THE FEASIBILITY OF A NICARAGUAN CAUSTIC SODA-CHLORINE CHEMICAL PLANT: 1966-1970

A Dissertation

Presented to

the Faculty of the Department of Economics and Finance

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy in Economics

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by

Willard Neal Mertz

January 1969

PREFACE

With the establishment of the Central American Common Market in 1960, the trade area has attracted much attention from investors all over the world. This experiment in coordinated economic development, if successful, could mark the beginning of a general renewal of the economies of the Central American nations. The global interest with which the progress of the Nicaraguan caustic soda-chlorine venture is watched has revealed the need for financial analysis of the project. It is with this intent in mind, a financial analysis of the Nicaraguan caustic soda-chlorine plant, that I have undertaken to write my dissertation.

During my trip in 1966 to Nicaragua, the Nicaraguan National Development Institute graciously provided its publications on the proposed Nicaraguan chemical plant and those of consulting American engineers and chemical companies. I must also thank the Economic Research Department of the Nicaraguan Ministry of Economics which made available its valuable collection of original research reports on the structure of the Nicaraguan economy. The Research Department of the General Collector of Customs of Nicaragua, publisher of annual reports on import and export data, also deserves recognition here for its practical assistance in providing a desk and free access to its materials. The Research Department of the Central Bank of Nicaragua put at my disposal its studies on the credit and monetary problems of Nicaragua.

I wish to express appreciation to everyone who assisted in writing this paper. Of particular help was Dr. Ervin K. Zingler, dissertation chairman, without whose very excellent constructive criticism and sound advice, this paper could not have been written.

I am also grateful to Dr. Joel Sailors for the many hours he spent reviewing the drafts and for his sound suggestions concerning problem areas of the study. In addition, I am indebted to Dr. Louis Dow for his suggestions concerning this paper.

I would also like to express my deepest appreciation to Miss Linda Poston and to Miss Margaret Guzman for their many hours spent in editing and typing of the rough draft of this paper.

Finally, I would like to thank Mrs. James F. Bartlett for typing the final copy of this dissertation.

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ABSTRACT OF

THE FEASIBILITY OF A NICARAGUAN CAUSTIC SODA-CHLORINE CHEMICAL PLANT: 1966-1970

One facet of the program of coordinated economic development in the countries of Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua is the establishment of a chemical plant in Nicaragua. The successful operation of the proposed caustic soda-chlorine plant could prove the stimulus for developing a chemical complex in the country. The purpose of this paper was to determine if establishment of such a plant would be feasible and profitable in Nicaragua during the years 1966-1970.

This study confined itself to financial analysis of the caustic soda-chlorine plant proposed for Nicaragua. Political, sociological and cultural problems were not considered. In addition, neither the effects of the proposed plant on the economy of Nicaragua nor the economy's effects on the plant's operation were discussed.

It was hypothesized that the caustic soda-chlorine venture would prove profitable on the basis of Nicaragua's raw materials, labor, energy, capital and technological resources in addition to the Central American Common Market demand for the chemicals.

In order to prove the Nicaraguan industry would be profitable, (1) the economic privileges to be enjoyed by the "infant industry" under the Central American Common Market agreements, (2) the procedure to be followed by Nicaragua to establish the plant, and (3) the

resource needs for production of caustic soda and chlorine were discussed. Feasibility reports on the prospects of such a plant, prepared by the United Nations, governmental and semigovernmental agencies of the United States and Central America, were consulted for evidence on how Nicaragua would meet the resource needs of her new plant.

Whenever possible, source material on the chemical industry in Central America and Nicaragua came from such institutions as the United Nations, the Inter-American Development Bank, the International Bank for Reconstruction and Development, the United States Department of Commerce, and the United States State Department. Among the private organizations from which source materials were obtained are the American Institute of Chemical Engineers, the Committee for Economic Development, the Center of Latin American Studies of the University of California, and the Stanford Research Institute.

It became evident that sufficient financial resources would be available through the Nicaraguan National Development Institute, Pennsalt Chemical Corporation and the Morton Salt Corporation of the United States. Research showed a demand for the caustic soda, chlorine and the plant's by-products does exist in Central America especially since the plant price is expected to be lower than the historical price.

Analysis of production costs, capital investment, productive capacities and projected sales revenues indicated net profits of $174,000 will first be realized in the second year of operation. Net

returns are expected to increase annually; in the ninth year of operation, net profits should reach $736,000. On a straight line method of depreciation, after nine years of depreciation on the total fixed assets, a salvage value of $217,000 remains. All loans of the caustic soda-chlorine plant should be paid within five years of the start of operations according to the payback method used here. The internal rate-of-return method yielded a positive net present value greater than a 17 per cent interest rate. Similar positive findings resulted when the net present value method was used.

The conclusions reached here may prove helpful in the financial analysis of other new industries being established in Central America and other developing areas of the world.

Additional research on unit costs at varying plant capacities and the creation of new product demand by newly established industries in other Central American Common Market nations could be quite useful in delineating the rapidly changing economic character of Central America.

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CHAPTER I

INTRODUCTION

In December, 1960, at Managua, Nicaragua, five Central American countries, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua, negotiated a treaty entitled El Tratado General de Integracion Economica Centroamericana for the purpose of establishing a free trade area. This treaty, commonly known as the General Treaty, gave birth to what is known today as the Central American Common Market. It was hoped that "The Central American Economic Integration Program" would form an economic system which, through broader markets and joint economic policies, might help to remove some of the obstructions to the economic development of each individual Central American nation.[1]

The individual markets of the Central American states have been unable to support extensive industrial activity.[2] One of the purposes of the C.A.C.M. is to widen the markets of these nations' enterprises by combining the national markets into C.A.C.M. product

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[1]When speaking of Central American, we are referring to these five countries: Nicaragua, Honduras, Guatemala, Costa Rica, and El Salvador. Panama is not included for it has not formally acceded to, or associated with, the Central American economic integration movement.

[2]Banco Interamericano de Desarrollo, Propiciones para la Creation del Mercado Comun Latinamericano (Washington, D.C.: Government Printing Office, 1965), p. 4.

markets.[3] In some instances, the expanded market might not be able to support in its early development more than one large-scale, economic enterprise or industry. Therefore, the C.A.C.M. had to limit firm entry to prevent wasteful competition when the enlarged market could economically support only one or a few firms in an industry. The C.A.C.M. engaged in coordinated planning of new industries which might attain economies of scale if the C.A.C.M. was reserved for a single or a few firms of an industry. This planning required that the C.A.C.M. select industries in which economies of scale might be realized and assign them to the various nations. In their selection, the C.A.C.M. has attempted to include industries which could be instrumental in the economic growth of all the participating nations.[4]

The Purpose of This Study

Under the provisions of the General Treaty, each member nation in the C.A.C.M. has been given, by mutual agreement, a basic industry to develop which would be protected from foreign competition for a period of ten years. On the basis of natural resources and geographic location, Nicaragua has been assigned chemical production as her industry.[5] The purpose of this study will be to analyze the feasibility of

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[3]The initials C.A.C.M. will be used in this study when referring to the Central American Common Market.

[4]These industries, important for the overall development of the countries, have been designated "integrated industries."

[5]Similar determinants have provided Guatemala with a basic rubber industry; El Salvador, a light bulb industry; and Honduras, a glass

establishing a profitable caustic soda-chlorine plant in Nicaragua during the period of 1966-1970. The production of these fundamental chemical products is considered the basis upon which a chemical complex can later be built.[6]

The Problem

Once assigned the chemical industry, Nicaragua decided to establish the facilities in stages.

To develop a profitable chemical enterprise, the National Development Institute, the official development agency of Nicaragua, decided first to establish a plant which would principally manufacture caustic soda and chlorine. This plant, the initial stage of the chemical industry in Nicaragua, is projected to be in operation before 1970.[7] The problem of this paper is to demonstrate how a profitable caustic soda and chlorine plant, the fundamental unit of chemical production in Nicaragua, can be established. These are the necessary

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industry. Costa Rica, as of this date, has not been assigned a specific industry.

E. M. Ubago, Protocolo al Convenio Sobre el Regimen de Industrias Centroamericanas de Integracion, La Gaceta: Diario Oficial, No. 216 (September, 1965), p. 3099.

[6]The by-products of the caustic soda-chlorine production plant are hydrogen, hydrochloric acid and sodium hypochlorite.

[7]The National Development Institute has set up a timetable, based on Nicaragua's and Central America's chemical needs, which tries to meet the schedule of the manufacture of chemicals in specific plants. Two time periods have been projected: the first one extends from 1966 to 1970; the second one from 1970 to 1975.

base products, and the profitability of an expanded chemical industry depends directly upon the success of this first productive phase.

Hypothesis

Nicaragua has the raw materials and resources required for caustic soda-chlorine production. Also, as a member of the C.A.C.M., she will enjoy economic privileges for developing her "infant industry." The necessary capital and technical knowledge can be obtained through the Central American Bank for Economic Integration, created by the General Treaty. Also, the Inter-American Development Bank, the World Bank, and various development programs of the United States are additional agencies available to Nicaragua in the development of the caustic soda-chlorine manufacturing project. Moreover, a large amount of private capital, foreign and domestic, is available. Since it is projected that the C.A.C.M. nations will require the Nicaraguan chemical products, caustic soda and chlorine, the first phase of chemical production, caustic soda and chlorine manufacture, will be profitable for Nicaragua.

Analytical Procedure

This study is an attempt to assess the profitability of a caustic soda-chlorine plant for Nicaragua and the Central American trade area. Therefore, the following points will be analyzed: first, the incentives being offered by the Central American Common Market integration movement for the development of a caustic soda-chlorine plant in Nicaragua; second, the steps which Nicaragua must take to

establish the chemical plant; and third, the resource needs for caustic soda-chlorine production in Nicaragua.

The basic resources of Nicaragua, including raw materials, labor supply, experience of individual workers, energy supply resources and financial resources have to be studied. Feasibility reports on major facilities of the chemical industry will be analyzed only to demonstrate how Nicaragua can profitably produce caustic soda, chlorine and their by-products. The importance of citing construction, labor, energy and raw material costs, overhead, administration and cost of sales lies in showing that this first major chemical plant will be a profitable venture--the fourth, and most important, area of investigation.

Scope of the Study

Although the economic development problems of Nicaragua are broad and complex, this study is only concerned with the feasibility and profitability of the caustic soda-chlorine plant, a project of the C.A.C.M. movement.

On account of the complexity of the subject, it is necessary to place the following limitations on this investigation:

1. This study examines only the financial problems in the establishment and operation of the proposed chemical plant; political, sociological and cultural problems are beyond the scope of this investigation.

2. The effect of changing economic conditions in the C.A.C.M. on the Nicaraguan chemical industry and the effects of the chemical industry on the economy of the C.A.C.M. and Nicaragua are not considered.

Plan of the Study

This study is divided into nine chapters, the first four provide introductory and background information to acquaint the reader with factors of Nicaragua's economic development involved in establishing the proposed chemical industry. The last five chapters analyze the short and intermediate-term profitability of a Nicaraguan chemical industry.

Following the introduction, which concerned the idea of the C.A.C.M., the problem, hypothesis, limitations and plan of study, the second chapter discusses development of the Nicaraguan chemical industry through C.A.C.M. tariff agreements, the economic characteristics of Central America and implications of the C.A.C.M. for Nicaragua's economic growth.

Chapter III reviews the factors involved in establishing a caustic soda-chlorine plant. Chapter IV delineates the role of the National Development Institute, the impetus behind the projected chemical industry. The next chapter discusses the demand for caustic soda, chlorine, and the plant's by-products in addition to the historic and projected prices for these products.

Chapter VI, by analysis of feasibility reports on facilities required for a complete chemical operation, examines the costs involved in producing caustic soda and chlorine. The operating company, Pennsalt de Centroamerica, is discussed in Chapter VII. Chapter VIII analyzes the profitability of the projected company.

Chapter IX presents a summation of the findings of the analytical study and makes recommendations for further investigations.

CHAPTER II

THE CENTRAL AMERICAN COMMON MARKET

Economic Background

The economic problems of the Central American countries reflect the need for integrated economies with a common basis. The economic difficulties of El Salvador, Honduras, Costa Rica, Guatemala and Nicaragua are similar because their economies revolve around the export of coffee, cotton and bananas.[1] In fact, approximately 40 per cent of the total G.N.P. of all the C.A.C.M. countries is derived from agriculture.

Although these nations experience an average real growth rate (see Table 1) of 4.1 per cent annually which is adequate in advanced countries it is inadequate in Central America because the G.N.P. of

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[1]Coffee is the leading export commodity in Central America. Exports of coffee normally run from 50 to 75 per cent of the total exports of Costa Rica, El Salvador, and Guatemala. They normally account for 15 to 30 per cent of the exports of Honduras and Nicaragua. From this we can see that any substantial decline in earnings from coffee would have a major effect upon the economic well-being and development of these countries. Such was the case in 1950 when a sharp decline in coffee prices caused a severe setback in the Central American economies. Today, cotton is tending to replace coffee as the major export product of Central America due to the limited international markets for coffee. Nicaragua and El Salvador are leading cotton producing countries, averaging three hundred thousand bales a year.

Banco Centroamericano de Integracion Economica, Opportunidades de Inversion en el Mercado Comun Centroamericano (Honduras: Banco Centroamericano de Integracion Economica, 1965), p. 37.

TABLE 1

CENTRAL AMERICA: GROSS NATIONAL PRODUCT AND PERCENTAGE OF ANNUAL GROWTH

Country	G.N.P. ($ millions)	Annual Growth of G.N.P., 1960-65
Costa Rica	$ 530	1.2%
El Salvador	783	5.2
Guatemala	1,220	3.7
Honduras	447	4.1
Nicaragua	486	6.9
Total	$3,466	4.1%

Source: "The Central American Common Market," World Business, I (July, 1966), 23.

each country is calculated from a low base as is the case for all underdeveloped countries.[2] However, the real per capita growth rate is quite small because of the average population growth of 3.2 per cent annually.[3]

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[2]The Secretariat General of the OAS reported that in 1966 the increase in Nicaragua's G.N.P. was 3.6 per cent; in 1967 it was 4.3 per cent. The per capita G.N.P. increased in 1966 by 0.7 per cent and 1.4 per cent in 1967.

"News from Latin America," Comercio Exterior de Mexico, XIV, No. 4 (April, 1968), 19.

[3]See Table 3.

Population

The population of Central America, which approximates that of the state of Pennsylvania, tends to settle in the temperate central plateau where much of the existing commercial and manufacturing activity is centered. The area of Central America is shown in Table 2 along with the total population, the urban and rural population and the density of people per square kilometer in each country.

TABLE 2

THE CENTRAL AMERICAN COUNTRIES: AREA, TOTAL POPULATION, URBAN AND RURAL POPULATION, DENSITY PER SQUARE KILOMETER MID--1967

Country	Area in Sq. Mi.	Total Population	Urban Population	Rural Population	Density Per Sq. Kilometer
Costa Rica	19,653	1,594,000	549,930	1,044,070	81
El Salvador	8,083	3,149,000	1,212,365	1,936,635	400
Guatemala	42,040	4,717,000	1,584,912	3,132,088	110
Honduras	43,277	2,455,000	569,560	1,885,440	53
Nicaragua	53,668	1,783,000	729,247	1,053,753	32

Source: Seventh Annual Report of the Social Progress Trust Fund, Inter-American Development Bank, Washington, D.C., 1968.

Central America's high rate of population growth (an average of 3.6 per cent per year) results in much unemployment because the rate of increase in employment opportunities is insufficient to provide employment for the increasing population. However, the problem

of unemployment is expected to decrease somewhat with the establishment of the Common Market. Table 3 illustrates the population growth rate per country, Gross Domestic Product per capita for 1967, and the estimated population of Central America for 1970.

TABLE 3

THE CENTRAL AMERICAN COUNTRIES: PERCENTAGE POPULATION GROWTH RATE 1963-1967; ESTIMATED POPULATION 1980; G.D.P. PER CAPITA--1966

Country	Population Growth Rate 1963--1967	Estimated Population 1980	G.D.P. Per Capita--1966
Costa Rica	3.6	2,728,000	415
El Salvador	3.8[a]	4,910,000	270
Guatemala	3.3	7,191,000	290
Honduras	3.5[a]	3,771,000	220
Nicaragua	3.8	2,824,000	330

[a]The population growth rate covers the years 1961-1967.

Source: Seventh Annual Report of the Social Progress Trust Fund, Inter-American Development Bank, Washington, D.C., 1968.

Topographical Factors

The path to economic growth chosen by Central American economies is to change from a purely agricultural economy to a more industrial economy. Since Nicaragua has the lowest ratio of arable land of all the Central American nations, industrial development is particularly

important to this country.[4] The major obstacle to industrialization in Nicaragua is a national economy which is too small to support alone an efficient manufacturing industry. Moreover, mountainous terrain imposes physical isolation which hinders geographic diversification of economic activity.[5]

Characteristics of the C.A.C.M.

The basic premises of the Central American Common Market are that (1) the Central American Market, if unobstructed by trade barriers, is large enough to support industries which could not be supported by individual national economies; (2) the opportunities of larger markets to attract foreign capital will augment insufficient domestic capital; and (3) it is necessary to diversify the economy of Central America and expand production in product areas where domestic demand will grow rapidly. An increase in the domestic market will decrease the export market's share of the total market; a desirable

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[4]Only a small proportion of arable land exists because of the area's mountains and rain forests. The proportion of arable land to total area is: El Salvador, 60 per cent; Honduras, 25 per cent; Costa Rica and Guatemala, 20 per cent each; and Nicaragua, 10 per cent.

[5]The five Central American countries occupy a narrow strip of land between Mexico and Panama encompassing 169,842 square miles as shown in Table 1. Parallel to Central America's Pacific coastline is the continuous chain of more than a hundred volcanic mountains, some of which are intermittently active. The characteristics of this rugged topography have made road construction an expensive and difficult task which, in turn, has hindered the economic development of this region.

situation since fluctuating prices of agricultural export commodities present many problems to these countries.[6]

In applying this general description of economic integration to Central America, the reader should note these basic characteristics of the Central American economies:

1. Although all of the countries have a low per capita income, there is substantial variance in per capita income among them.

2. In each nation, the distribution of income is uneven; that is, at one end of the income spectrum are a few very wealthy individuals while at the other end is the bulk of the population, which is extremely poor.

3. High rates of adult illiteracy--above 50 per cent--prevail in all the countries except Costa Rica.

4. All of the countries have high rates of population growth. From 1950 to 1962, annual rates of population increase varied from 3.9 per cent in Costa Rica to 2.8 per cent in El Salvador. Such high rates of population growth, in countries where available land and capital relative to the population are already low, greatly increase the difficulty of raising living standards.

5. Agriculture employs over half of the labor force of all five countries and produces between one-third and one-half of the Gross National Product.

6. All five economies are heavily export-oriented. Exports, mainly coffee, bananas, and cotton, account for the mass of their Gross National Product.

7. The majority of the populace is excluded from the market economy and exists by subsistence farming.[7]

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[6]"The Central American Community," Latin American Business Highlights, IX, No. 4 (Fourth Quarter, 1959), 2-4.

[7]Committee for Economic Development, Economic Development of Central America, The Research and Policy Committee of the Committee for Economic Development (New York: Committee for Economic Development, 1964), p. 24.

The purpose of the C.A.C.M. is economic integration of the member nations which will be accomplished in several steps: first, establishment of a free-trade area, then formation of customs union, followed respectively by a common market, an economic union and finally, complete economic integration.

Since the initial level of economic integration is traditionally a free-trade area, it becomes clear that tariffs must be abolished on goods produced and traded within the C.A.C.M. area. This is the primary step. However, member countries would maintain tariffs and other trade restrictions on imports from outside the C.A.C.M. The second step toward more complete economic integration is to be accomplished by forming a customs union which would establish a common external tariff on imports from nonmember nations. Third, inter-member restrictions on labor and capital must be eliminated which would result in formation of a common market at this stage. The next step in the progress toward economic union requires harmonization of economic policy among the participants of the C.A.C.M. Finally, economic integration requires unification and centralization of monetary, fiscal and social welfare policies.[8] The intergovernmental cooperation needed in the advanced stages of the C.A.C.M. integration is outlined in the "General Treaty" described later in this chapter.

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[8]Although the European Common Market integrates not only the local economies of each nation but also seeks a political union, it must be pointed out that at the moment no movement toward political unification among the C.A.C.M. nations is planned: only an economic one.

