked "D" in Figure III-2 is mainly for activities other than direct manufacturing.

These activities comprise:

- Offices for production planning and materials procurement, inspection, plant engineering, product engineering, tool design, and drafting and drawing control.

FIGURE III-2

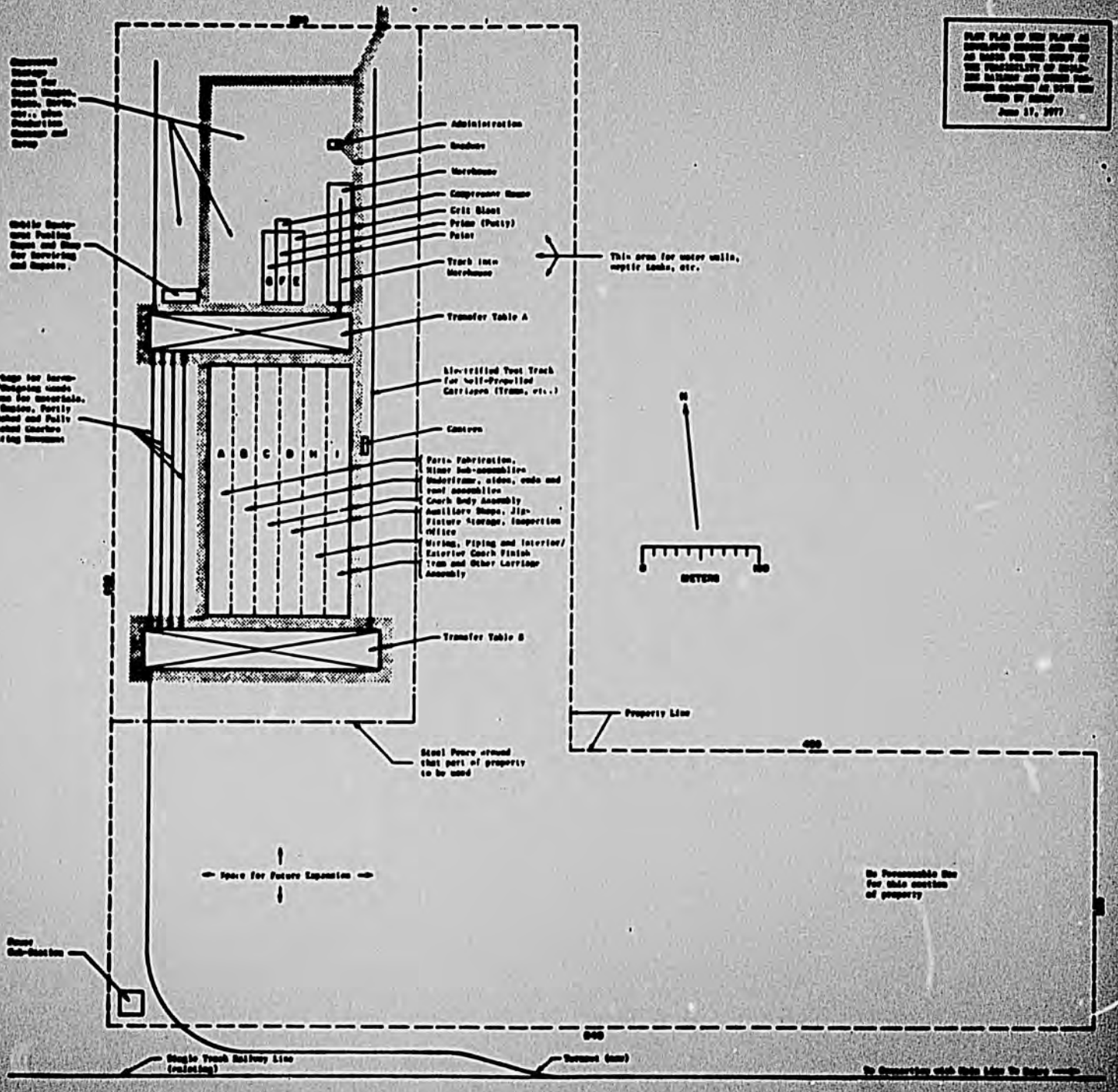

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TABLE III-5

COST ESTIMATE FOR CIVIL WORK AT NEW PLANT

		Units	$ Unit Price	U.S. $	E.L. Unit Price	E.L.
1.	Grade Site	200,000 M^3	1.74	348,000	.33	66,000
2.	Paving	25,700 M^2			3.50	89,950
3.	Curbs	1,930 M			6.20	11,966
4.	Sidewalks	3,500 M^2			5.00	17,500
5.	Fencing	3,420 M	6.90	23,598	2.50	8,550
6.	Crates	2 ea	1,150.00	2,300	200.00	400
7.	Railroad Track	1,800 M			89.00	160,200
8.	Switch	1 ea			1,200.00	1,200
9.	Test Track	900 M			89.00	80,100
10.	Transfer Pit A*	L.S.		155,500		176,000
11.	Transfer Pit B*	L.S.		172,500		196,600
12.	Fire Water System	L.S.		23.800		12,000
13.	Potable Water System	L.S.		12,160		73,500
14.	Sewage System	L.S.		950		21,800
15.	Compressed Air	L.S.		79,400		10,000
16.	Electrical System	L.S.		294,500		222,800
17.	R. R. Bumpers	3 ea	650.00	1,950	92.00	276
18.	Communications	L.S.		57,500		35,700
				1,172,158		1,184,542
	Contingency			234,432		236,908
				1,406,590		1,421,450
	*Less Transfer Tables above)	(delete from 10/11)		(174,000)		(119,000)
		Totals		1,232,590		1,302,450

- Rooms for training, factory meetings and conferences, and first aid and minor medical services.

- Shops for auxiliary production work (wood working, pipe and tube forming, upholstering, electrical component subassembly and pre-wiring). Manufacture, repair and re-conditioning of jigs, fixtures and production aids, manufacture, repair, re-conditioning of precision tools, dies and gauges plus the sharpening of cutting tools, and plant equipment maintenance.

- Storage spaces for jigs and fixtures, fabricating tools, consumable production supplies, and equipment spare parts.

This hall was included within the manufacturing area and among the actual production halls in order to make all of these services as near as possible to actual production for the foreseeable future. If at some time more space is needed for production, this hall could be vacated by the above activities and functions and provide production space already integrated with the transfer tables and roadways and readily meshed into overall work process flow.

The remaining five halls are for production. Each hall has an area of 4,200 square meters (210 x 20 meters). Omitting the one hall allocated for tram body production, the remaining floor area of 16,200 square meters compares with the 8,645 square meter area of SEMAF shops A-1, A-2, A-3 and A-5 (Figure III-1) which now house passenger coach body fabrication, assembly and finishing operations.

The length of the halls was set at 210 meters following this reasoning:

- The coach presently produced by SEMAF is 23.03 meters long.

- The European (UIC) international coach is 26.4 meters long.

- If sales are made in the export market, it is possible that some customers may specify the UIC coach length.

- Eight work stations for assembling the current length coach plus 3 meter spaces between work stations and between end stations and the end walls total 208.2 meters.

- Seven work stations for assembling the UIC length coach with the same spaces add up to 208.0 meters.

The second grouping of production buildings comprises the three located north of the "north" transfer table. They are for progressive grit blasting, puttying and prime coating of the bare steel outer surfaces of the body and finish painting. Two of these buildings have the same length, 60 meters, so as to accommodate two coach bodies. The other (grit blast) is shorter at 34 meters because new higher capacity grit blasting machinery should require about half the time that the unit now at SEMAF requires per coach body and the new unit is expected to be used on a two shift basis. Estimated costs of these buildings are included in Table III-6.

Support Buildings

Four other buildings required are:

- A two-story administration building,
- A canteen for employee meal service,
- A compressor house, and
- A fueling depot for gasoline powered equipment (fork lift tractors, the mobile cranes, buses, automobiles and trucks) combined with a service and repair shop for these units.

The administrative building should house the office of the chairman and administrative functions and a vault for safe storage of company records and papers.

In addition to these structures, there should be small cabins for gate guards and housings over well pumps, septic tank covers and the like. No buildings are separately provided for automotive vehicles. They can be given protection during sand and dust storms by parking them in production building aisles and in the automotive repair shop.

Outside Facilities

There are several facilities not under roof but in fixed locations within the property lines. These are discussed below.

Railway Trackage

As shown in Figure III-2, four straight tracks are provided paralleling and to the west of the manufacturing buildings connecting at both ends with the two transfer tables. Also shown is a track extending north from the northern transfer table into the area assigned for raw steel storage.

An electrified single track for the run-testing of electric self-propelled rail vehicles is provided. The supply of power to the

TABLE III-6

COST ESTIMATE FOR BUILDINGS AT NEW SITE

	Units	$ Unit Price	U.S. $	E.L. Unit Price	E.L.
1. Administration Building	1	12,400	12,400	72,200	72,200
2. Warehouse	1	--	--	78,228	78,228
3. Grit Blast Building	1	2,727	2,727	36,030	36,030
4. Prime Paint Shop	1	--	--	64,550	64,550
5. Finish Paint Shop	1	--	--	64,550	64,550
6. Compressor House	1	--	--	3,240	3,240
7. Assembly Buildings	6	16,840	101,040	411,122	2,466,732
8. Gate House	1	--	--	1,800	1,800
			116,167		2,787,330
Contingency			17,425		418,100
Total			132,582		3,205,430

vehicle being tested is planned to be through an overhead wire and one rail with additional "dead" rails spaced from the common rail to suit the gauge(s) of the different vehicles being tested. Access to this test track is through the "south" transfer table. This table would be equipped with the necessary additional rails if the track gauges of the vehicles require.

A short single track is provided from the north transfer table to the warehouse. Thus, incoming goods wagons of materials may be moved from the railway into the warehouse by passing across the south transfer table to one of the four tracks parallel to and west of the production buildings, onto the north transfer table, and then via that transfer table to the warehouse track.

The track of the Egyptian Railways is connected to the south transfer table by a single track with wide radius curves and one turnout. This simple low cost trackage layout is made possible by the use of trackmobiles and transfer tables.

Trackmobiles

These units provide traction to railed vehicles by coupling to them and moving on the rails. They are equipped with rubber-tired wheels which can be dropped to allow them to be moved at right angles from the tracks and steered along roadways to a different rail location. Trackmobiles may be used both inside and outside buildings.

Transfer Tables

Transfer tables provide for side-wide movement of all types of carriage bodies (on shop bogies), goods wagons, and coaches to other tracks. Two transfer tables are provided. Each table would be 30 meters long so that one coach plus the trackmobile could be moved without uncoupling. If the trackmobile model chosen is of such length that a SEMAF coach coupled to it exceeds 30 meters, the specifications for the two transfer tables should be lengthened. We did not consider that it was prudent to provide for the extra length of the UIC coach (3 meters longer than the SEMAF coach) because its production was not assured and, at worst, moving such coaches would mean simply uncoupling of the trackmobile and moving it separately. The extra investment in the pits and the longer tables did not seem justifiable.

Mobile Cranes

A rubber-tired mobile crane (often referred to as a "cherry picker") is included mainly for unloading steel from rail goods wagons or trucks and moving it to storage within a much larger area of the yard than practical with a conventional gantry type yard crane. This larger area allows the storage of each size of steel in a separate pile.

The "cherry picker" has many other applications in the yard and within the buildings. Only one such crane with spare parts is included. Should another "cherry picker" be deemed desirable as a "backup" unit or for other uses, funding for its acquisition should be available within the contingency funds included in the overall equipment cost estimate.

Roadways

Roadways are provided for movement of rubber-tired equipment around the fabrication and assembly building complex, between there and the two transfer tables, around the two transfer tables, around the steel storage area, to the warehouse and administrative building and to connect with the public road at the north of the property. No pavement is provided for movement within the steel storage areas as none is expected to be needed once that area has been graded and compacted by traffic.

Power Supply

A power substation is located in the southwestern corner of the property. This open air substation is expected to be connected to power company high tension lines so as to receive 3 phase 50 Hertz power at 6,300 volts.

Other Items

Deep wells are provided for supply of potable water. Septic tanks are provided for disposal of organic waste and the small amount of process waste water.

ENVIRONMENTAL IMPACT

The following initial examination of the environmental impact of the project is responsive to the definition of actions affecting the environment as set forth in paragraph 216.1(c)(3)(iv) of the USAID regulations governing environmental procedures.

In general, it can be said that all significant environmental impacts will be favorable. The proposed site is desert land which presently is totally unfit for human habitation and devoid of natural resources other than rock and sand. Flora and fauna are non-existant.

The specific effects of the plant would be as follows:

- Solid waste - ordinary garbage and a small amount of paint sludge would be disposed of at a refuse

disposal site in the desert. Metal turnings and other such waste will be collected and stored at the plant site for sale to scrap metal brokers.

- Toxic or obnoxious fumes - none will be produced except from a small number of gasoline fueled vehicles. Those exhaust fumes will be so small as to be unmeasurable even at most locations within the plant site.

- Noise - the high noise level in one of the plant buildings will be absorbed by the structure of that building so that it will be inaudible or at acceptable levels in other plant buildings and imperceptible outside of the plant site.

- Liquid waste - the small amount of water from the water curtain paint spray booths and neutralized spent pickling liquors can be readily accommodated by dry wells within the plant site.

- Hazardous substances - none

- Energy sources - the primary energy source will be the national electric transmission system. Energy consumption will be approximately the same as that of many railway car manufacturing plants elsewhere in the world and less than that of many because of the relatively high proportion of labor to machinery.

In regard to the overall impact, it can be said that the project will not degrade the quality of human environment. It will create a satisfactory human environment where none existed before. The secondary effects on the environment may be more substantial than the primary effects, but only in a favorable manner. The project will create employment opportunities and stimulate housing development in a manner which will help alleviate the population pressure in the very overcrowded existing urban areas. It is a part of an overall plan of the Government of Egypt to provide employment opportunities outside of Cairo and other large urban areas. The only visual impact will be that passengers on a nearby railway line will observe a modern factory rather than experience the continuous monotony of passing through barren desert. No sites of natural or cultural heritage exist in the vicinity of the project site.

In summary, the project would result in converting barren desert land into economically and socially useful property.

PROJECT EXECUTION

The actions necessary for execution of the project generally involve straightforward design, construction and startup of a relatively simple factory. A complicating factor is the expansion of capacity of the SEMAF bogie shop and transfer of coach production to the new facility without loss of output during the transition period. It is assumed that a new company would be formed to operate the new plant, and that SEMAF would be the major investor in this plant.

We estimate that the project can be completed in 37 months from the date that funding has been approved and selection of contractors can begin. A listing of activities necessary for execution of the project is shown in Table III-7. A separate tabulation of certain critical activities which would have a direct impact upon SEMAF operations is shown in Table III-8. Additional data in regard to lead times on individual items of machinery and other equipment is shown with the machinery requirements listed in Tables III-1 and III-2. A bar chart of the project schedule is shown in Figure III-3.

It is assumed that the new company would select an architecture/engineering (A&E) contractor to design the new facilities and act as its representative in supervising construction. The selected A&E contractor should include staff capable of providing technical assistance which is peculiar to railway car production technology as needed for efficient layout of the plant. In addition to the new company and the A&E contractor, it is anticipated that SEMAF would actively participate in the project by designating a project coordinator to be concerned with all aspects of the work schedule which would have an impact on existing and proposed operations at SEMAF.

Construction Manpower and Equipment Requirements

Costs have been included for design of the required buildings and appurtenances and for general supervision during the entire project up to the time that operating management has accepted all construction as satisfactory. This general supervision is expected to include the letting of bids, inspection of in-process work as to both materials and workmanship, and the issue of a certification that the improvements to the property are complete and it is proper for the owners to take possession.

We also have included costs for supervision by factory engineers/erectors of the installation of that equipment which requires specialized assistance.

We are satisfied as to the availability of Egyptian contractors and their capabilities in this kind of work at sites similar to the one where this new plant is to be located. Similarly, the availability of the kinds and numbers of construction equipment has been checked and the

TABLE III-7

DURATION AND TIMING OF PROJECT ACTIONS

	Action	Months Duration	Start Beginning of Month No.	Finish End of Month No.
A.	Establishment of project organization	1	1	1
B.	Selection of supervising architect	3	1	3
C.	Advise industrial schools of manpower requirements	1	1	1
D.	Designing of buildings - other civil work	6	4	9
E.	Invitation to bid on construction	1	10	10
F.	Evaluation of bids & awarding of contracts	1	11	11
G.	Grading of site	7	12	18
H.	Underground utility work and footings	3	16	18
I.	Building construction and paving	12	19	30
J.	Advise vocational schools of manpower requirements	1	25	25
K.	Installation of bridge cranes	4	31	34
L.	Installation of transfer tables	3	31	33
M.	Fabrication of 60 additional sets of coach parts and minor subassemblies at SEMAF	6	28	33
N.	Fabrication of shop bogies at SEMAF	4	32	35
O.	Design & fabrication of containers for 20 sets of coach parts for transport of parts from SEMAF to new plant and for in-plant materials movement at new plant	4	29	32

TABLE III-7 (continued)

	Action	Months Duration	Start Beginning of Month No.	Finish End of Month No.
P.	Construction by SEMAF of flat railway wagons (for use in transporting bogies from SEMAF to new plant	7	26	32
Q.	Designing of floor layout for installation of equipment for coach parts fabrication, assembly and finishing	6	29	33
R.	Development of location and space requirements of service activities to be carried out in Services Building and make layouts where equipment is to be located	3	31	33
S.	Development of telephone requirements and instrument locations and installation of terminals	4	29	32
T.	Installation of telephones	1	31	31
U.	Dismantling of coach parts fabrication equipment now at SEMAF	2	34	35
V.	Movement of coach fabrication equipment and jig, fixtures, tools from SEMAF to new plant and re-installation at new plant	3	34	36
W.	Dismantling of coach subassembly, final assembly and finishing equipment, jigs, fixtures, tools, inspection equipment, etc.	1	38	38
X.	Movement of coach subassembly and final assembly facilities including new and old shop bogies to new plant and re-installation	2	38	39

TABLE III-8

SUMMARY OF PROJECT SCHEDULE ITEMS DIRECTLY AFFECTING PRODUCTION

	Item	Months Duration	Start Beginning of Month No.	Finish End of Month No.
1.	Fabrication of coach body parts at SEMAF including 60 additional sets over current usage (10 sets per month)	6	28	33
2.	Assembly and finishing of coaches at SEMAF from parts made at SEMAF	n.a.	--	37
3.	Fabrication of coach body parts at new plant	n.a.	37	continuing
4.	Assembly and finishing of coaches at new plant from parts from SEMAF (10 sets) balance of parts made at new plant using addition jigs, fixtures and shop bogies provided to augment output over present such facilities.	1	37	continuing
5.	All operations at new plant site (except bogies manufacturing)	n.a.	38	continuing
6.	Start increased output of bogies at SEMAF	n.a.	34	continuing
7.	Start shipping of finished bogies from SEMAF to new plant	n.a.	36	continuing
8.	Develop final specification, place order for longest lead time equipment for SEMAF bogie shop and new plant, receive and install this. Do same for all other equipment at new plant and SEMAF bogie shop during this period	25	8	32

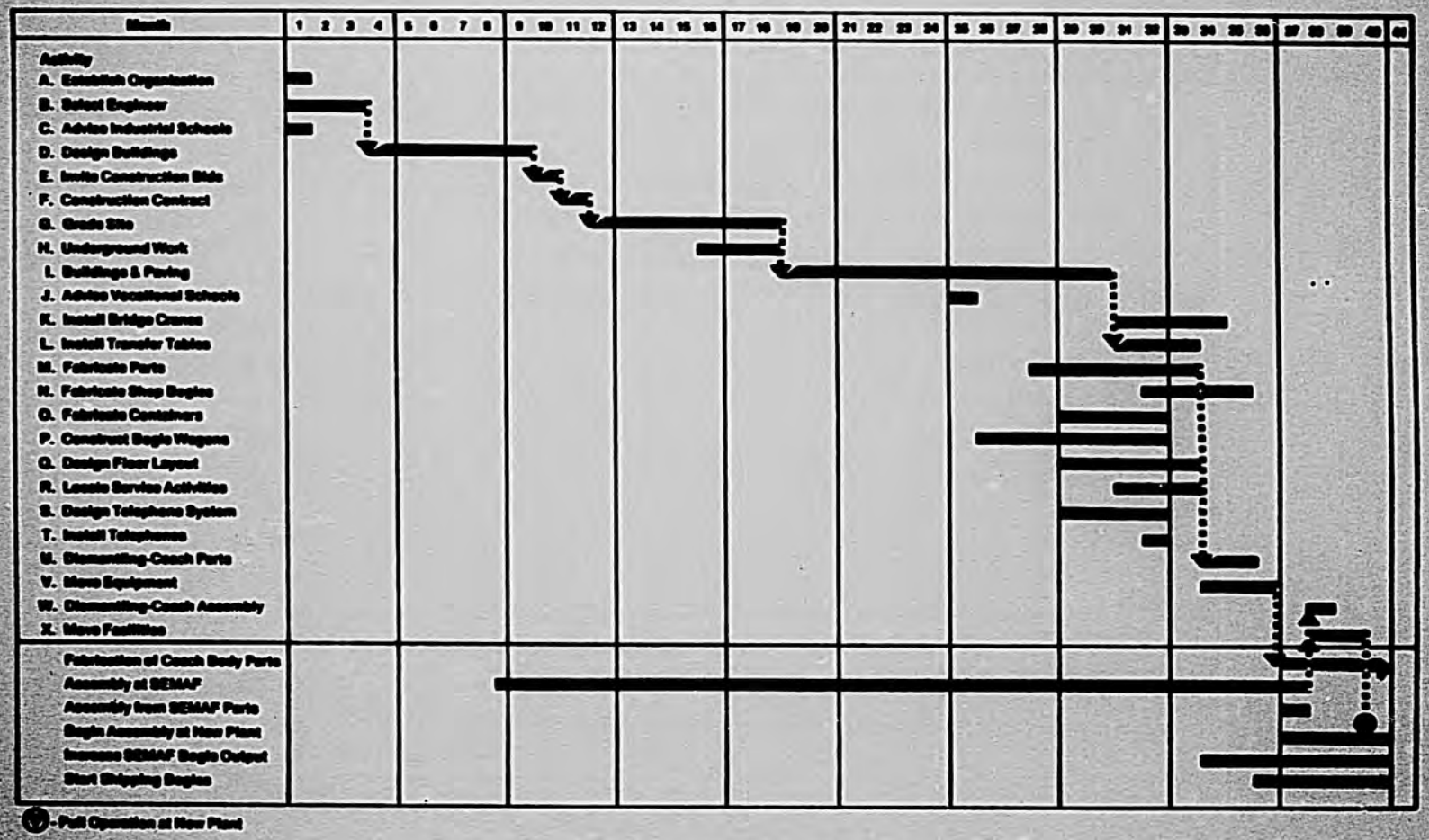


Figure III-3. Project Execution Schedule

overall civil work steps have been developed accordingly. Construction labor appears to be in reasonably good supply, and we anticipate no difficulty in executing the work.

