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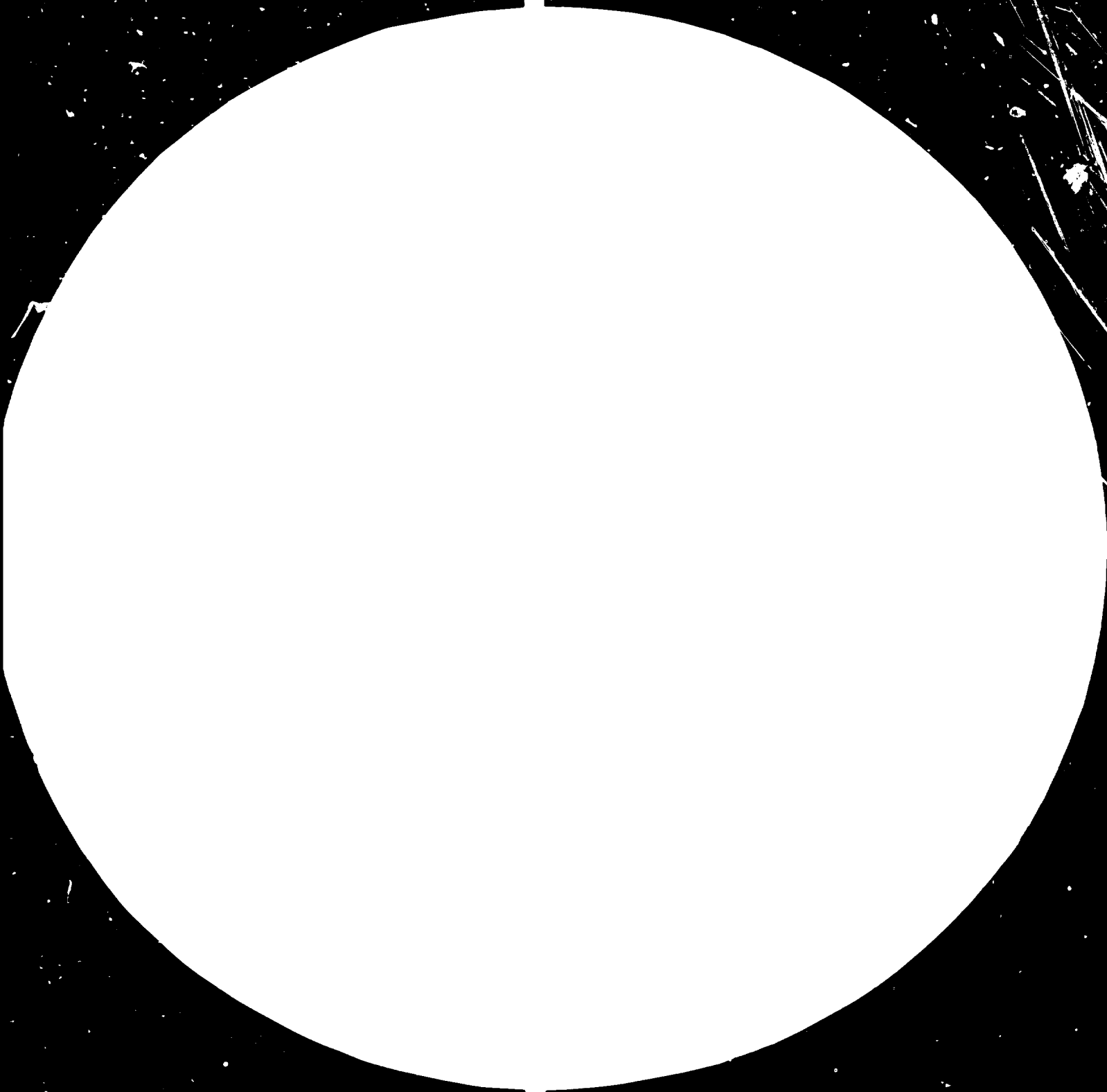
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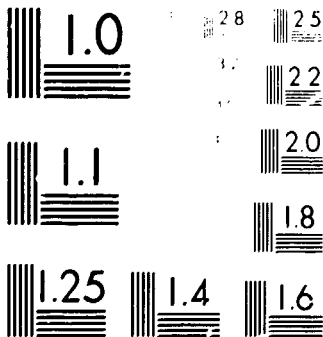
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11601

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25 March 1982  
English

Syria. TECHNO-ECONOMIC STUDY FOR  
PRODUCTION OF COMPRESSORS .