The Central American Common Market embodies the theory of comparative advantage i.e., a nation should produce and export commodities for which it enjoys a cost advantage relative to other commodities; similarly, it should import commodities for which it has a relative cost disadvantage. A relative cost advantage occurs when a country has a relatively abundant supply of the productive factors used to produce a given commodity because, ceteris paribus, price is inversely related to the supply of factors. By integrating and centralizing the economic activities of the Central American nations and by removing restrictions on factor flows among member countries, the Central American Common Market can expand the supply of productive factors available to each industry and reduce input costs.

Objectives of Integrated Industries

The objectives of the "integrated industries" scheme are: first, to encourage establishment of complementary industries in the Central American nations whose products will have freedom of movement within the C.A.C.M. and protection from competition until they are well established; second, to promote "rational" use of developmental resources; and third, to insure distribution of industrial development to some degree throughout the region.

By placing tariffs on key imported manufactured commodities, for instance, chemical products, the Central American Common Market applies the "infant industries" theory. Protective tariffs are used to prevent international competition of established industries from

harming newly founded enterprises. Once established, the new industry, it is expected, will enjoy a comparative cost advantage and will be able to compete against established industries of other countries.[9] The infant industries theory is a long-run application of the principle of comparative advantage.

Some Factors of Growth and Unification

Economic growth is a unique process; it can only be accomplished by adapting development programs to the special needs of an area. Benjamin Higgins claims: "To some degree, at least, each underdeveloped country is a base unto itself."[10]

An underdeveloped country's problems may be economic, technological, psychological, sociological, cultural, political, or geographic. In the case of Nicaragua, cultural and economic factors, education, agriculture and land reform, are the most significant and are deserving of more concentrated analysis regarding growth and unification.[11]

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[9]J. D. Cochran, "Central American Economic Integration: The Integrated Industries Scheme," Inter-American Economic Affairs, XIX (Autumn, 1965), 63-74.

[10]Benjamin Higgins, Economic Development: Principles, Problems and Policies (New York: W. W. Norton and Co., Inc., 1959), p. 81.

[11]Some economic factors of underdeveloped nations are a high proportion of the population in agriculture, low per capita income and expenditures only for necessities. Demographic factors may be high birth and mortality rates, malnutrition and rudimentary hygiene. Inadequate educational facilities, child labor, and no middle class are some cultural and political factors. Technological problems may include low yields per acre, poorly trained technicians, inadequate transportation and crude technology.

Education

One of the greatest problems in Latin America is the development of a skilled labor force. Plants using untrained or semi-trained manual labor make up much of the Central American industrial complex. Only 37 per cent of the total population in Central America have basic skills for the developing industries.[12] Also, the population of Central America consists mainly of young people; an estimated 40 per cent of the entire population are under fifteen years of age.

The relationships among education, literacy and economic development are important in Central American nations. Educational programs should be carefully selected and managed so that available skills will correspond to available opportunities. Therefore, in the opinion of some, business leaders should act in their own interest by supporting tax increases for education.[13] In addition to capital, the judgment and experience of the business world are also needed.

Although on-the-job training increases productivity and broadens the experience of the workers, worker education programs directly associated with the special needs of an industry can also be a useful contribution to the vocational curriculum in the school system. Since a supply of skilled labor is essential to industrial activity, the success of the "integrated industries" could largely

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[12]Committee for Economic Development, op. cit., pp. 17 and 36.

[13]The Research and Policy Committee of the Committee for Economic Development, A Statement on National Policy, Cooperation for Progress in Latin America (New York: Committee for Economic Development, 1961), p. 21.

depend on the ability of governments of the C.A.C.M. countries to improve education.[14]

Along with her economic development program, Nicaragua is attempting to improve her labor force by setting up better vocational schools and raising the academic standards of the university system.[15] Through the National Development Institute, scholarships and loans are made available to those who qualify for advanced degrees or technical studies. The government also provides stipends for study at American universities. To develop competent professional executives who will take their rightful places in Nicaraguan industry, a new university has been projected at a cost of ten million dollars by the Instituto Centroamericano de Administracion de Empresas (INCAE).[16]

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[14]The World Bank has recently granted a 4 million dollar credit line to Nicaragua for an improved secondary school system. The total cost will amount to 8 million dollars of which 4 million will be supplied by the Nicaraguan government.

"News from Latin America," Comercio Exterior de Mexico, XIV, No. 6 (June, 1968), 19.

[15]The Inter-American Development Bank has provided $250,000 for 8 years at 2 1/4 per cent interest for the plan and design for a Managuan university.

International Financial News Survey, XX, No. 20 (May 24, 1968), 175.

[16]Harvard University is participating in this program, not only by sending to Nicaragua trained professors, but also by contributing several million dollars.

F. D. Sola, Instituto Centroamericano de Administracion de Empresas (Nicaragua: Imprente Nacional, 1966), p. 1.

Changing Role of Agriculture

Since agriculture now plays a major role in the economic welfare of the Nicaraguan people and will for many years, this country's development policy should raise agricultural productivity to a level of self-sufficiency by developing an industrial base that would contribute to an increased output of agriculture. Table 4 presents the percentage of agriculture's contribution to G.N.P. of the five C.A.C.M. countries for the years 1960-1966. From these figures, it is evident Nicaragua has not kept pace with the other countries.

TABLE 4

PERCENTAGE OF AGRICULTURE'S CONTRIBUTION TO G.N.P. OF THE FIVE C.A.C.M. COUNTRIES, 1960-1966

Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
1960	.32	.31	.31	.38	.37
1966	.31	.27	.30	.41	.30

Source: The Seventh Annual Report of the Social Progress Trust Fund, op. cit.

The Central American governments are trying to combat the decline of agriculture by introducing advanced methods of mechanization, crop rotation, irrigation, and use of fertilizers and insecticides. These methods could make agriculture as promising in terms of regional development as the new industries coming into the area.

For agriculture to benefit from a chemical industry, vocational agriculture courses in the utilization of fertilizers and insecticides are needed. Besides, a large number of farm agents are necessary so farmers can obtain practical advice on growing of crops.

Land Reform

The old feudal system of land distribution has to be reformed. A broader distribution of land ownership in Nicaragua will change the traditional social structure. The tenure system of land ownership must be abolished. It is not merely a question of a more equitable distribution of income but also of the status and security associated with ownership of land. Large areas of undeveloped land are still publicly owned and are, therefore, immediately available without compensation to private owners. In some cases, extensive areas of privately owned land have not been developed because of lack of capital, transportation, or demand for the crops suitable for these areas. Such areas may be acquired from the owners for development at moderate prices. Land reform, although it may be difficult, expensive and slow, increases the stake of the common man in his society and in the economic development of his country.

Industrial Production

The industrial production of the Central American nations consists mostly of finished consumer products. Combined sales from food, drink, textiles, footwear and dress ornaments composed 72.6 per cent

of the industrial production in 1963.[17] However, the Central Bank of Central America (Banco Centroamericana de Integracion Economica) estimates the chemical industry's participation by share in the industrial sector will be approximately 22 per cent of Central America's total industrial production in 1970.[18]

The sale of chemical products in Central America during 1962 exceeded 106 million dollars. Since Nicaragua is the major importer proportionally (19.8 per cent of the total Nicaraguan imports are chemicals), there is a strong basis for assigning the chemical industry to Nicaragua. Furthermore, Nicaragua imports mainly organic products, insecticides, pharmaceutical products, cosmetics, soaps and detergents.[19]

Some Effects of Tariff Reduction

Since one of the major tasks of the C.A.C.M. is removal of import and export duties among the member nations, gradual tariff reductions have been coordinated with the creation of skilled labor and development of natural resources. The diminishing tariff rate for

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[17]Mision Conjunta de Programacion para Centroamerica, Encuesta Industrial Centroamericana (Guatemala: Secretaria Permanente del Tratado General de Integracion Economica Centroamericana, 1964), p. 29.

[18]Secretaria Permanente del Tratado General de Integracion Economica Centroamericana, Primer Seminario Nacional Sobre Integracion Economica Centroamericana (Guatemala: Secretaria Permanente del Tratado General de Integracion Economica Centroamericana, 1965), p. 42.

[19]Ibid., p. 53.

intra-zonal trade and a consequent increase in that trade has resulted primarily from the speedy utilization of the untapped capacities of the member nations when the Common Market became a reality. It is estimated during this decade that the trade between the countries of the Central American Common Market will rise approximately 25 per cent yearly.[20] Table 5 shows the value of this intra-regional trade from 1950 to 1963 while Table 6 provides later and more complete data on intra-Central American exports and imports.

Presently, intra-regional trade represents 12 per cent of Central America's imports and, as a result of substituting C.A.C.M. products for outside products, will increase to 17 per cent in 1969 and to 21 per cent in 1974.[21]

Background of the Central American Agreements

A caustic soda-chlorine chemical industry in Nicaragua is being established by the combined efforts of the five Central American countries through treaties and agreements which they have adopted.

Under the auspices of the Economic Integration Program, the result of a series of efforts since 1950 by the Central American Countries to broaden their internal markets, the participating nations have coordinated their development plans. Changes in the productive structure of each of the five member countries in the Latin American trade

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[20]"Growth of Inter-Central American Trade," Commercio Exterior de Mexico, XII, No. 1 (January, 1966), 23.

[21]Ibid.

TABLE 5

INTRA-CENTRAL AMERICAN COMMERCE 1950-1963
(MILLIONS OF DOLLARS)

Year	Volume, Millions of Dollars	Base Year 1960 = 100
1950	8.3	25.3
1957	16.6	50.7
1958	20.5	62.7
1959	28.0	85.6
1960	32.7	100.0
1961	36.8	112.5
1962	50.4	157.1
1963	66.2	202.4

Source: Banco Centroamericano de Integracion Economica, Oportunidades de Inversion en el Mercado Comun Centroamericano (Honduras: Banco Centroamericano de Integracion Economica, 1965), p. 47.

TABLE 6

INTRA-CENTRAL AMERICAN TRADE, 1966
(THOUSANDS OF DOLLARS)

Exporting Countries	Total	Importing Countries				
		Guatemala	El Salvador	Honduras*	Nicaragua	Costa Rica
Guatemala	55,885	----	27,192	10,614	8,936	9,143
El Salvador	57,528	23,910	----	15,971	9,976	7,651
Honduras	21,490	3,951	13,444	----	2,165	2,030
Nicaragua	15,288	2,120	5,542	3,258	----	4,368
Costa Rica	26,059	4,257	5,885	5,319	10,598	----
Total	176,250	34,238	52,063	35,162	31,675	23,192

*Estimates based on the first nine months of the year.

Source: Newsletter, Permanent Secretariat for Central American Economic Integration, May 12, 1967.

area are needed for complete economic union. Although the economic integrationists' desires for industrial unity in the Latin American Isthmus are rooted in early colonial periods, only recently when the need to meet the demands of the populace for economic development and to furnish employment for the rapidly increasing and expanding population was recognized, did the economic integration movement begin in earnest.

Three Stages of Development

Three stages are projected for economic integration in Central America: first, the period of formation from 1950 to 1958, the establishment of protective tariffs and development of regional industries; second, the period of organization from 1958 to 1960, the establishment of the C.A.C.M. as an administrative process; and third, the period of instrumentation which started in 1960 and will end once the customs union has been instituted among the members.

Period of Formation: 1950 to 1958

During the first phase, that of formation, many preliminary plans for economically unifying Central America were studied. However, it was necessary to keep economic policy broad and general to meet local conditions.

A uniform customs schedule.--Since the C.A.C.M. was to be a customs union, five years were spent studying and developing a uniform customs schedule for the five participating nations. This idea was formalized with the publication in 1955 of the Nomenclature Arencelaria

Uniforme Centroamericana which established a uniform customs schedule for the five Latin American countries. This document lists the duties to be levied on enumerated products imported into any of the Central American countries. A common external tariff, applied to 98 per cent of the commodities designated in the schedule, serves as an inducement for the Central American nations to purchase products from the integrated industries.[22] Table 7 presents these customs duties and charges applicable to chemical products expressly related to the Nicaraguan chemical complex.

The "Multilateral Treaty."--A second Central American compact which covered comparative import laws was actually the first integration agreement of the five nations allowing practical economic application. This treaty, signed in Tegucigalpa, Honduras, on June 10, 1958, is entitled the Multilateral Treaty on Central American Free Trade and Economic Integration.[23] This treaty liberalizes trade policies among the member nations. For example, agricultural and manufactured merchandise can be traded freely among the five countries; there will be no quota restrictions. Since Nicaragua is assigned a chemical industry, her chemicals have free access to the entire market area. The proposed chemical industry is to be treated as a domestic firm by

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[22]For more of the chemical products listed in the Nomenclature Arencelaria Uniforme Centroamericana (NAUCA), see Appendix A.

[23]The Multilateral Treaty on Central American Free Trade and Economic Integration will henceforth be referred to as the "Multilateral Treaty."

TABLE 7

SPECIFIC PORTIONS OF SECTION FIVE OF THE NOMENCLATURA ARANCELARIA UNIFORME CENTROAMERICA (NAUCA) WHICH APPLY TO THE CHEMICAL COMPLEX IN NICARAGUA

Description	Uniform Obligation for Imports		
	Unit	Specific Dollars Per Unit	Ad Valorem (Per Cent of C.I.F.)
1. 511-03-00			
Soda hydroxide (soda or caustic soda)	Gross Kilos*	$0.40	10%
2. 512-09-01			
Camphor (natural or artificial) and derivatives			
a. 512-09-01-01			
Camphene chlorides: insecticide preparation	Gross Kilos	$0.10	14
b. 512-09-01-09			
Other camphors	Kilos	$0.15	15
3. 512-09-03			
Halogen derivatives from hydrocarbons			
a. 512-09-03-01			
Chloroform	Gross Kilos	$0.05	10
b. 512-09-03-02			
Refrigeration gases, liquids or solids (Freon gas, etc.)	Gross Kilos	Free	10
c. 512-09-03-03			
Di-chlorine: Di-carbolic acid: Trichlorathane (DDT) and other chlorine chemical products needed for insecticide preparation	Gross Kilos	Free	10
d. 512-09-03-04			
Chemical products not chlorinated needed for insecticide preparation	Gross Kilos	Free	5

TABLE 7--Continued

Description	Uniform Obligation for Imports		
	Unit	Specific Dollars Per Unit	Ad Valorem (Per Cent of C.I.F.)
e. 512-09-03-09 Other derivatives of Halogen not listed above	Gross Kilos	$0.05	15%

all members of the C.A.C.M. to insure a ready market for its products. At the same time, each participating state is to refrain from granting favorable custom exemptions on imports from outside the C.A.C.M., a restriction applying to articles listed in the schedule of the "Multilateral Treaty." This limitation protects the chemical industry by enabling Nicaragua, with the help of the other member countries, to control more effectively foreign chemical competition. Furthermore, each member state must take the necessary steps to present exportation of its products to other member countries at prices lower than current market prices. All countries must also maintain standardized transportation rates.

It is further agreed that the central banks of the C.A.C.M. countries will follow a policy to prevent currency speculation and maintain currency convertibility among the members for the purpose of guaranteeing stability and uniformity of exchange and facilitate greater trade between the members.

To encourage investment in the C.A.C.M. industries, citizens of the member nations who wish to invest in domestic industries or in industries of other countries within the C.A.C.M. will receive equal treatment by all member nations. Under the "Multilateral Treaty," a Central American Commerce Commission has been created to research the feasibility of a complete customs union to facilitate investment.[24]

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[24]"Multilateral Treaty on Central American Free Trade and Economic Integration," Economic Integration Treaties of Central America, ROCAP (Guatemala: Agency for International Development, 1964), p. 6.

Actually, the purpose of this treaty is to broaden the base of existing and future industries and permit unrestricted circulation of all economic goods in the Latin American Isthmus, necessary factors for establishing the integrated industries.

The Period of Organization: 1958 to 1960

With the recognition that a compelling impetus was necessary to make the C.A.C.M. a reality, in September, 1959, the five member countries launched the second phase of their economic integration program.

The "Integrated Industries" Treaty.--The document, The System of Central American Integrated Industries, gives economic protection to industrial plants considered necessary for development of the Central American market. This agreement attempts to establish a system of protective tariffs, quotas and embargoes against nonmember nations of the C.A.C.M. to provide a regional monopoly for each country and eliminate vertical competition. Increased tariff rates on similar or substitute goods imported from nonparticipating nations into the C.A.C.M. area have been established by the member nations to protect the "infant industries."

Since Nicaragua is assigned the chemical industry, if a chemical company should install a new plant in another nation of the C.A.C.M., it will not enjoy the same privileges extended Nicaraguan industry. Also, products imported into the five nations of Central America from the rest of the world will have to pay full import duties,

based on standard charges as established in the Nomenclature Arancelaria Uniforme Centroamericana.

It is hoped that this agreement will serve to keep all prices and all qualities of goods equal during the first ten years of the existence of the "General Treaty" provisions.

The equalization of import duties.--The real impetus for the C.A.C.M. was found in the passage of the Central American Convention on the Equalization of Import Duties and Charges; a customs union for Costa Rica, Nicaragua, Guatemala, El Salvador and Honduras became a reality.[25] This treaty was signed in San Jose, Costa Rica on September 1, 1959. The purpose of this agreement is to establish a uniform Central American customs policy by equalizing import tariffs in all five Latin American countries. Such a tariff policy insures Nicaragua's right to trade freely with the other Central American Common Market countries and, at the same time, regulates the import of substitute goods for the protection of the industries of each member nation.

The Period of Instrumentation: 1960

The "General Treaty."--In the third phase, the instrumentation, the previous treaties were combined in The General Treaty of Central American Economic Integration which was signed in Managua, Nicaragua on

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[25]The Central American Convention on the Equalization of Import Duties and Charges will henceforth be referred to as the "Equalization of Import Duties."

December 13, 1960.[26] This treaty was the decisive step in establishing a Central American Common Market. The contracting parties agreed to establish among themselves a common market to be completed within a maximum of five years from the effective date of June 4, 1961. A uniform customs schedule was adopted, and the established monetary controls reaffirmed. Government subsidies by the member nations on exports to other C.A.C.M. countries would not be allowed. Normal value of goods would be maintained, full freedom of transit guaranteed, and the retailing or distribution of member countries' products in domestic markets protected against regulatory discriminations. These stipulations help to clarify the more abstract industrial development philosophy first mentioned in the "Multilateral Treaty."

Since the "General Treaty" became effective in 1961, free trade has become better established in Central America. All of the products of the C.A.C.M. trade area, with the exception of a few, are freely traded.[27] Hence, under the terms of this agreement, the chemical industry of Nicaragua receives fiscal incentives, import tariff advantages and free trade privileges.

Not only did the "General Treaty" adopt the industrial development philosophy of the "Multilateral Treaty," but it also establishes an administrative organization to coordinate and centralize the

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[26]The General Treaty of Central American Economic Integration will henceforth be referred to as the "General Treaty."

[27]This list of exceptions includes such items as sugar, cement, cigarettes, salt and beverages.

C.A.C.M. program. Two permanent bodies have been created: The Economic Council and the Executive Council. The Economic Council, the governing body of the C.A.C.M., will have to resolve all questions which might affect the efficient operation of the Common Market. The Executive Council essentially has a technical consultative function. When a member government wishes to establish and protect an infant industry, it makes a formal application to the Executive Council which examines the validity of the proposal. After studying the situation, this body proposes customs regulations which are sent to the Economic Council for its approval.

All provisions recommended by the Economic Council must then be ratified by the permanent Secretary for the General Treaty of Economic Integration (SIECA). These privileges are effective the first day of plant construction. This mechanism greatly speeds up the industrial integration process in the five Central American countries.

A second agreement of the "General Treaty," pertaining to the creation of a Central American Bank for Economic Integration, was concluded on December 13, 1960 by a group representing the five countries. This bank enables the C.A.C.M. members to finance and promote new industries in the trade area on an equal regional basis.

The "Fiscal Incentives Treaty."--This last phase also created a uniform fiscal-industrial code, adopted in 1962 by the five member countries of the C.A.C.M., to supplement each country's laws regarding their respective industries. This code established the Central

American Agreement on Fiscal Incentives for Industrial Development.[28] The basic feature of this agreement is the categorization of the industries into three groups: first, those pertaining to the fundamental area i.e., specifically designated as basic integrated industries; second, those pertaining to necessities and conveniences of industrial areas; and third, those pertaining to tax privileges.[29] Classification is based on the advantages which an industry gives the trade area.

