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PROJECT PERFORMANCE AUDIT REPORT

on

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

March 12, 1976

Operations Evaluation Department

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

PREFACE

This report presents a performance audit of achievements under the Tunisia El Borma-Gabes Gas Pipeline Project, for which Loan 724-TUN in the amount of US$7.5 million was fully disbursed in October 1974. 1/

This performance audit is based mainly on correspondence and reports in Bank files (Loan and Guarantee Agreements, President's and Appraisal Reports, Progress Reports, Supervision Reports, and correspondence between the Bank and the Borrower) as well as on discussions with staff members of the Société Tunisienne de l'Electricité et du Gaz (STEG) and the Bank. A Project Completion Report, prepared by the EMENA Regional Office in March 1975, also was useful in the preparation of this report.

In July 1975, a one-week visit was made to Tunisia in connection with this performance audit. The valuable assistance of STEG is gratefully acknowledged.

1/ Less than US$10,000 was cancelled.

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

PROJECT DATA

Loan Amount	US$7.5 million
Amount Disbursed	US$7.5 million[1/]
Date of Appraisal Mission	July/August 1970
Loan Agreement Date	February 25, 1971
Original Effectiveness Date	May 12, 1971
Actual Effectiveness Date	May 12, 1971
Original Closing Date	June 30, 1974
Final Disbursement Date	October 1974

Exchange Rates: Tunisian dinars (D)

1968-1970 ------- US$1 = D .52

1971 ---------- US$1 = D .48

1972 ---------- US$1 = D .48

1973 ---------- US$1 = D .45

1974 ---------- US$1 = D .41

1975 ---------- US$1 = D .39

1/ Cancellation of less than US$10,000.

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SUMMARY

Loan 724-TUN was made to the Societé Tunisienne de l'Electricité et du Gaz (STEG) for the El Borma-Gabes Gas Pipeline Project. This project comprised essentially a gas compression and treatment plant at the oil field of El Borma and approximately 290 km of pipeline from El Borma to Gabes (see map). At Gabes, the gas is used chiefly to fuel a new thermal power plant. There are also some minor industrial users.

STEG is a state-owned corporation formed in 1962 to take over and operate the assets of the nationalized electricity and gas companies. This was the first Bank loan to STEG.

The original approach from STEG to the Bank in connection with this project was early in 1970 and an appraisal mission visited Tunisia in July/August of that year. Discussion then focussed on four items: economic and technical aspects of the project itself, and more generally, financial and organizational problems of STEG. The economic discussion aimed to identify the least cost fuel supply for the power station at Gabes, with the choice between gas and fuel oil. Gas transported by the pipeline was found to be the best alternative for rates of discount of 12% and below. The technical discussion was concerned with the best diameter of the pipeline. Two possible pipeline diameters were considered; the additional capital cost of the larger diameter line was found to be economically justified on the basis of the expected savings in operating costs.

The financial discussion was centered chiefly on what was seen as a potential cash flow problem in the operation of the pipeline during 1971-72. In anticipation of this problem, the Government agreed to exempt STEG from import duties and taxes on imported material for the pipeline, to guarantee overdraft facilities for STEG, and to undertake studies of STEG's tariff structure. The organizational discussion resulted in STEG agreeing to hold staff constant in the face of increasing demand, thus effectively reducing overstaffing, and to implement a training program for pipeline operating personnel.

The loan agreement for US$7.5 million was signed in February 1971. The Bank was to finance 75% of the foreign exchange cost of the project, and the Kuwait Fund for Arab Economic Development was to finance the other 25%. The total cost of the project was estimated to be US$13.6 million. The principal components were the pipeline itself, the compression and treatment plant at El Borma, and other necessary installations to provide 34,000 m^3 per hour of dry gas at Gabes.

The project was completed in October 1972, about four to five months later than planned, although this did not itself affect consumption as a similar delay was experienced in the construction of the power plant. The actual cost was US$14.28 million compared with the US$13.64 million (including contingencies) expected at appraisal, and the 4.6% cost overrun is attributable to the devaluation of the dollar.

The growth of demand for electricity has been faster than anticipated at the time of appraisal. Hence the growth of gas consumption has also been faster than anticipated despite the delays and certain technical problems. In addition, it is now hoped to sustain a high level of output at the gas field for more years than was originally thought possible. Thus, in volume terms, consumption has grown faster, and should be sustained longer, than was originally forecast.

The project has, however, not been without its technical difficulties. Right from the start of operations, problems were experienced with the compression and treatment plant. According to STEG, the basic problem had arisen because of the inability of the motors, as specified, to drive the freon turbo-compressors, particularly at periods of high summer temperature. Under high-speed running, the permitted temperature of the cooling water was exceeded and internal vibration was experienced. The effect of these difficulties was initially to reduce the volume of gas sent and to make it impossible to supply gas to specifications. However, modifications by STEG engineers enabled a quality of gas to be achieved that was acceptable to the steam generators in the power plant. The costs associated with these technical difficulties are hard to measure, but are likely to produce a higher operating cost in the pipeline and higher maintenance expenditure in the power plant. Different ways of solving these technical problems were studied, and STEG expects to have the pipeline operating normally shortly.

STEG's financial performance has been satisfactory, with operating surpluses for 1972-74 higher than forecast, mainly because of the faster than expected growth in electricity sales. Thus the degree of STEG self-financing has also been better than expected and the overdraft facilities provided for in the loan agreement have not been required. The operating costs of the pipeline were 29% higher in 1974 than anticipated at appraisal and are expected to continue at about this level. The effect of this is not serious, as operating costs are not a large element of total costs, and consumption has, as noted, been higher than forecast.