SI/SYR/79/804

SYRIAN ARAB REPUBLIC

Technical Report \*

Prepared for the Government of the Syrian Arab Republic  
by the United Nations Industrial Development Organization  
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. H. J. Hemmings, Expert in  
Production of Compressors

United Nations Industrial Development Organization  
Vienna

003072

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INTRODUCTION:

Mr Ismat Khankan first introduced me to Mr Mamdouh al Mounajed, Director General of the Organization and finally Mr Nader Abboud, Eng. Deputy Director of Production, all three were very agreeable and prepared to assist in any manner possible in my study of compressors for manufacture for the refrigeration industry.

The following day Mr Khankan took me to Barada Metallic Industries, manufacturers of refrigerators, gas appliances, pressure cookers and enamel ware, here we met Eng. Al Banna, Technical Director and Eng. Markabi, Production Manager.

We discussed hermetic compressor manufacture then made a tour of the Plant, where it was noted that manufacturing methods were quite advanced.

The type of refrigerator produced are 8, 11 and 13 cu. ft., extremely old-fashioned and bulky and their yearly output is 125,000 units. It was stated that they intended to introduce new models in the next two years and increase output to 200,000.

General assembly is manual and handling rough, compressors were exposed to atmosphere with suction and discharge plugs removed, these should not be removed until fitted to a refrigerator.

These facts were made known to the Technical Director.

At this stage a request was made for a compressor to be dismantled so that I could weigh the different components in order that I could estimate material content. This was agreed.

MATERIAL COST:

Having got these weights and costs of imported raw material including Import Duty, it was now possible to estimate material costs to produce in Syria.

The compressor selected was a 1/6 HP Danfoss. An addition of 30% will be added to material weight of each component to allow for waste i.e. turning, boring, blanking, trimming and piercing.

MATERIAL	WEIGHT KG	COST L.S./KG	DUTY INCLUDED	MATERIAL COST L.S.
Copper Wire Motor	.90	45.00	35%	36.00
Lamination Steel	2.70	11.00	17%	29.70
Castings	2.25	2	17%	4.50
Sheet Steel	2.75	1.89	17%	5.19
Suction and Discharge Tubes, Springs, Bolts Insulating Paper	.50	14.00	20%	7.00
	<u>9.00</u>			<u>81.39</u>
L.S. 81.39 + 30% =				105.80

U.S. Dollar at present exchange rate 5.4

$$\text{Material Cost } \frac{105.80}{5.4} = \underline{\text{U.S. Dollar 19.59}}$$

LABOUR COST:

On the basis of the labour force in the Iran Compressor Manufacturing Co., and using the pay rates for different grades as advised in Syria, we will establish labour costs.

		<u>L.S. PER MONTH</u>	<u>TOTAL L.S. PER MONTH</u>
Direct Workers	250	1800	450,000
Indirect Workers	80	1200	96,000
Staff	16	1500	24,000
	<u>346</u>		<u>570,000</u>

The number of working days per year 288 broken down to 24 days of 8 hrs working 6 days per week they must produce 20833 units per month to produce 250,000 per year.

Labour Cost L.S. 570,000

= L.S. 27.56 Per Unit

Monthly Prod. 20,833

U.S. \$ 5.06 " "



CAPITAL COSTS:

Having established material and labour costs we must now estimate capital costs. These based on manufacturing machinery used in Tehran plus 30% to cover inflation.

Land	50,000 m <sup>2</sup>	L.S. 20 per sq. meter	= L.S. 1,000,000
Built-up area	31,000 m <sup>2</sup>		= L.S. 55,000,000

This covers buildings - roads, sheds, accessories

For building, heating - air conditioning

Equipment, mains services to factory, packing, transportation, insurance, setting up, assembly pre-production

Plant, including quality control and laboratory	= L.S. 80,000,000
Freight and insurance 15%	= L.S. 12,000,000
Installation	= L.S. 21,000,000
Office equipment, transport (buses, lorries, cars)	= L.S. 10,000,000

Running costs made up as follows:

Labour L.S. 27.32 x 250,000 units	= L.S. 6,830,000
200% overheads	= L.S. 13,660,000
Material L.S. 105.80 x 250,000	= L.S. 26,450,000
<b>Total</b>	<b>= L.S. 46,940,000</b>

Total capital costs therefore are as follows:

Land	L.S. 1,000,000
Buildings	L.S. 55,000,000
Plant, insurance, installation	L.S. 113,000,000
Transport and Furniture	L.S. 10,000,000
Running expenses	<u>L.S. 46,940,000</u>
<b>Total</b>	<b>= L.S. 225,940,000</b>

This figure converted to U.S. Dollars at the rate of 5.4 Syrian Pounds = US \$  
= 41,840,000

MANUFACTURING COSTS:

On the basis of the above figures we can now establish manufacturing costs based on U.S. Dollars

Material	19.59
Labour	5.06
200% overheads	10.12
Depreciation 10% of capital	<u>16.73</u>
	51.50

The imported price of a 1/6 HP compressor is 42 US Dollars plus Import Duty of 17% which increases its price to 49.14 US Dollars.