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[28]The Central American Agreement of Fiscal Incentives for Industrial Development will henceforth be referred to as the "Fiscal Incentives."

[29]Industries in the maximum benefit category are eligible for the following tax incentives:

a. total exemption from customs duties and charges on machinery and equipment imports for a ten-year period;

b. exemption on a decreasing scale from customs duties and charges on imports of raw material and semi-finished goods for ten years;

c. total exemption for five years from customs duties and charges on required fuel imports, except gasoline;

d. total exemption for ten years from income and profit taxes;

e. total exemption for ten years from taxes on assets and net worth.

CHAPTER III

THE ESTABLISHMENT OF A CAUSTIC SODA-CHLORINE PLANT: NICARAGUA, PHASE I, 1966-1970

The establishment of a chemical industry in Nicaragua, in accordance with the Central American Common Market integration movement, has been projected for two time periods. The basic inorganic chemicals such as caustic soda, chlorine and chlorinated camphene, needed for industrial development of Nicaragua and the entire C.A.C.M. trade area, should be available with the completion of the first phase of development. These products complement the second phase which is projected for establishment before 1975. These two time periods should give Nicaragua a diversified chemical industry which can supply the chemical markets in Nicaragua and Central America.

Chemical Projections: The First Phase

Electrolysis Plant

An electrolysis plant has been projected which will produce caustic soda and chlorine. The sale of these products and the process' by-products, sodium hypochlorite, hydrochloric acid and hydrogen,

should aid the company financially and stabilize the prices of these chemical products in Nicaragua and the trade area.[1]

Camphene and Camphene Chloride Plants

Research indicates camphene chloride should be produced as well as caustic soda to achieve economy of scale. A camphene chloride plant would utilize liquid chlorine, a product of the electrolysis plant, to produce chloride-based insecticides used in Central America.[2]

The Nicaraguan Long Leaf Pine Company plans an extraction plant which will produce pine oil, resin and turpentine.[3] From Figure 1 which presents a diagram illustrating the first phase of developing a chemical complex in Nicaragua, it can be seen that two separate operations are projected: an electrolytic plant producing caustic soda and chlorine and an extraction plant which will principally produce turpentine.[4] Turpentine is a prime raw material, along with liquid chloride, in the production of camphene chloride.

Although this study is limited to the feasibility of the caustic soda-chlorine plant, the extraction operation is included on

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[1]Instituto de Fomento, Estudio de Facibilidad de Una Planta de Canfenos y Canfenos Chorados (Nicaragua: Instituto de Fomento, 1964), p. 33. (Mimeographed.)

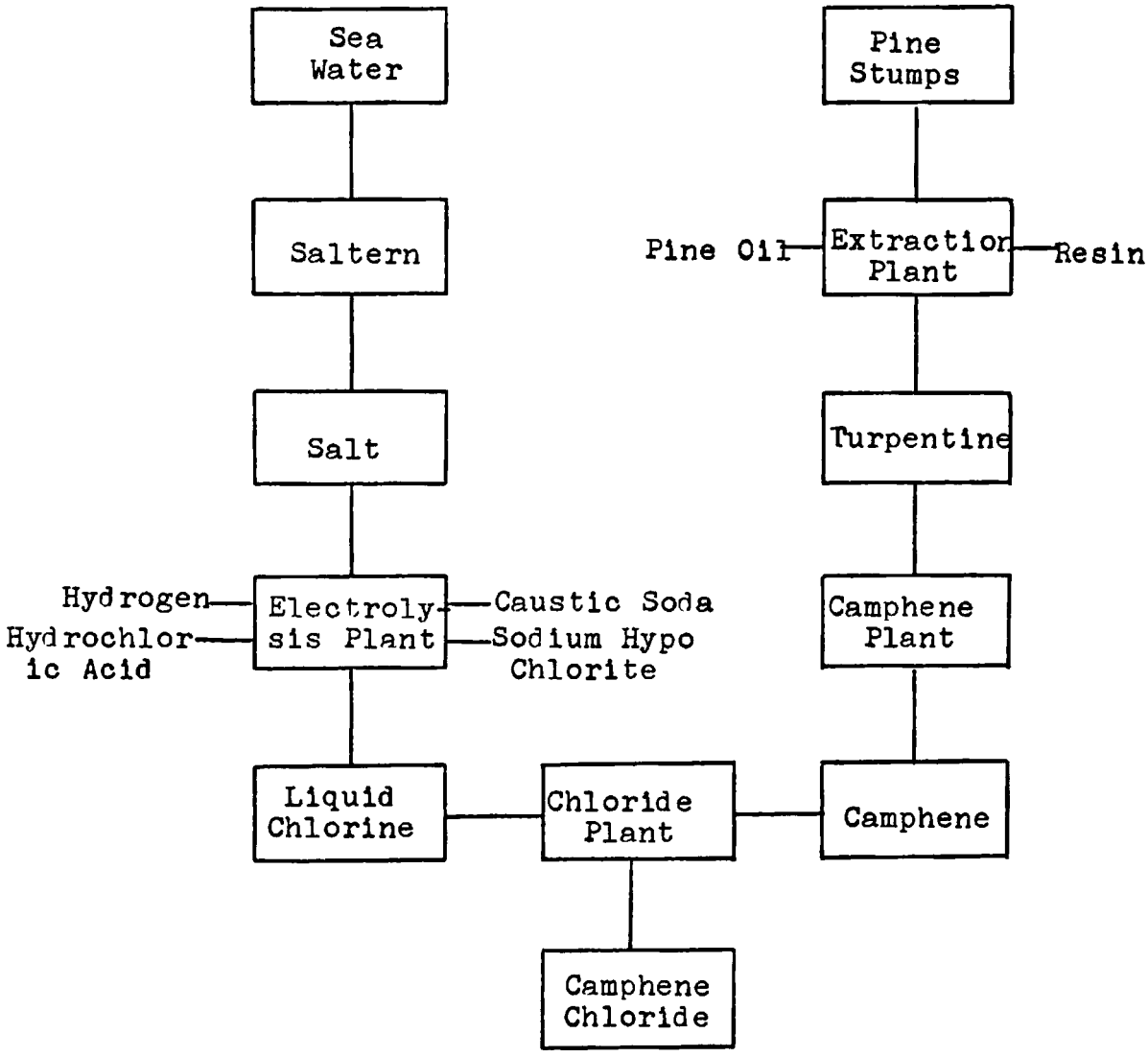
[2]Naciones Unidas, La Industria Quimica Pesada, Comite de Cooperacion (E/Cn. 12/CCE/323) (New York: United Nations, 1963), p. 46.

[3]Novedades, December 23, 1965.

[4]This electrolytic process is described in the next section of this chapter.

Nicaragua: Chemical Complex; Salt, Caustic Soda, Chlorine, Turpentine and Camphene Chloride.

(Figure 1)



Source:

F.A. Zayas, "The Central American Common Market and the Chemical Industry in Nicaragua," (Paper Read at the First World's Convention for Chemical Engineering, Mexico City, Mexico, October 17-20, 1965), p. 9.

the diagram because it provides one of the necessary raw materials for camphene chloride manufacture which insures a market for liquid chlorine.[5]

Chemical Projections: The Second Phase

Three plants for sulphuric acid, phosphoric acid and superphosphates are projected to provide the raw materials for fertilizer production in the second phase of development. Also, two plants are planned for the manufacture of pulp and paper. In addition, the feasibility of a wood distillation industry is being examined. If methylene can be produced in Nicaragua, the manufacture of such solvents as methyl chlorine, methylene chloride, chloraform and carbon tetrachloride will be possible. Studies are also underway to evaluate the feasibility of polyvinylchloride, parathion, benzene hydrochloride, ether, ethylene and polyethylene plants.[6]

It must be kept in mind that this paper attempts only to determine the profitability of a Nicaraguan caustic soda-chlorine plant; therefore, the following survey is designed merely to demonstrate this plant is feasible.

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[5]F. A. Zayas, "The Central American Common Market and the Chemical Industry in Nicaragua" (paper read at the First World's Convention for Chemical Engineering, Mexico City, Mexico, Oct. 17-20, 1965), p. 10.

[6]Consejo Nacional de Economia Oficina de Planificacion, Plan Nacional de Desarrollo Economico y Social de Nicaragua (Nicaragua: Imprente Nacional, 1965), pp. 99-107.

Raw Materials

Salt

Background.--Salt is the principal ingredient needed in the production of caustic soda and chlorine.[7] There are several existing salterns in the Tamarindo-Puerto Somoza area which is considered the most suitable site for the projected saltern operation.[8] Some of these salterns are idle while others operate on a "cottage scale." In some of these operations solar evaporation is combined with a crude type of thermal evaporation which produces a low grade of salt not suited for electrolysis.[9]

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[7]U.S. Department of Commerce, Summary of Infonac's Industrial Program for the Period 1965-1967 (Washington, D.C.: Clearinghouse for Federal Scientific and Technical Information, 1965), p. 16.

[8]For the successful operation of a solar salt evaporating facility, low annual rainfall, warm temperatures, low humidity and a prevailing wind, factors affecting evaporation, are needed. In addition, the saltern should be located close to the sea to capture the sea water at high tide and minimize pumping requirements. The soil in the saltern area must be impervious to reduce leakage in the pond area.

In addition, the Tamarindo-Puerto Somoza area has roads connecting with the main highway to Managua for easy delivery of the salt to the proposed plant location.

[9]The specifications of salt for electrolysis are the following:

Calcium, as Ca	0.2% maximum
Magnesium, as Mg	0.1% maximum
Sulphates, as SO_4	0.5% maximum
Chlorides, as Cl	58.0% minimum
Humidity	3.0% maximum

Saltern operation.--In a saltern operation, sea water first enters a concentrating pond. As the density of the brine increases with evaporation, the water is moved to another pond where impurities are precipitated.[10] After the precipitation of impurities, the brine is transferred to a crystallizing pond where most of the salt crystallizes in a fairly pure state. When this stage is completed, the bittern is drained from the crystallized salt and returned to the sea.[11] The salt is then harvested manually or mechanically from the crystallizing pond. This method of controlled operation is necessary to insure a maximum quality salt.

Cost of saltern.--The costs of constructing and operating a saline plant are not important in this study. Salt production is to

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Also the content of steel must be low; it must also contain vanadium, chrome, barium, nickel, aluminum and other heavy metals. The minimum quality of salt 95-96.5 per cent would have to be washed before use in the electrolysis plant.

C. L. Mantell, Electrochemical Engineering (New York: McGraw-Hill Book Company, Inc., 1960), pp. 256-57.

[10]During the stage of concentration, calcium magnesium, iron carbonate and calcium sulphate are precipitated.

Radha K. Raman, "Brine Preparation and Purification in the Electrolytic Caustic Soda Industry," Caustic Soda Production Technique (New York: Noyes Development Corporation, 1962), p. 8.

[11]Webster's New Collegiate Dictionary defines bittern as the the "bitter mother liquor in saltworks after the salt has crystallized out."

be undertaken by the Morton Chemical Corporation as a separate business venture from the caustic soda-chlorine plant.[12]

Auxiliary Raw Materials

Along with salt, which is the most important ingredient in the manufacture of caustic soda and chlorine, other necessary raw materials are sulphuric acid, mercury, barium carbonate, and sodium carbonate.[13]

Production Requirements

Physical Characteristics

Major factors which must be analyzed before building a chemical plant are: plant location, transportation facilities, natural resources (water, electrical energy, fuel), plant equipment, buildings and labor.

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[12]R. W. Booker and Associates, Inc., a U.S. chemical engineering firm which studied the costs of the first phase of the caustic soda-chlorine project, estimated that a new saltern in Nicaragua would cost a total of $624,716; the cost of renovating and expanding existing facilities would be $295,915.

[13]Specifications for raw materials:

	Pureness
Barium Carbonate	98-99%
Graphite	99 %
Mercury	99.5 %
Sodium Carbonate	98 %
Sulphuric Acid	98 %

S. L. Sastry, "Chemical Caustic Soda Production with special reference to Rayon Grade," Caustic Soda Production Technique (New York: Noyes Development Corporation, 1962), pp. 42-43.

Plant location.--Managua, along with Corinto and Tamarindo, has been considered for the plant location. The principal advantage of the Managuan site is the easy access to railroads, highways and airlines. Likewise, the availability of labor and markets also indicates Managua would be most advantageous for a plant. Raw materials can be brought to Managua from salt mines in the Tamarindo-Puerto Somoza area on the Managua-Corinto highway while imported items will come through the port of Corinto.[14]

Transportation facilities.--Transportation facilities are adequate in Managua. Hard-topped highways and good railroad tracks are adjacent to the plant. Products for the Central American market can be transported over the Pan American Highway, the best means of communication in the Isthmus.[15]

Natural resources.--Water, electrical energy and fuel resources are necessary for operating the caustic soda project.

Water.--The principal use of water in this project is for cooling purposes. Since large quantities are needed, a good source at the lowest price is important. At the Managua site water can be obtained

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[14]Instituto de Fomento Nacional, Empresas Industriales Privadas en Nicaragua (Nicaragua: Instituto de Fomento Nacional, 1964), p. 21.

[15]A. Gutt, Central American Transportation Study Summary Report, United States Information Service (Washington, D.C.: Government Printing Office, 1965), p. 32.

from Lake Managua or from wells which would only have to be approximately 150 feet deep.[16]

It is estimated that water from various sources would cost in decreasing order:

1. Water from a municipal system,
2. Deep wells,
3. Shallow wells and
4. A nearby body of water.[17]

Cost of water is estimated to be approximately $0.03 for each thousand gallons. However, the need to purify the water may raise the cost to an estimated $0.10. The cost of water is discussed in Chapter VII along with other costs of production.

Electrical energy.--Because of the nature of the industry, electrical energy will be a major cost.[18] An agreement with the National Light and Power Company (Empresa Nacional de Luz y Fuerza) to set the price of electricity at approximately $0.01 per kilowatt hour is anticipated.[19] Energy costs at this price level represent 30 to 35

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[16]R. W. Booker and Associates, A Feasibility Report: Caustic Soda-Chlorine and Insecticides, Prepared for Instituto de Fomento Nacional, Managua, Nicaragua, Second Report (Missouri: R. W. Booker and Associates, 1965), p. 62.

[17]Ibid.

[18]K. Vyasulu, Posibilidades de Desarrollo Industrial Integrado de Centro America, Comision Economica Para America Latina, Vol. II (Mexico: Naciones Unidas, 1965), p. 17.

[19]Instituto de Fomento Nacional, A Suggested Five Year Program for the Development of Industry in Nicaragua (Nicaragua: Imprente Nacional, 1964), p. 27.

per cent of the total cost of production.[20] During the first year of operation it is estimated that the plant will consume over 32 million kilowatt hours, costing $320,000 at the negotiated price. See Table 39, Chapter VI for the projected costs of electrical power.

The required energy resources are available in Managua; the heaviest electrical transmission lines are located near the proposed site. Also, the chemical facility is near the thermoelectric plant, the center of electrical distribution.[21] The proposed plant needs low voltage, direct current for the caustic soda-chlorine plant and normal voltage, alternating current for power and lighting.[22]

The Tuma hydroelectric project, about sixty miles from Managua, which is to be completed in 1968, and an older electrical system should furnish a total of 800,000,000 kilowatt hours per year.

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[20]High operating costs in Central America necessitate this high price which far exceeds that of the U.S. (The TVA provides electricity at .003 cents per kilowatt hour.)

[21]The International Bank for Reconstruction and Development (El Banco Internacional de Reconstruccion y Fomento) granted a loan of $5,000,000 for expanding the capacity of electric lines and the transmission facilities of the National Light and Power Company. This loan will help finance the purchase of a gas turbine, improvement of transmission networks and distribution.

In addition, major expansion of Nicaragua's electric power supply will be assisted by a loan of $15.25 million announced on May 22, 1968 by the World Bank. This loan to Empresa Nacional de Luz y Fuerza will increase this company's generating capacity by 90 megavolts for a total of 195 megavolts.

"RBRD Loan to Nicaragua," International Financial News Survey, XX, No. 22 (June 7, 1968), 9.

[22]R. W. Booker and Associates, op. cit., p. 61.

Excess or "dump power may be available during times of seasonal high water at rates estimated at $.007 per kilowatt hour and during flash high water at $0.003 per kilowatt hour."[23] However, to be assured of dependable, constant power, $.01 will have to be paid per kilowatt hour.

Fuel.--The proximity of the Standard Oil Petroleum Refinery will minimize the cost of shipping fuel. Bunker C fuel oil, required for the chemical plant, can be obtained for less than $0.10 per gallon. An estimated 60,000 gallons of oil will be required during the first year of operation at a total cost of less than $6,000.[24] .

Plant equipment and buildings.--Buildings needed for the caustic soda-chlorine process are one storage room for the salt, a room or building for the electrolytic cells and a building to house the equipment for the liquefication of chlorine. Another building will be necessary for the manufacture of caustic soda, a control room and a roofed area for the handling and filling of cylinders.[25]

Personnel

The entire Pacific zone of Nicaragua has an abundance of unskilled laborers; Managua, however, the largest city and capital of the country, has the largest number of skilled laborers. Also,

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[23]Republica de Nicaragua, Presumpuesto Por Programas 1966 (Nicaragua: Imprente Nacional, 1966), p. 12.

[24]R. W. Booker and Associates, op. cit., p. 63.

[25]Ibid., p. 59.

Managua has the best qualified professional personnel.[26] Table 8 shows the number of employees the projected caustic soda-chlorine plant will need when producing at the full capacity of 7,285 metric tons of caustic soda and 6,804 metric tons of chlorine during the first year of operation.

TABLE 8

ESTIMATED PERSONNEL: NICARAGUAN CAUSTIC SODA-CHLORINE PLANT; PRODUCTION CAPACITY OF 7,285 METRIC TONS OF CAUSTIC SODA AND 6,804 METRIC TONS OF CHLORINE

	Manufacturing Process	Administration	Sales	Total
Administrators	--	2	1	3
Office Workers	--	5	3	8
Technicians	14	-	-	14
Laborers:				
Skilled	54	-	-	54
Semiskilled	23	-	-	23
Nonskilled	8	-	-	8
Total	99	7	4	110

Source: Instituto de Fomento, "Estudio de Factibilidad de la Salina de El Tamarindo" (Nicaragua: Instituto de Fomento, 1964), p. 18. (Mimeographed.)

[26]Instituto de Fomento, Dept. de Credito, Analysis de Solicitud de Prestamo de Industrias Quimicas Atlas de Centroamerica, S.A. (Nicaragua: Instituto de Fomento, 1965), p. 26. (Mimeographed.)

Optimally, the plant will operate twenty-four hours a day, seven days a week. To comply with the labor laws of the country, four shifts will be necessary, each one working three days each week for eight hours. The other three working days will have a six-hour shift; the seventh day is free.[27] Table 9 shows the proposed four shift work program.

Technological Process

The electrolysis of common salt to obtain caustic soda, chlorine, hydrogen, and the synthesis of hypochloric acid and sodium hypochlorite are industrial processes which passed the experimental stage years ago.[28] It is anticipated that a United States chemical manufacturing corporation, the Pennsalt Chemical Company, will control and operate the Nicaraguan caustic soda-chlorine plant.[29] Since this company has operated electrolytic plants for many years, technological difficulties with processes and equipment are not expected. In keeping with the purpose of this study, the chemical technology of producing soda and chlorine is only briefly described.

Background.--There are several chemical processes which produce caustic soda and chlorine. However, an early United Nations feasibility study of a caustic soda-chlorine plant in Central America endorsed

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[27] Ibid., p. 32.

[28] Sastry, op. cit., pp. 40-43.

[29] See Chapter VII for a discussion of this company.