We believe that SEMAF maintenance craftsmen can remove and reinstall the equipment now in the bogie shops that requires relocation to make room for installation of new equipment such as radial drill presses and a welding positioner without any supervision from the machine tooler supplier. Supplier supervision is recommended, and costs are included, for installation of the planer mill and the horizontal boring mill.

Fabrication of jigs, fixtures and gauges has been carried out in the past by SEMAF personnel. Similarly, SEMAF personnel have constructed shop bogies and other production aids. Given reasonable lead time, these personnel should be able to produce all of such equipment needed for the project. The flat goods wagons needed for transportation of bogies to the new plant can be manufactured as part of SEMAF's regular schedule for goods wagons.

PROJECT OPERATION

The following discussion of operation of the proposed plant includes:

- A suggested operating organization
- Evaluation of SEMAF management capability in relation to the proposed plant.
- Staffing and training for the proposed plant.

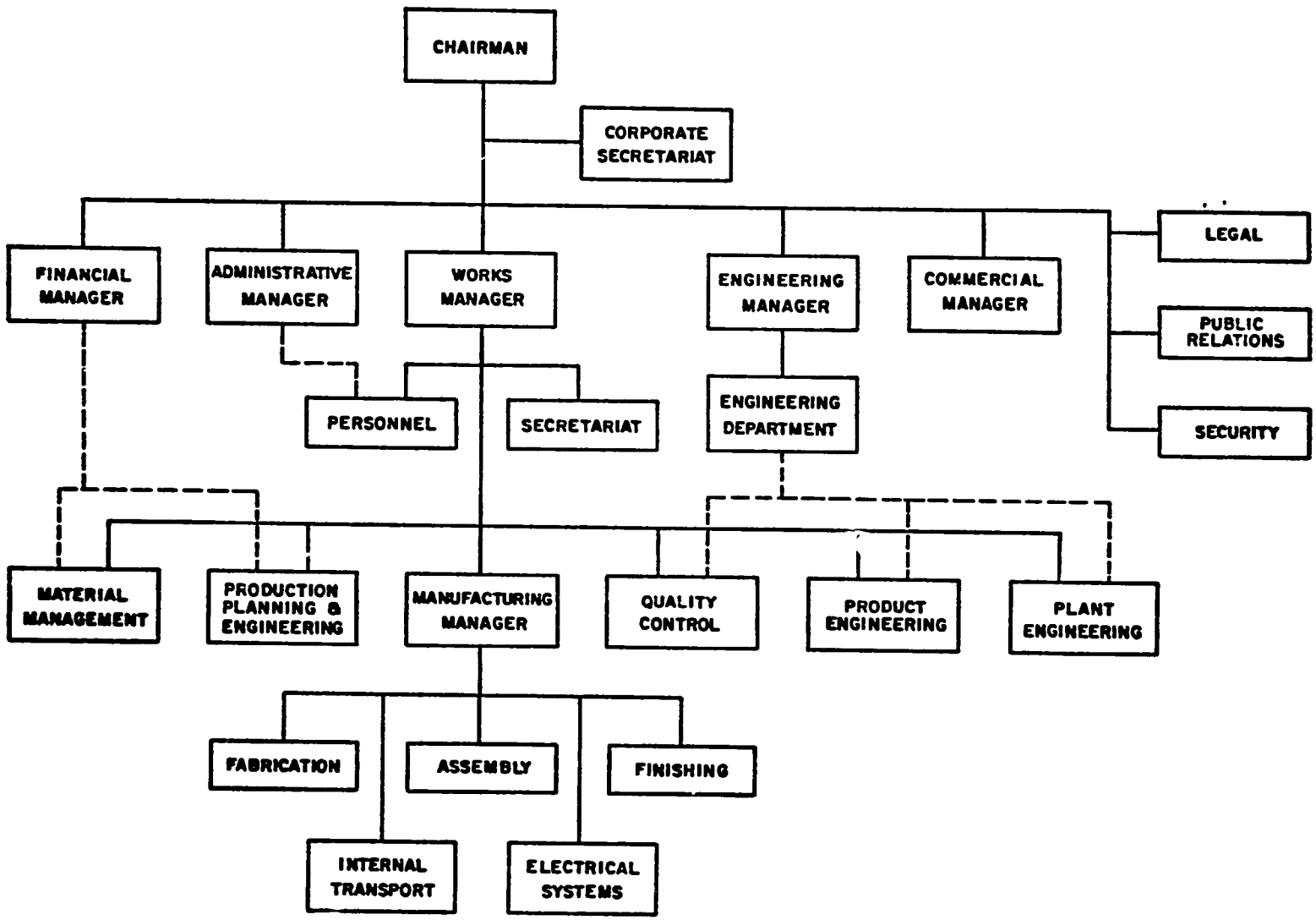
Operating Organization

Two basic organizational options were considered for the proposed plant; (1) operation as a division of SEMAF, and (2) operation as an independent company. The independent operation option was selected. The governing consideration was the desirability of establishing a private sector company to operate the new plant, with the attendant possibility of a joint venture with a foreign manufacturer. Although operation as a separate company would cause increased management overhead cost, we believe that the potential efficiencies from private sector operation would more than offset that cost. An organization chart for the proposed operation is presented as Figure III-4.

It is SEMAF's expressed desire to have a joint venture partner which would both provide technical assistance and strengthen the management capability necessary for the new plant. Our organizational assumptions do not preclude a joint venture, and it is reasonable to believe that such an association could provide foreign capital in a manner which could improve the long-range economics of the project.

Figure III-4

ORGANIZATION CHART



SEMAF Management Capability

We believe that SEMAF has a very competent management. It appears to be enthusiastic and progressive. This impression is based on:

- Demonstration of resourcefulness in obtaining the present rate of 10 passenger coaches per month from a facility designed for four per month and for continuing the program toward an objective of 12 coaches per month.
- The current program to assemble electrically powered passenger coaches, building the bodies and performing assembly work at SEMAF using imported electrical equipment.
- Knowledge of supervisors and management about their equipment capacities both as to capabilities and output rates.
- The rapid availability of records and statistics and the regular issue of periodic management reports.
- The presence of preventive maintenance system and the signs of its high effectiveness.
- The straightforward flow of work through the plant from raw material and purchased components to the finished product.
- The use of direct labor standards and labor incentives.
- The detail to which production planning including the control of material utilization is carried out.
- Generally good control of quality throughout the production process.
- Inclusion in the staff of approximately 50 graduate engineers.

It is evident to us that the continued high capability of total management would be available if the proposed project were to increase output capacity at the present plant site. Since that is not the case, we are concerned about the attraction of equally capable management to the new plant site.

It might appear that since the whole coach body fabrication, assembly and finishing organization will become redundant with the removal of these operations to the new plant, it would be logical to

move all of the wholly affected personnel including their supervision to the new location. Similar logic could be applied to part of the staff services group. Because of the remote location of the proposed site, the reality of transfer is not dealt with so easily. Given no option other than outright termination, a majority might accept transfer to the new plant in order to keep being employed or remain so while looking for employment elsewhere. The result could be disastrous in terms of high personnel turnover at all levels, lower "esprit de corps", lower output and higher costs resulting from an unhappy plant population.

SEMAF top management is aware of and is concerned about these matters. It believes that it can supply about 25 percent of the workforce including sufficient number of senior level technical and manufacturing personnel to assure the new plant of having an adequate nucleus of technical, supervisory and lead production personnel. Given adequate financial and other incentives to these personnel to relocate, effective profitable management of the new plant can be reasonably expected.

The availability of suitable housing is critical to actually attracting these personnel to the new plant. Attraction of management, technical and engineering personnel of a high level of competence is especially dependent on a supply of housing which will enable them to substantially better their living conditions as compared with the current situation in Cairo. Thus, it must be ensured that the housing authorities follow through on their plans to provide appropriate housing before the start-up date of the new plant.

Recruiting and Training

About 2,700 persons will be required to staff the new plant and about 200 more would be needed to increase the output of the SEMAF bogie operation from 10 to 20 coach bogie sets per month.

Because only about 25 percent of the total needs would be satisfied through present personnel opting to work at the new plant, about 2,200 additional personnel will have to be recruited and trained. This is not a small task and must begin early in the period of project execution.

It can reasonably be expected that a good portion of the needs for the SEMAF bogie shop will be satisfied by transferring to the bogie shop from SEMAF coach parts fabrication operations those persons somewhat qualified but redundant if they opt not to transfer to the new plant. The balance of about 50 persons, practically all for semi-skilled work assignments, would have to be recruited and trained.

Of the projected personnel required at full production output level (300 passenger coaches per year), about 10 percent will have assignments that are administrative, technical, supervisory or clerical

in nature, leaving about 2,450 production workers to be obtained either by transfer from SEMAF or by direct recruiting. Presuming that about a quarter of these workers will come from SEMAF, about 1,800 workers will have to be recruited. There are two primary sources for such manpower.

- Workers who have grown up within industries, starting as young apprentices, often with little or no general education. These workers often acquire high grades of skill but present two disadvantages. There is not enough supply of them to meet the demands of the local market, and, what is more, those of the Arab World, where Egyptian labor plays a major role. The second disadvantage is that most of them, lacking education and the "status" that goes with it, cannot qualify for promotion to higher echelons of supervisory ranks.

- Graduates of various systems of vocational education including:

  - Industrial schools admitting young men with nine years of general education for a 3-year curriculum of theoretical and practical training to bring them to an average grade of manual skill with enough education to make advancement possible.
  - Vocational training centers using a method wholly of apprenticeship whereby the trainee spends a whole year at the center and two years of apprenticeship at an employing institution with one day a week back at the center. The graduates of this system can be regarded as equal in skill to those of the industrial schools.

It is to be expected that applicants with diplomas from industrial schools and training centers will be available in larger numbers than heretofore and that there will be adequate numbers of these to satisfy the net requirements of the new plant for personnel. Training plans, therefore, should be based on these levels of knowledges and acquired skills, i.e., training in initial skills is to be excluded.

Altogether, the recruitment of plant workers seems manageable. The recruitment program should be timed as follows:

- Industrial schools should be alerted shortly after this project is funded because three years are required before their courses result in graduation.

- Slightly more than a year before the new plant is expected to start up, the vocational training centers should be brought into the program so that their students will have completed a year of study and training and be ready for in-plant training.

- The tapping of the established labor market should be left until shortly before plant startup.

ESTIMATED COST OF PHYSICAL FACILITIES

The estimated capital cost of civil work, construction, and machinery and equipment is:

	Foreign ($)	Local EGL
Design and construction supervision	475,000	275,000
Civil work	1,232,590	1,302,540
Construction of structures	116,167	2,787,330
Additional equipment for installation at SEMAF bogie shop	2,345,800	184,300
Equipment for new plant not including value of coach body fabricating and assembly equipment transferred from SEMAF Helwan plant to the new plant	3,290,750	265,825
Contingency provision for new equipment @ 5 percent	281,827	22,506
Provision for increased costs for in-plant training of new employees		100,000
Total	7,742,134	4,937,501

These capital costs do not include the cost of land, construction interest, working capital, the road leading to the plant site, and the cost of equipment transferred from Helwan to the new plant. Costs for these items are included in the financial analysis.

SUMMARY OF TECHNICAL SOUNDNESS

Our general conclusion is that the project as described above is technically sound. It can be expected to result in dependable operation of a reliable manufacturing process. Important specific conclusions about technical and engineering soundness are:

- The existing SEMAF plant is efficiently operated and it is expected that use of available staff

from that plant would have a favorable effect on operations of the new company.

- The existing operation, including fabrication, assembly and finishing operations is soundly conceived. No dramatic improvement could be expected from re-engineering those operations, although some improvements could result in from having more space for efficient storage and in-plant movement of raw materials and work-in-process.

- The increased space to be provided at the new plant is needed for the proposed level of production, and there is not sufficient space to expand the existing facility.

- With additional labor and machinery, the existing methods are suitable for reasonably foreseeable levels of production.

- The existing bogie shop at the SEMAF plant can, with additional machinery, meet projected bogie requirements for both plants.

- Existing machine tools and other equipment in use no for coach fabrication are in good condition, have many years of potential life, and should be used in the new facility. They are not generally useful for goods wagon production. Those machines are basic types with the flexibility needed for producing a varied mix of types of railroad passenger coaches.

- The existing SEMAF management has the technical capability needed for the new plant.

- Sources of the necessary work force are available within the design and construction lead time.

- Production management systems and controls in use at SEMAF are sound and adequate, and their use should be extended to the new plant.

SECTION IV - FINANCIAL ANALYSIS

This analysis of the financial feasibility of the proposed passenger rolling stock production facility is based on the information contained in Sections II and III regarding commercial and technical aspects of the project. Financial feasibility requires that operating revenues be sufficient to cover fixed and variable operating costs and amortization and interest on debt and provide adequate return on equity.

The project financial performance is measured within the framework established by the general analysis assumptions which follow immediately, and the capital cost, operating revenue and expense, and debt financing assumptions presented subsequently. The analysis which results from these assumptions constitutes the "base" using our best estimates of costs and revenues. In addition, we performed an analysis of sensitivity of financial performance to those costs and/or revenues subject to significant uncertainty.

GENERAL ANALYSIS ASSUMPTIONS

The following paragraphs set forth the general assumptions which form the framework of the present analysis.

Organizational Structure

The analysis assumes that the proposed passenger rolling stock production facility and the existing SEMAF enterprise would be mutually independent operating entities, each with its own production, managerial, and overhead support functions. This is consistent with SEMAF's interest in assuming an investment and technical assistance role in the proposed project.

The new enterprise would be classified as a private company and thus would not be subject to those government regulations concerning the operation of public companies. The most important implication of this private company classification is that there would be no wage rate controls. Thus, the company would be allowed to pay the wages necessary to retain qualified production and managerial personnel and induce them to work at a site location away from Cairo.

While there is a possibility of foreign investment in the passenger rolling stock production plant, this analysis does not assume such investment. The taxation benefits or currency exchange rate treatment associated with the ARE Law No. 43 of 1974 concerning the investment of Arab and foreign funds are therefore not considered.

It should be noted that the pro forma financial results presented here are for the purpose of overall evaluation of the project and do not explicitly consider the many possible structures of joint venture financing. We can, however, state that joint venture financing can be expected to result in an equal or imporved financial performance of the project.

The market projections previously presented indicate demand for several types of passenger rolling stock including first, second and third class railroad passenger coaches, regional, urban and surface metro cars, and town trams. As discussed in Section III of the report, there is little difference between producing one type of passenger car and another in terms of production facilities and labor skills. There are, however, significant differences between ordinary coaches and electrically propelled equipment in the amount of labor and material input. Thus, the value added per car by the new plant will differ according to the type of car produced.

Based on market demand projections and purely technical considerations, a target production and sales level was established at 300 cars per year of all types. For financial analysis, the value added equivalent of 300 third class passenger coaches per year was used. Since pricing is a function of production costs, this results in an actual understatement of revenue, cost and profit in the analysis.

While it is clear that the addition of electric propulsion equipment increases the cost of a car, the amount of the increase and the separate increases in labor and materials can not be readily estimated. Those costs are very much a function of the specifications of individual orders, and past experience indicates only that the cost would probably be in the range of 125 to 200 percent of the cost of an ordinary coach.

The proposed new plant described in Section III would have the physical capacity for producing 300 electrically propelled cars, if necessary. The significant planning problem is in work force utilization. Under Egyptian labor law, there is a strong incentive to a company to avoid year to year fluctuations in employment. A given labor force would produce fewer electric cars than it would passenger coaches. Thus, the implication of basing the financial analysis on the value added equivalent of 300 third class coaches is that the work force would remain stable while the annual number of cars produced would decrease as the percentage of annual production that is electric cars increases.

The use of the value added equivalent approach described above implies a conservative management policy of maintaining a stable work force and keeping annual production within the capacity

of that work force. Such a policy would significantly increase the 1990 backlog shown in Table II-6 as is illustrated in Table II-7. Thus, it can be reasonably said that the risk of the financial performance shown here being adversely affected by market conditions is very small. There is substantial room for improvement of financial performance if a stable mix of electric and ordinary cars can be achieved at a higher level of total output.

Analysis Period

Results are projected on a calendar year basis for the 37-month development period and the first 20 years of operation. The development stage corresponds to the period December, 1977 through December, 1980, while the operating period extends from calendar year 1981 through calendar year 2000.

No adjustments are made at the end of the operating period to reflect future cash flow; that is, no asset value is assigned to production facility, material inventory, or unsold product. Principal the payments on loans with a loan term extending beyond the analysis operating period are not accelerated, nor are accounts receivables made current at the end of the tenth year.[1/]

Monetary Units and Inflation

The analysis is performed in constant 1977 price levels using United States dollars ($) as the monetary unit. Throughout the analysis, the "parallel market" exchange rate, rather than the "official" exchange rate, is used for converting Egyptian pounds (EGL) to US dollars:

	$/EGL	EGL/$
Parallel Market Exchange Rate	$1.43	EGL 0.70
Official Exchange Rate	$2.56	EGL 0.39

The parallel market rate better reflects the market economic equilibrum level as determined by foreign currency demand and supply forces. Currently, a large percentage of foreign trade with free currency countries takes place at the parallel market exchange rate.

Since inflation can significantly impact project financial performance, a sensitivity test was conducted with revenues and all costs excluding interest and depreciation increased from their base analysis level at an average annual rate of 5 percent.

1/ These assumptions lend conservatism to the analysis since net cash flow would be likely to remain stable through year fifteen and increase sharply after that as a result of the foreign loan being fully amortized.

Accounting Method and Depreciation

The analysis assumes an accrual method of accounting for calculating profits and payment of the Egyptian profits tax. Tax losses, if any, are carried forward and applied against profits in subsequent years. Straight line depreciation, with the depreciable life varying according to the specific capital asset, is assumed.

CAPITAL COST SUMMARY

The capital costs of the project, totalling $19.6 million, are shown in Table IV-1. The costs are segmented into local and foreign purchase components by year of expenditure. All costs incurred up to the point of plant operation are capitalized.

Working capital is required to fund wage and material costs between time of order and delivery of rail cars. It is assumed that line-of-credit financing can be obtained for about 75 percent of the requirement. The balance, about the equivalent of $750,000 must be equity financing. This is typical of the debt/equity ratio that a financially sound company with a good credit rating could expect to obtain from a commercial bank.

Interest on the foreign loan during the development period is assumed to be capitalized. This capitalized interest amounts to $1.07 million. It is amortized over five years.