The tariff structure study was completed after lengthy delays. Its findings have been the subject of extensive discussions with the Bank, and STEG officials report that these discussions have been valuable in improving the study. Because of political considerations, no major revision of tariffs has yet taken place.

Staff levels have increased slowly and in 1974 were about 9% higher than in 1971. But given the larger than expected increase in electricity sales, this modest increase in staffing is not unsatisfactory. The training programs were successfully implemented. Their quality seems to have been adequate though greater use could and should have been made of experience of the operation of similar plants in other countries. This could have been either early on or, in STEG's view, after experience with operating problems had been gained.

The audit rate of return of the project is about 72%, after accounting for the effect of the technical difficulties. This is much higher than the appraisal expectation of 12%. The reasons for this higher rate are the substantial increase in oil prices (the alternative fuel for the power plant), faster than expected growth in gas consumption at Gabes (because of the faster growth in the demand for electricity), and higher than expected life for the gas output. The higher oil prices are clearly the main reason explaining the increase in the rate of return. If the original oil prices are used, the audit rate of return is the same as estimated at appraisal, with improved consumption prospects adequately balancing the effect of the technical difficulties and the cost overrun.

This project was prepared under considerable time pressure because the timing of the pipeline construction had to fit in with the commissioning of the Rhennouch power plant. All contracts were approved and signed before loan signature, and little time was available for extensive consideration of the technical factors involved. Given more time, it is possible that the question of the actual performance under similar conditions of the type of motors to be used may have been probed further. This time pressure continued during construction of the pipeline, and it meant that little time was available for extended testing and running of the installations. This was particularly unfortunate, given the highly technical nature of the project.

The malfunctioning of the compression and treatment plant led to excessive consumption of spares. The reordering system in use proved totally inadequate to meet these exceptional demands, partly because of delays in supply from the manufacturer and partly because of delays caused by STEG's and the Government's procedures for reordering. Time also was lost when the contractor and subcontractor argued about their respective responsibilities.

Supervision missions were concentrated in the construction period; the main technical and supply problems did not arise until completion of the project. More attention should have been given during the last supervision missions to the following points: (a) the problems with the motors, where firmer Bank insistence on urgent corrective measures could have helped STEG's engineers; (b) the maintenance capability available on site, in particular whether additional support could usefully have been given to the relatively inexperienced

STEG maintenance staff; and (c) the need for a stock control and replenishment system able to respond adequately to the heavy demands made upon it. This was a particularly vital subject, which merited much more emphasis.

It is concluded then that this was a successful project, which could have been more successful if greater attention had been given to supporting STEG's engineers in improving the technical performance of the system.

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

I. INTRODUCTION

1.01 Loan 724-TUN for the El Borma-Gabes Gas Pipeline Project was the first Bank loan to the Société Tunisienne de l'Electricité et du Gaz (STEG). STEG is a state-owned corporation formed in 1962 to take over and operate the assets of electricity and gas companies which had been nationalized. There had been earlier approaches by STEG to the Bank in the mid-1960s, which the Bank had declined to consider pending resolution of various disputes arising from compensation payments for the nationalized utilities. By the late 1960s, these problems had been settled.

1.02 Generating capacity in Tunisia had been traditionally concentrated in the northern part of the country near the major consumption areas (see map). The main source of energy for energy generation is fuel oil, with some small hydroelectric plants in the northwest.[1/] With the completion of a National Grid in 1967, the provision of generating capacity in the southern part of the country became both feasible and indeed desirable to offer greater protection to the grid supply. In addition, the construction of a new plant in the south offered the possibility of using gas from the El Borma oilfield. This is located in the southwestern part of Tunisia, near the border with Algeria. A high quality oil is produced there which is exported to European markets. Oil production is the responsibility of Société Italo-Tunisienne d' Exploitation Petrolière (SITEP), a company jointly owned by Tunisia and Italy. In the production of the oil, a large volume of natural gas is released as a by-product. For some years this had been flared, and a preliminary study, done in 1968, encouraged consideration of the use of this gas to fuel a new power station to be built at Rhennouch, near Gabes. The possibility of certain relatively minor industrial users of the gas, located near the power station, was also envisaged. The Government entrusted STEG with the duty of carrying out detailed feasibility and design studies, and the responsibility for any subsequent exploitation of the gas.

II. THE BANK AND THE LOAN

2.01 STEG first approached the Bank in connection with this project in early 1970. Supporting documentation included a technical/economic feasibility study already done by Société Francaise d'Etude et de Realisations d'Equipements Gaziers (SOFREGAZ) (France) for STEG. The study gave the technical details of the project, which comprised essentially a gas compression and treatment plant at El Borma, approximately 290 km of pipeline from El Borma to Gabes, and certain ancillary buildings and services.

1/ Three hydroelectric plants are located in northwestern Tunisia with 28 Mw total capacity (13% of STEG generating capacity).

2.02 Timing of the pipeline construction had to fit in with the commissioning of the power station. The first stage of this, a thermal plant,[1/] had already started with French financing; it was clear that time was very short -- indeed if Bank financing were to be used for the pipeline, some element of retroactivity would be involved.