TABLE 9

NICARAGUA: A FOUR SHIFT WORK PROGRAM
FOR THE CAUSTIC SODA-CHLORINE PLANT

Monday	Shift A	6 a.m. to 2 p.m.
	Shift B	2 p.m. to 10 p.m.
	Shift C	10 p.m. to 6 a.m.
	Shift D	Free
Tuesday	Shift D	6 a.m. to 2 p.m.
	Shift A	2 p.m. to 10 p.m.
	Shift B	10 p.m. to 6 a.m.
	Shift C	Free
Wednesday	Shift C	6 a.m. to 2 p.m.
	Shift D	2 p.m. to 10 p.m.
	Shift A	10 p.m. to 6 a.m.
	Shift B	Free
Thursday	Shift B	6 a.m. to 2 p.m.
	Shift C	2 p.m. to 10 p.m.
	Shift D	10 p.m. to 6 a.m.
	Shift A	Free
Friday, Saturday, and Sunday	Shift A	6 a.m. to 12 p.m.
	Shift B	12 p.m. to 6 p.m.
	Shift C	6 p.m. to 12 p.m.
	Shift D	12 p.m. to 6 a.m.

Source: Instituto de Fomento, Dept. of Credito, "Analisis de Solicituo de Prestamo de Industrias Quimicas Atlas de Centroamerica, S.A." (Nicaragua: Instituto de Fomento, 1965), p. 27. (Mimeographed.)

the use of the electrolytic process since it produced caustic soda and chlorine of the quality demanded.[30]

[30]Naciones Unidas, La Industria Quimica Pesada, op. cit., pp. 45-46.

This study also recommended that mercury cells be used instead of diaphragm cells. Although the original plant investment would be greater, production by mercury cells would yield liquid chlorine for use in other chemical plants in Nicaragua and Central America instead of solid chlorine, the product of the diaphragm process. In addition, mercury cells produce a higher grade caustic soda than diaphragm cells. Also, the savings in operation costs would justify the additional original investment. By producing liquid chlorine instead of solid chlorine there is an approximate cost differential of $17.00 to $20.00 per ton at the plant site. Liquid chlorine, produced in the mercury cells, costs less to transport than solid chlorine.[31]

Salt electrolysis.--"The heart of the mercury-type plant is a room filled with processing cells resembling lines of automobile batteries being charged."[32] The salt solution is moved into these electrolysis cells. The chlorine gas releases itself from the graphite anode and the sodium reacts with the mercury cathode forming an amalgamation which flows into a second cell.[33] The chlorine which has been released in a gas form flows to the upper part of the cell and then to a general collector. The chlorine is then dragged through this collector by the suction of compressors. Meanwhile, the sodium

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[31]Ibid.

[32]"Flowing Mercury Cathodes are Key to Producing Chlorine and Caustic Soda," Automation, XIII (August, 1966), 59.

[33]The cathode is a negative electrode while the anode is positive.

detaches from the mercury cathode and flows to the bottom of the cell. From there it goes to the regenerators where it reacts with hydrogen and oxygen in the water to produce caustic soda. Pure hydrogen is released simultaneously.

The caustic soda goes to measurement tanks and from there into tanks of storage for later use. The chlorine gas flows into an area for drying. In this process, approximately "eighty pounds of caustic soda are produced for every 71 pounds of chlorine."[34]

Products: Characteristics and Uses

Caustic Soda

Caustic soda, a white, deliquescent substance, is marketed in ground, flake, detached, pellet and stick form.[35] Among its uses are, "manufacture of other chemicals; rayon and film; petroleum and refining; pulp and paper; aluminum; detergents; soap; textile processing; vegetable oil refining; reclaiming rubber; as alkali in foods; regenerating ion exchange resins; organic fusions; etching and electroplating."[36] Also, caustic soda is a necessary ingredient in the plastic industries and beer industries in Central America.

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[34]"Flowing Mercury Cathodes are Key to Producing Chlorine and Caustic Soda," loc. cit., p. 59.

[35]Ralph K. Strong, ed., Kingzett's Chemical Encyclopaedia (New York: D. Van Nostrand Company, Inc., 1940), p. 894.

[36]The Condensed Chemical Dictionary (New York: Reinhold Publishing Company, 1961), p. 865.

The historical and projected demand for caustic soda in the C.A.C.M. countries is discussed in Chapter V.

Chlorine

Chlorine is an element that is found in nature only in the combined state. As a gas it has a greenish-yellow color but when compressed into a liquid, it is clear amber.[37] In the gaseous state chlorine is nonflammable and two and a half times as heavy as air. Liquid chlorine is one and one-half times as heavy as water with an irritating odor.[38]

Its uses include the manufacture of chemicals which do not contain chlorine; solvents; pesticides and herbicides; plastics and fibers; refrigerants and propellants; pulp and paper; water and sewage treatment; and textile bleaching.[39]

In Central America, the principal use of the Nicaraguan produced chlorine will be for the manufacture of insecticides, paper, rayon and textiles and for water purification. The demand, in the C.A.C.M. area for chlorine is discussed in Chapter V.

Hydrogen

Since hydrogen is obtained simultaneously with chlorine and caustic soda, there exists an interest in a hydrogen project in the

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[37]Edmund J. Laubusch, "Physical and Chemical Properties of Chlorine," Chlorine: Its Manufacture, Properties and Uses (New York: Reinhold Publishing Corporation, 1962), p. 21.

[38]The Condensed Chemical Dictionary, op. cit., p. 208.

[39]Ibid.

Central American Common Market area. This gas, the lightest known substance, is not usually found free in nature; at ordinary temperature, it is a colorless, odorless, tasteless gas.[40]

> Production of synthetic ammonia and synthetic methanol, refining petroleum, hydrogenation of organic materials such as napthalene, phenol; as oxyhydrogen flame for high temperatures; atomic-hydrogen welding; small balloons; making hydrochloric acid; rocket fuel; and cooling of electrical generators all require hydrogen.[41]

Hydrochloric Acid

Hydrochloric acid, a poisonous, highly corrosive acid, is another by-product of the caustic soda-chlorine process. It is a colorless or slightly yellow pungent liquid.[42] Hydrochloric acid, is needed for acidizing (activation) of petroleum wells, chemical intermediates; ore reduction; food processing; pickling and metal cleaning; industrial acidizing and general cleaning.[43]

Chapter V discusses the C.A.C.M. importations of hydrochloric acid and the specific Central American industries which are projected to use this chemical.

Sodium Hypochlorite

The sodium hypochlorite obtained in the caustic soda-chlorine installation will be a solution having a disagreeable, sweetish odor

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[40]Strong, ed., Kingzetts Chemical Encyclopaedia, op. cit., p. 498.

[41]The Condensed Chemical Dictionary, op. cit., p. 488.

[42]Ibid., p. 487.

[43]Ibid.

and a pale greenish color. Chapter V discusses the C.A.C.M. demand for this product. It is used as a reagent, as an oxidizing agent and as a bleaching agent.[44]

In Chapter IV the Nicaraguan National Development Institute, the impetus behind the development of Nicaraguan industry, is discussed.

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[44]Ingo W. D. Hackh, A Chemical Dictionary (Philadelphia: P. Blakiston's Son and Co., Inc., 1929), p. 669.

CHAPTER IV

THE NICARAGUAN NATIONAL DEVELOPMENT INSTITUTE

Background

During the middle 1950's, most of the banking facilities in Nicaragua were oriented toward short-term operations which were unable to support agricultural or industrial activities requiring long-term financing. The need for the development of an institution to finance and encourage long-range programs, utilizing available Nicaraguan raw materials for economic development, was evident.

On March 7, 1953 the National Development Institute was created by Nicaragua Government Decree No. 11.[1] It is an autonomous, centralized organization with its own financial resources, full authority to make legal commitments, acquire property and assume obligations.[2] Its main purpose is to advance Nicaragua's economy by providing financial and technical assistance. The programs and operations of the National Development Institute are an integral part of a concerted national effort to improve and expand the national economy. The Institute is the leader in the promotion of new Nicaraguan

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[1]Republica de Nicaragua, La Gaceta: Diario Oficial (Nicaragua: Imprenta Nacional, No. 81, 1953), p. 3.

[2]The National Development Institute of Nicaragua, Investment Opportunities in Nicaragua (New York: Nicaragua Office of Industrial Promotion, 1965), p. 4.

industries based on private initiative ownership such as that of the chemical industry. During its first ten years of operation, it has channeled over 40 million dollars into agricultural diversification, cattle improvement, and industrial development. Much of this development capital has been in the form of intermediate and long-term loans.

Table 10 shows the financial outlays of the Institute by sector.

TABLE 10

THE NATIONAL DEVELOPMENT INSTITUTE OF NICARAGUA,
TOTALS OF CHANNELIZED RESOURCES 1954-1964
(U.S. DOLLARS, IN THOUSANDS)

	Loans	Per Cent	Investments	Per Cent	Total	Per Cent
Agriculture	$14,409	45.5	$1,466	25.0	$15,875	39.6
Livestock	2,496	7.9	1,760	30.0	4,256	10.6
Manufacturing	14,784	46.6	1,596	27.2	16,380	40.8
Other sectors	----	----	----	17.8	1,041	2.6
Technical assistance	----	----	1,041	----	2,567	6.4
Total	$31,689	100.0	$5,863	100.0	$40,119	100.0

Source: The National Development Institute of Nicaragua, A Progress Report 1965 (Nicaragua: The National Development Institute of Nicaragua, 1965), p. 12.

In the above table it can be seen that $40,119,000.00 has been distributed in a ten-year period, basically for Nicaraguan economic growth purposes, with the manufacturing sector of the economy receiving

the greatest share, 40.8 per cent. Four local financial institutions aid the Institute. These are the Central Bank of Nicaragua, which directs the monetary policies of the country; the National Bank of Nicaragua which principally provides short-term lending operations; the Banco Nicaraguense and the Banco de America.[3]

Objectives and Functions

The broad objectives of the Institute are "to augment, diversify and rationalize national production in all its aspects."[4] This plan can be broken down into component parts: to serve executive programs for development of national production; to provide state and private technical assistance; to promote agriculture and livestock production, diversification and creation of new exports; to establish, develop and expand those activities and industries which permit the most desirable utilization of natural resources. Also, by channeling private savings into productive uses and by supporting private enterprise in industrial activity, the Institute hopes to stimulate capital.[5]

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[3]Banco Central de Nicaragua, Informe Anual 1965 (Nicaragua: El Taller de la Editorial y Litografia San Jose, 1966), p. 243.

[4]Instituto de Fomento Nacional, Manual de Departmento Tecnico, Seccion de Estudios Economicos (Nicaragua: Instituto de Fomento Nacional, 1963), p. 111.

[5]The National Development Institute of Nicaragua, A Progress Report 1965, op. cit., pp. 6-7.

Loans and Investments

The Institute is not a banking institution in the strict legal sense; however, it is authorized and qualified to grant loans, negotiate loans from foreign sources, guarantee loans granted to domestic enterprises by national or foreign credit institutions, buy and sell stocks, bonds, and other obligations, participate in the ownership of enterprises and attract public savings deposits.[6]

Financial Structure

To establish the National Development Institute, the Nicaraguan government set aside $7,143,000 for capital.[7] The law which created the Institute emphasizes that should the capital become depleted, the government will reimburse the accounts with allocations from the national budget.[8] Also, the Institute's assets can be augmented by government transfer to the Institute of rights to government land, or by earnings from any item produced on nationally owned property.[9] For example, raw materials for the proposed turpentine and pine oil chemical industry on the east coast of Nicaragua are available through the transfer of government land to the Institute.

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[6] Ibid., p. 7.

[7] Instituto de Fomento Nacional, Empresas Industriales Privadas en Nicaragua (Nicaragua: Instituto de Fomento Nacional, 1964), p. 49.

[8] Ibid.

[9] Ibid., p. 50.

Sources of Capital

The National Development Institute obtains its funds from two principal sources: domestic savings and bonds and foreign loans; Table 11 shows the principal balance sheet items of the Institute as of December 31, 1965. Since the inception of this development agency, the citizens of Nicaragua have been putting excess funds into savings accounts or bonds of the Institute. Table 12 shows these resources and their accumulated balances for 1954-1964. Many foreign financial institutions loan to this development agency such as international and American financial institutions and private corporations in the United States. For information on the foreign loans obtained during the years 1954-1964, see Table 13. For instance, the Institute has obtained a loan of $28 million from the Agency of International Development. Also, it proposes to start negotiations with the Inter-American Development Bank for a loan of $24.5 million for financing Nicaraguan industrial development.

Industrial Development Promotion

An office established in New York by the National Development Institute proposes to attract foreign capital. The Nicaraguan Investment Corporation, also sponsored by the National Development Institute, promotes investment in project development.[10] It has the authority to help promoters in the marketing of securities. In this way, it resembles the investment banker in the United States who underwrites

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[10] Ibid., p. 9.

TABLE 11

FINANCIAL STATEMENT: THE NATIONAL DEVELOPMENT INSTITUTE DECEMBER 31, 1965 (U.S. DOLLARS)

Assets	
Cash	$ 676,539.74
Loans	8,455,727.92
Salable Equipment	308,516.81
Investments	4,076,547.21
Furniture	111,330.83
Other Assets	2,942,085.69
Total	$16,570,748.20
Liabilities	
Deposits	$ 5,198,658.60
Foreign Obligations	4,079,402.90
Other Liabilities	404,921.44
Credit Accounts	11,705.70
Special Accounts	96,355.87
Capital and Reserves	6,779,703.69
Total	$16,570,748.20

Source: The National Development Institute. The Year--1965. (Nicaragua: The National Development Institute, 1966), p. 3.

TABLE 12

ASSET GROWTH 1954-1964: THE NATIONAL DEVELOPMENT INSTITUTE OF NICARAGUA (U.S. DOLLARS)

Year	(Accumulated Balances in U.S. Dollars		
	Savings Bonds	Savings Accounts	Total
1954	$ 109,356	----	$ 109,356
1955	161,774	----	161,774
1956	247,663	----	247,663
1957	309,734	$ 42,857	352,591
1958	402,684	385,714	788,398
1959	448,503	592,857	1,041,360
1960	524,582	592,857	1,117,439
1961	686,333	692,857	1,379,190
1962	892,841	827,143	1,719,984
1963	1,508,000	1,980,000	3,480,000
1964	2,093,280	2,051,430	4,144,710

Source: The National Development Institute of Nicaragua, A Progress Report 1965, op. cit., p. 10.

TABLE 13

FOREIGN LOANS TO THE NATIONAL DEVELOPMENT INSTITUTE OF NICARAGUA, 1954-1964 (U.S. DOLLARS)

Lending Institution	Amount of Loan
World Bank	$ 1,914,250
Export-Import Bank	2,716,979
Moller and Rothe	136,815
Caterpillar	827,651
Bentall	138,311
Tyler	25,609
IADB (Interamerican Development Bank)	4,330,000
Bank of America, N.A. and S.A.	1,245,400
A.I.D. (Agency for International Development)	4,000,000
Total	$15,335,015

Source: Ibid., p. 11.

new stock issues until the public market can safely absorb them. Through this Nicaraguan Investment Corporation, the caustic soda-chlorine plant proposes to obtain part of its capital structure.[11]

The next chapter, Chapter V, will discuss the prices of and the demand for caustic soda, chlorine and the process' by-products.

[11]See Chapter VII for further discussion of this agency's financing of the corporation.

CHAPTER V

THE DEMAND FOR CAUSTIC SODA, CHLORINE AND BY-PRODUCTS, AND THEIR PRICES IN THE CENTRAL AMERICAN COMMON MARKET

Before the feasibility of a caustic soda-chlorine plant in Nicaragua can be determined, the demand for the installation's chemicals must be analyzed. Also, the prices which have been paid in Central America for caustic soda, chlorine, hydrogen, hydrochloric acid and sodium hypochlorite must be studied in order to calculate the profitability of the new chemical plant. In addition, the cost of each chemical produced must be considered.[1]

This chapter analyzes the historical and projected prices and demand in Central America for the products of the Nicaraguan caustic soda-chlorine plant.

Caustic Soda

The Historical Central American Demand

Since caustic soda is the principal product of the proposed Nicaraguan chemical plant, the Central American demand for this product will be reviewed first.

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[1]Chapter VI discusses the costs of production.

The major use of caustic soda.--In world commerce, "the manufacture of soap has historically provided caustic soda with its biggest world market."[2] In Central America, also, the manufacture of soap is the major consumer of caustic soda.[3] In fact, in 1959 two-thirds of the C.A.C.M.'s supply of this product was used by the soap industry as shown in Table 14.

TABLE 14

CENTRAL AMERICA: INDUSTRIAL CONSUMPTION OF CAUSTIC SODA, 1959 (IN METRIC TONS)

Industry	Metric Tons
Beer	250
Cotton textiles	300
Miscellaneous	828
Refined vegetable oil-greases	750
Soap	4,000
Total	6,128

Source: Naciones Unidas, La Industria Quimica Pesada, Comite de Cooperacion (E/Cn. 12/CCE/323) (New York: United Nations, 1965), p. 44.

[2]"Chlorine Producers Bask in Sunny Chemical Markets," Chemical Engineering (New York: McGraw-Hill, Inc., October 24, 1966), p. 60.

[3]See Chapter III for other uses of caustic soda in Central America.

A United Nations feasibility study estimates that 12 per cent of the weight of soap produced in Central America represents caustic soda.[4]

Central American importation of caustic soda.--Although caustic soda has been purchased from numerous nations by the C.A.C.M. republics, the United States and England have been the principal suppliers.[5] Tables 15 and 16 present import data for the years 1962 and 1963 respectively for the five Central American countries.

From these tables, it can be seen that in addition to England and the United States, France, Germany, Holland and Italy supply caustic soda to the C.A.C.M. However, Belgium, Jamaica, Japan, Mexico, Panama and Sweden have also sold small quantities of caustic soda to Central America. Since the sales of these latter countries are very small, they are not recorded for statistical purposes by the importing countries.[6]

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[4]In 1964 and 1965 the United Nations conducted feasibility studies on the projected "integrated industries" in Central America. However, because of limited governmental budgets for statistical purposes the available data in the C.A.C.M. countries were five and six years old. The United Nations group, therefore, based its projections for the 1970's for these industries, including the caustic soda-chlorine plant, on data considered reliable but which may have been several years old. These projections, derived from past performances, are shown in this chapter.

[5]The United States supplied approximately 66 per cent of the Central American caustic soda imports in 1963 while England supplied approximately 24 per cent.

[6]Interview with Francisco Barrientos, oficina de El Instituto de Centroamericano, Industrial y Tecnico Investigaciones, El Salvador, July 17, 1966.

TABLE 15

CENTRAL AMERICA: IMPORTATION
OF CAUSTIC SODA IN 1962
(IN METRIC TONS)

	Nicaragua	Guate-mala	El Sal-vador	Hon-duras	Costa Rica	Total
England	267	282	a	174	212	953
France	---	360	a	---	---	360
Germany	---	2	a	---	152	154
Holland	---	---	a	---	---	---
Italy	36	---	a	---	36	72
United States	625	1,221	a	498	253	2,597
Total	928	1,865	2,140	672	653	6,258

[a]The originating country is not given.

Source: Instituto de Centroamericano, Industrial y Tecnico Investigaciones, La Industria Quimica (El Salvador: Instituto de Centroamericano, Industrial y Tecnico Investigaciones--ICAITI--1966), p. 19.

TABLE 16

CENTRAL AMERICA: IMPORTATION OF CAUSTIC SODA IN 1963 (IN METRIC TONS)

	Nicaragua	Guatemala	El Salvador	Honduras	Costa Rica	Total
England	437	230	424	204	236	1,531
France	---	11	---	---	16	27
Germany	87	19	126	1	205	438
Holland	---	5	---	---	10	15
Italy	---	185	---	---	---	185
United States	638	2,249	728	486	181	4,282
Total	1,162	2,699	1,278	691	648	6,478

Source: Instituto de Centroamericano, Industrial y Tecnico Investigaciones, La Industria Quimica (El Salvador: Instituto de Centroamericano, Industrial y Tecnico Investigaciones--ICAITI--1966), p. 22.

The volume of caustic soda imports into Central America has steadily increased during the past five years. Table 17 presents the C.A.C.M. caustic soda import figures, by country, for the years 1961-1965.