A significant amount of machinery and equipment would be transferred from the SEMAF plant to the new plant and purchased from SEMAF by the new company. Because there is an active market for such equipment in Egypt, a market price must be estimated. For this purpose we have used the new price less accumulated depreciation based on expected life of the equipment. For the new company the equipment is assumed to have a remaining life of 10 years for the calculation of depreciation. The land required for the new plant is assumed to be acquired from the lot now owned by SEMAF at a price which reflects cost of utilities to be installed by the land development company.

All passenger coach bogies would be produced at the present SEMAF plant and sold as a subassembly to the new rolling stock plant. The additional machinery and equipment required by the bogie shop would be purchased by the new company and resold to SEMAF at the same price and terms as set forth in the foreign loan agreement. Therefore, depreciation of this new equipment would be a non-cash operating expense of the SEMAF bogie shop rather than the new plant.

DEBT/EQUITY STRUCTURE

Funding of capital costs and cash operating deficits, if any, would be provided through a combination of long-term and short-term debt financing and equity contributions.

TABLE IV-1

SUMMARY OF PROJECT CAPITAL COSTS BY FOREIGN AND LOCAL COMPONENTS 1978 - 1980
(Thousands of $)

	1978		1979		1980		Total	
	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local
Land Purchase	$ --	$ 1157.0	$ --	$ --	$ --	$ --	$ --	$ 1157.0
Civil Works - Except Road	493.0	745.0	493.0	745.0	246.6	372.5	1232.6	1862.5
Road Construction	--	312.0	--	--	--	--	--	312.0
Buildings	--	--	79.6	2750.3	53.0	1833.5	132.6	4583.8
Additional Equipment for SEAMF Bogie Shop	615.8	69.2	1231.5	138.3	615.8	69.2	2463.1	276.7
Equipment for New Plant	863.0	100.0	1727.5	199.1	863.9	100.0	3455.3	399.1
Cost of Transferred Equipment from Helwan to New Plant Site*	--	--	--	--	--	932.5	--	932.5
Design and Construction Supervision	200.0	183.8	160.0	125.9	115.0	83.6	475.0	393.3
Provision for Costs of In-Plant Training	--	--	--	--	--	143.0	--	143.0
Capitalized Interest	--	97.8	--	361.7	--	613.0	--	1072.5
Working Capital (Equity Portion)	--	--	--	--	--	750.0	--	750.0
Total	$2172.7	$ 2664.8	$3691.6	$ 4320.3	$1894.3	$ 4897.3	$7758.6	$11882.4

*Replacement value less depreciation.

Foreign Machinery and Equipment Costs

All foreign machinery and equipment required for the proposed project would be procured according to applicable regulations using funds made available through an international lending agency. That agency would issue a loan to the Egyptian government for 100 percent of the foreign capital requirements.[2/] The Egyptian government would re-lend the funds to the new entity with the following terms assumed:[3/]

Term	15 years from first year of operation
Interest Only Period . .	Through first year of operation
Interest Rate	9 percent
Principal Repayment . .	Normal amortization

The anaylsis assumes that yearly draw-downs during the development period are sufficient to meet foreign purchase cash requirements:

Year	Annual Draw-Downs (Thousands of $)
1978	$2,175
1979	3,700
1980	1,884
Total	$7,759

The interest only period would extend through the first year of normal operations. Interest is capitalized during the development period. No loan fees are included.

Local Capital Costs

Funding of all local capital costs, including land, site improvement, construction, and machinery and equipment, is assumed to be derived entirely from equity contributions. The analysis assumes that equity is contributed in annual amounts sufficient to cover local capital costs, capitalized interest on the foreign loan, and working capital requirements:

2/ Terms of the foreign loan are 40 year term, 10 year interest only period at a 2 percent interest rate; the principal is amortized over the remaining 30 years with an interest rate of 3 percent.

3/ While the terms of this loan have not been specified as yet, these assumed terms are generally consistent with loans of this type.

Year	Equity Contributions (Thousands of $)
1978	$2,770
1979	4,320
1980	4,792
Total	$11,882

Thus, the equivalent of $11.88 million, in local currency, is required to implement the project.

Line-of-Credit Financing

Cash operating deficits and working capital shortages are assumed funded through a line-of-credit agreement between the new company and the Bank of Alexandria. Funds would be borrowed at 10 percent annual interest (the current and maximum rate allowed by law) with repayment out of positive cash flow.[4/]

OPERATING REVENUES AND EXPENSES

The following revenue and expense assumptions are employed in the project financial analysis.

Operating Revenues

Operating revenues derive from domestic and export product sales, and scrap metal sales. Sales volume is projected as follows:

	Annual Railcar Sales (Number of Railcars)		
Year	Domestic	Export	Total
1981	150	---	150
1982	200	---	200
1983	300	---	300
1984	300	---	300
1985	300	---	300
1986	300	---	300
1987	270	30	300
1988	270	30	300
1989	270	30	300
1990	270	30	300
Total	2,630	120	2,750

4/ The cash flow statement does not show line-of-credit borrowings which are repaid in the same period, although an interest charge for use of these funds is shown.

The domestic price used in the base analysis is $75,000, as derived below. The export price is $100,000, FOB Alexandria as discussed in Section II. Scrap metal sales, based on historical experience, are estimated at 0.3 percent of product sales .

Sales terms assume a 20 percent down-payment, 70 percent due upon delivery and the final 10 percent due one year following delivery; this final 10 percent representing a product guarantee. On average, a 3-month period is required for construction of a railcar. Thus, the difference between cash operating costs and the 20 percent down-payment must be funded by a combination of working capital and the line-of-credit for a 3-month period.

In recent years, the price of coaches delivered to the Egyptian Railways by SEMAF has been based on the production cost. The cost base includes allowances for working capital cost and depreciation. In addition, a profit of 10 percent of total cost is included. The resulting annual unit prices have been as shown below.

Year	Number of Coaches	Price (Third Class Coach)
1974	44	EGL 36,750
1975	67	EGL 43,525
1976	94	EGL 46,350
1977	27	EGL 47,850

The prices now in use are based on converting the cost of imported components ($8,735 per car) to Egyptian pounds using the official exchange rate of $2.56: EGL 1.00. If the cost of imported components were converted to Egyptian pounds at the "parallel market" exchange rate of $1.43: EGL 1.00, the per unit 1977 price would increase from EGL 47,850 to EGL 50,816. There seems to be an increasing probability that the parallel market will cease to exist in future years. Since the analysis of this project is directed a period of 5 to 25 years in the future, we consider it appropriate to use the "free market" rate in the analysis.

Another adjustment is required because the cost basis includes depreciation of machinery and equipment which is valued at a fraction of current replacement cost. Adjusting for this factor would bring the price to EGL 52,450.

The practice of using a cost plus 10 percent pricing policy presents problems in analyzing the feasibility of a new project. First, this pricing policy always results in a project appearing to be financially feasible, regardless of whether the product is being produced efficiently and is competitive with foreign imports. Second, in the initial operating years, when productivity is low because of

manpower training programs and startup problems, the cost, and hence price, per unit would be extremely high. Third, there is little incentive to produce coaches efficiently if they can be sold for the price established under this practice. In fact, there is an incentive to produce cars at higher cost since this would then result in higher profits.

Based on the above revisions in the foreign exchange ratio and the cost basis for depreciation, the domestic per unit price of a third class passenger coach has been established at EGL 52,450, about 10 percent above the price of those coaches delivered from SEMAF to the Egyptian Railways in early 1977. Converted to U.S. dollars the price is $75,000.

Operating Expenses

Operating expense factors and assumptions are outlined below relative to the production and sales level previously indicated.

- Direct Production Materials and Supplies - direct coach body material cost, shown by component in Table IV-2, is estimated at $20,721 per car, of which $215 is for foreign exchange (imported) components.

TABLE IV-2

DIRECT COST OF MATERIALS FOR PRODUCTION OF THIRD CLASS COACH BODY
(Constant 1977 $)

Cost Element	Cost per Coach
Steel Components	$ 6,084
Imported Mechanical Parts	215
Locally Manufactured Mechanical Parts	12,598
Bolts, Rivets, Welding Electrodes, Other Hardware	668
Oils, Paints, Other Chemicals	1,079
Import Duties	77
Total Direct Material Costs per Coach Body	20,721
Foreign Exchange Components	(215)
Locally Manufactured Components and Cost	$20,506

- Bogies - purchased from existing SEMAF plant at $20,218 per set (two bogies) as derived in Table IV-3. Direct cost of materials, the principal component, is derived in Table IV-4. The direct cost of materials is estimated at $14,172 per set, of which $8,720 are foreign exchange (imported) components.

- Direct Production Wages - estimated at $624,000 in 1981, $758,000 in 1982 and $949,000 in 1983, as exhibited in Table IV-5. The average standard wage rate assumes a 25 percent premium relative to existing wage rates at SEMAF to attract labor with required skills.

TABLE IV-3

ESTIMATED PURCHASE PRICE OF THIRD CLASS PASSENGER COACH BOGIE SET OF TWO

Component	Cost per Bogie Set
Direct Cost of Materials	$14,172
Indirect Materials & Supplies	675
Direct Production Wages	820
Indirect Wages	655
Other Services & Misc. Costs	280
Interest*	594
Depreciation - Existing Equipment	141
Depreciation - New Equipment	761
Profits Tax	1,293
Total Cost per Set	19,391
Plus: 10 Percent Profit	1,939
Subtotal	21,330
Less: Principal and Interest Payment	(1,112)
Total Purchase Price per Set	$20,218

*Represents average annual interest charge on new equipment purchase.

TABLE IV-4

DIRECT COST OF MATERIALS FOR PRODUCTION OF THIRD CLASS BOGIE SET OF TWO

Cost Element	Cost per Bogie Set
Steel Components	$ 1,246
Imported Mechanical Parts	8,720
Locally Manufactured Mechanical Parts	2,580
Bolts, Rivets, Welding Electrodes, Other Hardware	137
Oils, Paints, Other Chemicals	221
Import Duties	1,268
Total Direct Material Costs per Bogie Set	14,172
Foreign Exchange Components	(8,720)
Locally Manufactured Components and Cost	$ 5,452

- Indirect Wages and Salaries - a fixed cost, estimated at $712,000 annually. Because of redundant employment at the existing SEMAF plant, indirect and overhead employment is expected to represent 35 percent of total new company employment compared with 38 percent at SEMAF. Thus, the number of indirect and overhead employees is estimated at 950 earning an average of $750 per year ($0.375 per hour).

- Employee Benefits - estimated at 15 percent of payroll for health, retirement, holiday, and other allowances and benefits.

- Indirect Materials and Supplies - a fixed cost, estimated at $700,000 annually.

- Manpower Training Costs - a one-time-only cost occurring in 1981, estimated at $135,000.

TABLE IV-5

DIRECT LABOR WAGES

	Year 1981	1982	1983*
Total Paid Manhours (000)**			
Skilled	858	1044	1305
Semi-Skilled	1430	1740	2175
Unskilled	572	696	870
Total	2860	3480	4350
Average Standard Wage Rate/ Hour***			
Skilled	$0.26	$0.26	$0.26
Semi-Skilled	0.22	0.22	0.22
Unskilled	0.15	0.15	0.15
Total Payroll (Thousands of $)			
Skilled	$ 223	$ 271	$ 339
Semi-Skilled	314	383	479
Unskilled	86	104	131
Total	$ 624	$ 758	$ 949

* Values constant for balance of projection period.
** Total paid manhours are derived in Section III of the report.
***Includes a 25 percent premium.

- Miscellaneous Services and Transportation Costs - a fixed cost, estimated at $500,000 annually ($250,000 for insurance, office supplies, public relationships, auditing and other serivices and $250,000 for internal transportation operating expenses.)

- Export Marketing, Travel, and Commission Costs - estimated at 5 percent of export sales revenue.

- Depreciation - straight line depreciation with the following depreciation schedules:

Buildings/Improvements	20 years
Machinery and Equipment	12 years
Construction Supervision, Capitalized Interest	5 years

All machinery and equipment transferred to the new plant from the existing SEMAF plant is depreciated on a straight line basis over ten years.

- Line-of-Credit Interim Interest - estimated at $935 per railcar produced. Year-end negative cash flow is financed at 10 percent interest (calculated on an average balance of one-half the year-end amount.)

- Initial Supplies and Materials - estimated at $2.3 million for purchase of supplies, materials, and parts required to build one-fourth of first year product (37.5 coaches) and foreign mechanical parts for the first year's production (150 coaches).

PROJECT PERFORMANCE

A statement of net operating income for the period 1981-1990 is presented in Table IV-6. There is a net operating loss of $124,000 in 1981 followed by a pre-tax net operating income of $1.5 million in 1982. This income increases to $4.8 million when full production is achieved in 1983, $5.5 million in 1986 when construction supervision and capitalized interest are fully depreciated, and $6.2 million in 1987 when export sales begin. Over the first ten years of operation, net operating income after taxes totals $28 million, representing 13.3 percent of the total ten-year sales value of $210 million. At production stabilization (1983), the project yields annually before and after tax returns on equity of 40 percent and 24 percent, respectively.

An operating cash flow statement (sources and uses of funds) for the period 1978-1990 is presented in Table IV-7. The cash flow analysis assumes that a minimum year-end cumulative cash flow balance of $100,000 is maintained in the working capital account. As well, there is no provision for distribution of dividend payments in the analysis.

In addition to the $11.88 million in equity contributions during the 1978-1980 development period, line-of-credit borrowings of $1.75 million are required to maintain a $100,000 cumulative cash flow balance by year-end 1980. Then, another $1.98 million is borrowed on the line-of-credit during 1981, when only 150 coaches are produced,

TABLE IV-6

PRO FORMA PROJECT NET OPERATING INCOME STATEMENT 1981 - 1990
(Thousands of $)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Ten-Year Total
Gross Revenue											
Domestic	11,250	15,000	22,500	22,500	22,500	22,500	20,250	20,050	20,250	20,250	197,250
Export	--	--	--	--	--	--	3,000	3,000	3,000	3,000	12,000
Scrap Metal	34	45	67	67	67	67	67	67	67	67	615
Total Gross Revenue	11,284	15,045	22,567	22,567	22,567	22,567	23,317	23,317	23,317	23,317	209,865
Operating Expenses											
Direct Production Materials*	3,108	4,144	6,216	6,216	6,216	6,216	6,216	6,216	6,216	6,216	56,988
Bagie Purchase	3,033	4,044	6,065	6,065	6,065	6,065	6,065	6,065	6,065	6,065	55,597
Direct Production Wages	623	758	948	948	948	948	948	948	948	948	8,966
Indirect Wages & Salaries	712	712	712	712	712	712	712	712	712	712	7,120
Employee Benefits	249	249	249	249	249	249	249	249	249	249	2,490
Indirect Materials & Supplies	700	700	700	700	700	700	700	700	700	700	7,000
Misc. Services, including Transp.	635**	500	500	500	500	500	500	500	500	500	5,135
Export Marketing & Commissions	--	--	--	--	--	--	150	150	150	150	600
Subtotal	9,060	11,107	15,390	15,390	15,390	15,390	15,540	15,540	15,540	15,540	143,887
Depreciation											
Buildings/Improvements	406	406	406	406	406	406	406	406	406	406	4,060
Machinery & Equipment	414	414	414	414	414	414	414	414	414	414	4,140
Other ***	417	417	417	417	417	--	--	--	--	--	2,085
Subtotal	1,237	1,237	1,237	1,237	1,237	820	820	820	820	820	10,285
Interest Payments											
Long-Term - Foreign Loan	698	686	659	630	597	561	522	480	433	382	5,648
Line-of-Credit	413	520	492	314	281	281	281	281	281	281	3,425
Subtotal	1,111	1,206	1,151	944	878	842	803	761	714	663	9,073
Total Operating Expenses	11,408	13,550	17,778	17,571	17,505	17,052	17,163	17,121	17,074	17,023	163,245
Net Operating Income Before Tax	(124)	1,495	4,789	4,996	5,062	5,515	6,154	6,196	6,243	6,294	46,620
Income Tax	--	598	1,916	1,998	2,025	2,206	2,462	2,478	2,497	2,518	18,698
Net Operating Income After Tax	(124)	897	2,873	2,998	3,037	3,309	3,692	3,718	3,746	3,776	27,922

* Includes import duties.
** Includes first-year manpower training costs.
*** Includes design, construction supervision and capitalized interest.

TABLE IV-7

PRO FORMA PROJECTED CASH FLOW STATEMENT 1978 - 1990
(Thousands of $)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Sources of Funds														
Gross Revenue from Operations				8,190	14,014	20,504	22,567	22,567	22,567	23,111	23,317	23,317	23,317	203,471
Borrowings														
Long-Term Foreign Loan	2,175	3,700	1,884											7,759
Line-of-Credit	--	--	1,746	1,981										3,727
Subtotal	2,175	3,700	3,630											11,486
Equity	2,770	4,320	4,792											11,882
Total Sources of Funds	4,945	8.020	8,422	10,171	14,014	20,504	22,567	22,567	22,567	23,111	23,317	23,317	23,317	226,839
Uses of Funds														
Capital Development Costs:														
Land	1,157													1,157
Civil Works	1,550	1,238	619											3,407
Buildings/Improvements	--	2,830	1,887											4,717
Machinery & Equipment	1,649	3,296	2,582											7,527
Other	384	286	341											1,011
Subtotal	4,740	7,650	5,429											17,819
Initial Supplies & Materials			2,308											2,308
Operating Costs & Expenses				9,060	11,107	15,390	15,390	15,390	15,390	15,540	15,540	15,540	15,540	143,887
Interest Payments:														
Long-Term Foreign Loan	98	362	613	698	686	659	630	597	561	522	480	433	382	6,721
Line-of-Credit	--	--	87	413	520	492	314	281	281	281	281	281	281	3,512
Subtotal	98	362	700	1,111	1,206	1,151	944	878	842	803	761	714	663	10,233
Principal Payments														
Long-Term Foreign Loan	--	--	--	--	291	318	347	380	416	455	497	544	595	3,843
Line-of-Credit	--	--	--	--	812	1,729	1,186	--	--	--	--	--	--	3,727
Subtotal	--	--	--	--	1,103	2,047	1,533	380	416	455	497	544	595	7,570
Profits Tax	--	--	--	--	598	1,916	1,998	2,025	2,206	2,462	2,478	2,497	2,518	18,698
Total Uses of Funds	4,838	8,012	8,437	10,171	14,014	20,504	19,865	18,673	18,854	19,260	19,276	19,295	19,316	200,515
Net Cash Flow	107	8	(15)	0	0	0	2,702	3,894	3,713	3,851	4,041	4,022	4,001	26,324
Cumulative Cash Flow	107	115	100	100	100	100	2,802	6,696	10,409	14,260	18,301	22,323	26,324	--

increasing the line-of-credit principal balance to its peak level of $3.73 million. The borrowings are repaid as cash flow becomes available with $812,000 repaid in 1982, $1.73 million in 1983 and the remaining $1.19 million in 1984.

Net cash flow from operations increases from $2.7 million in 1984 to $3.89 million in 1985, remaining relatively constant through 1987. In 1988, when cash from export sales is received, net cash flow reaches $4.04 million and remains near that level through the end of the projection period.

Direct net foreign exchange earnings of the project for the ten-year operating period are calculated as follows:

	Ten-Year Total $ Thousands	Annual from 1987 $ Thousands
Export Product Sales	$12,000	$3,000
Less:		
Coach Body Import Parts	591	59
Bogie Import Parts	23,980	2,398
Export Marketing and Commission Costs	600	150
Subtotal	(25,171)	(2,607)
Net Foreign Exchange Earnings	($13,171)	$ 393

Thus, foreign exchange requirements exceed foreign exchange earnings by slightly more than $13 million over the ten-year projection period, yet upon initiation of export sales in 1987, foreign exchange earnings exceed requirements by $393,000 per year. The substitution of domestically produced coaches for foreign produced coaches as a result of the new plant yields a substantial reduction of foreign exchange requirements; however, these benefits are not included above.

It is useful to examine the financial internal rate of return on investment (ROI) since this is one measure of financial performance which can be compared with alternatives derived under other assumptions. The ROI is based on a twenty year operation period for the plant with the net cash flow values for the 11th through 20th years extrapolated from 1990 net cash flow. This internal ROI is estimated to be 16.6 percent.

A project balance sheet for the period 1978-1990 is provided in Table IV-8. The "cash" account is based on the cumulative cash flow as shown on the cash flow statement. Both the "cash" and "retained earnings" accounts are stated without any allowance for distribution of dividends.