2.03 In July 1970, an appraisal mission visited Tunisia. Discussions concentrated on economic, technical, and financial aspects of the project and STEG's organizational structure. The economic discussion focussed on the least cost alternative to supply fuel to the Rhennouch power station. The alternatives considered were treated natural gas from El Borma and imported fuel oil. The gas was supplied free at El Borma to STEG by SITEP under an agreement between this company and the Government. Estimates of gas reserves at El Borma indicated that supply would exceed demand until 1978. Thereafter, gas supply would be insufficient for the demand at Rhennouch. Subsequently increasing reliance would have to be placed on fuel oil. With these assumptions, and based on a very thorough analysis, breakeven discount rates of 10.6% (conservative) or 12% (most probable) were calculated. More expensive fuel oil or a longer availability of gas would naturally favor the gas alternative even more.

2.04 The technical discussions focussed on the diameter of the pipeline. Gas demand projections could be matched by the capacity of either an 8-5/8 in or a 10-3/4 in pipeline. The larger diameter pipeline would have had a slightly higher capital cost than the smaller diameter one, but would have required less compression horsepower and cost less to operate. Comparison of the additional investment in the larger diameter line with the expected saving in the operating cost of the system over the life of the project produced a satisfactory rate of return, therefore the 10-3/4 in diameter line was chosen. Furthermore, this line would give also more flexibility if greater quantities of gas than foreseen became available.

2.05 The financial discussions focussed on a potential cash flow problem in the operation of the pipeline during 1971-72. Two measures were agreed upon to deal with this problem: (a) the Government would exempt STEG from all import duties and taxes on goods imported for the pipeline and the power station; and (b) the Government would make available to STEG overdraft facilities from local banks of not less than D 1 million (about US$1.9 million).

2.06 There was extensive discussions also on the general organizational problems of STEG. STEG had to overcome many problems in the earlier years, and technical problems had been given priority. Bank staff identified the need for changes in STEG's tariff structure, and in the staffing situation, especially with regard to the need for training and for reduction in staff. A number of agreements were reached with STEG concerning these points; in particular that they would aim to keep the total staffing constant until 1975 despite a forecast 50% increase in electricity production and that the results of a study aiming to relate tariffs to costs, then in progress, would be implemented not later than January 1973. Agreement also was reached concerning the collection of data for management control, financial targets (STEG would maintain a ratio of net operating

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1/ Two 30 Mw generators which were expected to be in service in 1972.

surplus to net fixed assets of not less than 10% and a debt equity ratio of not more than 45:55), and training of personnel for the pipeline project.

2.07 The loan agreement for US$7.5 million was signed on February 25, 1971. The total cost of the project was US$13.6 million and the loan was to cover 75% of the foreign exchange costs of the project. The Kuwait Fund for Arab Economic Development was to finance the other 25%.

2.08 The project consists of the facilities necessary to provide 34,000 m^3 per hour of dry gas for use in the Gabes area. Details are described in Annex 1.

III. PROJECT IMPLEMENTATION AND COSTS

3.01 The project was completed in October 1972, about four to five months later than expected at appraisal. This delay did not have a negative effect on the project because of a similar delay in the construction of the Rhennouch power plant, which also was completed in October 1972. The actual cost was US$14.28 million as against US$13.64 million (including contingencies) expected at appraisal (Annex 2). Thus, there was a cost overrun of 4.6%.

3.02 The main reasons for the delay in completion of the project were organizational problems of the contractors and transport problems, which caused delays in the delivery of the pipeline and the compression and treatment plant (Annex 2). Various problems, primarily related to the security of the welds and civil engineering, arose during installation of the pipe. But they were successfully overcome, and the installation itself has proved trouble free after completion.

3.03 The contracts for the compression and treatment plant were let on a design and construct basis. SOFREGAZ prepared the specifications and the outline design. But in the call for tenders, bidders were permitted to submit alternative designs. The successful bidder, Black Sivalls and Bryson (USA), did do this, and proposed the use of two Waukesha motors to drive compressors in the degassing section of the station. This alternative was examined by SOFREGAZ, STEG's engineers, and Bank representatives, who concluded that it was a satisfactory solution and approved it. But, from the start of operations, problems were experienced with the compression and treatment plant, which are discussed in detail in Section IV. STEG's engineers, who were aware of these incipient difficulties from the initial test runs in the summer of 1972, discussed a number of alternative solutions and hoped to have the problem resolved by the end of 1975.

3.04 The water treatment plant also proved troublesome and for a ten-month period did not function because of the lack of spare parts. STEG

was able to purchase water for essential (technical) purposes from SITEP and salty water was used for domestic use, with what appears to have been commendable fortitude on the part of the site staff.

3.05 The 4.6% cost overrun in the project is explained by a 28% cost overrun in the compression and treatment plant (Annex 2) caused by the devaluation of the US dollar. The other project component, the procurement of the pipeline and its installation, was completed with a cost underrun of about 3%. But the contractor put in a substantial claim for the payment of increased costs, partly in respect of alleged delivery and transport problems and partly in respect of the costs of change orders. STEG has offered to discuss the latter, but in general rejects the former. Discussion is complicated by STEG's insistence that the claim be dealt with under Tunisian law, and the contractors' desire to have it heard at the International Chamber of Commerce in Geneva. The contract itself appears to lend support to both arguments and the matter was as yet unresolved in July 1975 at the time of the evaluation team's visit.