Imported Caustic Soda Prices

The U.S. price.--The price of caustic soda produced in the United States has been stable in recent years. According to the Chemical Economics Handbook, the average U.S. price of liquid caustic

TABLE 17

CENTRAL AMERICA: IMPORTATIONS OF CAUSTIC SODA, 1961-1965 (IN METRIC TONS)

	1961	1962	1963	1964	1965
Costa Rica	659	653	648	970	1,108
El Salvador	1,975	2,140	1,278	2,737	2,120
Guatemala	1,640	1,865	2,699	2,104	2,912
Honduras	722	672	691	633	878
Nicaragua	968	928	1,162	1,478	1,325
Total	5,964	6,258	6,478	7,922	8,343

Source: Secretaria Permanente del Tratado General de Integracion Economica Centroamericana, Sexto Compendio Estadistico Centroamericano (Guatemala: Naciones Unidas, 1966.

soda remained $.029 per pound or $63.80 per metric ton (2,200 pounds) from 1957 to 1965.[7] Solid caustic soda, which is projected for production in Nicaragua, has been quoted at $.048 per pound or $105.60 per metric ton for the years 1957 through 1967.[8] In mid-1968 solid caustic soda is quoted at $.0555 per pound or $122.10 per metric ton.[9]

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[7]Stanford Research Institute, Chemical Economics Handbook (California: Stanford Research Institute, 1968), p. 776.

[8]Ibid.

[9]Oil, Paint and Drug Reporter, June 10, 1968.

Another source reports the 1968 price of solid caustic soda as $.0515 per pound or $113.30 per metric ton.[10]

The price of caustic soda in Nicaragua and in the U.S.--Table 18 depicts the average port of entry price per metric ton of caustic soda imported into Central America in 1963 and 1964.

TABLE 18

CENTRAL AMERICA: AVERAGE PORT OF ENTRY PRICE OF IMPORTED CAUSTIC SODA--COST, INSURANCE, FREIGHT AND CUSTOMS CHARGES IN 1963-1964 (DOLLARS PER METRIC TON)

	1963	1964
Costa Rica	$100.77	$101.76
El Salvador	83.03	87.25
Guatemala	80.46	98.45
Honduras	95.24	95.32
Nicaragua	94.96	105.33
Average	$ 90.89	$ 97.22

Source: Files of El Ministerio de Hacienda, Managua, Nicaragua.

These figures include cost, insurance, freight and customs charges levied by each country on this product before application of the uniform customs charges of the C.A.C.M. treaties. The average cost per metric ton of caustic soda imported into Central America was $90.89 in 1963 and $97.22 in 1964.

[10] Purchasing Week, July 29, 1968.

The price of caustic soda in Nicaragua and in the C.A.C.M.--Tables 19 and 20 present the typical cost structure of caustic soda imported into Nicaragua in 1964 and 1965 respectively.[11] The total value of the caustic soda from the U.S. and England, cost data and prices per metric ton are shown at Nicaragua's port of entry, Corinto, for selected months in 1964 and 1965.

In accordance with the C.A.C.M. treaties, particularly the uniform customs schedule (NAUCA), customs duties on caustic soda imported by a C.A.C.M. nation from a country other than Nicaragua will be approximately $409.72 per metric ton.[12]

The Projected Central American Demand

Future caustic soda consumption--by country.--From data on soda consumption in the C.A.C.M. in 1959, a United Nations group made projections for the use of the product by 1970. Table 21 contrasts the total metric tons of caustic soda consumed in Central America in 1959 and the estimated number of metric tons which each country will consume in 1970.

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[11] Import policies for shipments of caustic soda were reviewed in the Office of the Collector General of Customs, Managua, Nicaragua, for the years of 1964 and 1965. The data found in Tables 19 and 20 reflect representative policies for caustic soda imported from the United States and England.

[12] On every gross kilogram (approximately 2.2 pounds), a "specific duty" of $0.40 will be levied; in addition, a 10 per cent ad valorem fee is to be charged by the importing country. Thus, for each metric ton (1,000 gross kilograms), the "specific duty" would be $400. If the average cost of Central American caustic soda in 1964, $97.22, is used as a base for computing the ad valorem charge, an additional $9.72 will be levied for a total customs fee of $409.72.

TABLE 19

NICARAGUA: COST STRUCTURE OF IMPORTED CAUSTIC SODA, 1964 (U.S. DOLLARS)

Country of Origin	1964			
	United States		England	
	Per M/T*	Total	Per M/T*	Total
Date	April		March	
Weight (M/T*)	31.75 M/T		34 M/T	
Value, F.O.B.	$58.80	$1,866.90	$ 62.50	$2,125.00
Freight	$21.00	$ 666.75	$ 23.42	$ 796.28
Insurance	$ .80	$ 25.40	$ .44	$ 14.96
Value, C.I.F.	$80.60	$2,559.05	$ 86.36	$2,936.24
Duties:				
Consular	$ 4.12	$ 130.81	$ 4.98	$ 169.32
Specific	---	---	---	---
Ad Valorem	$ 8.47	$ 268.92	$ 9.14	$ 310.76
Wharfage, Storage and Handling	$ 1.87	$ 59.37	$ 1.03	$ 35.02
Total value: Port of entry--Corinto	$95.06	$3,018.15	$101.51	$3,451.34

*M/T--Metric ton.

Source: Department of Economic Research. Collector General of Customs, Managua, Nicaragua, 1966.

TABLE 20

NICARAGUA: COST STRUCTURE OF IMPORTED CAUSTIC SODA, 1965 (U.S. DOLLARS)

Country of Origin	1965			
	United States		England	
	Per M/T*	Total	Per M/T*	Total
Date	December		November	
Weight (M/T*)	63.50 M/T		17 M/T	
Value, F.O.B.	$50.06	$3,178.81	$50.33	$ 855.61
Freight	$26.64	$1,691.64	$25.95	$ 441.15
Insurance	$ .53	$ 33.65	$ .39	$ 6.63
Value, C.I.F.	$77.23	$4,904.10	$76.67	$1,303.39
Duties:				
Consular	$ ---	---	---	---
Specific	$10.29	$ 653.41	$10.25	$ 174.25
Ad Valorem	$ 7.72	$ 490.22	$ 7.74	$ 131.58
Wharfage, Storage and Handling	$ .55	$ 34.93	$ 1.98	$ 33.66
Total value: Port of entry--Corinto	$95.79	$6,082.66	$96.64	$1,642.88

*M/T--Metric ton.

Source: Department of Economic Research. Collector General of Customs, Managua, Nicaragua, 1966.

TABLE 21

CENTRAL AMERICA: CAUSTIC SODA CONSUMPTION
BY COUNTRY, 1959 AND 1970
(IN METRIC TONS)

Country	1959	1970
Costa Rica	656	1,700
El Salvador	1,975	2,750
Guatemala	1,801	2,750
Honduras	722	5,000
Nicaragua	968	1,800
Total	6,122	14,000

Source: Naciones Unidas, La Industria Quimica Pesada, op. cit., p. 44.

The estimated consumption of caustic soda (14,000 metric tons) in 1970 by the C.A.C.M. countries was considered a conservative projection by the United Nations group. It did not include the future demands of new Central American plants (rayon, commercial paper and writing paper production) which could amount to a minimum requirement of several thousand metric tons.[13]

In contrast to the data in Table 21 which projects the demand for caustic soda, R. W. Booker predicted that the caustic soda

[13]Naciones Unidas, La Industria Quimica Pesada, op. cit., p. 44.

produced by the Nicaraguan plant during the first year of operation would be sold as follows:[14]

Costa Rica	970 M/T	12.2%
El Salvador	2,737	34.5
Guatemala	2,104	26.6
Honduras	633	8.0
Nicaragua	1,478	18.7
Total	7,922 M/T	100.0%

In the study by Booker and Associates, it was assumed that 7,922 metric tons of caustic soda would be produced in the Nicaraguan caustic soda plant the first year. However, the projected capital expenditure covers a chemical plant with a capacity of only 7,285 metric tons of caustic soda during the first year of operation.[15]

Future caustic soda consumption: by industry.--A demand for caustic soda is being created in several of the Central American countries for use in new cellulose, viscose rayon and pulp and paper plants.[16] For instance, a projected "integrated industry" in Costa Rica for paper production would consume approximately 3,000-4,000 tons of caustic soda annually.

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[14]R. W. Booker and Associates, Inc., The Nicaraguan Caustic Soda-Chlorine Feasibility Study, Report II (June, 1965), p. 54.

[15]The production capacity and capital costs of the projected chemical plant are discussed in Chapter VI.

[16]K. Vyasulu, Posibilidades de Desarrollo Industrial Integrado de Centro America, Commission Economica Para America Latina, II (Mexico: Naciones Unidas, 1965), 41.

In anticipation of new industries requiring caustic soda, the United Nations group which prepared the data shown in Table 21 also projected the demand for caustic soda by industry. Table 22 presents these estimates for 1970.

TABLE 22

CENTRAL AMERICA: PROJECTED INDUSTRY DEMANDS FOR CAUSTIC SODA, 1970 (IN METRIC TONS)

Industry	Projected Production	Caustic Soda Consumption
Alcoholic beverages		
Beer	N.A.*	2,270
Cotton textiles	N.A.*	850
Paper		
Corrugated	32,500	3,800
Writing	12,000	1,000
Rayon and cellophane	8,800	8,800
Refined petroleum	2.5**	1,600
Soap	50,000	6,000
Table salt	4,000	480
Vegetable oils	60,000	1,200
Total		26,000

*N.A.--Not available.

**Millions of tons.

Source: Ibid., p. 45.

These data, however, include a projected use of caustic soda by proposed C.A.C.M. rayon and corrugated paper manufacturing facilities. Although the soap industry in Central America has traditionally been the chief consumer of caustic soda, the largest projected use of this substance by 1970 will be in the rayon, cellophane and the paper-pulp manufacturing companies.[17]

Thus, the C.A.C.M. area should demand much more caustic soda than the plant can produce.[18]

The plant's projected productive capacity is discussed in Chapter VI.

The Projected Price of Caustic Soda in the C.A.C.M.

The maximum price for the commercial grade caustic soda to be produced in Nicaragua has been set, by agreement, at $120.00 per metric ton, freight-on-board the plant.[19] Therefore, the projected sales

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[17] Novedades, November 24, 1967.

[18] In fact, the Economic Commission for Latin America has estimated that the demand for caustic soda in all of Latin America will exceed the supply from domestic producers by 111,000 tons in 1965; in 1970 the demand may exceed the supply by 251,000 tons. These data include caustic soda projections for not only the C.A.C.M. countries but all of the Latin, Central and South American nations.

Naciones Unidas, Commission Economica Para America Latina, La Industria Quimica en America Latina (New York: Naciones Unidas, 1963), p. 95.

[19] This price was established by the authorities of the Central American Common Market. The prices for the five products of the proposed Nicaraguan caustic soda-chlorine plant were set by a resolution, adopted at the eighth meeting of the Committee of Economic Cooperation of the Central American Isthmus. This list of proposed prices appears in a United Nations document E/Cn. 12/CCE/303, 1964.

revenue will be computed at $120.00 per metric ton for the estimated amounts of caustic soda to be produced and sold in the C.A.C.M. trade area.

Figure 2 has been prepared to show graphically the variations in consumption of imported caustic soda in Central America from 1961 to 1965. Also, from data on Central American caustic soda imports, estimates for the demand in 1966-1970 have been plotted on this figure.

To make these projections, the Pearson product-moment coefficient of correlation statistical method is used to obtain the Pearson "r," the variance between the time (as shown on the "x" axis) and the metric tons (on the "y" axis).[20] The Pearson product-moment coefficient of correlation is as follows:

$$\gamma_{xy} = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}}$$

The values used in this formula are:

1. x = time (years)
2. y = metric tons
3. N = 5 (years)
4. ΣX = 9815
5. ΣY = 34965
6. ΣY^2 = 249,060,077
7. ΣX^2 = 19,266,855
8. ΣXY = 68,642,717
9. γ_{xy} = 0.95

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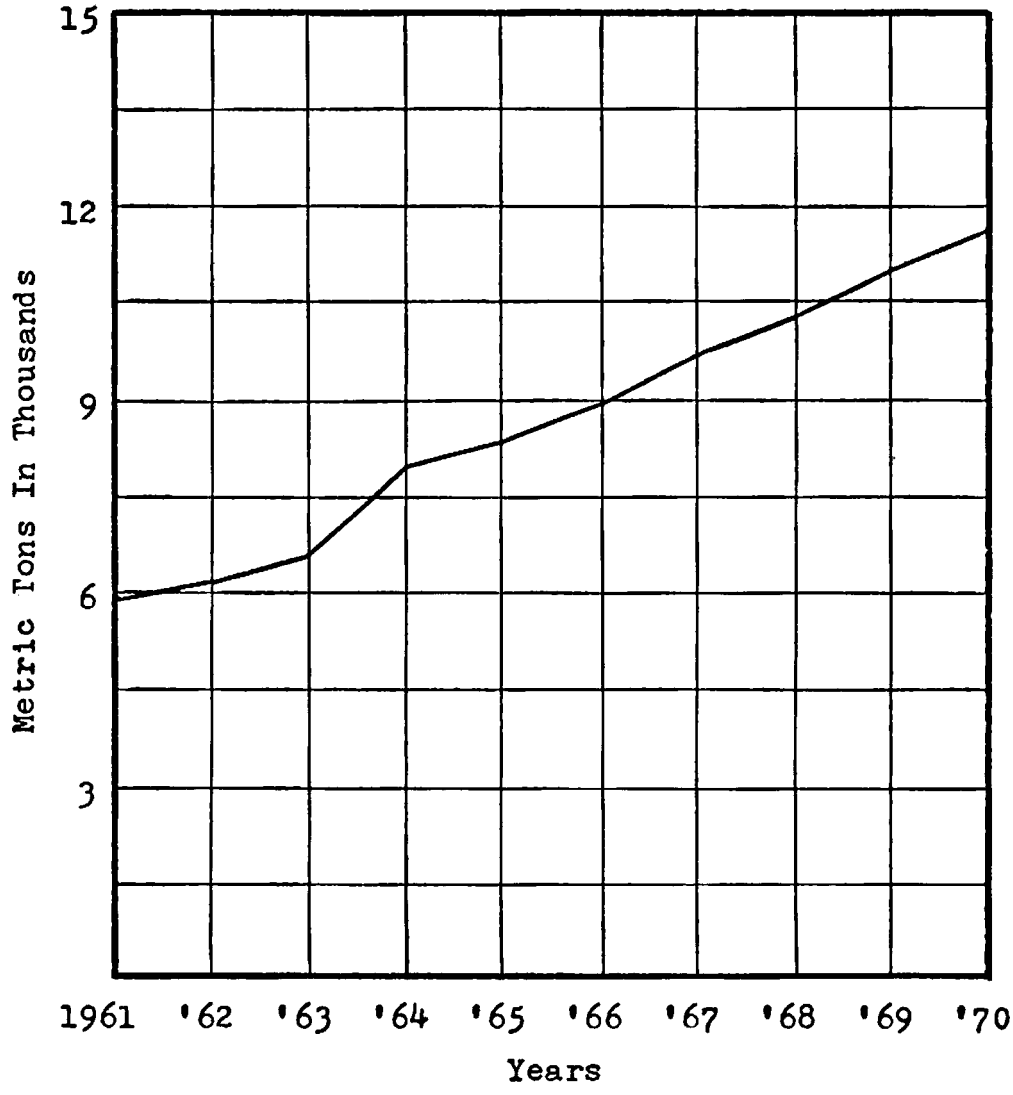
[20] J. P. Guilford, Fundamental Statistics (New York: McGraw-Hill Book Company, 1965), p. 109

Central America: Demand Estimates
Of Caustic Soda 1966-1970; Based
On Importation Data, 1961-1965.



(Figure 2)

A regression formula is then used to predict the 1966-1970 demands for caustic soda in Central America.

The regression equation is: $Y = bx + a$. To compute,

$$b = r\frac{\sigma y}{\sigma x} \quad \text{and} \quad a = MY - (Mx)b$$

In the regression equation, the symbols represent:

1. $Mx = 1963$
2. $My = 6993$
3. $\sigma x = 1.41$
4. $\sigma y = 933.9$
5. $b = 644.05$
6. $a = -1,257,277$
7. $r = .952$

The final demand equation is $Y = 644.05X - 1,257,277$.

These two formulas are used to project the Central American demand for the following quantities of caustic soda, 1966-1970:

1966	8,925 Metric tons
1967	9,569 Metric tons
1968	10,213 Metric tons
1969	10,857 Metric tons
1970	11,502 Metric tons

It is to be noted that the data in Table 17 from which the 1966-1970 predictions are made can be considered very conservative. The projections in Tables 21 and 22 are much larger. Nevertheless, the projected C.A.C.M. demand will exceed considerably the full capacity of the proposed Nicaraguan plant. Moreover, future consumption could exceed easily these conservative projections as new Central American industries develop.

Chlorine

The Historical Central American Demand

Although liquid chlorine historically has had a limited use in Central America, its manufacture in Nicaragua may stimulate wider commercial use.[21] Since chlorine weighs one and a half times as much as water, high freight rates on Central American imports have restricted the use of this chemical.[22] Also, "as chlorine cylinders are classified by all carriers, road, rail or sea, as dangerous cargo, transport costs are substantial."[23] In addition, when chlorine is imported into the C.A.C.M. trade area, freight must be paid on the return of the steel shipping cylinders to the exporter.[24]

Imported Chlorine Prices

The U.S. price.--The United States price of commercial grade liquid chlorine remained stable from 1960-1965, $.0325 per pound for

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[21]In 1964, 1965 and 1966 approximately 90 per cent of the commercial world shipments of chlorine were "liquid" rather than gaseous.

Stanford Research Institute, Chemical Economics Handbook Berkeley: Stanford Research Institute, 1968), p. 732.

[22]Van Nostrand's Scientific Encyclopedia (New York: D. Van Nostrand Company, Inc., 1947), p. 308.

[23]United Nations, Development Prospects of Basic Chemical and Allied Industries in Asia and the Far East, Economic Commission for Asia and the Far East (New York: United Nations, 1963) E/Cn. 11/635, p. 16.

[24]Instituto de Fomento, Estudio de Factibilidad de Sosa Caustica-Cloro (Nicaragua: Instituto de Fomento, 1964), p. 22. (Mimeographed.)

the six years.[25] At this rate, a metric ton (2,200 pounds) will cost $71.50. However, its price has gradually risen; presently, chlorine is quoted at $.0440 per pound or $96.80 per metric ton.[26]

The imported price of chlorine in Nicaragua.--Table 23 shows the structure of costs for chlorine imported into Nicaragua during the year 1965. These data were derived from a representative Nicaraguan customs document chosen from the files of the Collector General of Customs, Managua, Nicaragua covering one shipment for May, 1965.

The Projected Central American Demand

"All industrial countries have encountered the difficult problem of how to utilize chlorine at the early stage of development of their caustic soda-chlorine industries."[27] This problem also confronts the promoters of the Nicaraguan facility. Presently, the Central American market for chlorine is quite small.[28]

Future chlorine consumption--by industry.--As discussed in Chapter III, chlorine produced in the projected caustic soda-chlorine plant will be available as an input for a Nicaraguan camphene chloride

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[25]Stanford Research Institute, Chemical Economics Handbook, op. cit., p. 732.

[26]Oil, Paint and Drug Reporter, June 10, 1968.

[27]United Nationa, Development Prospects of Basic Chemical and Allied Industries in Asia and the Far East, op. cit., p. 16.

[28]Instituto de Fomento, Estudio de Factibilidad de Sosa Caustica-Cloro, op. cit., p. 8.

TABLE 23

NICARAGUA: COST STRUCTURE OF IMPORTED CHLORINE, 1965 (U.S. DOLLARS)

Country of Origin	United States	
	Per M/T*	Total
Date	May	
Weight (M/T*)	1.36 M/T	
Value, F.O.B.	$334.56	$ 455.00
Freight	$265.31	$ 360.82
Insurance	$ 54.18	$ 73.68
Value, C.I.F.	$654.05	$ 889.50
Duties:		
Consular[a]	$ ---	---
Specific[a]	$ ---	---
Ad Valorem	$ 65.41	$ 88.95
Wharfage, Storage and Handling	$ 49.24	$ 66.96
Total value: Port of entry--Corinto	$768.70	$1,045.41

*M/T--Metric ton.

[a]Prior to the adoption of the C.A.C.M. uniform customs schedule, Nicaragua did not impose a consular or a specific charge on imported chlorine.

Source: Files of the Collector General of Customs, Managua, Nicaragua.

facility.[29] Both plants should begin operations at the same time.[30] Table 24 presents the projections for the quantities of chlorine required for the production of toxaphene.