TABLE IV-8

PRO FORMA PROJECT BALANCE SHEET 1978 - 1990
(Thousands of $)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Assets													
Cash	107	115	100	100	100	100	2,802	6,696	10,409	14,260	18,301	22,323	26,324
Supplies & Materials			2,308	2,308	2,308	2,308	2,308	2,308	2,308	2,308	2,308	2,308	2,308
Land	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,157
Improvements/ Equipment*	3,681	11,693	17,822	17,822	17,822	17,822	17,822	17,822	17,822	17,822	17,822	17,822	17,822
Less: Depreciation				(1,237)	(2,474)	(3,711)	(4,948)	(6,185)	(7,005)	(7,825)	(8,645)	(9,465)	(10,285)
Balance	3,681	11,693	17,822	16,585	15,348	14,111	12,874	11,637	10,817	9,997	9,177	8,357	7,537
Accounts Receivable	--	--	--	3,094	4,125	6,188	6,188	6,188	6,188	6,394	6,394	6,394	6,394
Total Assets	4,945	12,965	21,387	23,244	23,038	23,864	25,329	27,986	30,879	34,116	37,337	40,539	43,720
Liabilities/Capital													
Loans - Principal Balance													
Foreign Line-of-Credit	2,175	5,875	7,759	7,759	7,468	7,150	6,803	6,423	6,007	5,552	5,055	4,511	3,916
			1,746	3,727	2,915	1,186							
Subtotal	2,175	5,875	9,505	11,486	10,383	8,336	6,803	6,423	6,007	5,552	5,055	4,511	3,916
Equity	2,770	7,090	11,882	11,882	11,882	11,882	11,882	11,882	11,882	11,882	11,882	11,882	11,882
Retained Earnings				(124)	773	3,646	6,644	9,681	12,990	16,682	20,400	24,146	27,922
Total Liabilities/ Capital	4,945	12,965	21,387	23,244	23,038	23,864	25,329	27,986	30,879	34,116	37,337	40,539	43,720
Net Worth (Assets-Liabilities)	2,770	7,090	11,882	11,758	12,655	15,528	18,526	21,563	24,872	28,564	32,282	36,028	39,804

*Includes Capitalized Interest

The "net worth" of the project is calculated at the botton of the balance sheet on an annual basis. As noted, net worth is equal to the value of equity contributions through the development period $11.88 million in total), and increases steadily through the operating period to $39.8 million by 1990.

SENSITIVITY ANALYSIS

The financial performance measures generated above are predicated on several key assumptions which comprise the "base" analysis. Sensitivity analyses were conducted by altering the principal economic assumptions and measuring the impact of these changes on project financial performance. This is a parametric analysis in that the impact of changing one variable is measured while holding all other variables constant. The assumptions which were subjected to sensitivity analysis are product sales price, inflation, production and sales rate, currency exchange rate, and the mix of domestic and export product sales. The results of these sensitivity tests are summarized in Table IV-9. While the sensitivity tests were based on a twenty year operating period, details of results are presented only for the first 10 years. Performance over the second 10-year period would be better because much of the investment would be fully amortized during the first period.

Product Sales Price

The project financial performance is measured under each of the following price change alternatives:

	Product Price ($)		
	Base Analysis	Alt. I	Alt. II
Domestic Product	75,000	75,000	67,000
Export Product	100,000	85,000	100,000

As shown, the domestic product price for a third class coach under Alternative I is maintained at $75,000, while the domestic product price under Alternative II is the price at which SEMAF-manufactured third class coaches were delivered to the Egyptian Railways in early 1977. The export product price is decreased to $85,000 under Alternative I but maintained at $100,000 under Alternative II.

Project net cash flow is extremely sensitive to the price variable as seen below:

	Thousands of $		
	Base	Alt. I	Alt. II
Ten-Year Gross Operating Receipts	$203,471	$201,794	$183,026
Ten-Year Net Cash Flow	$ 26,324	$ 25,367	$ 13,457
Annual Cash Flow Beyond Analysis Period	$ 4,001	$ 3,731	$ 2,685
Internal Return on Investment	16.6%	16.0%	10.5%

TABLE IV-9

COMPARATIVE RESULTS OF SENSITIVITY TESTS
NET CASH FLOW
(Thousands of $)

Alternative*	Internal ROI**	Ten-Year Total	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Base Case	16.6%	$26,324	107	8	(15)	0	0	0	2,702	3,894	3,713	3,851	4,041	4,022	4,001
Price - Alternative I	16.0	25,367	107	8	(15)	0	0	0	2,702	3,894	3,713	3,704	3,771	3,752	3,731
Price - Alternative II	10.5	13,457	107	8	(15)	0	0	0	0	519	2,253	2,469	2,725	2,706	2,686
Inflation	24.0	45,005	112	9	(17)	0	0	0	3,948	5,842	5,947	6,501	7,185	7,549	7,929
Sales Rate - Alt. I	9.8	13,721	107	8	(15)	0	0	0	1,209	2,111	1,930	2,017	2,137	2,119	2,088
Sales Rate - Alt. II	21.6	39,949	107	8	(15)	0	0	0	3,609	5,677	5,496	6,093	6,344	6,325	6,305
Product Mix	17.2	28,004	107	8	(15)	0	0	0	3,456	4,254	4,073	4,057	4,041	4,022	4,001
Devaluation	15.6	24,126	97	(28)	(76)	0	0	0	1,921	3,677	3,488	3,634	3,824	3,805	3,784

*See text for complete description of alternatives
** Based on 20-year project life.

For every $1.00 increase (decrease) in gross operating receipts, there is approximately a $.60 increase (decrease) in net cash flow, with the profits tax acting as a "damper" on net cash flow.

Inflation

This sensitivity test assumed a moderate annual inflation level of 5 percent (from base 1977 values) which is applied to captial costs, operating revenue, and operating expenses, with the exception of debt service and depreciation.

The impact of this assumption on project capital cost, net cash flow, and internal ROI are summarized as follows:

	Thousands of $	
	Base Analysis	Inflation Analysis
Capital Costs		
Foreign Costs	$ 7,759	$ 8,544
Local Costs	11,882	13,214
Total	$19,641	$21,758
Ten-Year Net Cash Flow	$26,324	$45,005
Annual Cash Flow Beyond Analysis Period	$ 4,001	$ 7,929
Internal ROI	16.6%	24.0%

If inflation increases all costs and revenues by the same percentage rate, it has a positive effect on project performance. Under this condition, profits, or net cash flow, increase at a faster rate than the inflation rate because principal and interest payments on borrowed funds remain fixed at a constant level. This positive effect is slightly offset by the fact that the tax savings benefit attributable to depreciation also remains constant. Note that the change in the internal ROI from the base analysis is greater than the inflation rate of 5 percent.

Production and Sales Rate

The impact of a change in production and sales rate (at stabilization - 1983) on project financial performance was analyzed under the following assumptions:

	Annual Production and Sales Rate
Base Analysis	300
Alternative I	200
Alternative II	400

Under Alternative II, the sales rate stabilizes at 400 coaches per year by 1984.

Sales volume changes affect gross operating receipts equally as much as price changes but, because of an extremely high level of variable production costs, sales volume changes have significantly less impact on net cash flow:

	Thousands of $		
	Base (300/yr.)	Alt. I (200/yr.)	Alt. II (400/yr.)
Ten-Year Gross Operating Receipts	$203,471	$144,427	$255,001
Ten-Year Net Cash Flow	$ 26,324	$ 13,721	$ 39,949
Annual Cash Flow Beyond Analysis Period	$ 4,001	$ 2,098	$ 6,305
Internal Return on Investment	16.6%	9.8%	21.6%

A breakeven point analysis is developed in Figure IV-1 by plotting gross revenue and operating costs relative to different stabilized production levels. The cash breakeven point occurs at a production and sales level of 90 coaches per year. Accounting operating expenses include allowance for depreciation but exclude loan principal payments. Cash payments include all cash disbursals and thus exclude depreciation expense.

Currency Exchange Rate

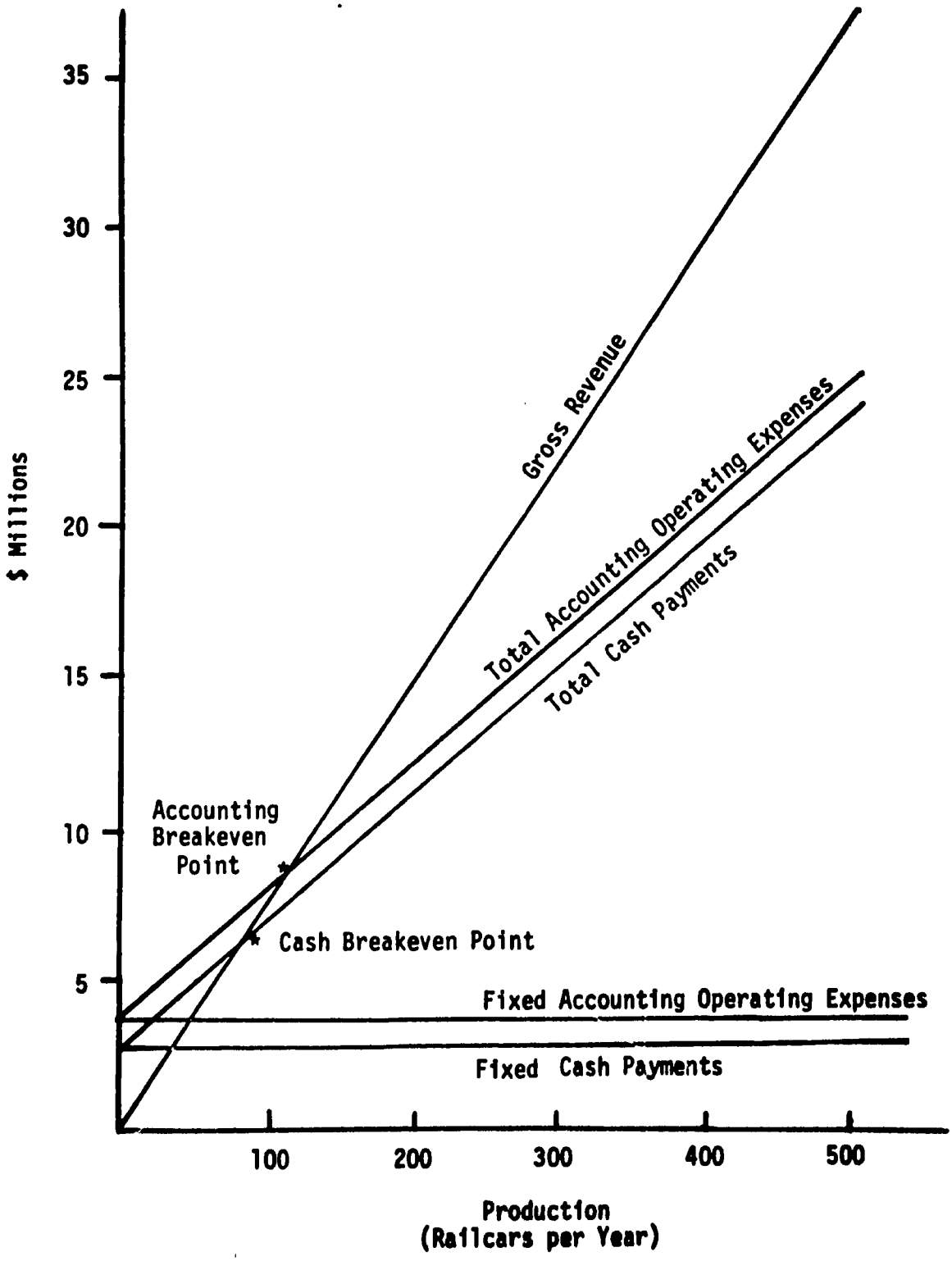
The "base" analysis is performed using the parallel market exchange rate ($1.43: EGL 1.00) for converting dollars to Egyptian pounds. However, an Egyptian currency devaluation might reflect better the equilibrium conditions of the foreign exchange market, based on recent Egyptian balance of payment deficits. Therefore, the project financial performance is measured on the assumption of a 10 percent Egyptian currency devaluation yielding an exchange rate of $1.30:EGL 1.00.

The impact of this assumption on project capital cost, net cash flow, and ROI is summarized below.

	Thousands of $	
	Base Analysis	Devaluation Analysis
Capital Costs		
Foreign Costs	$ 7,759	$ 8,544
Local Costs	11,882	11,989
Total	$19,641	$20,533
Ten-Year Net Cash Flow	$26,324	$24,126

FIGURE IV-1

BREAKEVEN POINT ANALYSIS FOR PASSENGER ROLLING STOCK PRODUCTION FACILITY



Annual Cash Flow Beyond Analysis Period	$ 4,001	$ 3,784
Internal Return on Investment	16.6%	15.6%

The devaluation increases foreign capital costs and thus borrowings by $785,000 which affects both debt service and depreciation. Also affected are production material costs (amounting to about $160,000 per year at full production) since the price of imported body and bogie components increases by 10 percent. However, project performance is not affected significantly by the Egyptian currency devaluation.

Mix of Product Sales

The market demand projections incorporated in the "base" financial analysis assume that production and sales will be allocated so as to satisfy domestic demand before serving the export market. Consequently, export sales do not begin until 1987. This sensitivity test measures the financial performance of the project under the policy assumption that 10 percent of production is exported beginning in the second year of operation, 1982.

The impact of this assumption on project cash flow, foreign exchange earnings, and internal ROI is summarized below:

	Thousands of $	
	Base Analysis	Increase in Export Sales
Ten-Year Foreign Exchange Earnings	$12,000	$26,000
Less: Foreign Exchange Costs	(25,171)	(25,871)
Earnings	($13,171)	$ 129
Ten-Year Net Cash Flow	$26,324	$28,004
Annual Cash Flow Beyond Analysis Period	$ 4,001	$ 4,001
Internal ROI	16.6%	17.2%

While shifting more production from domestic to export sales has an insignificant impact on net cash flow (only $1.7 million over the ten-year operating period), net foreign exchange earnings are sharply increased. As noted, sufficient foreign exchange earnings are generated under this alternative to cover all foreign exchange requirements of the project, excluding capital costs.

SECTION V - ECONOMIC ANALYSIS

The economic feasibility analysis considers the proposed passenger rail car production facility from a cost-benefit standpoint in relation to the Egyptian economy. The financial analysis was performed on the basis of actual product and factor prices with project performance measured on the basis of actual profits or cash flow. In more advanced economies, the price mechanism is believed to work in such a way that actual profits are a reasonable measure of net economic benefit. In most developing countries, however, actual profits do not reflect net economic benefit for a variety of reasons including currency overvaluation, underemployment, price and income subsidies, imperfect capital markets, high inflation rates, and import restrictions. Consequently, the economic analysis is conducted by modifying or adjusting product and factor prices such that they more closely reflect their economic value. Deriving the net economic benefit of a project on the basis of these modified prices indicates what the results would be if the economy's scarce resources are allocated efficiently.

ANALYSIS APPROACH

The following differences were assumed from the factors used in the financial analysis.

Financing

Borrowings, and thus principal and interest payments, are excluded from the concept of cash flow when used for the purpose of assessing the economic feasibility of a new investment. As in the financial evaluation, the analysis excludes dividend payments.

Project Life and Salvage Value

Accurate measurement of the project internal ROI requires that a project life be assigned and the salvage value estimated. A 30-year economic life is assumed with annual project earnings remaining constant for the period from year ten through year thirty. Salvage value at the end of the 30-year period is assumed equal to land, valued at its original cost. These are commonly used assumptions for evaluation of a manufacturing plant.

Shadow Pricing

During the last 20 years, the Egyptian Government has resorted extensively to administrative controls over prices, wages, and allocation of economic resources. The result has been the emergence of a complex system of price and wage rate controls,

rationing schemes, subsidies, and other resource allocation dictates. In certain instances, these interventions may have created distortions, and mis-allocations in the Egyptian economy. Therefore, the observed wage and price structure does not reflect intrinsic economic value or cost with complete accuracy. Thus, employing the wage and price structure as a guide may result in an inefficient allocation of economic resources.

Consequently, in those instances where distortions or mis-allocations exist, this analysis develops "shadow" or "accounting" prices and wages which better reflect the economic value or cost of the resource. Because of the complexity of the Egyptian price structure, it is often difficult to estimate shadow prices with a high degree of confidence, although free market international prices and other estimates may serve as surrogates.

Taxes and Duties

All taxes and duties are excluded from the economic feasibility analysis since these are merely income transferences from the new entity to the government and therefore do not constitute economic costs. Elements which were included in the financial assessment but are excluded from the economic evaluation include the "profits tax" and "import duties".

Depreciation

Depreciation is a non-cash expense which affects net operating income and hence "profits tax" which, in turn, impacts net cash flow. Thus, depreciation is excluded from the economic analysis.

DETERMINATION OF ECONOMIC COSTS AND BENEFITS

The following paragraphs are concerned with modifying actual costs and revenues so as to reflect their economic costs and revenues (benefits).

Capital Costs

Capital cost items remain unchanged from values used in the financial analysis, with the exception of capitalized interest and import duties which are excluded from the economic assessment, and the cost of the machinery and equipment transferred from the Helwan plant to the new site. The majority of capital costs are imported machinery and equipment from the United States - therefore actual expense is equal to economic cost. Egyptian local capital costs, except as noted below, are assumed to approximate economic cost.

Land, at original cost, is included in the analysis, as is the value of the machinery and equipment which is transferred from the

SENAF Helwan plant to the new plant. In the economic analysis, this machinery and equipment is valued at current replacement cost loss depreciation ($933,000).

Reinvestment in machinery and equipment must also be taken into account. For the new equipment which is purchased, reinvestment amounting to $6.59 million is assumed in year twenty, while for the equipment transferred from Helwan to the new plant, reinvestment totalling $2.22 million is assumed in year fifteen. No salvage value is assigned to the replaced equipment.

Operating Revenues

Operating revenues are directly a function of the railcar coach price. Determining the proper shadow price for a third class passenger coach in the Egyptian economy would require a thorough study of the economy's transportation sector, which is beyond the scope of this study. Although it can be argued that the minimal international third class passenger coach price of $100,000 is an appropriate surrogate for the economic social benefit associated with producing a third class passenger coach, the economic analysis uses the same price structure ($75,000 for domestic and $100,000 for international coaches) as employed in the financial analysis. This is considered to lend conservatism to the economic assessment.

Operating Costs

Upon review of the operating costs of the new facility in conjunction with available information and data on the Egyptian economy, shadow prices are developed for labor (shadow wage rates), iron and steel, and petroleum based products.

Shadow Wage Rate - Skilled Labor

If there is reasonably full employment of skilled labor and if this labor has a reasonable degree of mobility, labor can be regarded as a "traded" good thus allowing the shadow wage rate to be estimated by observing the implicit actual wage rate of the skilled employee. Unemployment of skilled labor is low in Egypt and there is labor mobility as many Egyptians are attracted, through higher wages, to other African and Middle Eastern countries.[1/]

The implicit actual or shadow wage rate for skilled labor is defined as the actual wage rate less taxes (government price and income subsidies are negative taxes and thus added to the direct actual wage rate.) Therefore, the shadow wage rate is, in effect, equvalent to consumption.

1/ The real or shadow wage rate for skilled labor is set high enough in Egypt so as to retain enough potential emmigrants as required by the economy.

The financial analysis used $0.26 per hour as the wage rate for skilled labor and $0.22 per hour for semi-skilled labor. The following modifications yield a shadow wage rate for skilled and semi-skilled labor at the new plant:

	Wage Rate per Hour ($)	
	Skilled Labor	Semi-Skilled Labor
Actual Wage Rate	$.260	$.220
Less: Taxes	(.026)	(.022)
Add: Subsidies	.118	.100
Shadow Wage Rate	$.352	$.298

Taxes are estimated at an average rate of 10 percent of the gross wage level.[2/] Direct subsidies in the economy have been estimated at approximately $880 million (1975) or about 15 percent of gross domestic product.[3/] This does not include indirect subsidies of which there is no published estimate.[4/] For the purpose of this analysis, doubling the direct level of subsidies to account for indirect subsidies does not appear unreasonable.

- Total Economy Subsidies (direct plus indirect) - $1,760 million divided by,
- Egyptian Employment (annual hours) - 18 billion yields,
- Subsidy per Hour of Employment - $0.098

Then, multiplying the ratio of the skilled wage rate to the average wage rate (1.2) yields a skilled labor subsidy of $0.118. The same exercise relative to semi-skilled labor yields a labor subsidy of $0.100 per hour.

2/ Includes personal income tax, property tax and excise tax on services and goods.

3/ See Arab Republic of Egypt Economic Report, January 5, 1976, prepared by The World Bank.

4/ For example, petroleum products are indirectly subsidized in Egypt since they are based on a national price of crude oil which is far under the international price level. Consequently, nearly every sector of the economy from manufacturing industries to electricity consumers is subsidized.

Shadow Wage Rate - Unskilled Labor

In a developing economy with significant unemployment and underemployment conditions, the actual wage rate for unskilled labor is generally greater than the marginal productivity of that labor (MPL).5/ Therefore, the shadow wage rate must be estimated by calculating the opportunity cost of that labor. If, in the absense of the new enterprise, the labor would be totally unemployed, the opportunity cost approaches zero. In the Egyptian economy very few people are totally unemployed. A reasonable assumption is that, in the absence of industrial or service employment, the labor could be employed in the agricultural sector. The opportunity cost of this unskilled labor is approximated by measuring the MPL of an agricultural sector employee.