3.06 Consulting engineering services and supervision were provided by SOFREGAZ. Their performance was generally satisfactory, although personnel changes at the beginning of the construction phase were unfortunate, as was the consequent less frequent on-site supervision. The SOFREGAZ contract expired at the end of 1972, after the actual completion of the major part of the works. It did, however, mean that STEG's engineers were not provided with the consulting engineers' support in resolving the technical difficulties with the Waukesha motors.

3.07 The time pressure at all stages of pipeline design and construction had a number of undesirable side effects. It meant that Bank approval had to be given for tender documents before the loan was signed and at very short notice. There was, therefore, little time available for extended consideration of the technical factors involved. It also meant that during the construction phase little time was available for extended testing and for running in. Thus the pipeline had to be put in use immediately after hydraulic tests of its security had been done. Finally, it meant also that insufficient time was available for proper testing of the Waukesha motors. STEG engineers had suspected from the start that these were underpowered for the summer desert climatic conditions (though this view was only reluctantly accepted by SOFREGAZ); nevertheless the motors had to go into use at once.

IV. OPERATING PERFORMANCE OF THE PIPELINE

4.01 The operating performance of the pipeline, and especially of the compression and treatment plant, has not been trouble free. STEG engineers have had to cope with problems arising from the original design, from shortages of spares, and, perhaps, from their own lack of experience.

Their resourcefulness and determination have been impressive, but it may be that greater advantage could and should have been taken of drawing on experience elsewhere.

4.02 The operating performance of the pipeline can be measured by two parameters: the volume and the quality of gas sent down the pipe. Both the volume and quality depend on the performance of the compression and treatment plant. The gas goes through three phases of treatment: (1) elimination of dust; (2) compression by one of the two auto-compressors (piston compressors and motors on same artery); and (3) degassing through the exchangers and separators. There are seven Waukesha motors: two drive the York turbo-compressors which ensure closed circuit circulation of freon carrying the necessary cooling elements to the degassing units and five are at the power station.

4.03 According to STEG, the basic technical problem has arisen from the inability of the Waukesha motors, as specified, to drive the freon turbo-compressors, particularly at periods of high summer temperature. The problems started with the two motors running those compressors and gradually all seven motors have been affected through the need for continuous maintenance and spares' replacement. Heavy demands were, therefore, made on STEG's relatively inexperienced maintenance staff. Major problems first manifested themselves in early summer 1973, although even during the testing phases, in 1972, STEG engineers had suspected trouble. Waukesha engineers made site visits in June 1973 and August 1973, following the discovery of excessive piston wear, and larger air coolers were supplied later that year.

4.04 These did not solve the problem. Some difficulties also arose with the units used for power generation and because of their overriding priority, the freon compressor motors had to be first undermaintained and subsequently cannibalized to keep the electric generators going. The effect on operations was to reduce the volume of gas sent through the pipe and to make it impossible, first intermittently and later continually, to supply dry gas. In 1974, nearly 80% of the gas was sent through the pipe wet (Annex 3).

4.05 Measurement of the cost associated with the sending of wet gas down the pipe and of receiving it at the power station is very difficult. In the pipe, the wet gas may be the cause of, or at least a contributing factor toward, the deposit of residual materials which gave problems during cleaning. STEG has estimated the associated cost at US$75,000. In addition, some production was lost because of the consequent delays. At the power station end, the most serious effect probably arises from solid particles transported by the gas entering the turbines, causing pitting on the blades. A sensible estimate of the cost involved at the power station would require extensive investigation and the resolution of a number of technical uncertainties.

4.06 These technical problems with the operation of the pipeline raise three main issues:

(a) Would it have been possible to reduce or to resolve the problems by better maintenance? The audit mission could not make a detailed review of the maintenance record of the engines, but it seems unlikely that inadequate maintenance was a major factor, particularly given the visits of the manufacturer's engineers in 1973, who were themselves unable to rectify the situation.

(b) Should the problem have been envisaged at the design phase? An answer to this question would necessitate deeper study. The choice of the Waukesha motors was presumably on cost grounds. The problem was really that of stretching a small motor under extreme environmental conditions. The responsibility was that of the suppliers, Black Sivalls and Bryson, and the consultants, SOFREGAZ, who, given the "design and construct" nature of the contract, were in a slightly difficult position. The contract was approved by a Bank representative, again under considerable time pressure. Given more time, it is possible that the question of actual experience with such motors under similar conditions might have been probed further, though this is not certain.

(c) Were the right ameliorative measures taken expeditiously? Solutions suggested for the problem ranged from replacing the two motors in the treatment plant by electric motors and retaining the four similar motors for electricity generation, replacing all motors with similar but larger gas driven motors, or supplementing the existing motors with additional standby motors. The replacement solution was rejected because of the delays and on cost grounds (though the units concerned represented less than 5% of the total project cost). Instead, the solution adopted has been the purchase of a Caterpillar motor to act as standby for the two Waukesha motors. This is due for installation later this year. The precise position on contractors' liability, particularly now that the guarantee period has passed, is not known, and this will no doubt have affected thinking on the problem, although it is understood that this additional motor was supplied by the contractor.

4.07 The supply of spare parts has also been a continuing problem. Excessive wear has led to an increased demand for parts. In the absence of sufficient spares, maintenance staff have had to reuse worn parts and to cannibalize, and this in turn has led to higher wear. This problem has been particularly serious, apart from the Waukesha motors, with the water treatment plant, where shortage of spares and inability of the single plant to cope with the demands made on it meant that it was out of action, as already mentioned, for ten months. A duplicate plant has been ordered to resolve this situation.