TABLE 24

NICARAGUA: DEMAND PROJECTIONS OF CHLORINE FOR USE IN TOXAPHENE PRODUCTION

Production of Toxaphene 100%	Necessary Quantities of Chlorine	
Pounds	*MT/Year	*MT/Day
8,000,000	4,700	14.3
8,500,000	5,000	15.2
9,000,000	5,300	16.1
9,500,000	5,600	17.0
10,000,000	5,900	17.9
10,500,000	6,200	18.8
11,000,000	6,500	19.7

*Metric ton.

Source: Instituto de Fomento, Estudio de Facibilidad de Una Planta de Canfenos y Canfenos Chlorados (Nicaragua: Instituto de Fomento, 1964), p. 33. (Mimeographed.)

[29]Hercules Incorporated of the United States has established a subsidiary, Hercules de Centroamerica, S.A., which will operate the camphene chloride plant.

[30]See Chapter III for more information on the production of camphene chloride.

The projected Nicaraguan caustic soda-chlorine plant is to produce 6,804 metric tons of chlorine during the first year of operation. Therefore, it is to be noted from Table 25 that the principal use of chlorine in the Central American chemical complex plans, will be for camphene chloride production.

TABLE 25

CENTRAL AMERICA: DEMAND PROJECTIONS FOR LIQUID CHLORINE (IN METRIC TONS)

Year	Camphene Chloride Plant	Pulp Mills	Sanitary Uses	Textile Uses	Total
1967	---	---	330	237	567
1968	---	---	363	284	647
1969	4,700	---	399	341	5,440
1970	5,000	1,000	439	409	6,848

Source: Instituto de Fomento, Estudio de Factibilidad de Sosa Caustica-Cloro, op. cit., p. 28.

In accordance with agreements between producers of chlorine and those of camphene chlorides, the caustic soda-chlorine facility will provide all the chlorine which the second company may need.

Future chlorine consumption--by use.--Chlorine is used in Central America in the aqueducts of populated areas to purify water. In Nicaragua, Managua is the only city using chlorine for water treatment

with an importation of twenty-five to thirty metric tons annually.[31] If chlorine is used for this purpose by other Central American countries, importation of chlorine for the entire Central American area would be only 300 metric tons annually, a very low figure considering the large population of the Isthmus.[32] However, the use of chlorine for sanitation should increase from the estimated 300 metric tons with rising hygienic standards, population and water consumption.

Besides its use in water purification, it is indispensable in the synthetic chemical industry, for whitening textiles, manufacturing synthetic rubber, plastics and DDT.

In accordance with the expansion plans for the textile industry in Central America, Dr. Eberhard Schafer, consultant for the textile industry who has been assigned by the United Nations to the Integration Program of Central America, estimates an annual increase in the production of the textile industry of 20 per cent.[33]

One instance of the expansion of the textile industry, is the financing of a $9.2 million textile mill for Nicaragua. To be known as "Fabritex," this mill with an annual productive capacity of 1,800 tons of cotton will begin production in 1969.[34]

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[31]Instituto de Fomento, Estudio de Factibilidad de Sosa Caustica-Cloro, op. cit., p. 25.

[32]Ibid., p. 26.

[33]Consejo Nacional de Economia, El Cloro: Programa de Desarrollo Industrial (El Salvador: Instituto de Centroamericano, 1966), p. 8.

[34]"IFC Investment in Nicaragua," International Financial News Survey, XX, No. 11 (March 22, 1968), p. 95.

In addition to the potential demand for chlorine for sanitation, insecticides and textile manufacture, a Central American paper manufacturing company plans a pulp mill requiring approximately 1,500 metric tons of chlorine annually.[35]

The United Nations Committee on Economic Development for Central America estimates the internal market of the C.A.C.M. will be 12,600 metric tons of liquid chlorine by 1970.[36]

The Committee of Economic Cooperation of the Organization of American States (ODECA) has estimated that the use of chlorine in Central America (1967-1970) will be sufficient to make the production of chlorine in the caustic soda-chlorine plant financially beneficial.[37] Table 26 shows this Committee's demand projections, except Nicaragua, by use over a four-year period while Table 27 shows the yearly requirements of industry for liquid chlorine in all the Central American countries, including Nicaragua.

The Projected Price of Chlorine in the C.A.C.M.

Chlorine is projected to be sold to three categories of purchasers.

1. An agreement has been reached between the owners of the caustic soda plant and the camphene chloride facility whereby $105 per

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[35]Interview with Hector Garcia, Departamento de Economia, Banco Central de Nicaragua, Managua, Nicaragua, June 28, 1966.

[36]Naciones Unidas, La Industria Quimica Pesada, op. cit., p. 32.

[37]Ibid., p. 43.

TABLE 26

CENTRAL AMERICA (EXCEPT NICARAGUA): DEMAND PROJECTIONS OF CHLORINE FOR ITS USE IN THE TEXTILE INDUSTRY

Year	Metric Tons
1964	237
1965	284
1966	341
1967	409

Source: Consejo Nacional de Economia, El Cloro: Programa de Desarrollo Industrial (El Salvador: Instituto de Centroamericano, 1966), p. 9.

TABLE 27

CENTRAL AMERICA: ESTIMATED CHLORINE DEMAND, 1965-1970 (IN METRIC TONS)

	Metric Tons
Insecticide manufacture	7,200
Paper manufacture	3,360
Rayon and textile manufacture	1,260
Water purification	1,000
Total	12,820

Source: Naciones Unidas, La Industria Quimica Pesada, op. cit., p. 46.

metric ton will be charged for the first five tons purchased daily, $100 per metric ton for the next five metric tons and $95 for additional metric tons.[38]

2. Chlorine is to be sold to paper pulp mills for $100 per metric ton, freight-on-board the plant.

3. The remaining liquid chlorine is to be sold in steel cylinders to small consumers at $200 per metric ton.

These prices were established by the C.A.C.M. authorities.

Hydrochloric Acid

The Central American Demand

In recent years the relatively small demand for hydrochloric acid, a by-product of the Nicaraguan caustic soda-chlorine plant, has been increasing in the C.A.C.M.[39]

The data on hydrochloric acid imports for the years 1960 through 1965, shown in Table 28, indicate that imports of this product have risen in recent years resulting perhaps from increased activity in the Central American metallurgical industry.

In Figure 3 are depicted the different quantities of hydrochloric acid imported during the years, 1960-1965 as derived from

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[38]With the two plants projected to work 350 days each year, 1,750 metric tons of chlorine will be purchased at $105.00 per ton and an equivalent amount at $100.00 per ton. It is estimated that 3,500 metric tons in all will be needed each year. However, the quantities purchased at $95 will vary from year to year as discussed in Chapter VI.

[39]Chapter III discussed the uses of this product.

TABLE 28

CENTRAL AMERICA: IMPORTATION OF HYDROCHLORIC ACID, 1960-1965
(IN METRIC TONS)

	1960 (a)	1961 (a)	1962 (b)	1963 (b)	1964 (c)	1965 (c)
Costa Rica	8	9	17	24	33	46
El Salvador	23	29	22	38	55	69
Guatemala	39	122	166	105	157	172
Honduras	8	4	1	1	3	7
Nicaragua	12	20	55	120	117	144
Total	90	184	261	288	365	438

Source: (a) Tercera Compendio Estadistico Centroamericano, 1963.

(b) Cuarto Compendio Estadistico Centroamericano, 1964.

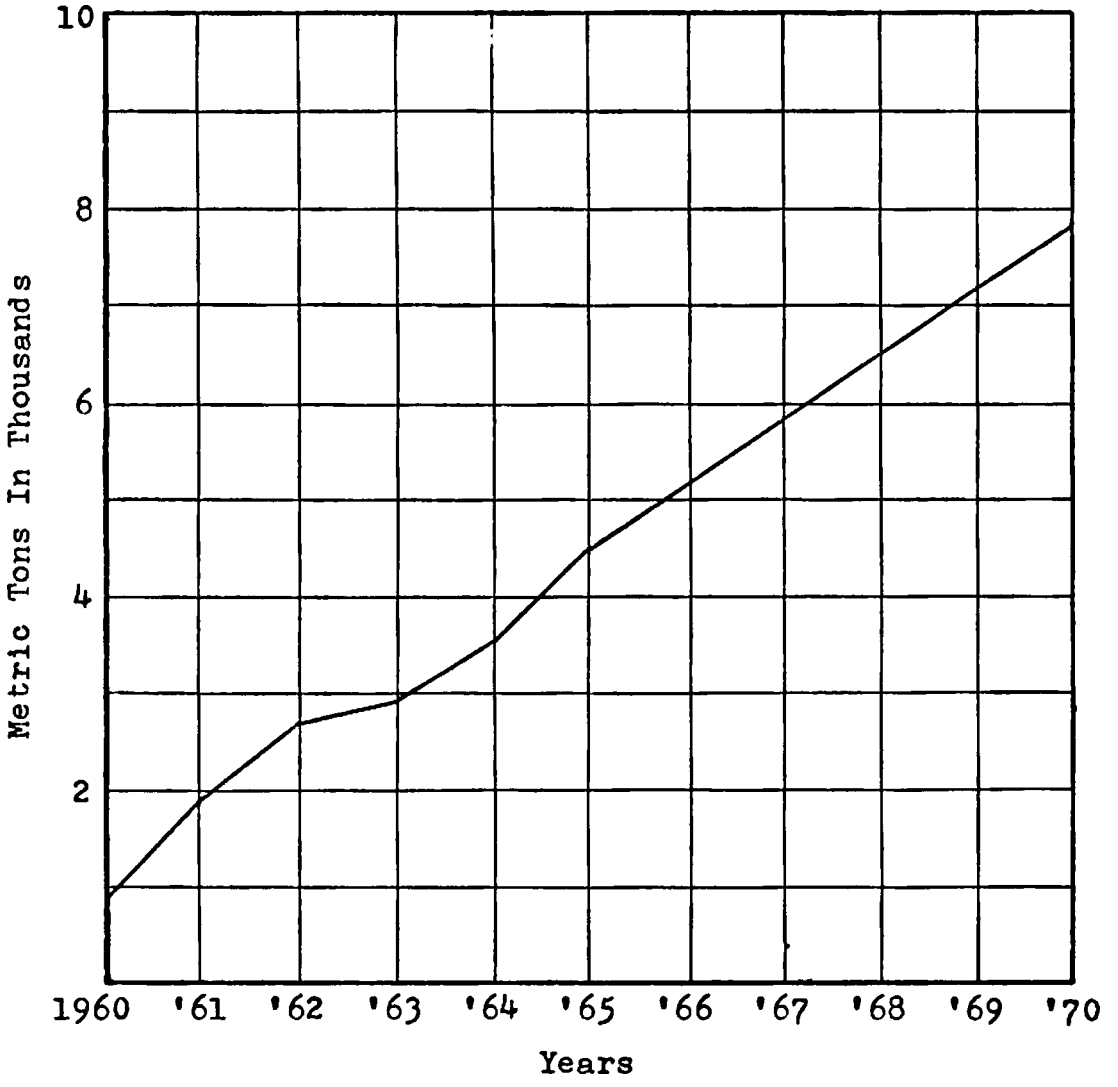
(c) Sexto Compendio Estadistico Centroamericano, 1966.

Secretaria Permanente del Tratado General de Integracion Economica Centroamericana.

Table 28. This figure also presents predictions for Central American hydrochloric acid demands for 1966-1970.

Here, as in the computation of future caustic soda consumption, the Pearson-moment coefficient of correlation formula is used to determine the variance ("r") between the time ("x" axis) and the metric tons ("y" axis). A regression coefficient is then used to project the 1966-1970 demands for hydrochloric acid.

Central America: Demand Estimates
Of Hydrochloric Acid 1966-1970;
Based On Importation Data For
1960-1965.



(Figure 3)

The Pearson product-moment coefficient of correlation is as follows:[40]

$$r_{xy} = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}}$$

The values used in this formula are:

1. x = time (years)
2. y = metric tons
3. N = 6 (years)
4. ΣX = 11775
5. ΣY = 1626
6. ΣY^2 = 518,090
7. ΣX^2 = 23,108,455
8. ΣXY = 3,192,180
9. r_{xy} = .99

The regression equation is:[41] $Y = bx + a$. to compute,

$$b = \frac{y}{x} \qquad a = My - (Mx)b$$

In the regression equation, the symbols represent:

1. Mx = 1962.5
2. My = 271
3. σx = 1.71
4. σy = 113.60
5. b = 65.77
6. a = -128,802
7. r = .99

The finald demand equation is y = 65.77X - 128,802

The C.A.C.M. countries should demand yearly the following metric tons of hydrochloric acid:[42]

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[40] Guilford, op. cit., p. 109.

[41] Ibid., p. 366.

[42] Since these projections are based on 1960-1965 import data, these predictions may be considered conservative.

1966 - 502 metric tons

1967 - 568 metric tons

1968 - 633 metric tons

1969 - 699 metric tons

1970 - 765 metric tons

Figure 3 shows there exists a C.A.C.M. demand for the full hydrochloric acid productive capacity of the proposed Nicaraguan plant.[43]

Imported Hydrochloric Acid Prices

The U.S. price.--The Chemical Economics Handbook states that the price of commercial grade hydrochloric acid has remained at $36.00 per metric ton for the past ten years in the United States.[44] The mid-1968 price is still quoted at $36.00 per metric ton.[45]

The price of hydrochloric acid in the C.A.C.M.--The office of the Central American Institute for Industrial and Technological Investigation, El Salvador, states that the average yearly prices per

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[43]Chapter VI discusses the projected productive plant capacity of hydrochloric acid.

[44]The price is quoted at $30 per ton. However, since a metric ton is equal to approximately 1.2 tons, the price would be $36 per metric ton.

Stanford Research Institute, Chemical Economics Handbook (Berkeley: Stanford Research Institute, 1968), pp. 738.5060.

[45]Oil, Paint and Drug Reporter, June 10, 1968, p. 19.

metric ton of hydrochloric acid, imported into Central America have been:[46]

1960:	$259
1961:	$244
1962:	$267
1963:	$302
1964:	$344
1965:	$356

It should be noted that a sizable disparity exists between the F.O.B. price of hydrochloric acid and the Central American port of entry prices.

Table 29 presents the cost structure of hydrochloric acid which has been imported into Nicaragua during given months in 1964 and 1965. From this table, it can be noted that the Nicaraguan port of entry cost for hydrochloric acid approximates the averages for the entire C.A.C.M.

The Projected Price of Hydrochloric Acid in the C.A.C.M.

As a by-product of the Nicaraguan caustic soda-chlorine plant, the projected price of hydrochloric acid will be low when compared with costs of imported acid. The price has been set at $25 per metric ton, freight-on-board the plant site.

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[46]These prices are quoted at the port of entry value including cost, insurance, freight and customs charges.

Central American Institute for Industrial and Technological Investigation, Estudios Quimicas Centroamericana (El Salvador: Instituto Centroamericano Industrial Tecnico Investigaciones--ICAITI, 1967), p. 39.

TABLE 29

NICARAGUA: COST STRUCTURE OF IMPORTED HYDROCHLORIC ACID, 1964-1965
(U.S. DOLLARS)

Country of Origin	1964		1965	
	West Germany		Belgium	
	Per M/T*	Total	Per M/T*	Total
Date	September		May	
Weight (M/T*)	25 M/T		10.33 M/T	
Value, F.O.B.	$ 76.74	$1,918.50	$106.30	$1,098.08
Freight	$110.90	$2,772.50	$102.90	$1,062.96
Insurance	$ 5.31	$ 132.75	$ 2.30	$ 23.76
Value, C.I.F.	$192.95	$4,823.75	$211.50	$2,184.80
Duties:				
Consular	$ ---	$ ---	$ 7.45	$ 76.96
Specific	$ 11.14	$ 278.50	$ ---	$ ---
Ad Valorem	$ 28.94	$ 723.50	$ ---	$ ---
Wharfage, Storage and Handling	$ 3.93	$ 98.25	$ 4.29	$ 44.31
Total value: Port of entry--Corinto	$236.96	$5,924.00	$223.24	$2,306.07

*M/T--Metric ton.

Source: Files of the Collector General of Customs, Managua, Nicaragua.

Sodium Hypochlorite

The Historical Central American Demand

Another by-product of the Nicaraguan caustic soda-chlorine plant, sodium hypochlorite, is projected to play a minor role in the profitability of the plant operations. In the past, the C.A.C.M. countries have only imported 100 to 200 metric tons of the chemical annually.[47]

The Historical Price of Imported Sodium Hypochlorite

No individual records have been kept by the Central American governments for the small quantities of sodium hypochlorite; import statistics are included in a miscellaneous category.[48] However, data shows that imported sodium hypochlorite has averaged $450 per metric ton.[49] Table 30 shows the cost structure of the importation of this chemical into Nicaragua for given shipments in 1964 to 1965.

Projections for Sodium Hypochlorite in Central America

The future demand.--In a study by the Economic Section of the Central Bank of Nicaragua, it was concluded that the C.A.C.M. countries

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[47]Secretaria Permanente del Tratado General de Integracion Economica Centroamericana, Tres Anos de Labores (Guatemala: Secretaria Permanente del Tratado General de Integracion Economica Centroamericana, 1965), p. 38.

[48]Ibid., p. 17.

[49]Instituto de Fomento, Estudio de Factibilidad de una planta de Canfenas y Canfenas Chloradas (Nicaragua: Instituto de Fomento, 1966), p. 22. (Mimeographed.)

TABLE 30

NICARAGUA: COST STRUCTURE OF IMPORTED SODIUM HYPOCHLORITE, 1964-1965
(U.S. DOLLARS)

Country of Origin	1964		1965	
	Japan		Germany	
	Per M/T*	Total	Per M/T*	Total
Date	March		May	
Weight (M/T*)	1.25 M/T		2 M/T	
Value, F.O.B.	$399.00	$498.75	$412.26	$ 824.52
Freight	$ 57.20	$ 71.50	$ 50.62	$ 101.24
Insurance	$ 3.54	$ 4.43	$ 4.11	$ 8.22
Value, C.I.F.	$459.74	$574.68	$466.99	$ 933.98
Duties:				
Consular	$ 28.00	$ 35.00	$ ---	$ ---
Specific	$ 2.20	$ 2.75	$ 11.00	$ 22.00
Ad Valorem	$ 4.88	$ 6.10	$ 70.05	$ 140.10
Wharfage, Storage and Handling	$ 5.08	$ 6.35	$ 29.91	$ 59.82
Total value: Port of entry--Corinto	$499.90	$624.88	$577.95	$1,155.90

*M/T--Metric ton.

Source: Files of the Collector General of Customs, Managua, Nicaragua.

will use approximately 300 metric tons annually of sodium hypochlorite.[50] Since this product is used widely for bleaching purposes, the demand for sodium hypochlorite should parallel the production of cotton cloth in Central America.[51]

The future price.--Since only a small product demand exists in the C.A.C.M. for sodium hypochlorite, the price of this product, freight-on-board the plant site, has been set at $50 per metric ton. When this price was established by common market representatives and the prospective plant owners, it was thought this low price would encourage new industries which would use this product, for instance, textile manufacturing. With new industrial users, the demand may increase.

Hydrogen

The Historical Central American Demand

Hydrogen, another product of the Nicaraguan chemical plant, virtually has not been imported into Central America because of its explosive nature.[52] Chapter III described the properties and major uses of hydrogen.

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[50]Banco Central de Nicaragua, Departamento de Economia, La Industria de Progreso (Nicaragua: Banco Central de Nicaragua, 1966), p. 7. (Mimeographed.)

[51]See Chapter III for a discussion of the principal uses of sodium hypochlorite.

[52]Secretaria Permanente del Tratado General de Integracion Economica, op. cit., p. 19.

The Projected Central American Demand

It is expected the availability of locally produced hydrogen will increase the demand for this substance in Central America. However, its commercial production is not to begin until the third year of plant operation.[53]

In Central America, oil refineries plan to install plants for the hydrogenation of gases.[54] Not only will hydrogen be required for oil refineries, but it also will be needed for the production of other chemicals, greases, napthalenes and for steel and metal welding.

Therefore it may be said a demand exists for hydrogen.

The Projected Price in the C.A.C.M.

The price established by the C.A.C.M. authorities for hydrogen is to be $600 per metric ton.

In the following chapter, the capital investment, production costs and distribution of the chemical products will be discussed.

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[53]The projected quantities of hydrogen which are to be produced are shown in Chapter VI.

[54]Interview with Mr. O. Davila, General Manager Texaco Ltd., S.A., Managua, Nicaragua, June 15, 1966.