The MPL for the agricultural sector is derived as follows:

- Agricultural Value-Added Product - $2,012 million, divided by
- Agricultural Employment - 4.2 million, yields
- Value-Added Product per Employee - $480

Then, subtracting factor costs for such items as fertilizer, seed, land rental, water, power, insecticide, and return on capital which total $268 per employee yields an MPL value of $212 per employee. On the basis of 2,185 annual hours per employee, the MPL per hour worked is calculated at $0.097. In the financial analysis an actual wage rate of $0.150 per hour was employed.

Iron and Steel Shadow Price

Iron and steel is a critical factor of production for the proposed new rolling stock plant. The price of Egyptian iron and steel is fixed by the government at a level which creates a situation where demand exceeds supply. Thus, those manufacturers who are able to procure iron and steel materials are being subsidized.

The international price of iron and steel is used as a surrogate for the shadow price. Not only does the international price better reflect the economic cost of producing iron and steel but also is the actual price which the Egyptian manufacturer occassionally must pay to secure a continuous supply of material.

A recently negotiated contract between SEMAF and Interstell (Switzerland) provides an estimate of international iron and steel prices:

5/ In a purely competitive market economy, labor is employed to the point where the wage rate equals the marginal productivity of labor.

Type	Price per Metric Ton ($) Egypt	International*
Steel Plates and Sheet	259	258
Equal Angles	213	257
Unequal Angles	216	263
Channels and I-Beams	216	277
Round Bar	210	289

*Price is CIF, Alexandria and excludes import duties

Based on the quantity of steel used in production of a coach, the increase in steel price raises the total direct material costs by approximately $200 per coach. This does not take into account the impact of a higher iron and steel price on the procurement of locally manufactured mechanical parts used in passenger coach production.

Petroleum Based Products Shadow Price

Since the price of oil is held far below the international market price, nearly all products which directly or indirectly use oil in their manufacturing process are produced and sold for less than their economic cost. This impacts the price of electric power, fuel oils, lubricating oils, paints, other chemicals, and all manufactured parts. While this subsidization is recognized, the lack of available data precludes the quantification of the subsidy for all items in the production process. However, the increase was estimated at $250,000 per year (from the $500,000 level used in the financial analysis) for miscellaneous services and transportation. This includes an increase from $40,000 annually for electricity and fuel oil to $150,000.

Shadow Currency Exchange Rates

The consequence of an overvalued currency is the subsidization of imported goods, and the taxation of exported commodities. Because of prolonged balance of payments deficits, the shadow exchange rate would appear to be on the order of 10 percent less than the existing parallel market exchange rate, or about $1.30: EGL 1.00.

The shadow currency exchange rate, when applied, has the effect of increasing the price of imported products by 10 percent. Thus, the price of imported components used in producing the bogies and coach bodies are augmented by 10 percent in the economic analysis.

ECONOMIC PERFORMANCE

Based on the modifications discussed above, a revised project cash flow statement is shown in Table V-1 for the period 1978-2010. The negative annual net cash flow values represent capital investment

TABLE V-1

REVISED CASH FLOW STATEMENT - 1978 - 2010

	1978	1979	1980	1981	1982	1983	1984*	1987	1988*	1990*	1995*	2000*	2005*	2010
Sources of Funds														
Gross Revenue - Cars				8,156	13,969	20,437	22,560	23,044	23,250	23,250	23,250	23,250	23,250	23,250
- Scrap				34	45	67	67	67	67	67	67	67	67	67
Project Salvage Value														1,157
Total Sources				8,190	14,014	20,504	22,567	23,111	23,317	23,317	23,317	23,317	23,317	24,474
Uses of Funds														
Capital/Development Costs:														
Land	1,157													
Civil Work	1,599	1,287	644											
Buildings		2,838	1,892											
New Machinery	1,797	3,592	1,797											
Transferred Machinery			933									7,186		
Other	404	302	353								2,442			
Subtotal	4,957	8,019	5,619								2,442	7,186		
Initial Supplies & Materials			2,442											
Operating Costs:														
Direct Production Materials				3,130	4,173	6,260	6,260	6,260	6,260	6,260	6,260	6,260	6,260	6,260
Supplies				3,164	4,218	6,327	6,327	6,327	6,327	6,327	6,327	6,327	6,327	6,327
Direct Wages				794	953	1,197	1,192	1,192	1,192	1,192	1,192	1,192	1,192	1,192
Indirect Wages				895	895	895	895	895	895	895	895	895	895	895
Employee Benefits				313	313	313	313	313	313	313	313	313	313	313
Indirect Materials				700	700	700	700	700	700	700	700	700	700	700
Misc. Services				885**	750	750	750	750	750	750	750	750	750	750
Export Marketing								150	150	150	150	150	150	150
Subtotal				9,891	12,002	16,437	16,437	16,587	16,587	16,587	16,587	16,587	16,587	16,587
Total Uses	4,957	8,019	8,061	9,891	12,002	16,437	16,437	16,587	16,587	16,587	19,029	23,773	16,587	16,587
Net Cash Flow	(4,957)	(8,019)	(8,061)	(1,701)	2,012	4,067	6,130	6,524	6,730	6,730	4,288	(456)	6,730	7,887
Cumulative Cash Flow	(4,957)	(12,976)	(21,037)	(22,738)	(20,726)	(16,659)	(10,529)	8,255	14,986	28,445	59,653	86,117	119,767	154,574

* Items included in Sources of Funds and Operating Costs remain unchanged for intermediate years.
** Includes first-year manpower training costs.

requirements totalling $22.7 million by year-end 1981. Cumulative cash flow turns positive in 1986 and increases to $28.4 million by 1990. By 2010, cash flow totals $154.6 million.

The internal rate of return on investment is computed, as shown in Table V-2, using the annual net cash flow values from the revised cash flow statement. The economic internal ROI is estimated to be about 18 percent for the project.

EXTERNALITIES

The implementation of a new passenger rolling stock production facility creates numerous externalities -- that is, external economies or diseconomies resulting from development and operation of the new facility. The following paragraphs identify the major areas of impact, but no attempt is made to quantify the externalities.

Those positive externalities associated with the proposed new venture are outlined below:

- Employment Opportunities - The new plant would provide new employment opportunities and, through training, improve the technical capabilities of the labor force. In addition to the 2700 employees at the new plant (of which 675 would relocate from the existing plant) the demand for bogies would increase employment at the SEMAF Helwan bogie operation by about 300 employees.

- Improved Productivity - The employees transferring from the SEMAF plant to the new plant would provide an outlet for reducing the level of redundant employment at the SEMAF Helwan plant, thus improving the productivity and profitability of the SEMAF operation.

- Improved Bogie Shop Efficiency - Demand for passenger car bogies by the new plant and installation of additional bogie shop equipment would substantially improve the utilization of the existing bogie shop equipment and, therefore, the bogie shop efficiency would be substantially increased.

- Catalyst for New Industrial Area - As envisaged, the new plant would be the first of many industries to locate in this industrial park. The activity created by the new plant and the resulting off-site infrastructure (roads, power, water) would provide a catalyst for establishing a needed exurban industrial park.

TABLE V-2

ECONOMIC ANALYSIS INTERNAL RATE OF RETURN ON INVESTMENT

THE DISCOUNTED RATE OF RETURN IS 17.61 PERCENT.

ANALYSIS OF CASH FLOWS AND DISCOUNTED VALUES:

YEAR	ANNUAL CASH FLOW	CUMULATIVE CASH FLOW	PRESENT VALUE	CUMULATIVE VALUE
1	-4957.00	-4957.00	-4957.0	-4957.00
2	-8019.00	-12976.00	-6818.34	-11775.34
3	-8061.00	-21037.00	-5827.82	-17603.16
4	-1701.00	-22738.00	-1045.63	-18648.79
5	2012.00	-20726.00	1051.63	-17597.17
6	4047.00	-16679.00	1807.45	-15789.71
7	6130.0	-10549.0	2314.30	-13475.39
8	6130.00	-4419.00	1962.56	-11513.7[illegible]
9	6130.00	1731.0	1678.67	-9835.0[illegible]
10	6524.0	8255.0	1515.66	-8319.[illegible]
11	6730.0	14985.0	1322.23	-7096.[illegible]
12	6730.00	21715.00	1130.21	-5966.[illegible]
13	6730.00	28445.00	960.0[illegible]	-5003.2[illegible]
14	6730.0	35175.00	817.10	-4076.11
15	6730.00	41905.00	694.76	-3381.35
16	6730.00	48635.00	590.74	-2790.62
17	6730.00	55365.0	502.29	-2288.33
18	428[illegible].00	59653.0	272.11	-2016.2[illegible]
19	6730.00	6[illegible]353.00	363.14	-1653.08
20	6730.00	73113.00	308.76	-134[illegible].32
21	6730.0	79843.00	262.53	-1081.78
22	6730.00	86573.00	223.23	-858.56
23	-456.00	86117.00	-1[illegible].86	-871.42
24	6730.00	92847.00	161.38	-710.03
25	6730.00	99577.00	137.22	-572.81
26	6730.00	106307.00	116.68	-456.14
27	6730.00	113037.0	99.21	-356.93
28	6730.00	119767.0	84.35	-272.58
29	6730.00	126497.00	71.72	-2[illegible].86
30	6730.00	133227.00	60.98	-139.87
31	6730.00	139957.00	51.85	-88.02
32	6730.00	146687.00	44.00	-43.93
33	7887.00	154574.00	43.93	.00

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- Housing Relief - The policy of the Government is to provide jobs and housing outside the major metropolitan areas. This project would provide exurban jobs and a market for supporting industry and for development of social infrastructure.

- Foreign Exchange Earnings - To the extent that part of production from the new plant is exported, needed foreign exchange would be earned. In the absence of exported product, satisfaction of domestic requirements would reduce potential foreign exchange outflow.

APPENDIX A

BACKGROUND INFORMATION ON ELECTRIC RAILWAYS

APPENDIX A

DESCRIPTION OF ELECTRIFIED LINES

This appendix presents background information on present and proposed electrified railway and urban transit lines which comprise the market for electrically propelled units. The following are included:

- Cairo Metropolitan Area
- Heliopolis Company for Housing and Development
- Alexandria Passenger Transport Authority

CAIRO METROPOLITAN AREA

The Cairo Transport Authority (CTA) operates the largest passenger transport system in Egypt. The system presently handles approximately 3.7 million passengers per day. These passengers are handled by approximately 2000 motor buses, 421 tramcars, 115 trolley coaches and 15 Nile River boats. Motor buses handle the bulk of the traffic at present.

Current plans for transport in the Cairo area call for improvements in the following general categories:

- Service expansion on the CTA town tram system,
- Regional metro,
- Urban metro, and
- Helwan and Cairo surface metro.

The present Cairo 5-year transportation plan calls for the construction of an underground network comprised of three lines of which one would be designated regional metro and two would be urban metro. The regional metro would be created by joining two segments of suburban lines presently operated by Egyptian Railways (ER) by construction of a 4.5 kilometer underground link creating a through line from Helwan to El Marq. The entire line would be electrified.

CTA Town Tram System

Important factors in projecting tram requirements for Cairo include the condition of the present fleet and the plans for expansion of the fleet.

Present Fleet Condition

As a result of the shop situation and other factors, the number of tram cars in operation is small compared with the number

owned. The following data has been derived from "Preliminary Study of the 1976-1980 5-Year Plan and the Development of the Sector Up to the Year 2000" and interviews with CTA officials:

Type	Age Years	No. of Trams Owned	No. in Daily Operation	% of Total in Service
Belgian	24-38	110	75	68.2
PCC	20-40	111	40	36.0
Tatra K-5	7-8	200	30	15.0
Total		421	145	34.4

The very low utilization levels can be explained only in terms of the local situation in Cairo. Traffic conditions in the city result in frequent extensive body damage to tram cars. The PCC cars were purchased secondhand from Los Angeles, California in 1965-66 and the supply of replacement parts has become a problem. The Tatra K-5 cars are of twin-body articulated pattern mounted on two motor bogies and one trailer. The electrical equipment is of PCC design. In addition to the excessive body damage suffered by all cars, the CTA has been awaiting technical assistance from Tatra. Fifteen of the cars have suffered fire damage and may be beyond economic repair. The roof mounted pantographs are damaged frequently due to use on wire arranged primarily for trolley pole operation.

The Belgian cars, while newer than the PCC cars, are generally of single bogie design operated in motor/trailer sets. Although they are of an obsolete design, parts have been available, but may not be in the future. These cars will probably be retired as soon as the Tatra fleet can reliably enter service in large numbers. Thus, it can be estimated that potentially 311 cars will be available in the future.

Workshops

The tramways operate under a substantial handicap. There is only one major repair shop, taken over from a predecessor company in 1961. The shop is old, inadequate to the task required and unsuitable for the maintenance of articulated cars. A new workshop is planned.

At present, the tram workshops are engaged in the reconstruction of the PCC fleet. Replacement body parts for these cars are being fabricated at the workshops as are trolley poles and certain bogie parts. Electrical equipment is being rehabilitated in the electrical shop under conditions that are far from ideal. CTA has experienced difficulty obtaining electrical and braking equipment as many of the parts are no longer manufactured in the United States. ACEC in Belgium, Tatra in Czechoslovakia and CGE in Italy produce PCC equipment which may be interchangeable with parts on the Cairo PCC trams.

Fleet Expansion Plans

Overall, the Cairo transport plan calls for the expansion of the tram fleet from 421 cars to 926 cars in 1980. This would include the replacement of 111 PCC trams by new three-car sets and also the acquisition of 100 additional articulated trams. An analysis of the tram fleet requirements indicates that the projected 1980 operation would only require 491 cars out of the total of 926 shown in the plan. This results in an operating ratio to reserve of 53.0 percent, or approximately the present ratio. The projection was evidently based upon the presumption that a new repair shop would not be available by then. It does not seem to be a logical basis for market projection to assume that hundreds of additional cars would be purchased rather than improving the shop. Good practice throughout the world shows that a spare to active ratio of from 5 to 10 percent is reasonable to maintain a tram fleet in good working order. Allowing for the indefinite status of the tram workshops, an allowance of 20 percent seems reasonable. This would result in a total fleet of 589 cars or 337 fewer than in the plan.

On April 30, 1977, tender offers were opened by the Cairo Transportation Authority for the supply of 80 two-car town tram sets in 1978-79, with not less than 50 sets in 1978. The tender provides that the contractor may arrange to license SEMAF for the manufacture of the tram cars at the Helwan plant.

Regional Metro (Helwan-El Marq)

At present, service on the electrified Helwan-Bab el Luq segment of the future regional metro is furnished by 45 three-car sets. Of these, 25 sets (75 cars) are of recent orgin and will be retained, reconstructed and repowered to bring them up to the new regional metro standards. The balance of 24 sets (72 cars) will be replaced in 1977-78.

The 5-year plan calls for a total of 166 train sets for the ultimate regional metro line. It is anticipated that if work on the regional metro commences during 1977-78 the balance of 121 sets (363 cars) will be acquired no later than 1980.

Urban Metro

The Cairo transport plan calls for Line 1 of the urban metro to be in service by 1985 and Line 2 by 1990. Current indications are that financing delays will cause the opening of Line 1 to be set back at least to 1989 and Line 2 about 1992. For Line 1 it is proposed to acquire 29 8-car train sets (232 cars), and for Line 2 it is proposed to acquire 22 sets (176 cars).

Surface Metro

The Cairo 5-year transport plan (1976-1980) calls for the expansion of the tramway network as a first priority due to growing traffic congestion and inability to construct underground (regional and urban metro) lines immediately.

The present Cairo tram lines are basically of the town tram type wherein rails are laid in pavement and trams share movement with other road vehicles. The proposed extensions would be largely surface metro with track laid generally in reservations physically separated from other traffic. The tracks may be separated from congested major crossings by over or underpasses, similar to lines of the Heliopolis company.

At present, such lines are under construction in the Helwan area under a scheme predating the present 5-year plan. To operate these new lines, CTA has placed an order for 70 metro sets jointly with Mitsubishi Corporation and SEMAF. Each set will be comprised of three cars in a motor-trailer-motor configuration. The first 110 motor cars are to be built in Japan with delivery to commence during 1977. During 1978, SEMAF will construct 30 identical motor cars and complete the order in 1979 with 70 trailer cars. Assuming that construction of the additional surface metro lines envisaged in the present 5-year plan is begun shortly, CTA would require an additional 27 sets (81 cars) in 1980. This is based upon a fleet spare to active ratio of 20 percent, which would also reduce the number of sets required to protect the new Helwan lines. The overall fleet of 97 surface metro sets would be available to service the new surface metro lines proposed in the 5-year year plan and the Helwan lines.

HELIOPOLIS COMPANY FOR HOUSING AND DEVELOPMENT

The Heliopolis Company was founded in 1905 by Baron Empain as the Heliopolis Oasis Company. It was organized originally to build a planned community for Europeans residing in the Cairo area. The company undertook the entire development and operation of the community; housing, utilities and transportation.

From the inception of Heliopolis as a community, the surface metro lines were laid out in central reservations on what became wide boulevards. As Heliopolis grew, so did the surface metro network. From 1950 to 1970, the network grew from 12 to 75 kilometers. Annual passenger traffic increased from about 21 million in 1950 to 150 million in 1976. During this timespan, the population of Heliopolis has grown from about 70,000 in 1950 to 400,000 now.

Currently, the Heliopolis Company operates 250 surface metro cars of which 221 have been acquired under six contracts with Mitsubishi of Japan since 1962. They are operated either as single cars or in fixed sets of two, three and four cars. The Japanese cars are similar to the surface metro cars operating in Alexandria.

SEMAF has built one set of test bogies for Heliopolis identical in design to those produced new in Japan. These test bogies are in service in the surface metro car fleet and have been satisfactory according to the Heliopolis Company.

The transport plan for the Heliopolis Company calls for a number of route extensions to the system including service to Cairo Airport. An important route extension will bring the line that now ends at Darassa south and then west to a point near the Nile River and the Giza Bridge. At this point, the new line would connect with a projected CTA surface metro line running south from Tahrir Square. The CTA line would then turn westward and cross the Giza Bridge enroute to the Giza pyramids. Present plans call for the Heliopolis surface metro cars to utilize the CTA tracks across the Giza Bridge to a terminal in Giza.

The company estimates that the Cairo Airport extension will require eight four-car surface metro sets (32 cars). Continuing systemwide traffic growth would require approximately twenty additional cars per year over the next decade.

ALEXANDRIA PASSENGER TRANSPORT AUTHORITY (APTA)

The Alexandria Passenger Transport Authority (APTA) operates the passenger transport system in the Mediterranean seaside resort of Alexandria. The APTA was formed in 1928 to take over and operate the then separate town tramways and the Alexandria and Ramleh Railway Company; the latter operating a suburban tramway with surface metro characteristics.

The town-tram lines were modernized during 1969-72 when APTA purchased 99 secondhand articulated cars from Copenhagen, Denmark. The cars were built by Düwag of Dusseldorf, Germany and are of that company's standard design. All are between 12 and 20 years old. These cars now maintain most of the town service with the exception of one line served by another type of car. Of those cars, 83 are in service.

In 1966-1968, APTA acquired 140 PCC tram cars from Toronto, Canada. These cars were constructed between 1938 and 1944 and have been used on both the town-tram and Ramleh lines. Alexandria has experienced difficulty in acquiring spare parts to maintain these cars and has resorted to a number of measures designed to keep them in service, the more extreme of which has been to cannibalize a portion of the fleet to keep the balance active. At the present time, 80 cars are regarded as active and 60 as a parts resource.