The difference therefore = 2.36 Dollars

2.36 Dollars x 250,000 = 590,000 Dollars Loss

In addition to the above loss, no doubt, the supplier of technical know-how will expect a royalty of 5% based on the selling price. If we use the imported cost of 42 U.S. Dollars x 250,000 compressors it will amount to U.S. Dollars 527,750.

Total Loss = U.S. Dollars 1,117,750

**ALTERNATIVES**

On the basis of the above loss, the production of 250,000 would not justify the capital expenditure and to double the output would mean export, in this respect, it is doubtful if the suppliers of technical know-how would agree to their product being exported, this would be a matter which the Syrian Authorities would have to iron out with whichever compressor company they choose to do business with.

As a matter of interest, to produce 500,000 per year would produce a price below the 49.14 dollars paid by customers in Syria. This is shown as follows:

If we increase the manufacturing quantity to 500,000 by working the Plant on two shifts plus some overtime we could decrease the depreciation figure by 6.67 dollars made up as follows:

Material	=	U.S. \$ 19.59
Labour	=	5.06
Overheads	=	10.12
Depreciation	=	10.06

---

44.83

Difference between local manufacturing cost and imported cost shows a profit of 4.31 dollars multiplied by 500,000 = 2,155,000 dollars.  
Deduct from this royalty of 2.1 dollars multiplied by 500,000 units = 1,050,000 dollars  
This leaving a profit of 1,105,000 = 2.21 dollars each.

On the basis of my experience in Tehran where we had a similar problem but not so great as it appears in Syria because our capital costs were much lower, i.e. 30,000,000 dollars, the company requested the Government to allow material for the production of compressors to be imported free of duty, this was agreed and we were then able to produce at a cost equal to the C.I.F. value of imported compressors, the Government retained the Import Duty on imported units.

ALTERNATIVES (cont'd)

The import duty on raw material is equal to 4.69 dollars, this reduced from 44.83 = 40.14 dollars. This would increase profit by 2,345,000 plus 1,105,000 = 3,450,000 dollars = 6.90 dollars each.

The manufacturing costs would then be as follows:

Material	=	U.S. \$ 14.90
Labor	=	5.06
Overheads	=	10.12
Depreciation	=	10.06
		<hr/>
		40.14

The above suggestions will have to be the subject of agreement by all parties concerned. This therefore, concludes my feasibility study.

**GENERAL OBSERVATIONS AND RECOMMENDATIONS:**

On the basis of my experience in Iran, I find that general conditions follow the same lines, in other words, cast iron components cannot be produced using local sand mainly due to the silica content which tends to produce a rough porous casting.

The cylinder housing casting must be close grained to withstand the reciprocating action of the piston, the crankshaft must be close grained and contain a percentage of nickel to increase its tensile strength to resist shock from the action of the piston and connecting rod and again, must produce a good finish to ensure lubrication, again no porosity, this also applies to the connecting rod and piston.

It must be appreciated, that hermetic compressors must be guaranteed for a period of at least five years, consequently, to set up a foundry it would be necessary to import what is commonly known as "green sand", this plus the cost of a foundry would increase the capital costs by approximately thirty million dollars.

This cost would rule out any hopes of feasibility except perhaps, on the basis of one million units per year and this quantity is completely out of the question for a country of only ten million population unless, exports could be guaranteed to cover the excess seven hundred and fifty thousand units. This being a fact, all cast iron components would have to be imported, namely:-

Cylinder Housing  
Motor Housing  
Crankshaft  
Connecting Rod  
Valve Plate  
Cylinder Head  
Piston

These could be in the as cast condition, then shot blast and machined in Syria or, imported in the fully machined and graded kit form for assembly.

In addition to the seven components above, it will also be necessary to import the suction and discharge valves and the ceramic insulated electrical connector, these are specialized items which are bought out by the European compressor manufacturers.

The other items such as motor laminations for stator and rotor can be produced and motor wound, rotor pressure die cast, turned and bored by the Electric Motor Co., in Lattakia.

Sheet Metal Components i.e.

Motor Housing  
Cover  
Feet  
Overload Protector Housing  
Suspension Brackets  
Muffler Covers

These are pressed components and could be produced without too much difficulty.

The motor housing should be produced by hydroform press methods to reduce to a minimum the reduction in cross sectional area at the radius at the bottom of the housing, this has the advantage of reducing the noise level of the compressor when starting and running.