CHAPTER VI

CAPITAL INVESTMENT, PRODUCTION COSTS AND DISTRIBUTION OF THE CHEMICAL PRODUCTS

In this chapter are discussed the estimated fixed capital requirements of Nicaragua's caustic soda-chlorine plant and the production costs at different levels of output. Also, the chapter will show how the chemical products will be sold and distributed in the C.A.C.M. trade area.

The cost projections cited here are based on an earlier feasibility study on a Nicaraguan caustic soda-chlorine plant.[1] Productive capabilities of the plant, capital investment, projected production costs, sales and profits are given. However, data from other feasibility studies are included for comparative purposes.

The Productive Capacity of the Chemical Plant

In Chapter V it was demonstrated that a demand exists in the C.A.C.M. for the products of a Nicaraguan chemical plant. Therefore, the projected production schedules of the five chemicals will be

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[1]This feasibility study, entitled Caustic Soda: A Manufacturing Opportunity in Nicaragua, was prepared by the Nicaraguan National Development Institute. R. W. Booker and Associates also participated in the study. Other groups which contributed their research to the feasibility study were the United States, the Central American Bank of Economic Integration, the Inter-American Development Bank and the economic research staff of the Agency for International Development, Washington, D.C.

discussed first. After reviewing the market for the goods and the productive capabilities of the new plant, the profitability of the proposed Nicaraguan caustic soda-chlorine installation can be assessed more accurately. The invested capital requirements and the costs of production can then be analyzed in view of the sales revenues of the chemicals.[2]

Table 31 presents the chemical plant's projected productive capacity for the first nine years of operation. It should be noted that the capacity of the plant for the fifth through the ninth year is assumed to be constant.

This table projects the maximum output of the Nicaraguan chemical plant. However, it should not be assumed that the plant will produce at full capacity. The productive output is based on the projected quantities of the chemicals demanded in the C.A.C.M.

Capital Investment

Table 32 presents the investment plan of the Nicaraguan caustic soda-chlorine plant. The necessary fixed investment is projected to be $3,265,000, and the total working capital required is $555,000 for a total capital requirement of $3,820,000.[3]

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[2]The United Nations' Manual on Economic Development Projects advocates making a market study before undertaking most development projects.

United Nations, Manual on Economic Development Projects (New York: United Nations, 1958), E/Cn. 12/426/Add. 1/Rev. 1, p. 6.

[3]The sources of the required chemical plant investment are discussed in Chapter VII.

TABLE 31

NICARAGUA: ESTIMATES OF PRODUCTIVE CAPACITY--
THE CAUSTIC SODA-CHLORINE PLANT FIRST
NINE YEARS PLANT OPERATION
(IN METRIC TONS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Through Ninth Year
Caustic soda	7,285	7,962	9,096	9,866	9,866
Chlorine	6,804	7,505	8,647	9,408	9,408
Hydrochloric acid	500	500	600	600	700
Hydrogen	---	---	20	25	30
Sodium hypochlorite	840	1,040	1,620	2,560	3,000
Total	15,429	17,007	19,983	22,459	23,004

Source: National Development Institute, Caustic Soda, A Manufacturing Opportunity in Nicaragua (Nicaragua: Instituto de Fomento, 1966), p. 85.

TABLE 32

NICARAGUA: ESTIMATED PLAN OF INVESTMENT
THE CAUSTIC SODA-CHLORINE PLANT
(U.S. DOLLARS)

I.	Fixed Capital	
	Land	$ 60,000
	Street improvements	17,365
	Buildings	264,305
	Machinery and fixed equipment	2,247,765
	Engineering fees	217,365
	Contingencies	158,200
	Organizational expense	70,000
		$3,035,000
	Technical knowledge	230,000
	Total Fixed Capital	$3,265,000
II.	Working Capital	
	Raw materials	$ 301,000
	Inventory and net accounts receivable	116,000
	Spare parts	70,000
	Cash	68,000
	Total Working Capital	$ 555,000
	Grand Total	$3,820,000

Source: Ibid., p. 95.

The original capital investment in the Nicaraguan caustic soda-chlorine plant allows for expanding the manufacturing facilities in order to increase production each year.[4]

The Projected Sales and Gross Revenues

Table 33 estimates the gross revenues for the first nine years of plant operations. As discussed in Chapter V, the prices cited below for the products were established by the authorities of the C.A.C.M.

1. Caustic soda is to be sold to all purchasers for $120 per metric ton at the plant site.

2. Liquid chlorine is to be sold to purchasers at varying prices. The toxaphene plant, owned by Hercules de Centroamerica, S.A. has agreed to pay $105 per metric ton for the first 1,750 metric tons purchased during a year. For the second 1,750 metric tons purchased for toxaphene production, chlorine will sell for $100 per metric ton. If its demand for liquid chlorine exceeds 3,500 metric tons a year, Hercules de Centroamerica will pay $95 per metric ton at the caustic soda-chlorine plant site. Liquid chlorine sold in cylinders is to be sold at $200 per metric ton to all consumers except toxaphene and paper producers. A charge of $100 per metric ton at the plant site is to be levied on liquid chlorine sold for use in the manufacture of paper in the C.A.C.M. trade area.

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[4]The operating company and the methods of financing the chemical plant are discussed in Chapter VII.

TABLE 33

NICARAGUA: ESTIMATES OF GROSS REVENUES BY CHEMICAL PRODUCT--
THE CAUSTIC SODA-CHLORINE PLANT FIRST NINE YEARS
OPERATION (IN THOUSANDS OF DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Through Ninth Year
Caustic soda	$ 874	$ 955	$1,090	$1,185	$1,185	$1,185
Chlorine						
Toxaphene plant @ $105 MT	184	184	184	184	184	184
Toxaphene plant @ $100 MT	175	175	175	175	175	175
Toxaphene plant @ $95 MT	116	142	172	200	229	256
Paper plant	---	91	135	135	135	135
Public--cylinders	148	168	190	240	215	215
Hydrochloric acid	13	13	15	15	18	18
Hydrogen	---	---	12	15	18	18
Sodium hypochlorite	32	52	81	128	150	150
Total	$1,542	$1,780	$2,054	$2,277	$2,309	$2,336

Source: Ibid., p. 86.

3. Hydrochloric acid is priced at $25 per metric ton at the plant site.

4. Hydrogen is priced at $600 per metric ton at the plant site.

5. Sodium hypochlorite is priced at $50 per metric ton at the plant site.

Excess Capacity--the Chemical Plant

It is projected that the caustic soda-chlorine plant has an excess capacity to meet future chemical demands of the C.A.C.M. Table 34 shows the projected yearly sales in metric tons of each chemical product.

The data presented in Table 34 should be explained somewhat. The figures shown in Tables 31 and 33 were prepared by the Nicaraguan National Development Institute, other governmental and semi-governmental groups and chemical engineers. However, the amounts in Table 34 are extrapolated from the data in Tables 31 and 33.

1. The plant's capacity for producing caustic soda is given in Table 31 as 7,285 metric tons. With the gross sales revenue of $874,000 shown in Table 33, the entire production is to be sold at the stipulated sales price of $120 per metric ton (7,285 metric tons x $120 per metric ton equals $874,000 rounded to the nearest thousand dollars). Therefore, there will be no excess caustic soda produced during the first year of plant operation.

TABLE 34

NICARAGUA: ESTIMATES OF YEARLY CHEMICAL PRODUCT SALES--THE CAUSTIC SODA-CHLORINE PLANT FIRST NINE YEARS PLANT OPERATION (IN METRIC TONS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Through Ninth Year
Caustic soda	7,285	7,962	9,096	9,866	9,866	9,866
Chlorine	5,460	6,745	7,610	8,155	8,335	8,620
Hydrochloric acid	500	500	600	600	700	700
Hydrogen	---	---	20	25	30	30
Sodium hypochlorite	640	1,040	1,620	2,560	3,000	3,000
Total	13,885	16,247	18,946	21,206	21,931	22,216

Source: See Tables 31 and 33.

2. An excess productive capacity of 1,344 metric tons of liquid chlorine is projected for the first year. The estimated amounts of chlorine which will be sold as shown in Table 33 are:

1,750 M/T	@ $105 ea.	$184,000
1,750 M/T	@ $100 ea.	$175,000
1,220 M/T	@ $ 95 ea.	$116,000
740 M/T	@ $200 ea.	$148,000

The projected sales of liquid chlorine total 5,460 metric tons. With a plant capable of producing 6,804 metric tons of chlorine and projected sales of 5,460 metric tons, the chemical plant will have an excess capacity of 1,344 metric tons of liquid chlorine during the first year of plant operation.

3. An excess productive capacity of 200 metric tons of sodium hypochlorite is also projected during the first year. Table 33 shows a projected gross revenue of $32,000 at a given price of $50 per metric ton; therefore, an estimated 640 metric tons of this chemical may be sold. Since the plant has a capacity (as shown in Table 31), there will be an excess capacity of 200 metric tons during the first year of plant operation.

4. Table 31 shows the caustic soda-chlorine plant's productive capacity of hydrochloric acid as 500 metric tons. With a gross sales revenue of $13,000 for the product as presented in Table 33, it is assumed that the entire production will be sold at the stipulated C.A.C.M. price, $25 per metric ton (500 metric tons x $25 per metric ton equals $13,000 then rounded to the nearest thousand dollars).

5. No hydrogen is projected to be commercially produced during the first two years of operation.

All calculations in Table 34 for years 2 through 9 are computed in a manner similar to the above explanation. Therefore, this explanation will not be repeated beyond the first year. Table 35 shows the excess plant capacity in metric tons for each chemical for the first nine years.

Data are presented in Table 36 (derived from Table 35) which indicate additional gross revenues will be realized if the C.A.C.M. demand requires the full production capacity of the caustic soda-chlorine installation. Table 36 shows that gross revenues will exceed the estimate in Table 33 by:

$279,000.00	First year of operation
$152,000.00	Second year of operation
$207,000.00	Third year of operation
$251,000.00	Fourth year of operation
$215,000.00	Fifth year of operation
$158,000.00	Sixth through ninth year of operation

It should be noted that:

1. It is assumed the plant's full capacity of caustic soda (shown in Table 31) will be demanded by the C.A.C.M. during the first nine years of operation.

2. From Table 34, it seems a C.A.C.M. demand for full production of liquid chlorine is lacking. However, if there was a demand

TABLE 35

NICARAGUA: ESTIMATES OF EXCESS PLANT CAPACITY--THE CAUSTIC SODA-CHLORINE PLANT FIRST NINE YEARS PLANT OPERATION (IN METRIC TONS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Through Ninth Year
Caustic soda	---	---	---	---	---	---
Chlorine	1,344	760	1,037	1,253	1,073	788
Hydrochloric acid	---	---	---	---	---	---
Hydrogen	---	---	---	---	---	---
Sodium hypochlorite	200	---	---	---	---	---
Total	1,544	760	1,037	1,253	1,073	788

Source: See Tables 31 and 34.

TABLE 36

NICARAGUA: ESTIMATES OF EXTRA GROSS REVENUES--THE OPERATION OF THE CAUSTIC SODA-CHLORINE PLANT AT FULL CAPACITY VS. THE PROJECTED PRODUCTION SCHEDULES (IN THOUSANDS OF DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Through Ninth Year
Caustic soda	$---	$---	$---	$---	$---	$---
Chlorine	269	152	207	251	215	158
Hydrochloric acid	---	---	---	---	---	---
Hydrogen	---	---	---	---	---	---
Sodium hypochlorite	10	---	---	---	---	---
Total	$279	$152	$207	$251	$215	$158

Source: See Table 35.

for all the chlorine produced and it could be sold at $200 per metric ton, the company would earn the extra revenue as shown in Table 36.

3. It is expected that excess production of sodium hypochlorite will occur only in the first year. Thereafter, the C.A.C.M. should demand all sodium hypochlorite produced.

4. A Central American demand is anticipated for all hydrochloric acid produced in the Nicaraguan facility.

5. An adequate demand is projected for all hydrogen manufactured in the caustic soda-chlorine plant.

Costs of Production

In determining the profitability of the proposed plant, production costs must be considered. In this section, unit costs of production are analyzed. Also, the findings of various feasibility studies are compared.

Table 37 presents the projected sales and productive costs of the chemical installation for the first nine years of plant operation. All sales and production costs are assumed constant for the fifth year through the ninth year.

Raw Materials

The costs of raw materials required by the caustic soda-chlorine plant are projected in Table 38. It is estimated that the total cost of the raw materials will be $244,000 during the first year, $268,000 the second year, $308,000 the third year and $336,000

TABLE 37

NICARAGUA: ESTIMATES OF SALES AND PRODUCTION COSTS--
THE NICARAGUAN CAUSTIC SODA-CHLORINE PLANT
FIRST NINE YEARS PLANT OPERATION
(IN THOUSANDS OF DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Through Ninth Year
Raw materials	$ 244	$ 268	$ 308	$ 336	$ 336
Labor: semiskilled	33	33	33	33	33
Maintenance	155	157	160	164	164
Control	14	14	14	14	14
Supervision	23	23	23	23	23
Utilities: services	340	375	435	471	471
Overhead	107	108	109	110	110
Administration and sales	111	111	111	111	117
Total	$1,027	$1,089	$1,193	$1,262	$1,268

Source: National Development Institute, op. cit., p. 63.

TABLE 38

NICARAGUA: ESTIMATES OF RAW MATERIAL COSTS--THE CAUSTIC SODA-CHLORINE PLANT FIRST NINE YEARS PLANT OPERATION (U.S. DOLLARS--THOUSANDS)

	First Year	Second Year	Third Year	Fourth Through Ninth Year
Barium and sodium carbonate	$ 40	$ 43	$ 49	$ 54
Graphite	13	15	17	18
Mercury	13	15	17	18
Salt	166	182	210	230
Sulfuric acid	12	13	15	16
Total	$244	$268	$308	$336

Source: Ibid., p. 38.

for each of the next six years. It should be noted that salt represents approximately 68 per cent of these costs for each year.

Labor, Maintenance, Control, Supervision, Services and Plant Overhead Expenses

While Table 37 categorized production and sales costs, Table 38 showed the projected cost of each raw material. However, for further analysis of the plant's profitability, Table 39 has been included to illustrate the projected costs of semiskilled labor, maintenance, control and supervision. Also, the costs of electricity, water and fuel oil are cited along with overhead expenses.

TABLE 39

NICARAGUA: ESTIMATES OF ANNUAL PRODUCTION COSTS EXCLUDING RAW MATERIAL, SALES AND ADMINISTRATIVE EXPENSES--THE CAUSTIC SODA-CHLORINE PLANT, FIRST NINE YEARS PLANT OPERATION
(IN THOUSANDS OF DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Through Ninth Year
Semiskilled labor					
Operators	$ 16	$ 16	$ 16	$ 16	$ 16
Helpers	9	9	9	9	9
Cell mechanics	8	8	8	8	8
	$ 33	$ 33	$ 33	$ 33	$ 33
Maintenance					
Control specialists	$ 3	$ 3	$ 3	$ 3	$ 3
Mechanics	19	19	19	19	19
Electricians	13	13	13	13	13
Helpers	6	6	6	6	6
Materials	114	116	119	123	123
	$155	$157	$160	$164	$164
Control					
Analysts	$ 8	$ 8	$ 8	$ 8	$ 8
Helpers	4	4	4	4	4
Laboratory materials	2	2	2	2	2
	$ 14	$ 14	$ 14	$ 14	$ 14
Direct supervision					
Chemical engineers	17	17	17	17	17
Superintendents	6	6	6	6	6
	$ 23	$ 23	$ 23	$ 23	$ 23

TABLE 39--Continued

	First Year	Second Year	Third Year	Fourth Year	Fifth Through Ninth Year
Utilities: services					
Electricity	$320	$352	$410	$443	$443
Water	15	17	18	20	20
Fuel oil	5	6	7	8	8
	$340	$375	$435	$471	$471
Plant overhead					
Process engineers	$ 10	$ 10	$ 10	$ 10	$ 10
Plant engineers	6	6	6	6	6
Warehouse superintendent	2	2	2	2	2
Warehouse operators	5	5	5	5	5
Guards	7	7	7	7	7
Insurance	18	19	20	21	22
Social security--pension plan	45	45	45	45	45
Chauffeur	2	2	2	2	2
Uniforms	12	12	12	12	12
	$107	$108	$109	$110	$111
Total	$672	$710	$774	$815	$816

Source: Ibid., p. 43.

Sales and Administrative Expenses

To complete this study of the major production costs of the caustic soda-chlorine plant, Table 40 has been prepared as a categorized cost statement of estimated sales and administrative expenses. The total for the administrative and sales expense ($111,000) will remain constant for the first four years. For the next five years, these expenses will increase by $6,000; expenses for this later period will average $117,000 each year.

Unit Production Costs

While Table 37 presented the total projected production costs, this section reviews the projected production costs per unit (metric ton) of chemical output. Although necessary for realistic evaluation, depreciation charges and interest on loans have not been included here in the calculation of unit costs. Depreciation and interest costs are computed in Chapter VIII and added to the costs calculated in this section. Chapter VII explains the financing of the Nicaraguan caustic soda-chlorine plant on which the interest data are based.

To compute the unit production costs of the projected output, several assumptions are necessary.

1. Unit costs will be based on the total production costs shown in Table 37.

2. The projected sales (in metric tons) shown in Table 34, are assumed to match the quantities produced. Since the metric ton sales projections were extrapolated from the data in Table 33, unit costs are

TABLE 40

NICARAGUA: ESTIMATES OF SALES AND ADMINISTRATIVE EXPENSES--THE CAUSTIC SODA-CHLORINE PLANT FIRST NINE YEARS PLANT OPERATION (U.S. DOLLARS--THOUSANDS)

	First Through Fourth Year		Fifth Through Ninth Year	
Salaries				
General manager	$18		$18	
Comptroller	5		5	
Sales manager	6		6	
Office employees	12		12	
Three secretaries	7		7	
Entertainment Expenses	9	$ 57	9	$ 57
Other Expenses				
Travel	$ 5		$ 6	
Office materials	3		4	
Telephone & telegraph	1		2	
Legal, auditing and technical services	22		22	
Miscellaneous	6		7	
Sales and supervision	17	54	19	60
Total		$111		$117

Source: Ibid., p. 41.

based on these figures rather than those in Table 31 which show the full productive capacity of the plant. Therefore, costs of production are computed on the basis of the quantity produced and quantity sold.

3. The production costs are distributed according to the output percentages which are found in Table 41.

TABLE 41

NICARAGUA: PERCENTAGES OF PROJECTED CHEMICAL OUTPUT CATEGORIZED BY PRODUCT AND YEAR OF PLANT OPERATION--THE CAUSTIC SODA-CHLORINE PLANT

	First Year	Second Year	Third Year	Fourth Year	Fifth Through Ninth Year
Caustic soda	52%	49%	48%	45%	44%
Chlorine	39	42	40	38	39
Hydrochloric acid	4	3	3	3	3
Hydrogen	---	---	1	1	1
Sodium hypochlorite	5	6	8	13	13
Total	100%	100%	100%	100%	100%

Source: Table 34

For instance, during the first year caustic soda will represent 52 per cent of the total production of the installation.[5] Therefore, the production of this product will claim 52 per cent of the production costs for that year.[6]

Tables 42 and 43 present the total production costs of each chemical product for each year and the production costs per metric ton of each chemical product respectively.

Table 42 contains data derived from Table 37 showing the total production costs. Using the percentages of Table 41, it can be seen that caustic soda's 52 per cent share of the total production costs for the first year's plant operation will amount to $534,000 (52 per cent of $1,027,000 equals $534,000).

Table 43 shows the projected production costs per metric ton of each chemical product. To obtain these data, the total annual production cost of each product was divided by the estimated number of metric tons of the chemical to be produced. For example, Table 42 showed that in the first year of plant operation it will cost approximately $534,000 to produce 7,285 metric tons of caustic soda. When the $534,000 is divided by the 7,285 metric tons, each metric ton

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[5]Table 34 showed that 13,885 metric tons of chemical products are projected to be produced during the first year of operation. The production of caustic soda was projected to be 7,285 metric tons which is 52 per cent of 13,885. This procedure is followed for the other computations in Table 41.

[6]This method of allocating costs is used in the feasibility studies of the United Nations and the Nicaraguan National Development Institute.