The majority of the active PCC cars are assigned to the Ramleh lines while a small number provide town tram service. These cars are generally operated as two and three car trains in Ramleh

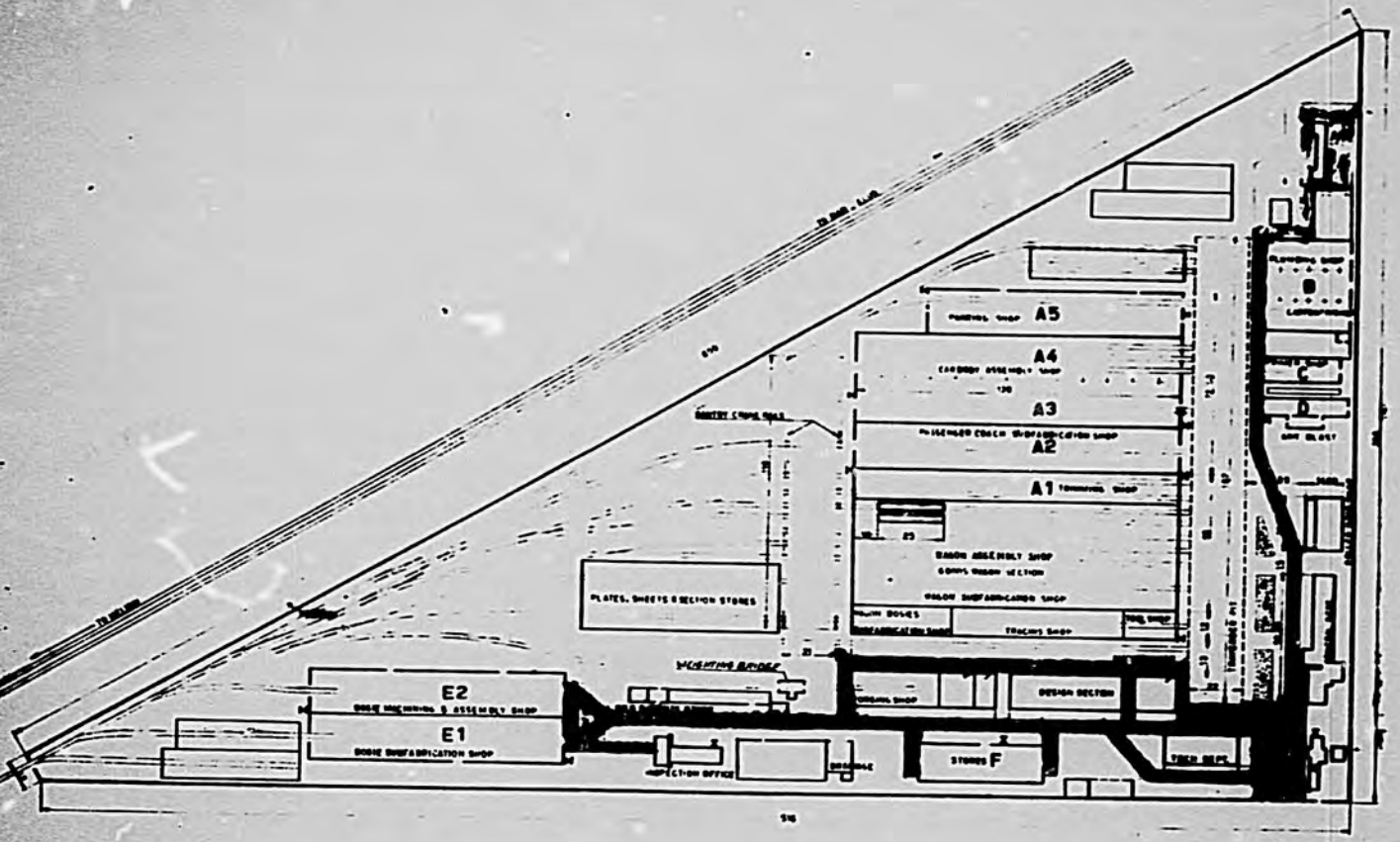
service. The basic Ramleh service is now provided by 22 three-car surface metro sets acquired from Mitsubishi of Japan. The mechanical portions of these cars were made by Kinki Sharyo and the electrical by Toshiba Electric. They entered service in 1975 and 1976 and are similar in design to the Heliopolis cars. Of these, 19 sets are currently in service. The balance of service on the Ramleh lines is maintained with seventy year old cars of both single and double deck design. These are formed into three car trains. Some of these cars are equipped with PCC motors and bogies. There are 45 such cars in service.

The Ramleh lines are the heaviest in Alexandria, with peak traffic reaching 15,000 passengers. These services carry about 150 million passengers annually, compared with 100 million on the town tram lines. Most of the line through the center of the city is affected by road traffic at the frequent grade crossings. There is a long range plan to place a major segment of the line underground.

Not too long ago, APTA planned to form 45 three-car sets of PCC cars. Since that time, the 22 Mitsubishi sets were acquired and only now is the first PCC set being readied for service. This set will have operating controls at each end requiring that doors be installed on both sides of each car.

APPENDIX B

SEMAF PLANT LAYOUT AND EQUIPMENT



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SEMAF

GENERAL LAYOUT

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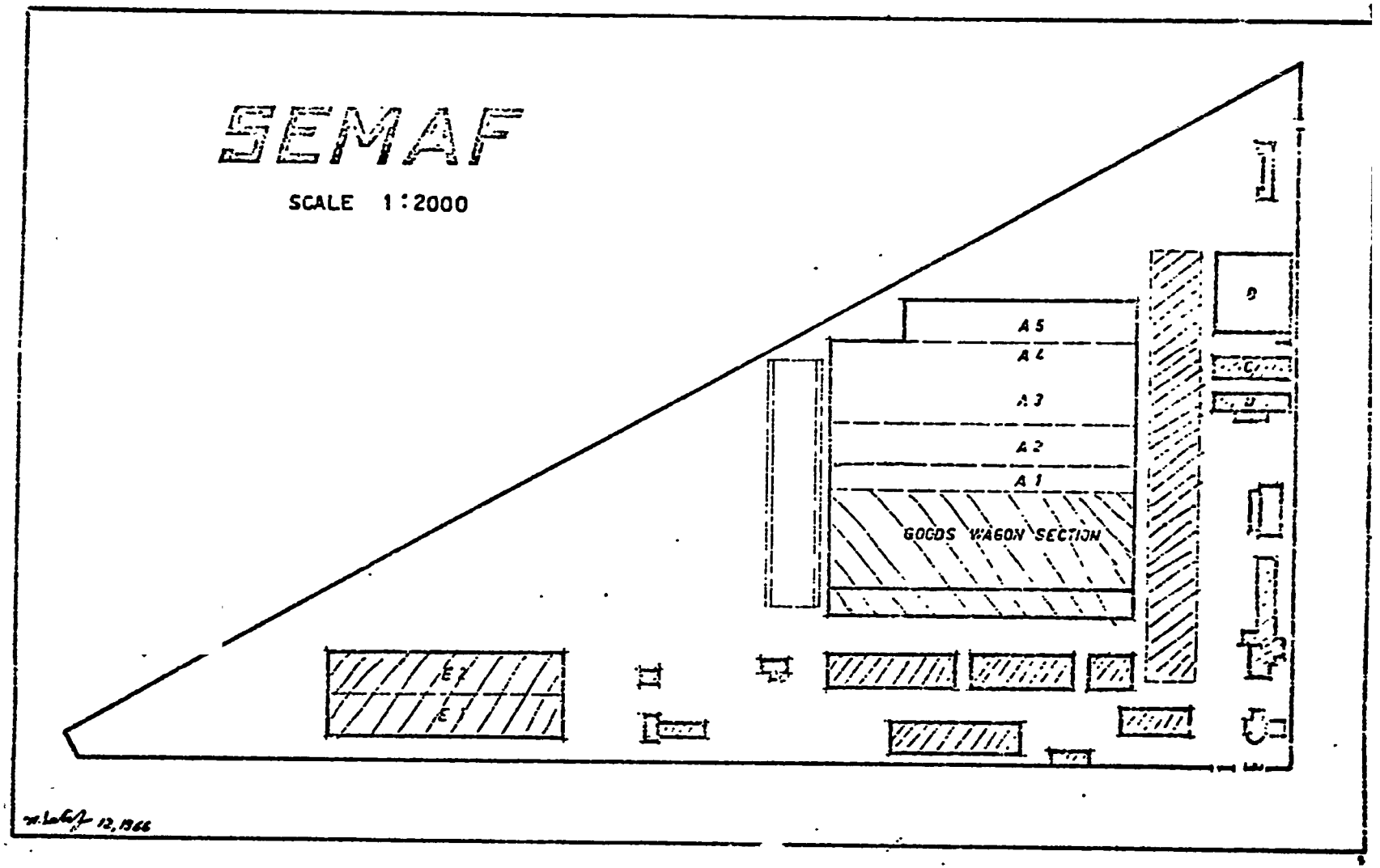
Removed on 1975



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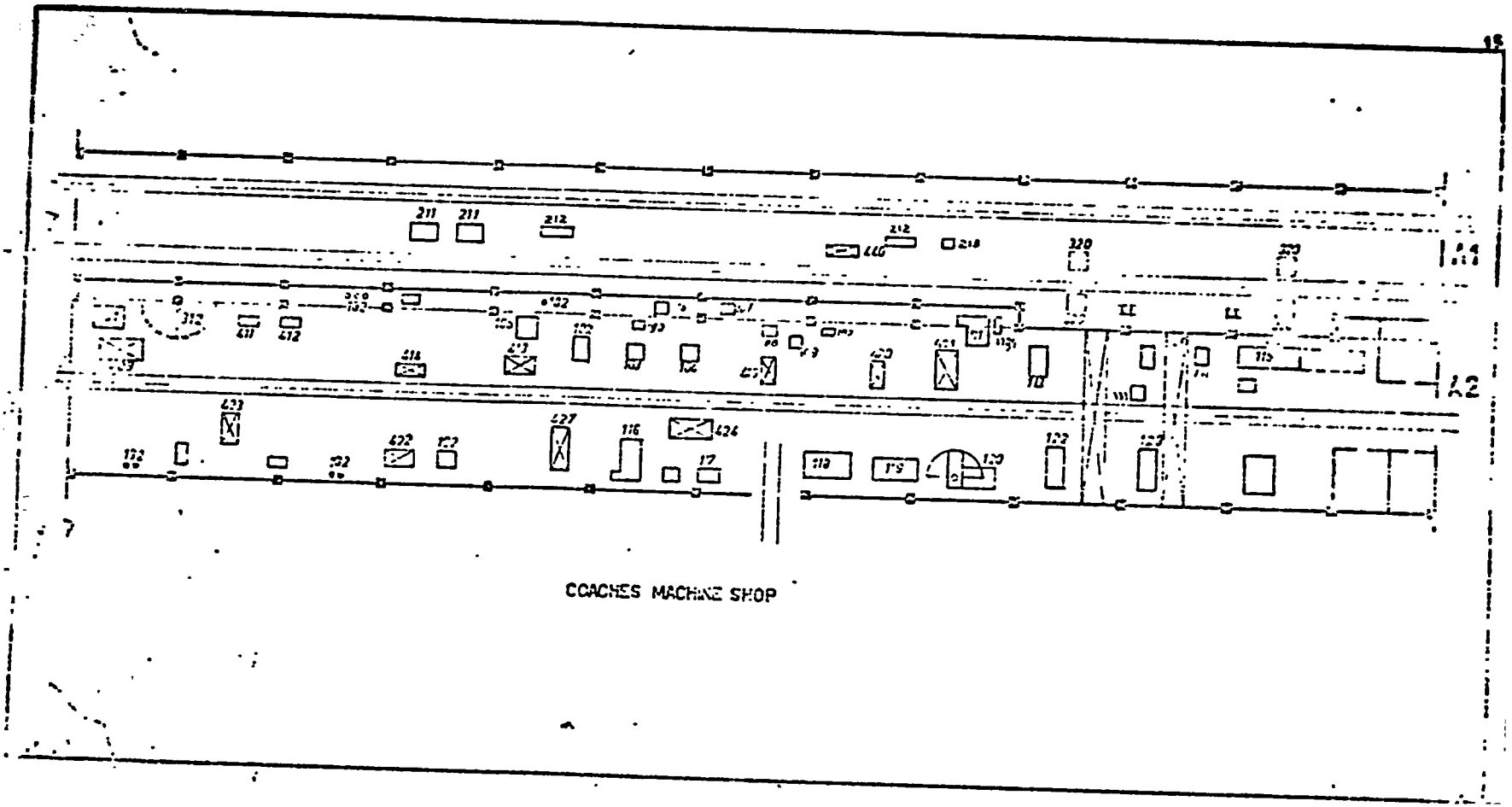

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MACHINES OF COACHES FINISHING SHOP A1

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
211		CIRCULAR SAW FORWOOD	2		891.995		
212		HAND_ FED PLANER	2		327.582		
213		BENCH DRILL	1		352.982		
320		SCREW JACK	4		5561.094		
440		SURFACE BLOCK	1		816.996		211

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MACHINES OF COACHES FABRICATING SHOP A2

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
101		310 KVA STATIONARY SPOT WELDER	1		2100.890		
102		FRICTION PRESS (250 TONS)	1		11503.573		
103		FRICTION PRESS (50 TONS)	1	5 KW	3713.701		
104		FRICTION PRESS (50 TONS)	1	5 K.W.	3713.700		
105		HEATING FURNACE	1		1586.923		
106		HEATING FURNACE	1		1586.923		
107		HEATING FURNACE	1		1586.924		
108		FRICTION PRESS (30 TONS)	1	3 K.W.	3088.584		
109		UPRIGHT DRILLING MACHINE	1	2.2 K.W.	1182.626		
110		UPRIGHT DRILLING MACHINE	1	2.2 KW	1182.626		
111		NIBBLING MACHINE	1	2.2 KW	1875.567		
113		ROLL LEVELER	1				
114		SHORT SHEAR	1		4732.966		
115		AUTOMATIC GAS CUTTER (OXY TOME)	1		760.102		
116		BENDING ROLLER	1	13.5 KW	11587.780		

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MACHINES OF COACHES FABRICATING SHOP A 2

MACHINE No.		DESIGNATION	No. OFF	POWER	COST E.L		REMARKS
117		FRICTION PRESS (100 TONS)	1	5.5 K.W.	5536.791		
118		BRAKE PRESS (200 TONS)	1	15 K.W.	9170.005		
119		BRAKE PRESS (100 TONS)	1	8.5 K.W	9224.020		
120		RADIAL DRILLING MACHINE	1	925 K.W.	5240.927		
122		GAP SHEAR	1	3 K.W	3524.829		
123		GAP SHEAR	1	7.5 K.W	5020.686		
409		SURFACE BLOCK	1		3120.927		4 M x 3 M
411		SURFACE BLOCK	1		816.997		2 M x 1 M
412		SURFACE BLOCK	1		816.997		2 M x 1 M
414		SURFACE BLOCK	1		1291.876		3 M x 1.5 M
415		SURFACE BLOCK	1		1291.876		4 M x 2 M
419		SURFACE BLOCK	1		800.657		2 M x 1 M
420		SURFACE BLOCK	1		310.459		2 M x 1 M
421		SURFACE BLOCK	1		3120.927		4 M x 2 M
423		SURFACE BLOCK	1		1291.876		3 M x 1.5 M

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MACHINES OF COACHES FABRICATING SHOP A2

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
426		SURFACE BLOCK	1		1291.876		3M x1.5 M
427		SURFACE PLATE	1		1339.875		4 M x1.5 M
428		SURFACE BLOCK	1		3120.927		4M x2M
132		CIRCULAR METAL SAW	1	5 KW	3270.979		CAP 200 ϕ
305		5-TON OVERHEAD CRANE	1	22 KW	5488.973		
306		5-TON OVERHEAD CRANE	1	22 KW.	1652.348		
312		1-TON WALL HOIST	1	2.2 KW	1012.164		
182		300 A, AC. ARC WELDER	6	13 KW	1713.344		8 SETS
190		BENCH GRINDER	3	0.7 KW	267.339		
110-1		BAND SAWING MACHINE	1	1.5 HP	860.111		
133		HIGH SPEED CUTTER	1		747.500		
		AUTOMATIC GAS CUTTER (BYROTOME)	1		2[illegible]2.647		

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MACHINES OF COACHES FABRICATING SHOP A 2

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E L		REMARKS
		GAP SHEAR	1		5207.150		
		COMBINED SHEAR	1		1456.808		
		MECHNICAL PRES	1		1165.552		
		WALL DRILL	1		5784.169		
		MULTIPLE SPINDLE DRILL	1		4080.453		
		SMITH HEARTH	1		53.624		
		WELDING GENERATOR	1		00.00		

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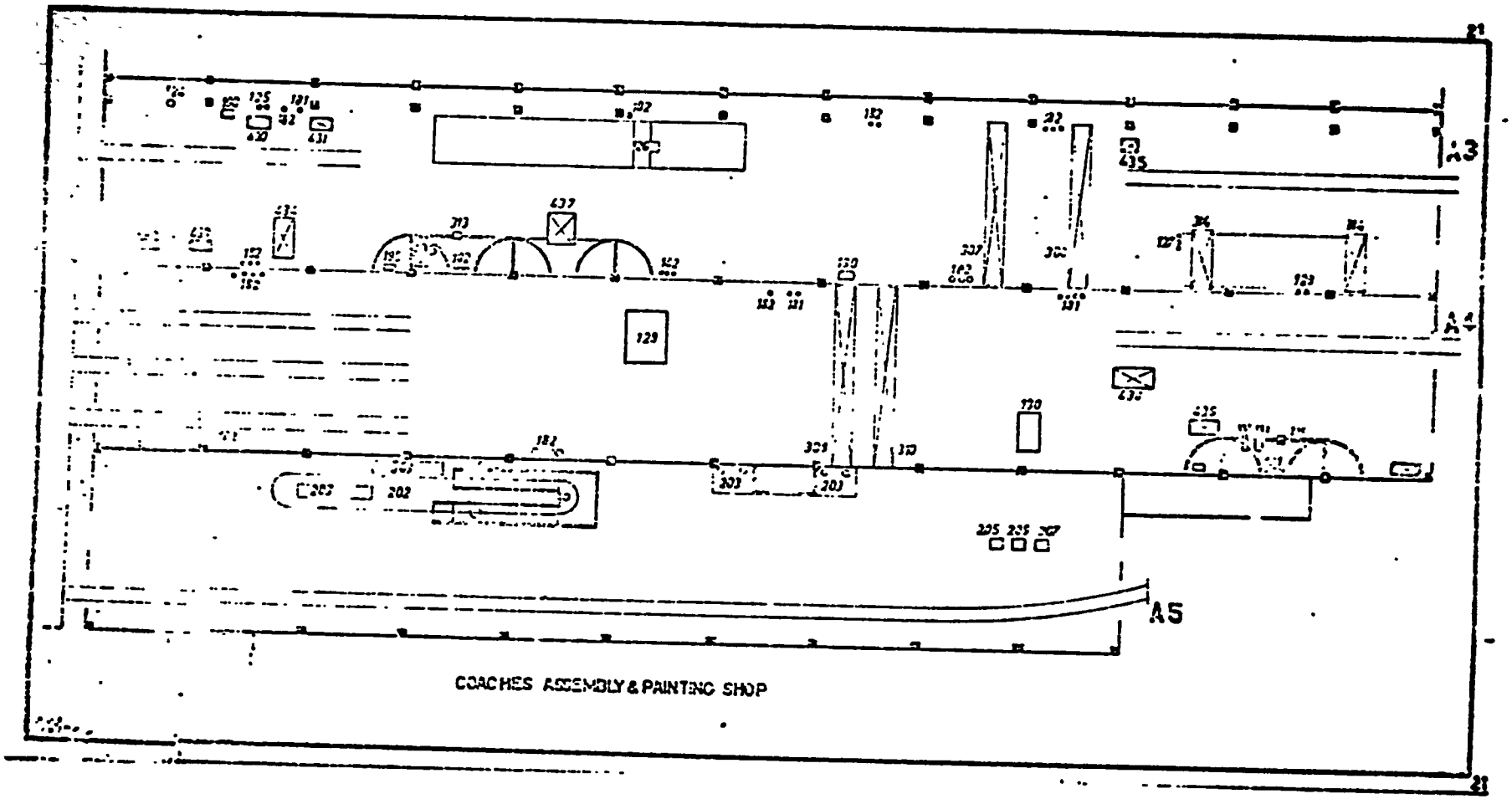

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MACHINES OF COACHES ASSEMBLING SHOP A3

MACHINE No.		DESIGNATION	No. OFF	POWER	COST E.L		REMARKS
124		STUD WELDER	1		1457.071		
125		300 A. HELI ARC. WELDER	2		896.216		
126		UNIONMELT WELDING EQUIPMENT	1	40 KW	3474.024		
127		400 KVA PORTABLE SPOT WELDER	3	144 KVA	7945.649		
128		200 A. D.C. ARC. WELDER	2	104 KVA	378.835		
430		SURFACE BLOCK	1		816.997		2 M x 1 M
431		SURFACE BLOCK	1		816.997		2M x 1 M
429		SURFACE BLOCK	1		816.996		2 M x 1M
433		SURFACE BLOCK	1		816.997		2 M x 1 M
434		SURFACE BLOCK	1		3120.927		4 M x 2M
437		SURFACE BLOCK	1		1470.594		3 M x 3 M
307		5-TON OVERHEAD CRANE	1	20 KW	9619.238		
308		5-TON OVERHEAD CRANE	1	20 KW	5543.688		
313		1-TON WALL HOIST CRANE	1	2.2 KW	1892.399		
314		2-TON "SEMI GANT" CRANE	2	5 KW	6250.463		

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MACHINES OF COACHES ASSEMBLING SHOP A 3

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
182		300 A. AC.ARC WELDER	19	23 K.V.A.	4069.193		
190		BENCH GRINDER	3	0.7 KW	53.188		
181		500 A. AC. ARC WELDER	1	23 K.V.A	287.969		
		SURFACE BLOCK	2		150.328		0,80 x 0,80

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MACHINES OF COACHES ASSEMBLING SHOP A4