4.08 Delivery times of spare parts are a major negative factor. At the time of the evaluation team's visit in July 1975, one third of the 44

orders for spares that were overdue was more than 12 months late. The poor performance of suppliers is the main cause, with possibly some additional delays because of STEG purchasing procedures and Government regulations. There was no evidence that proper stock control and replenishment procedures had been implemented; certainly not ones that could respond to extraordinary demands. This is a point that should have received more attention during supervision missions. STEG took the unusual step of sending a team to the USA, in particular to the Waukesha plant, to try to speed up delivery, though with somewhat disappointing results.

V. FINANCIAL PERFORMANCE OF STEG

5.01 The sale of gas is an internal transfer within STEG, therefore the study of the statement of profit and loss for the pipeline is not meaningful. The financial performance in relation to the pipeline can be judged by considering its expected and actual operating cost. The detailed comparison is included in Annex 4 and summarized below:

	1973	1974
	(D million)	
Actual	.156	.266
Forecast	.206	.206

5.02 The operating cost of the pipeline was lower than expected in 1973 and its substantial increase in 1974 can be explained by the technical problems referred to in Section IV.

5.03 The appraisal of this loan also contained provisions to improve the overall financial situation of STEG. It was expected that the financial rate of return would not fall below 10% and that the debt/equity ratio would not be more than 45:55. Actual financial performance was very close to the appraisal expectation, as can be observed in the table of STEG's key financial ratios below:

	1972		1973		1974	
	Forecast	Actual	Forecast	Actual	Forecast	Actual
Debt/Equity ratio	44:56	34:66	44:56	34:66	43:57	29:61
Operating surplus/net fixed assets	8.8	9.7	10.5	11.6	11.1	12.0
Debt service coverage	2.16	1.8	1.82	2.1	1.91	2.1
Operating ratio	.52	.49	.47	.48	.48	.51

5.04 Electricity sales grew more than expected during the 1972-74 period and the higher revenue generated in that way was enough to offset the increase in operating expenses and still permit an operating surplus higher than forecast over the whole period (Annex 5). This higher operating surplus resulted in a financial rate of return on net fixed assets also higher than forecast and above the 10% minimum set in the loan agreement. STEG's self-financing was also better than forecast. At appraisal, it was expected that STEG would obtain 60% of the funds required during the 1971-73 period from sources other than borrowing. The actual contribution of STEG self-financing during the 1972-74 period[1/] has been about 63%.

5.05 The covenant about the need to prepare a study on tariffs and adjust them to costs was not completely adhered to. The study was completed after lengthy delays, and there were extensive discussions with the Bank about its findings. According to STEG's officials, these discussions were valuable in improving the study. But tariffs were not revised, and in December 1974 the Bank agreed with STEG's proposal to introduce the new tariff structure, "as and when oil and natural gas prices are revised by the Government from their present levels, which presently are below world prices."

VI. STAFFING AND TRAINING

6.01 Two important aspects in relation to the manpower requirements of STEG were considered in the appraisal of this project: the need to reduce overstaffing and the need for training in the operation and maintenance of the pipeline.

6.02 At appraisal time, STEG had about 3,150 employees, while only about 2,700 were required. Given the expected growth in electricity demand, it would not be until 1975 that the staffing position would not be in excess of what was required. Therefore, STEG had agreed not to employ more than 3,200 people by 1975 despite a 50% expected increase in electricity production. The actual staff level at the end of 1974 was 3,548, of whom 3,434 were in active employment. This shows an increase of 284 people over the 1971 level of 3,150 -- an increase of 9%. Given the greater than expected increase in electricity sales in the same period (40% as against 32%), STEG's performance with regard to the staffing situation cannot be regarded as entirely unsatisfactory.

6.03 The other important staffing issue was the need for training. There was no available experienced gas operating talent in Tunisia and, therefore, it was necessary to train personnel for the operation and maintenance of the pipeline. This training had to take account of the fact

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1/ The actual figures for 1971 were not available.

that the majority of the personnel would be based at El Borma, in the extremely inhospitable conditions of the desert, and that there was within STEG little detailed knowledge of gas pipeline operation.

6.04 The general policy was to recruit personnel from the south of Tunisia, who were already accustomed to the general climatic conditions, and to require a minimum of three years of secondary education, plus practical experience in the case of maintenance operatives. El Borma had already a substantial population of SITEP employees, and STEG very rightly decided to align the conditions of employment of their men as closely as possible to those of SITEP. This meant living in bachelor conditions and remaining on site for continuous periods, interspersed by leave. Five-year contracts were offered and a substantial Saharan allowance was offered to compensate for the arduous conditions.

6.05 The recruitment policy appears to have been successful. Numbers built up rather more slowly than had been plannned, but by 1974 actual employees were only two short of target (Annex 6). Hours worked were considerably longer than originally envisaged, as can be seen from comparison of planned and actual overtime figures in Annex 6. This arose largely as a result of the various problems encountered in the operation of the pipeline. There were undoubtedly times when excessive demands had to be made on personnel and their positive response says much for the morale of the unit and its leadership. The overtime situation seems now to be under control.