At this stage it is pointed out that the Westinghouse and Sanyo have reduced the number of cast iron components by aluminium pressure die casting the:-

Cylinder Housing  
Motor Housing  
Connecting Rod  
Cylinder Head

The only components of cast iron are cylinder sleeve which is cast into the cylinder housing, crankshaft, and piston.

The valve plate is made of carbon steel, machined, hardened, tempered, surface ground and lapped.

The aluminium used must not contain more than 3% of zinc since this element becomes soluble when in contact with refrigeration gas.

These comments are made following several visits to Barada Metallic Industries, the Press Shop is very spacious and its Press Shop capacity could be more than doubled. They are quite well experienced but the tool room would have to be reorganised and new equipment introduced, the presence of a qualified European tool maker for a two year period would prove an advantage.

This Company also produce pressure die castings, the addition of three 250 ton capacity machines to produce cylinder housing, motor housing, connecting rod and cylinder head could be introduced, after all, it will be appreciated that having the experience is a considerable asset and indeed, this Company certainly has the experience, twenty years.

The layout of the Plant leaves a lot to be desired but with the help of European engineers could soon be improved.

The Plant is very large and I am sure that with reorganisation, an air-conditioned assembly line could be introduced into one of their existing buildings and still leave sufficient space for a conveyerised dehydration unit, submerged arc welding, pressure testing, evacuation pumps, oil and refrigerant charging, at this stage the compressor would have its suction and discharge tubes plugged ready for painting.

Their paint shop is also very spacious, obviously a new conveyerised system for degreasing, drying and painting would have to be installed since refrigerators are painted white and compressors would be black.

Finally, machine shop, this would have to be in a separate building because special purpose machines would have to be installed, these capable of producing constant accuracy together with quality control equipment to ensure that machining limits are maintained plus a standard room, air-conditioned, to control measuring equipment.

In the case of assembly and machining these sections would have to be laid out and controlled by engineers from the company supplying the technical know-how. These engineers plus a quality control specialist would teach local engineers everything they would have to know from a practical point of view, they in turn would be expected to train local labour in all aspects of manufacture, production assembly and testing to the final operation of suction and discharge tube plugging. These foreign engineers would have to be resident in Syria for at least four years.

This suggestion is put forward on the basis that some know-how is available so it would be easier to introduce new machinery and tools and since roads and buildings already exist, capital costs for buildings could be reduced by approximately ten million dollars making it possible to produce compressors at a price of 46.77 dollars which is less than the price charged to customers of an imported compressor.

It is possible of course, that Barada Metallic Industries would not agree to this proposal but, since it is a state owned industry and they use more compressors than any other company, it is in their interest and the interests of Syria.

Finally I consider that the authorities should select a compressor which has its principle components aluminium pressure die cast rather than cast iron which would mean fewer components to be imported.



**RECOMMENDED PHASING:**

In the event that it is decided to produce hermetic compressors on the basis of 250,000 per year the following phasing is recommended.

- 1st Phase      Assembly of 250,000 pieces per year using complete set of components supplied by selected compressor manufacturer.
  
- 2nd Phase      Manufacturing of electric motor (stator and rotor). This could be carried out by the Electric Motor Co. in Lattakia.
  
- 3rd Phase      Manufacture of sheet metal components.
  
- 4th Phase      Machining of seven principle components. This includes pressure die casting. (If the compressor selected has principle components of cast iron then these should be imported).

## CONCLUSIONS

In my several visits to Barada Metallic Industries, Cable Factory Damascus, and Syrian Arab Co. for Electronic Industries, it became very evident that Engineering responsibility was lacking, firstly all units were very dirty, quality control non-existent, Plant laid out haphazardly, in fact so much space wasted that all equipment could have been housed in half the space. Drive ways lined with scrap.

Technical personnel are qualified from a theoretical point of view, but no practical experience, how then, is it possible for them to instruct on methods to be adopted, tool operations and maintenance, machine setting, inspection or quality control.

On this basis alone, I would not recommend the manufacture of hermetic compressors even if they could be manufactured economically except, under a European management team, i.e. engineers and quality control for a period of at least four years during which period, local engineers could be trained to keep machines clean, oiled and greased and to keep the entire Plant clean after all, a sealed compressor built with dirty components would not operate for more than a few weeks, after which, the company would have to replace free of charge.

The probability therefore, of local manufacture is completely out of the question until such times as management and engineers are prepared to get down to the business of practical engineering and operator training, production and quality control.

Finally, I would like to express my appreciation to all the staff of G.O.E.I. with whom I have been associated and in particular Mr Ismat Khankan who has been extremely helpful and whom I have advised, to solicit the aid of UNIDO in the event that the authorities decide to proceed with the project, indeed, a UNIDO representative should be present at the initial meeting with the selected compressor manufacturers in order to advise both parties, and assist in negotiations.