MACHINE Nº.		DESIGNATION	Nº. OFF	POWER	COST E.L		REMARKS
129		OUTER SHEATHING PLATE STRAIGHTENING EQUIP	1	5 KW.	00.00		CAP.4.5 M x 4.5 M
130		RADIAL DRILLING MACHINE (GIRDER TYPE)	1	5 KW.	5087.537		RAIL SPAN 4.3
131		1-TON POSITIONER	1	4 KW.	1590.280		CAP 0.21 M x 0.21 M
438		SURFACE BLOCK	1		3120.928		4 M x 2 M
436		SURFACE BLOCK	1		150.327		3 M x 1.5 M
309		25/5 TON OVERHEAD CRANE	1	70 KW.	17972.114		
310		25/5 TON OVERHEAD CRANE	1	70 KW.	17972.114		
315		1- TON WALL HOIST	1	1 KW.	1012.165		
181		500-A. AC. ARC. WELDER	9	42 K.V.A	2591.717		
182		300 A. AC. ARC. WELDER	11	43 KW	2355.859		
190		BENCH GRINDER	1	0.7 KW.	53.189		

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MACHINES OF COACHES PAINTING SHOP A5

MACHINE Nº		DESGINATION	Nº OFF	POWER	COST E.L		REMARKS
201		POLISHER	2	2 KW	~~0.0.0.0~~		
202		TROLLEY CONVEYER CHAIN	1		1783 5.3 1 8		
203		PAINT SPRAY BOOTH	4		9 0 3 7.1 9 6		
204		PICKLING EQUIPMENT	1		0 0.0 0		
205		EDGE RUNNER MIXER	1	4 KW.	7 7 2.0 6 1		
206		PUTTY MIXING ROLLER	1	4 KW	1 1 1 2.3 7 0		
207		PAINT MIXER	1	4 KW	5 2 4.2 2 9		

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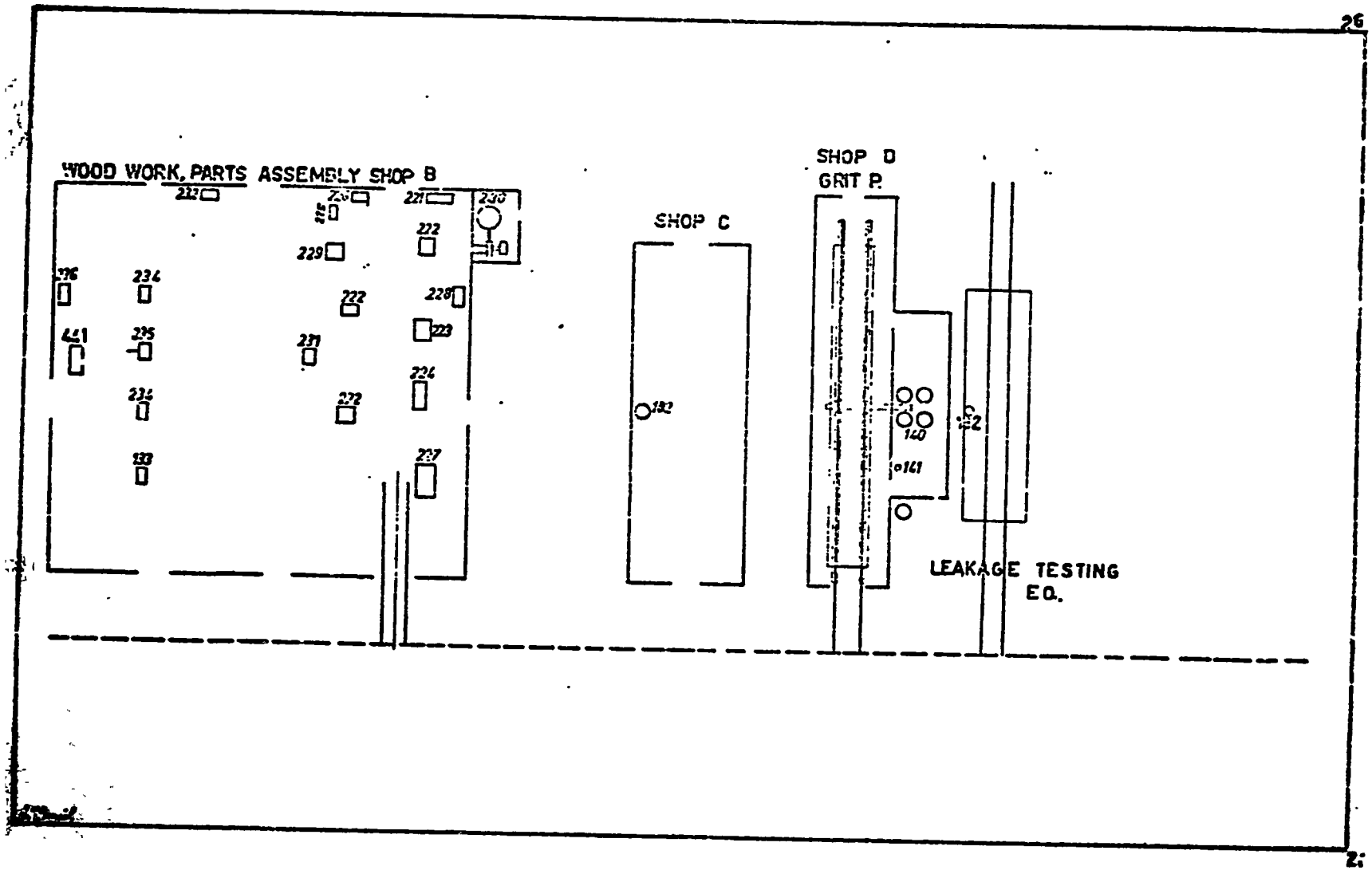

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WOOD WORK & PARTS ASSEM. SHOP B

MACHINE Nº.		DESIGNATION	Nº. OFF	POWER	COST E.L		REMARKS
221		BELT SANDING MACHINE	1	4 K.W.	468.264		
222		CIRCULAR SAW FOR WOOD WORK	3	4 K.W.	1,337.954		
223		SINGLE SURFACE PLANER	1	5 K.W.	737.053		0.6 M
224		SURFACE PLANER FOR WOOD WORK	1	1.5 K.W.	505.311		0.3 M
225		AUTOMATIC PLANER PLADE GRINDER	1	0.75 K.W.	522.751		
226		AUTOMATIC BAND SAW SHARPENER	1	1 K.W.	522.251		
227		BAND SAW FOR WOOD WORK	1	4 K.W.	417.626		
228		SPINDEL SHAPER FOR WOOD WORK	1	4 K.W.	669.775		
229		HOLLOW CHISEL MORTISING MACHING	1	1.15 K.W.	360.207		
230		SAW-DUST COLLECTOR	1	15 K.W.	4,367.074		
231		BENCH DRILL	1	5 K.W.	356.983		
234		PIPE THREAD CUTTER	2	2.2 K.W.	2,936.649		
232		BENCH DRILL C.	1	5 K.W.	212.328		
236		BENCH DRILL	1	5 K.W.	358.983		
233		HIGH-SPEED CUTTER	1	7.5 K.W.	298.226		

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WOOD WORK & PARTS ASSEMBLY SHOP B

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST £.L		REMARKS
441		SURFACE BLOCK	1		3,120.928		4 M x 2 M
235		PIPECOLD BENDING MACHINE	1		2897.091		

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GRIT BLAST & FINISH INSPECTION BOOTH SHOP C & D

MACHINE No		DESIGNATION	No OFF	POWER			REMARKS
182		300 A A.C. ARC WELDER SHOP - C -	1	23 KVA	214.169		
140		GRIT BLAST EQUIPMENT	1		29166.099		
141		(METALLICON) SPRAY MACHINE	1		1415.061		
1009		2-TON OVERHEAD CRANE	1		2238.871		
		CENTER PLATE FOR TURNING WHEEL & AXLES	2		130.737		
182		300 A A.C. ARC WELDER - LEAKAGE TEST	1	23 KVA	214.168		

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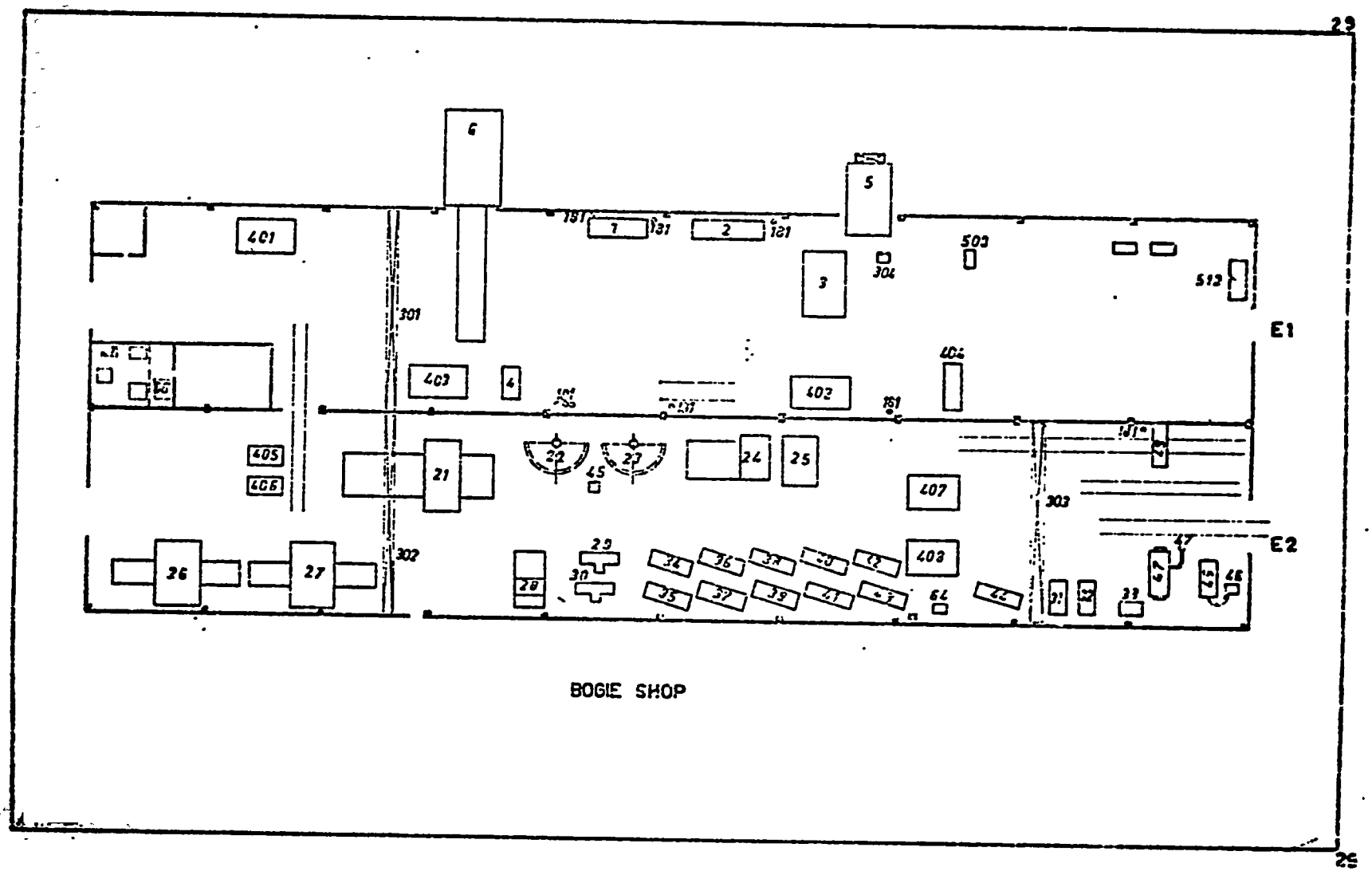

BOGIE SHOP

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MACHINES OF BOGIE SHOP E.1

MACHINE NO		DESIGNATION	No. OFF	POWER	COST E.L		REMARKS
1		1-TON BALANCING POSITIONER	1		419.433		
2		UNIONMELT WELDER	1	60 kw	3217.112		
3		500-TON HYDRAULIC PRESS	1	60 KW	37666.710		5M x 2.5M
4		8-TON WELDING POSITIONER	1	4 KW	5537.787		TABLE 1.5M x 1.5M
5		HEATING FURNACE	1	15 kw	12399.806		2M = 1M x 4.7 M
6		OIL-FIRED ANNEALING FURNACE	1	20 kw	9070.771		3M x 1.5M x 7M
304		½ TON WALL HOIST CRANE	1		527.565		
		AUTOMATIC GAS CUTTER OXYTME	2		7854.27		2 SETS
121		500 A.A.C ARC WELDER	8	42 K.V.A	2303.752		8 SETS
301		5-TON OVERHEAD CRANE	1	20KW	1652.347		
61		TUNGSTEN CARBIDE TOOL GRINDER	1	3 KW	368.914		
52		UNIVERSAL TOOL GRINDER	1	25 KW	1037.373		
03		FACE-CUTTER GRINDER	1	25KW	3450.43		

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MACHINES OF BOGIE SHOP E.1

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST £ L		REMARKS
65		TWIN-HEAD TOOL GRINDER	1	3 KW	434.262		
66		DRILL GRINDER	1	3 KW	602.643		
401		SURFACE PLATE	1		3431.386		5M x 3M
402		SURFACE BLOCK	1		217.321		
403		SURFACE PLATE	1		3431.386		5M x 3M
404		SURFACE PLATE	1		3737.822		5M x 3M
508		HYDRAULIC RIVETING PRESS	1		2324.061		
512		PNUM.GAS CUTTER PYROTOME	2		405.295		
			/				

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MACHINES OF BOGIE SHOP E2

MACHINE No.		DESIGNATION	No. OFF	POWER	COST E.L		REMARKS
405		SURFACE PLATE	1		3431.386		4.5 M x 3 M
406		SURFACE PLATE	1		1470.594		3M x 1.5 M
407		SURFACE PLATE	1		3431.386		4.5 M x 3 M
408		SURFACE PLATE	1		1470.594		3 M x 1.5 M
21		DOUBLE COLUMN 4.HEADS PLANOMILLER	1	70 KW.	76231.081		TABLE 5M x 2.2M
22		2.5M RADIAL DRILLING MACHINE	1	10 KW.	3196.399		70Φ
23		1.6M RADIAL DRILLING MACHINE	1	10 KW.	3196.399		70Φ
24		HORIZONTAL DRILLING MACHINE	1	6 KW.	6583.200		80Φ
25		SLOTTER	1	21 KW.	15036.064		MAX STROK 0.6 M
26		DOUBLE COLUMN PLANER	1	58 KW.	21711.215		TABLE 4.5M x 1.25M
27		OPENSIDE PLANER	1	65 KW.	26531.934		TABLE 5.3M x 1.5M
28		PLANER TYBE BORING MACHINE	1	15 KW.	28034.661		TABLE 3M x 1.4M
29		HORIZONTAL DRILLING MACHINE	1	12.8 KW	2798.593		1.55M x 0.355M
30		VERTICAL MILLING MACHINE	1	12.8 KW	2612.807		1.55M x 0.350M
31		SHABER	1	3.7 KW	1699.299		MAX STROKE 0.63

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MACHINES OF BOGIE SHOP E.2

MACHINE Nº		DESIGNATION	Nº. OFF	POWER	COST E.L		REMARKS
32		SHAPER	1	3.7 KW.	1699.299		MAX STROCK 0.63M
33		CENTERLESS GRINDING MACHINE	1	13.5 KW.	5373.605		1.5φ–90φ
34		6' LATHE	1	11.12 KW.	2370.191		0.575 M x 1M M
35		6' LATHE	1	11.12 KW.	2370..191		~ ~
36		6' LATHE	1	11.12 KW.	2370.191		~ ~
37		6' LATHE	1	11.12 KW.	2370.191		~ ~
38		6' LATHE	1	11.12 KW.	2370.191		~ ~
39		6' LATHE	1	11.12 KW.	2370.190		0.575 M x 1 M
40		6' LATHE	1	11.12 KW.	2370.190		0.575M x 1.5M
41		8' LATHE	1	11.12 KW.	2370.190		0.575Mx 1.5 M
42		TURRET LATHE (CHUCK MACHINE)	1	12.42 KW.	3808.530		CHUCK CAP 0.23
43		TURRET LATHE (CHUCK MACHINE)	1	12.42 KW.	3808.530		~ ~
44		TURRET LATHE (BAR MACHINE)	1	8 KW.	3895.363		~ ~
45		UPRIGHT DRILLING MACHINE	1	2.2 KW.	1056.203		50φ
46		50KW HIGH FREQUENCY WAVE INDUCTION HEATER	1	30 KW.	6693.604		

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MACHINES OF BOGIE SHOP E.2

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
47		BOX TYPE ELECTRIC FURNACE	1	25 KW	1 7 2 2,7 5 1		0.4Mx0.3Mx07M
49		SPRING PRESS-IN MACHINE	1	15 KW	1 2 0 9,1 3 6		
		BENCH GRINDER	1		1 7 0.4 9 7		
64		COLUMN GRINDER	1	3 KW	1 5 9,1 5 6		
121		500 A.C ARC WELDER	1	42 KV-W	2 3 7.9 5 9		
302		7.5 TON OVERHEAD CRANE	1	25 KW	4 5 1 6.4 6 3		
303		15/5 TON OVERHEAD CRANE	1	35 KW	15 2 8 0.8 5 7		

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MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
		AIR COMPRESSOR	2	136 H.P.	9924.187		
		AIR COMPRESSOR	1	136 H.P	4601.058		
		400 K.V.A TRANSFORMER	2				
		100 K.V.A. TRANSFORMER	1		10001 3.660		
		MOVABLE TRAVERSER	1		22353.607		
1008		2-TON OVERHEAD CRANE	1		2953.375		
513		DRAWINGS PRINTING MACHINE	1		750.000		
		WEIGHT BALANCE	1		2152.648		
		SEWAGE	1		315.000		
		GANTRY CRANE	1	17.5 K.W	19742.563		
		X-RAY TESTER	1		2664.644		
		STRAIN MEASURING APPARATUS	1		757.500		

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INTERNAL TRANSPORTATION EQUIPMENTS

MACHINE Nº		DESIGNATION	Nº OFF	POWER	COST E.L		REMARKS
		FORK LIFT TRUCK 1 TON	2		3027.490		
		FORK LIFT TRUCK 2 TON	1		2511.125		
		FORK LIFT TRUCK 3 TON	1		3586.396		
		10 TON DIESEL SHUNTING LOCOMOTIVE	1		9000.000		
		LIGHT DUTY FLAT CAR WITH CENTER LATHE	30		17242.183		
		LOCO PULSOR	1		619.861		
		RAIL-O-ROAD KRANE KAR	1		9209.030		
		FORK LIFT	1		1572.713		
		MOBILE CRANE	1		7065.900		
		MOBILE CRANE	1		10000.000		
		10 TON FLAT WAGON	1		950.655		
		10 TON FLAT WAGON (SCRAP)	2		364.110		
		TABLE CARRIAGE	4		202.941		

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APPENDIX C

EXAMPLES OF BILL OF MATERIAL

60 Cars 3rd. class passenger Coach

Parts to be manufacured in the local market

rubber parts

	VE.1048	Rebound spring	As Drawing	rubber local	4	245		82		item 44 (VA 1088)
1:2	VD.1184	Buffer	–	~ & m22 ~	36 set	2203 set		736		~ 7 (——)
1:2	VD.877	–	–	—~— ~	12 ~	734 ~		244		~ 12 (——)
1:2	VD.1183	Draw	–	—~— ~	6 ~	367 ~		122		~ 8 (VB 1025)
1:3	VC.3026/1	Bolster rubber spring	–	—~— ~	8	490		163		
1:8	VC.3009	Side bearing rubber sp.	–	rubber & m22 & m3 –	4 set	245 set		82		
1:2	VD3001	Axle box rubber spring	–	—~—	16 ~	979		326		
1/4	VC.1125/1	Rubber moulding sliding door for end	–	natural Rubber	4	245		82		greyish blue Colour
1/8	——	Rubber moulding for partition		—~— ~	1	61		20		~ ~ ~
2/4	——	Rubber moulding for sliding door for end		—~— ~	4	245		82		~ ~
2/8	——	moulding for partition		—~— ~	1	61		20		~ ~
[illegible]	——	Rubber moulding for window and door sash		—~— ~	52	3182		1021		~ ~
[illegible]	——	moulding for sliding door of end		—~— ~	2	122		40		~ ~
[illegible]	——	~ ~ ~		—~— ~	2	122		40		~ ~
4	——	moulding for end		latex Rubber ~	4	245		82		Black Colour
2	VE 1187	Door stop rubber for lavatory		natural Rubber	RH 2 LH 2	122 122				Greyish blue colour
2	——	Door stop rubber for partition		—~— ~	RH 1 LH 1	61 61		20 lb.		~ ~

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60 Cars 3rd. class passnoger coach

				Brass bars							
Brass Bars	50 mm⁺	4.5 mt.		BSBM local		570 kg.		19		1	Kil
	38 mm⁺	4.5 mt.		—~— ~		360 ~		120		1	~
	32 mm⁺	4.5 mt.		—~— ~		280 ~		73		1	~
	30 mm⁺	—		—~— ~		10 mt.		2		1	~
	20 mm⁺	6.0 mt.		BSW2 ~		8 kg.		1		1	~
	12 mm⁺	6.0 mt.		—~— ~		53 ~		18		1	~
	11 mm⁺	6.0 mt.		—~— ~		38 ~		13		1	~
	14 mm⁺	—		—~— ~		11 mt.		4		1	~
				Brass. Sheets							
Brass sheets	2000x1000x 1mth.			BSW2 local		2		1		1	kil
	700 x 1400 x 3mth.			—~— ~		25		8		1	~
	2000 x 1000 x 4mth.			—~— ~		5		2		1	~
				Copper pipes							
Copper pipes	inside dia 10mm 6mth length			cup local		63		21		1	kilo
				Copper flat. bar							
Copper flat bar	20 x 4 mm	6.0 mt.		CU local		4		1		1	kilo
				BSW2 local		8		3		1	~
Teak wood				teak wood		30 mt.³					

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APPENDIX D

CIVIL WORKS COST ESTIMATES

CIVIL WORKS COST ESTIMATES

Cost estimates for civil works are predicated on the assumptions and specifications which follow. They are in the major categories of:

- Grading
- Asphalt Paving
- Concrete Curbs
- Concrete Sidewalk
- Fencing
- Trackwork
- Site Preparation
- Project Execution

GRADING

1. <u>Excavation</u>. The contractor shall remove all rock, earth and other material required by the plans and as ordered by the Engineer. He shall dispose of this material as required by the various items of this Specification or otherwise dispose of the material in spoil areas.