6.06 Training was done in two main stages: first, the senior personnel -- engineers and foremen operators -- were trained over a 3-1/2 month period in Tunis. The program included classroom work interspersed with periods in workshops and power stations and was jointly organized by the Centre d'Instruction et de Perfectionnement d'Electrotechnique (CIPE) and the Production Division of STEG. Next, site operatives and site maintenance staff were given instruction at El Borma by the contractors and by the newly trained senior STEG personnel.

6.07 The initial high level training appears to have been good. One possible weakness was the failure to make sufficient visits to gas compression and treatment plants in other countries. Two such visits had been scheduled, but do not appear to have taken place because of time pressure. The site course for operative and maintenance staff seems to have been well planned and successfully completed. No formal provision appears to have been made for refresher courses, or for new recruits, although STEG has just set up a training center to carry on the necessary programs for its staff.

VII. ECONOMIC JUSTIFICATION OF THE PROJECT

7.01 The economic justification of the project in the appraisal was based on the study of two alternatives to supply fuel for the power station of Rhennouch and other industries in the area. The alternatives considered were: (a) the use of natural gas from El Borma and (b) the use of imported fuel. This study indicated that use of natural gas from El Borma and construction of the pipeline was a better alternative than use of imported fuel for rates of discount below 12%. Therefore, the rate of return on the investment in the pipeline was also 12%.

7.02 The audit rate of return is much higher, and it is estimated at about 72% after accounting for the effect of the technical difficulties. The reasons explaining this higher rate are the substantial increase in oil prices, faster than expected growth in the consumption of gas at Gabes, and higher than expected life for the output of the gas field for a longer period than originally expected.

7.03 The price of fuel has increased by a factor of 7 since the appraisal's calculation, so that the cost advantage of gas, originally somewhat borderline, is now very clear. The higher oil price is clearly the main factor explaining the substantial increase in the rate of return. If the original oil prices are used, the rate of return is the same as the one estimated at appraisal. Therefore, it seems that the negative effect of the technical difficulties has been offset by the higher and longer than expected gas production.

7.04 The actual gas sales and those currently forecast are shown below compared with those expected at appraisal:

Year	Appraisal's Estimate of Gas Sales	Actual Sales (1972-74) and Current Estimate of Future Sales
	(million m^3)	
1972	15	18
1973	120	111
1974	120	199
1975	120	225
1976	226	260
1977	226	260
1978	288	260
1979	256	260
1980	219	260
1981	192	260
1982	171	260

7.05 The estimation of the cost associated with the technical difficulties has been difficult. The costs included are: (a) lost production: 8.1 million m^3 in 1973 and 21.0 million m^3 in 1974, and (b) additional maintenance cost and excessive spare parts' consumption. It has not been possible to include any estimation of the higher maintenance cost at the power station. We think even after allowing for this higher maintenance cost, the project will remain clearly justified not only because of the very high audit rate of return but also because of the transitory character of the difficulties which were expected to be overcome by the end of this year.

VIII. THE ROLE OF THE BANK

8.01 The role of the Bank is discussed at the two principal stages of project preparation and project implementation:

Project Preparation

8.02 The project was conceived by STEG, and technical details were prepared by SOFREGAZ, prior to STEG's initial approach to the Bank. There was thus less opportunity than usual for Bank staff to contribute to project definition.

8.03 In the appraisal of the project, technical and specialized economic support were provided by consultants while the financial analysis was carried out by Bank staff. The main effort during the appraisal stage went into the assessment of the life of the gas supply, the basis for the cost comparison with fuel oil, and the financial analysis of the project and of STEG itself. This emphasis is reflected in the accuracy of the financial forecasts.

8.04 Technical discussions chiefly concerned gas quality requirements and pipeline diameter. In retrospect, the economics favoring the larger diameter pipeline, which was finally selected, have been substantially reinforced by the higher than anticipated output at the gas field. There was little detailed discussion of training programs, although the need was clearly recognized, or of the necessary support systems such as stores. Also, in retrospect, the subsequent technical problems were not anticipated.

8.05 All major contracts were approved and signed prior to the signature of the loan itself, and under time pressure. In particular the contract for the compression and treatment plant was discussed and agreed in the context of a three-day meeting in Paris. Detailed scrutiny of the tender documents, or of the tenders themselves, was not possible in this context. Given more time, it is possible that the question of the actual performance under similar circumstances of the type of motors to be used might have been probed further.

Project Implementation

8.06 There were four supervision missions: two in 1971 and one each in 1972 and 1973. Supervision was concentrated in the construction period. The main technical problems in fact actually started on completion of the project, in 1972, and were felt more intensely in the summer of 1973. It is doubtful whether the full significance of these problems was realized at the time, and firmer Bank insistence on urgent corrective measures might have helped STEG's engineers.

8.07 Technical difficulties in a project such as this, which has a fairly high technical content, do highlight the question of the extent to which Bank staff should and indeed can be expected to offer technical support. The difficulty has been sharper in the present case, where the Bank's original technical input was provided by a consultant.

8.08 Good emphasis was placed on the need for adequate programs for training during supervision, though the outcome of these programs has not been documented in detail. More emphasis might have been given in the supervision visits to technical aspects -- in particular the various difficulties at El Borma and their consequential effects at Rhennouch -- which although referred to, are not discussed in any great detail. The El Borma end of the pipeline is not easily accessible and a visit has usually to be either of one hour or of three-days duration and this has probably tended to discourage detailed physical inspection. It is arguable also in a project of this kind, where operating performance depends on a small number of key components, that more emphasis might have been placed on the need for an adequate supply of spares.

8.09 A further complicating factor has been the involvement of a second Bank division, EMENA's Power and Energy Development Division, in a directly related component of the project -- the financing of the gas turbines at Rhennouch (Loan 815-TUN of 1972).1/ Similar covenants with respect to STEG's overall position were made in regard to that loan and, by tacit agreement, supervision of those aspects of Loan 724-TUN has been taken over by the specified Division. There has also been some technical interaction between the two loans through the effect of the problems with the treatment plant and, during the cleaning of the pipeline, on the operations of the power station and, in particular, on the gas turbines. There does seem to be a case in this overlapping situation either for one Bank division to accept total responsibility for supervision or, if that is not technically possible, to ensure that supervision missions are coordinated.

1/ This loan is helping to finance the expansion of the Rhennouch power plant and the distribution and transmission system expansion.

IX. CONCLUSIONS

9.01 Loan 724-TUN has been successfully completed with an audit rate of return of about 72%, which is much higher than the appraisal expectation of 12%. This higher than expected rate is explained by the substantial increase in oil prices and higher gas production forecasts than anticipated at appraisal time.

9.02 The technical difficulties, chiefly in the compression and treatment plant, raise the question of the Bank's role in the face of highly technical engineering problems. The question is particularly difficult when the full seriousness of the problem is realized only after the project has been physically completed. More time devoted to the study of the contracts and a firmer Bank insistence on urgent corrective actions when the problems first appeared might have contributed to the solution of these technical difficulties.

9.03 A technically integrated project of this nature required both training for the staff and adequate supply of spares. The training program was successfully implemented, but the supply of spares was a major problem. More emphasis on the need for proper stock control and replenishment procedures for spares might also have increased the success of the project.

ANNEX 1

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

Detailed Project Description

The project was to include a gathering, compressing and treatment plant at El Borma oil field and 294 km of transmission line between El Borma and Gabes. Three sales laterals were to be constructed to supply the Rhennouch plant, Industries Chimiques Maghrebines, and Briqueterie d'El Hamma. Gas was not to be distributed for domestic or other nonindustrial use.

The main components of the project were procurement and installation of:

(a) 4.1 km of 12-3/4 inch pipe to transport wet gas from the SITEP production center to a compression and treatment plant.

(b) Approximately 3,300 HP of gas engine driven compressors including necessary controls and ancillary facilities.

(c) Facilities to treat the gas to remove condensable gasoline fractions by cooling it to a low temperature in contact with diethylene glycol to remove water vapors.

(d) Ancillary facilities at the compression and treatment center, including operating buildings and employee housing with electric, gas, water and communication systems.

(e) 294 km of 10-3/4 inch transmission pipeline including coating, corrosion potential test stations, sectioning stations, scraper traps and measurement and pressure control stations.

(f) Sales laterals from the transmission line consisting of 2.9 km of 12-3/4 inch pipe to the Rhennouch electric generating station of STEG, 0.8 km of 4-1/2 inch pipe to the Industries Chimiques Maghrebines plant near Gabes, and 3.7 km of 4-1/2 inch pipe to the brick plant at El Hamma. Laterals were to be coated and equipped with corrosion potential test stations and gas pressure controls.

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

Estimated and Actual Project Costs and Completion Dates

Project Component	Appraisal Estimate (including contingencies)	Actual Cost	Actual Cost as a Proportion of Estimated Cost	Original Completion Date	Actual Completion Date
	(US$ thousand)		(%)		
Pipe	2,625	2,513	96	October 1971/1	January 1971/1
Pipe Installation	6,149	6,029	98	January 1972	June 1972
Compression and Treatment Plant	3,333	4,264	128	June 1972	October 1972
Engineering and Supervision	988	898	91		
Buildings	550	579	105		
Total	13,645	14,283	104.6		

/1 Delivery dates.

Source: Appraisal Report PTR-66a and PCR.

ANNEX 2

PROJECT PERFORMANCE AUDIT REPORT
TUNISIA EL BORMA–GABES GAS PIPELINE PROJECT (LOAN 724–TUN)
Periods of Wet Gas in the Pipe

1973, May–December	May	June	July	August	September	October	November	December
Periods of functioning with wet gas								
Volume of wet gas sent in the pipe	781,200	805,300	4,848,400	849,100				

1974, January–June						
Month	January	February	March	April	May	June
Periods of functioning with wet gas						
Volume of wet gas sent in the pipe		1,460,000	7,685,100	17,696,600	11,743,800	12,446,600

1974, July–December						
Month	July	August	September	October	November	December
Periods of functioning with wet gas						
Volume of wet gas sent in the pipe	17,661,300	19,346,000	19,531,200	19,444,000	23,297,700	24,363,600

ANNEX 3

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

Forecast and Actual Statements of Pipeline Costs
(D million)

Year ended December 31	1973		1974	
	Forecast	Actual	Forecast	Actual
Compression and Treatment				
Maintenance	.048	.042	.048	.080
Materials	.003	.007	.003	.022
Labor	.041	.009	.041	.008
	.092	.058	.092	.220
Transmission				
Maintenance	.062	.001	.062	.003
Labor	.017	.001	.017	.004
	.079	.002	.079	.007
Operating Center				
Labor	.016	.071	.016	.126
General Office	.019	.005	.019	.023
Total Operating Expense	.206	.156	.206	.266
Provision for Depreciation	.478	.418	.478	.434
Interest on Long Term Debt	.338	.415	.326	.401
Total Costs	1.022	.969	1.010	1.101

Source: Appraisal Report PTR-66a and STEG.