The contractor shall conduct all excavation in a safe and prudent manner. All damages caused by the Contractor's operations shall be repaired by the Contractor at his own expense and to the satisfaction of the Engineer.

Unsuitable material shall be excavated within the grading limits and to the depths ordered. The entire area including ditches, slopes, railroad turn out, road and railroad stations, shall be graded to the required lines and elevations and within the tolerances specified under the various items of work. The preparation of the embankment foundations and the placing and impacting of the excavated materials shall be included in the work to be done.

Grading operations shall not be started until the Engineer is satisfied that sufficient equipment is available to perform the work properly.

All suitable materials from the excavation shall be placed in the embankment and at such other places as called for on the plans. Unsuitable material shall be disposed of, on the site, as directed by the Engineer.

Any surplus suitable material shall be used for flattening the embankment slopes or shall be deposited in spoil areas as directed by the Engineer. All spoil areas shall be left in a neat and satisfactory condition.

Embankment. Embankments shall be formed of suitable materials. The manner in which the materials are placed, the type, weight and condition of the equipment, including rollers, shall provide an embankment uniformly compacted to the required densities, herein specified.

Any portion of an embankment or subgrade which has, in the opinion of the Engineer, been damaged by the Contractor's equipment in progressing his construction operations, shall be repaired and recompacted by the Contractor to the satisfaction of the Engineer, and no extra payment will be made therefor.

The maximum density is defined as the maximum dry weight density in pounds per cubic foot as determined by the A.A.S.H.O. Designation: T-99 Method C.

A thoroughly and satisfactorily compacted earth embankment is defined as having a minimum dry density of 90 percent of the Maximum Density. However, where the enbankment material consists of sand, or sand and gravel mixtures, a minimum dry density of 95 per cent of the Maximum Density will be required. The in-place density shall be determined by the sand cone method in accordance with ASTM Designation D1556.

Where the embankment material contains less than one third, by volume, of stones or rocks larger than 6 inches in greatest dimension, it shall be placed in successive uniform layers not exceeding 8 inches in thickness, loose measure, over the entire area of the embankment. Each layer shall be thoroughly rolled over its entire area as described under "Compaction".

Subgrade Areas. The subgrade areas shall mean a cross-sectional area with top dimension equal to the width of pavement, railroad trackage and building areas plus 1 foot on each side thereof, and with sides sloping downward and outward on a 1 on 1 slope to a depth of 4 feet below the outer edges. This depth of 4 feet need not apply in areas of cuts or shallow fills where in the opinion of the Engineer, the existing material is satisfactory. After compaction the top surface of the subgrade shall not extend above true grade and surface at any location.

The Contractor shall conduct the excavation operation so that available and suitable material shall be utilized in the subgrade area.

Where soils are suitable, the subgrade subbase course in cuts shall be rolled to obtain the required densities to a depth of 8 inches.

Compaction. Equipment, suitable and adequate for uniform compaction to the specified densities, must be on hand and approved by the Engineer before any embankment or backfill operations are started by the Contractor. All compaction equipment must be in good working order and any worn or defective equipment shall be immediately replaced or repaired to the satisfaction of the Engineer. Sheep's foot rollers shall exert a pressure of not less than 300 pounds per square inch of foot area. Pneumatic tired rollers shall have an operating weight of not less than 1000 lbs. per tire.

Smooth steel wheel rollers shall have a minimum weight of 10 tons and shall exert a pressure of not less than 300 pounds per lineal inch of compression wheel or roll width. Earth moving and other equipment not specifically manufactured for compaction purposes will not be considered as compaction equipment. The use of sheep's foot rollers with tamping feet worn to less than 7 inches in length and less than 5 square inches of flat end surface will not be permitted.

All fill material shall be compacted at a moisture content determined by the Engineer to be suitable for obtaining the required density. In no case, shall the moisture content be less than 3 per cent drier than the Optimum Moisture Content determined by the A.A.S.H.O. Designation: T-99 Method C.

When the moisture content of the material in the layer is less than the required amount, water shall be added by pressure distributors or other equipment. The water shall be uniformly and thoroughly incorporated into the soil by disking, harrowing, blading or by other approved means. The manipulation may be omitted for coarse sand and gravel soils.

When the moisture content of the layer is within the limits, as determined by the engineer, for proper compaction, the entire surface shall be rolled with the appropriate type of roller or compactor until the specified density has been obtained. In no cases, shall the number of passes of the roller over each portion of the fill area be less than the minimum number specified.

A pass of a piece of compaction equipment over any area is defined as a direct vertical contact of the compactor wheel, tire, drum or plate load upon all elements of that area in such a manner as to assure complete coverage of the area. No successive layers shall be placed until the layer under

construction has been brought to the required density and has been approved by the Engineer.

The minimum number of passes required for each layer shall vary in accordance with the following descriptions:

1. A minimum of 6 passes will be required for each successive layer for sheep's foot rollers of the type exerting between 300 and 450 pounds of foot pressure per square inch; pneumatic tired rollers having operating weights between 1000 and 2500 pounds per tire; and smooth steel rollers with a minimum weight of 10 tons.

2. For heavier, vibratory or more efficient types of approved compaction equipment, the minimum number of passes required on all portions of each successive layer shall be determined by the Engineer. However, layer thicknesses shall not, under any circumstances exceed those specified under "Enbankment".

Compaction equipment shall not operate at speeds exceeding 6 kilometers per hour. In no case shall the rate of application of fill or backfill exceed the capacity of the compaction equipment based on the actual operating speed of that equipment, all as determined by the Engineer.

In areas inaccessible to the equipment designated in the foregoing, other types of compaction equipment shall be used, as approved by the Engineer. Where the impact rammer type is used, such rammer shall weigh not less than 200 pounds, have a rammer foot area not exceeding 80 square inches and be capable of delivering not less than 200 foot pounds of compacting energy per blow. Where plate vibratory compactors are used, such compactors shall be capable of delivering blows of a minimum of 2500 pounds impact at a rate of not less than 1100 per minute. A minimum number of 3 passes will be required for either rammer or vibrator equipment. For other types of compaction equipment used in areas of limited space, the minimum number of passes required on all portions of each successive layer shall be determined by the Engineer after appropriate field tests to evaluate the efficiency of the equipment.

ASPHALT PAVEMENT

1. Prepare Fine Grade. The contractor shall prepare the fine grade to receive the pavement in conformity with the lines and grades as shown on the plans.

Before any base material is placed upon the fine grade, it shall be shaped to line and grade and compacted with an approved self-propelled roller weighing not less than 10 tons. All hollows and depressions which develop under rolling shall be filled with acceptable granular material and shall again be rolled. This process of shaping, rolling and filling shall be repeated until no depressions develop. After compaction, the top surface of the fine grade shall not extend above nor more than 15 mm below true grade and surface at any location. If the fine grade becomes rutted or displaced due to any cause whatsoever the Contractor shall regrade same.

2. Macadam Base Course. The Contractor shall furnish and place stone or gravel conforming to the requirements in the following paragraph upon the properly prepared fine grade. This stone or gravel shall be of sizes specified below.

All stone and or gravel shall be crushed with 75 percent broken faces. Of the particles retained on the 1/2" sieve, not more than 10% by weight shall consist of flat or elongated

pieces. A flat or elongated piece is defined herein as one the greatest dimension of which is more than 3 times the least dimension.

After the subgrade has been properly prepared a course of broken stone or gravel shall be spread evenly so that it will have after rolling the required thickness. Stone and gravel shall be a uniform mixture of 1½ and 2 inch sizes. The stone or gravel shall be spread, rolled and filled in two separate layers for a total of 25 cm.

The spreading of any layer or course of broken stone or gravel, shall be done with approved spreader equipment. No segregation of large or fine particles will be allowed but the stone or gravel as spread shall be well graded with no pockets of fine material.

After the base course of stone or gravel has been laid loose it shall be thoroughly rolled with an approved roller weighing not less than 10 tons.

This rolling must begin at the sides and continue toward the center and shall continue until there is no movement of the course ahead of the roller. After the course is thoroughly compacted No. 80 sieve stone, screenings or sand, or a mixture of these, shall be uniformly spread upon the surface and swept in by means of a drag broom or by hand brooming and rolled dry. The process of filling and brooming

After compaction, the top surface shall not extend above the theoretical elevation and when tested with a straight edge 5 meters in length any depressions over 6 mm, below the theoreti grade line, shall be eliminated.

After the completion of the rolling, no hauling other than that necessary for bringing material for the next course will be allowed over the rolled material. It is the intention to bind this course with small stone or sand, but no surplus of filler will be allowed on the top course.

In lieu of the above method of rolling, the Contractor may, at his option, use vibratory compactors.

After the base course has been completed and cleaned of all loose and foreign material, the surface of the pavement shall be uniformly sprayed by means of an approved pressure distributor with R.C.1 at the rate of .25 gals per sq. yard. at a pressure between 20 and 50 pounds per square inch. The bituminous material shall be heated to between 200° F and 300° F.

<u>Bituminous Concrete Pavement</u>. The bituminous concrete shall meet the following:

Material passing 1/2" Screen	100%
Material passing 1/4" Screen	90 - 100%
Material passing 1/8" Screen	65 - 80%

Material passing No. 40	35 - 70%
Material passing No. 80	17 - 40%
Material passing No. 200	5 - 13%
Asphalt Cement	7.5 - 8.5%
Penetrational Asphalt	60 - 70%
Placing Temperature	275 - 350 F.

The contractor shall construct a pavement as shown on the plans on the prepared base course in conformity with the lines, grades and cross sections shown on the plans.

The thickness indicated for each of the various courses of bituminous pavement is the nominal thickness as is practical. The surface shall be tested with a 5 meter straight edge or string line. Variations exceeding 1 c.m. shall be satisfactorily eliminated.

The pavement shall be laid with a finishing machine of an approved type, which has an edging attachment to aid in securing a satisfactory joint between lanes. Such finishing machine shall be in charge of an experienced operator.

Mixtures shall be placed only where the surface to be covered is dry and clean. All defective areas in the base course shall be repaired, as directed, in advance of laying bituminous concrete.

The contact surfaces of all curbing, gutters, manholes and of adjacement pavement edges shall be painted or sealed with approved bituminous material before placing the course. Upon arrival, the mixture shall be dumped into the approved mechanical spreader and immediately spread and struck off to the full width required and to such appropriate loose depth that when the work is completed the compacted thickness of mixture in each square meter will be secured. The course shall be struck off by mechanical equipment. For use in striking off the course, the machine shall be equipped with easily adjustable strike-off plates.

Before any rolling is started, the finished surface struck off by the machine shall be checked any inequalities adjusted, and all fat spots or fat areas from any source shall be removed and replaced with satisfactory material.

Compaction. After placing and while still hot or workable, the course shall be initally rolled with a 10-ton ton three-whell power-driven roller or an 8-10 ton tandem roller. The rollers used for this rolling shall have steel wheels. During the inital rolling, the roller shall travel parallel to the center line of the pavement beginning at each edge and working toward the center, overlapping on successive trips by one-half the rear wheel of the roller.

Immediately following the above mentioned initial rolling, the bituminous course shall be compacted using [illegible]

Maximum Wheel Load	5600 lbs.
Tire compression	80 psi
Total maximum load on front or back axle	22,400 lbs.

The rubber tired rollers shall be self-proplelled and shall consist of two axles on which are mounted multiple pneumatic-tired wheels in such a manner that the group of wheels will not follow in the tracks of the forward groups and will be spaced to give essentially uniform coverage with each pass. The wheels shall be so mounted as to associate individually or in pairs. Rollers shall be equipped with tires of equal size and diameter which shall be uniformly inflated so that the air pressure of the several tires shall not vary more than five pounds per square inch.

Tires shall be smooth and show no tread pattern. The wheel loads and the pressure shall be controlled so as to produce the required degree of compaction without resulting rutting of the pavement surface. A minimum of 8 passes of the rubber-tired roller will be required.

The rollers shall operate at a speed satisfactory to the Engineer but not to exceed 3 miles per hour and the rolling shall proceed continuously.

Shallow ruts and ridges which may develop from pneumatic-tired rolling shall be smoothed with a steel wheel roller. The entire surface shall be finished with a steel-wheel roller after pneumatic compaction.

If depressions remain after rolling, more of the mixture shall be added at such points and firmly rolled into place. After rolling has been finished, the surface of the course shall have the required crown, density and thickness and be at the grade established for the surface.

CONCRETE CURB

1. Under this item, Concrete Curb, the contractor shall place curb of the type shown on the plans and where shown on said plans or ordered by the Engineer.

Concrete shall conform to a 1:2-1/4:4-1/2 mix with the longest aggregate passing a 3/4" sieve.

Curb shall be cast in place in sections approximately 6 meters long and provision made at each joint for expansion of 1 c.m.

All forms shall be set true to line and grade and held rigidly in position. They shall be so constructed that a smooth face will be provided.

Upon removal of the forms, the curb shall be immediately rubbed down to a smooth and uniform surface.

The Contractor shall protect the curb and keep it in alignment and first class condition until the completion of the contract.

CONCRETE SIDEWALK

1. Under this item the Contractor shall build sidewalks upon properly prepared subgrades as indicated on the plans or as ordered by the Engineer.

Concrete shall conform to a 1:2-1/4:4-1/2 mix with the largest aggregate passing a 3/4" sieve.

The concrete shall be worked and floated so as to produce a smooth uniform surface. The concrete shall be laid in one course.

Sidewalks shall be of the depth shown on the plans and have transverse construction joints to the full depth of the concrete spaced 6 to 8 meters apart and the edges of such joints finished with an edging tool of 1 cm. radius. The top surface shall be scored at intervals of 1 meter so that the finished walk will be marked in squares both longitudinally and transversely.

Premolded bituminous joint filler shall be placed between sidewalks and buildings.

FENCING

Under this item the Contractor shall furnish and erect Chain Link Fencing of the type and size indicated on the plans and in the locations shown on the plans or ordered by the Engineer.

Fabric shall be standard Galvanized Fence Fabric. Posts, top rack and braces shall be of the type and size and shape indicated on the plans or approved equivalent. All materials shall be new and first class and shall not include reconditioned thin wall pipe. All materials shall be thoroughly galvanized on the inside and outside surface.

Fittings shall be malleable iron, cast steel or cast iron thoroughly galvanized.

All line posts shall be spaced equidistant in the fence line on a maximum of 3 meter centers. Posts shall be set plumb in concrete bases of the depth and diameter indicated on the plans. The top of the posts shall be brought to a smooth grade line.

Intermediate posts shall be placed at the following locations: corners; changes in direction; abrupt changes in grade; intervals no greater than 150 meters in the fence line.

Each end or gate post shall have one brace assembly and each corner or immediate post to have two brace assemblies.

All top rails shall pass through the base of the post caps and shall form a continuous brace from end-to-end of each stretc of fence. Top rails shall be joined with sleeve couplings with expansion sleeves provided at 30 meter intervals. Horizontal braces shall be provided at all terminal ports, corner posts and intermediate posts, midway between top rail and ground and shall extend from the above-mentioned posts to the first adjacent line post. Braces shall be securely fastened to the line posts by brace ends and brace bands, and to the terminal posts by approved rail and connectors. Diagonal brace rods shall be trussed from the brace end on the line post back to the terminal post or imtermediate post and fastened to it by an approved connector.

Three strands of barbed wire shall be installed on top of the fence, leaning inward at 45° from the vertical and fastened to approved fitting on each post.

Fence fabric shall be installed 10 c.m. above the ground level and securely fastened along the bottom and to all braces, top rails and immediate posts at the interval indicated on the plans.

The fabric shall be secured to all end, corner and gate posts with stretcher bars fastened to the posts in such a manner that will permit adjustment of the fabric tension.

Fence gates of the size and type shown on the plans shall be provided where shown.

Gate frames shall be composed of tubing braced with rods, bars or angles and filled with wire mesh of the same size and type as in the fence. Gate posts shall likewise be made of tubing and bracing as shown on the plans. All iron and steel parts shall be galvanized.

Each gate shall be supplied with a lock and triplicate keys. Use of old or reconditioned materials will not be permitted.

TRACKWORK

Upon the prepared subgrade, as prescribed under pavement 12" of crushed stones, meeting the following gradiation shall be placed:

Pass	1-1/2"	100%
	1"	90 to 100
	3/4"	40 to 75
	1/2"	15 to 35
	3/8"	0 to 15
	#4	0 to 5

On top of this layer of ballast, ties will be placed, 20" center to center. These ties shall be of steel similar to the first class tie used by the Egyptian Railroad.

The rails shall be UIC standard 52 kilograms per meter as currently produced in Egypt.

The rail shall be laid to line and grade as shown on the plans. Additional ballast shall be added as needed and the complete track, ties and rail shall be jacked until a smooth grade is obtained. Ballast shall be forced under the ties using pneumatic tampers.

All rail joints shall consist of 2 - 36 in. joint bars with six bolts and spring washers per rail joint. The rail bars shall be of a design to fit the rail used.

All bolts shall be of heat-treated carbon steel with carbon steel nuts. The bolts shall have a forged button type head with either an oval or elliptic neck to prevent turning in the joint bar. The threads shall be rolled and the nuts finger-free fit.

Spring washers shall be used to maintain bolt tension and reduce the amount of bolt tightening required.

A turnout from the main line shall be constructed as shown on the plans. The turn out shall consist of a manually operated switch, a pair of switch points with accessories, a frog, a pair of guard rails and a set of turnout ties, all as shown on the plans.

The one test track shall have a catenary system capable of supplying either 600 or 1500 volts.

Track bumpers shall be installed at the ends of all rail lines.

SITE PREPARATION

The services of several contractors should be engaged to:

- Grade the site from elevation 9.9± on the western side to elevation 9.4± on the eastern side.
- Erect a 50,000 gal. water tank 25 meters high.
- Construct a turn out from the railroad and track into the property.
- Fence the area with security fencing including necessary gates.

In addition, arrangements should be made for a telephone line to be run to the property, a temporary one at least for use during the construction work at the plant site.

PROJECT EXECUTION

The new company shall enter into firm price contracts with local Egyptian construction companies and the supervising engineers, for all the work.

The Civil Works contracts shall be on a unit price basis and the building construction a lump sum, fixed price contract or contracts.

All imported materials shall be procured by the supervising engineer, after receiving firm bids for the materials, two or more quotations per item, with the freight and insurance on a cost basis.

The materials that are imported are expected to be turned over to the appropriate contractor free of charge at the point of entry to Egypt.

It shall be the contractor's responsibility to transport these materials from such points of entry to the site of the work, protect against damage and pilferage and replace, at his expenses, all materials damaged or lost.

The supervising engineer, besides procuring the imported materials shall design all aspects of the work with details

to enable the successful contractor to carry out such work in a workmanlike manner with a minimum of delays. He shall also lay out the work, giving the contractor lines and grades, so he can proceed without undue delay in constructing his work.

A resident engineer shall be furnished who will be available during all working hours, on the site, to interpret any questions concerning the plans and specifications, to settle any differences between contractors working in the same area and to process partial payments to all contractors engaged in the work.