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

STEG's Forecast and Actual Statements of Profit and Loss
(D million)

	1972		1973		1974	
	Forecast	Actual	Forecast	Actual	Forecast	Actual
Sales of Electricity (GWH)	705	737	785	820	851	902
Revenue	13.20	14.65	14.07	17.45	14.99	20.04
Expenses	6.85	7.24	6.60	8.44	7.12	10.16
Operating Surplus	6.35	7.41	7.46	9.01	7.86	9.88
Depreciation	4.73	4.40	4.95	5.33	5.17	6.10
Operating Profit	1.62	3.01	2.50	3.68	2.68	3.78
Interest	1.27	1.45	1.62	1.66	1.39	1.72
Net Profit	.33	1.56	.88	2.02	1.29	2.06

Source: Appraisal Report PTR-66a and STEG.

PROJECT PERFORMANCE AUDIT REPORT

TUNISIA EL BORMA-GABES GAS PIPELINE PROJECT (LOAN 724-TUN)

Planned and Actual Personnel Employed in the Operation of the Pipeline

	Year					
	1972		1973		1974	
	Planned	Actual	Planned	Actual	Planned	Actual
Number of Employees	34	25	47	43	54	52
Overtime (hours)	420	5,390	1,200	10,398	1,200	12,560

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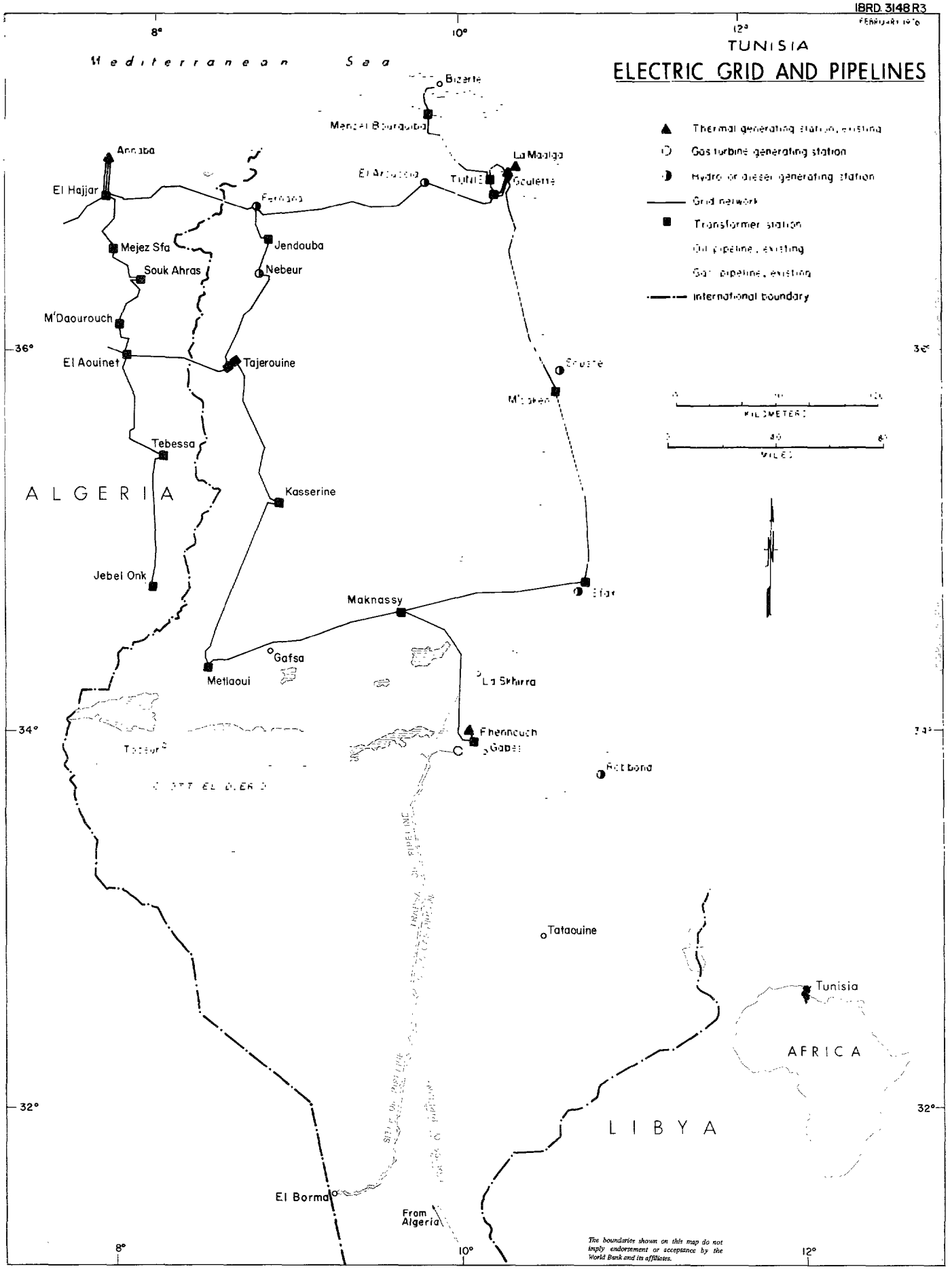
TUNISIA
ELECTRIC GRID AND PIPELINES



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