TABLE 42

NICARAGUA: ESTIMATES OF TOTAL PRODUCTION COSTS FOR EACH CHEMICAL PRODUCT BY PRODUCTION YEAR THE CAUSTIC SODA-CHLORINE PLANT (IN THOUSANDS OF DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Through Ninth Year
Caustic soda	$ 534	$ 534	$ 573	$ 568	$ 558
Chlorine	401	457	477	480	494
Hydrochloric acid	41	33	36	38	38
Hydrogen	---	---	12	12	13
Sodium hypochlorite	51	65	95	164	165
Total	$1,027	$1,089	$1,193	$1,262	$1,268

Source: Tables 37 and 41.

TABLE 43

NICARAGUA: PRODUCTION COSTS PER METRIC TON FOR EACH CHEMICAL PRODUCT BY PRODUCTION YEAR THE CAUSTIC SODA-CHLORINE CHEMICAL PLANT (IN U.S. DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Through Ninth Year
Caustic soda	$73.30	$67.07	$62.99	$57.57	$56.56	$56.56
Chlorine	73.44	67.75	62.68	58.86	59.27	57.31
Hydrochloric acid	82.00	66.00	60.00	63.33	54.28	54.28
Hydrogen	---	---	60.00	48.00	43.33	43.33
Sodium hypochlorite	79.69	62.50	58.64	64.06	55.00	55.00

Source: Tables 34 and 42.

produced will cost $73.30, the amount indicated in Table 43. This method is used to compute the unit costs of each chemical per metric ton for the various years.

Figures depicting the decreasing annual production costs of the chemical products could be included here in the study. However, the presentation of these cost data may be found in Chapter VIII after interest and depreciation charges have been added to the costs of production.

Production Variations: A Comparative Analysis

Data from several Nicaraguan caustic soda-chlorine studies are found in this section of the chapter; different production schedules and costs of varying outputs are given for the products. In the studies cited, however, sodium hypochlorite, hydrochloric acid and hydrogen are considered by-products and no cost projections are made for them. All expenses and output totals are based on the production of two chemical products, caustic soda and chlorine.

Table 31 projected an initial annual plant capacity of 7,285 metric tons of caustic soda and 6,804 metric tons of chlorine. The combined chemical plant capacity of 14,089 metric tons is the quantity which the plant can produce, not the quantity projected for sale as shown in Table 34. The figures in this section of the study also represent plant capacity.

Tables 44, 45 and 46 present separate production costs for caustic soda and chlorine at different production levels. Table 44

TABLE 44

NICARAGUA: ESTIMATES OF MANUFACTURING COSTS FOR 4,524 METRIC TONS CAUSTIC SODA AND 4,080 METRIC TONS CHLORINE IN PRODUCTIVE CAPACITY CHEMICAL PLANT OF 9,604 METRIC TONS
(U.S. DOLLARS)

	Caustic Soda		Chlorine	
A. Raw Materials		$ 68,783		$ 63,180
B. Direct Expense				
1. Labor				
a. Supervisors	$ 8,723		$ 7,750	
b. Process	15,964		14,137	
c. Maintenance	30,000		30,000	
2. Power	101,816		90,116	
3. Water	1,248		1,080	
4. Plant Supplies	32,040	189,791	27,780	170,863
C. Indirect Expense				
1. Laboratory	$ 1,596		$ 1,414	
2. Plant Overhead	6,385	7,981	5,655	7,069
D. Fixed Charges				
1. Depreciation	$ 55,900		$62,750	
2. Insurance	3,500	59,400	3,000	65,750

TABLE 44--Continued

	Caustic Soda		Chlorine	
E. General Expense				
1. Administration	$ 22,200		$20,000	
2. Sales	22,600	$ 44,800	6,500	$ 26,500
Total		$370,755		$333,362
Unit Production Costs		$81.95		$81.70

Source: R. W. Booker and Associates, Inc., The Nicaraguan Caustic Soda-Chlorine Feasibility Study, Report I (November, 1964), p. 37.

TABLE 45

NICARAGUA: ESTIMATES OF MANUFACTURING COSTS FOR 6,786 METRIC TONS CAUSTIC SODA AND 6,120 METRIC TONS CHLORINE IN PRODUCTIVE CAPACITY CHEMICAL PLANT OF 12,906 METRIC TONS
(U.S. DOLLARS)

	Caustic Soda		Chlorine	
A. Raw Materials		$103,530		$ 94,199
B. Direct Expense				
1. Labor				
a. Supervisors	$ 11,136		$ 9,867	
b. Process	20,298		18,035	
c. Maintenance	38,250		38,250	
2. Power	152,780		135,204	
3. Water	1,875		1,620	
4. Plant Supplies	40,851	265,190	35,419	238,395
C. Indirect Expense				
1. Laboratory	$ 2,029		$ 1,804	
2. Plant Overhead	8,119	10,148	7,213	9,017
D. Fixed Charges				
1. Depreciation	$ 73,922		$ 83,357	
2. Insurance	5,000	78,922	4,500	87,857

TABLE 45--Continued

	Caustic Soda		Chlorine	
E. General Expense				
1. Administration	$ 28,305		$ 25,500	
2. Sales	33,900	$ 62,205	4,947	$ 30,447
Total		$519,995		$459,915
Unit Production Cost	$76.63			$75.15

Source: Ibid., p. 52.

TABLE 46

NICARAGUA: ESTIMATES OF MANUFACTURING COSTS FOR 10,500 METRIC TONS CAUSTIC SODA AND 9,470 METRIC TONS CHLORINE IN PRODUCTIVE CAPACITY CHEMICAL PLANT OF 19,970 METRIC TONS
(U.S. DOLLARS)

	Caustic Soda		Chlorine	
A. Raw Materials		$160,129		$154,315
B. Direct Expense				
1. Labor				
a. Supervisors	$ 14,477		$ 12,827	
b. Process	26,386		23,445	
c. Maintenance	49,725		49,725	
2. Power	236,420		209,190	
3. Water	2,900		2,500	
4. Plant Supplies	53,106	383,014	46,045	343,732
C. Indirect Expense				
1. Laboratory	$ 2,638		$ 2,345	
2. Plant Overhead	10,555	13,193	9,377	11,722
D. Fixed Charges				
1. Depreciation	$111,581		$125,827	
2. Insurance	7,000	118,581	6,000	131,827

TABLE 46--Continued

	Caustic Soda		Chlorine	
E. General Expense				
1. Administration	$ 36,796		$ 33,150	
2. Sales	52,500	$ 89,296	12,000	$ 45,150
Total		$764,213		$686,746
Unit production cost		$72.78		$72.52

Source: Ibid., p. 73.

shows data based on a total capacity of 9,604 metric tons, Table 45 of 12,906 metric tons and Table 46 of 19,970 metric tons. The costs of raw materials, direct and indirect expenses, fixed charges and general expenses are considered production expenses for each product.

The cost estimates presented in Tables 44, 45 and 46, show economies of scale; namely production costs per metric ton decrease with an increase in the size of plant when used to full capacity.

Table 47 shows the production costs of each metric ton of caustic soda processed in three projected chemical plants, each with a varying production capacity. Table 48 presents the production costs of each metric ton of chlorine processed in the same three chemical plants. Their total annual productive capacity of caustic soda and chlorine are 9,604, 12,906 and 19,970 metric tons respectively. Each cost projection assumes 100 per cent utilization of plant capacity.

Sales and Distribution

The proposed operating company will sell its products at the plant site. To facilitate operations, sales will be made primarily on a cash basis, f.o.b., the plant. However, a few selective credit sales will be made on a 30, 60, or 90 day basis. Letters of credit must accompany credit sales to guarantee their collection.[7]

To aid Nicaraguan industry and ease collection problems for the "integrated industry" in that country, the Nicaraguan National

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[7]National Development Institute, Caustic Soda, A Manufacturing Opportunity in Nicaragua, op. cit., p. 87.

TABLE 47

NICARAGUA: ESTIMATES OF PRODUCTION COSTS PER METRIC TON OF PROCESSED CAUSTIC SODA IN PROJECTED CHEMICAL PROCESSING PLANTS WITH OPERATING CAPACITIES OF 9,604, 12,906 AND 19,970 METRIC TONS OF CAUSTIC SODA AND CHLORINE

Total Productive Capacity of Caustic Soda-Chlorine Plant (Metric Tons)	Production of Caustic Soda (Metric Tons)	Unit Costs (Metric Tons) (U.S. $'s)
9,604	4,524	$81.95
12,906	6,786	76.63
19,970	10,500	72.78

Source: Tables 44, 45 and 46.

TABLE 48

NICARAGUA: ESTIMATES OF PRODUCTION COSTS PER METRIC TON OF PROCESSED CHLORINE IN PROJECTED CHEMICAL PROCESSING PLANTS WITH OPERATING CAPACITIES OF 9,604, 12,906 AND 19,970 METRIC TONS OF CAUSTIC SODA AND CHLORINE

Total Productive Capacity of Caustic Soda-Chlorine Plant (Metric Tons)	Production of Chlorine (Metric Tons)	Unit Costs (Metric Tons) (U.S. $'s)
9,604	4,080	$81.70
12,906	6,120	75.15
19,970	9,470	72.52

Source: Tables 44, 45 and 46.

Development Institute will help finance the exportation of manufactured chemicals. In 1966 the Institute launched a pilot plan for establishing a means of financing exports which included Nicaraguan chemical products and other manufactured items.

To expand its line of financing, the National Development Institute has been authorized by the Agency for International Development, Washington, D.C., to utilize resources of $1,000,000 for exports. Furthermore, it has negotiated a line of revolving credit with the Bank of America for $1,000,000. In addition, the Inter-American Development Bank, Washington, D.C. has established a $1,000,000 revolving line of credit for Nicaragua to finance exports of capital goods to other Latin American countries.[8]

The next chapter, Chapter VII, will discuss the proposed financing and the operative company for the Nicaraguan caustic soda-chlorine plant.

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[8]International Financial News Survey, XVIII, No. 26 (July 1, 1966), 218.

CHAPTER VII

FINANCING OF THE NICARAGUAN CAUSTIC SODA-CHLORINE PLANT: THE OPERATING COMPANY

Background

When the Nicaraguan National Development Institute was established to provide long-term financing, the proposed chemical plant gained substantial financial support. Also, the C.A.C.M. demand for chemicals produced in Nicaragua seemed to justify additional planning for a caustic soda-chlorine installation.

Therefore, a corporation, Pennsalt de Central America, S.A., a subsidiary of the Pennsalt Chemical Company of Philadelphia, Pennsylvania, has been formed to manufacture caustic soda-chlorine and their by-products. This corporation proposes to purchase 51 per cent of the ownership stock in the plant while the Morton Chemical Company of Chicago, Illinois, will purchase 9 per cent. The National Development Institute of Nicaragua will purchase, in the name of Central American stockholders, the remaining 40 per cent of the ownership stock which will be sold later to foreign and domestic investors.[1]

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[1]National Development Institute, Caustic Soda, A Manufacturing Opportunity in Nicaragua (Managua: Instituto de Fomento, 1966), p. 2.

The Financial Plan

Capital Structure

The projected capital for the Nicaraguan caustic soda-chlorine plant includes equity capital ($880,000), subordinated loans ($860,000) and bank loans ($2,080,000) for a total of $3,820,000 as shown in Table 49.[2]

Equity capital.--Eight thousand eight hundred shares of common stock will be used for equity capital at a book value of $100 per share. However, of this $880,000 only $750,000 is to be paid in cash. Pennsalt will pay $348,800 in cash; Morton Chemical Corporation, $79,200; the Nicaraguan Development Institute, $322,000. The Pennsalt Chemical Corporation will receive common stock valued at $100,000, 1,000 shares of common stock at $100 each, in payment for technical assistance.[3]

Three hundred shares totaling $30,000 will be given to the National Development Institute to cover its expense of studying and promoting the project. In addition, the Institute will underwrite 3,220 shares which will be marketed to raise Central American capital.

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[2]The disposition of the capital was projected in Table 32, Chapter VI, p. 102.

[3]Pennsalt will contribute manuals of operation, technical data including diagrams of the manufacture of caustic soda and chlorine, requirements for ingredients, general facilities, storage facilities, services, auxiliary plants, tubing, instruments and drawings of machinery and equipment. In addition, this company will pay costs of engineering, supervision, purchasing and shipping of equipment. It will also provide engineers, chemists and other technicians needed to initiate operations and train local personnel.

TABLE 49

THE NICARAGUAN CAUSTIC SODA-CHLORINE PLANT:
CAPITAL SOURCES (IN U.S. DOLLARS)

	Technical Knowledge & Assistance	Cash	Equipment	Total	Grand Total
A. Equity Capital					
Pennsalt Chem. Corp.	$100,000	$348,800	$ ---	$ 448,800	
Morton Chem. Corp.	---	79,200	---	79,200	
Nic. Dev. Institute	30,000	322,000	---	352,000	
	$130,000	$750,000	$ ---		$ 880,000
B. Subordinated Loans					
Pennsalt Chem. Corp.	$100,000	$124,400	$ ---	$ 224,400	
Morton Chem. Corp.	---	39,600	420,000	459,600	
Nic. Dev. Institute*	---	176,000	---	176,000	
	$100,000	$340,000	$420,000		860,000

TABLE 49--Continued

	Technical Knowledge & Assistance	Cash	Equipment	Total	Grand Total
C. Bank Loans					
Fixed Capital				$1,780,000	
Working Capital				300,000	$2,080,000
Total Capital					$3,820,000

*These securities will be offered to foreign and domestic investors.

Source: National Development Institute, Caustic Soda, A Manufacturing Opportunity in Nicaragua (Managua: Instituto de Fomento, 1966), p. 2.

Subordinated loans.--One of the subordinated loans for the caustic soda-chlorine plant will be obtained from the Morton Chemical Company. Equipment valued at $420,000 will be provided by this company in return for 4,200 debenture bonds, each valued at $100.

A second subordinated loan of $440,000 for the plant is represented by 4,400 debenture bonds also with a book value of $100 each.[4] Of this number, 1,000 bonds will be given Pennsalt for its contribution. In addition, the National Development Institute will purchase 1,760 debenture bonds, Pennsalt, 1,244 debenture bonds, and the Morton Chemical Company, the remaining 396 debenture bonds.

Bank loans.--Bank loans for the caustic soda-chlorine plant will be negotiated through the Central American Integration Bank, banks in the United States or a combination of the two.

Over the years Nicaragua has maintained a good credit rating with the International Monetary Fund and the United States government. Her applications for economic development loans are acceptable to the IMF, government and semi-governmental financial agencies in the U.S. For example, on February 26, 1968, the International Monetary Fund approved a stand-by arrangement for the government of Nicaragua which authorized drawings up to the equivalent of $19 million during the next year.[5]

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[4]These loans, in the subordinated loan category, totaling $860,000 will earn 7 per cent interest and will have priority over other obligations of the company.

[5]"Stand-by Arrangement for Nicaragua," International Financial News Survey, XX No. 8 (March 1, 1968), 61.

Also, on March 4, 1968 an exchange agreement for $4.75 million was signed by the United States Treasury and the Government and Central Bank of Nicaragua.[6]

The fixed capital loan for the plant must be secured; however, no collateral is required for the loan ($300,000) for working capital. The machinery and fixed equipment valued at $2,247,765 and the buildings appraised at $264,305 (a total value of $2,512,070) will be offered as collateral for the fixed capital loan of $1,780,000.[7] The estimated worth of the machinery, fixed equipment and buildings, $2,512,070, represents 141 per cent of the loan. An interest rate of 6 per cent will be charged on the bank loans.

Sources of Capital: the Investment Plan

Since the Central American Bank for Integration requires a "source and use" of funds financial statement for the integrated industries' loan applications, capital sources have been projected for specific cost purposes in the plant's investment plan. Table 50 shows this "source and use" investment data.

In this table the equity capital figure of $1,320,000 included the amount of the subordinated loans ($340,000) as well as the stock payments ($230,000) to Pennsalt and the Nicaraguan National Development Institute for technical assistance.

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[6]"Nicaraguan-U.S. Exchange Agreement," International Financial News Survey, XX No. 10 (March 15, 1968), 87-88.

[7]See Table 32, Chapter VI, p. 102 which is reproduced in Table 50.

TABLE 50

ESTIMATED PLAN OF INVESTMENT AND SOURCES OF CAPITAL
FOR SPECIFIC EXPENDITURES: THE NICARAGUAN
CAUSTIC SODA-CHLORINE PLANT
(U.S. DOLLARS)

Use		Source		
Projected Value		Equity Capital	Other Capital	Bank Loans
I. Fixed Capital				
Land	$ 60,000	$ 60,000		
Street improvements	17,365	17,365	$ ---	$ ---
Buildings	264,305	84,305		180,000
Machinery and Fixed Equipment	2,247,765	407,765	$420,000	1,420,000
Engineering Fees	217,365	117,365		100,000
Contingencies	158,200	78,200		80,000
Organizational Expense	70,000	70,000		
Sub-total	$3,035,000	$ 835,000	$420,000	$1,780,000
Technical Knowledge	230,000	230,000	---	---
Total Fixed Capital	$3,265,000	$1,065,000	$420,000	$1,780,000

TABLE 50--Continued

Use		Source		
Projected Value		Equity Capital	Other Capital	Bank Loans
II. Working Capital				
Raw materials	$ 301,000	$ 126,000	$ ---	$ 175,000
Inventory and net accounts receivable	116,000	61,000		55,000
Spare parts	70,000	---	---	70,000
Cash	68,000	68,000	---	---
Total Working Capital	$ 555,000	$ 255,000	$ ---	$ 300,000
Grand Total	$3,820,000	$1,320,000	$420,000	$2,080,000

Source: National Development Institute, Caustic Soda, A Manufacturing Opportunity in Nicaragua (Managua: Instituto de Fomento, 1966), p. 2.

It should be kept in mind that only $750,000 in cash has been advanced as equity. However, both equity capital figures, $1,320,000 and the cash paid-in, $750,000, are to be used in assessing the profitability of the new chemical plant.

An analysis of the profitability of the projected caustic soda-chlorine plant is presented in the following chapter.

CHAPTER VIII

THE PROFITABILITY OF THE CAUSTIC SODA-CHLORINE PLANT

Before the profitability of the Nicaraguan caustic soda-chlorine plant can be determined, depreciation and interest charges must be computed. Also, the proposed method of repayment of loans should be explained. Table 33, Chapter VI, showed the projected annual gross revenues while Table 37 presented the projected production costs for the first nine years of plant operation, exclusive of the depreciation and interest charges. Table 51 now presents the projected gross sales revenue, costs of production, the projected depreciation and interest charges and the estimated net profit of the chemical plant for the first nine years of plant operation.

The dollar amounts of the gross sales and the costs of production in Table 51 were prepared by the Nicaraguan National Development Institute after reviewing the feasibility studies of R. W. Booker and Associates, Inc.

Amortization

Depreciation

"Depreciation generally consists of a fixed annual charge on facility investment which will result in recovery of the initial

TABLE 51

NICARAGUA: ESTIMATES OF PROFIT AND LOSS--THE CAUSTIC SODA-CHLORINE PLANT, FIRST NINE YEARS PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Gross sales (Table 33)	$1,542	$1,780	$2,054	$2,277	$2,309
Costs of production (Table 37)	1,027	1,089	1,193	1,262	1,268
Amortizations					
Depreciation*	332	332	332	332	332
Loan interest**	185	185	185	151	118
	$ 517	$ 517	$ 517	$ 483	$ 450
Net Profit	$ (-2)	$ 174	$ 344	$ 532	$ 591

*The straight-line depreciation method has been used.

**The computation of the interest charges are shown in the following tables 52 through 58.

Source: National Development Institute, op. cit., p. 102.

TABLE 51--Continued

	Sixth Year	Seventh Year	Eighth Year	Ninth Year
Gross sales (Table 33)	$2,336	$2,336	$2,336	$2,336
Costs of production (Table 37)	1,268	1,268	1,268	1,268
Amortizations				
Depreciation*	332	332	332	332
Loan interest**	88	59	29	---
	$ 420	$ 391	$ 361	$ 332
Net Profit	$ 648	$ 677	$ 707	$ 736

*The straight-line depreciation method has been used.

**The computation of the interest charges are shown in the following tables 52 through 58.

Source: National Development Institute, op. cit., p. 102.

investment at the end of the useful life of the facility."[1] In the case of the Nicaraguan caustic soda-chlorine plant, it is assumed that the plant has a nine-year life, it is to be depreciated on a straight-line method, and that it has a salvage value at the end of the nine years of $217,000. Table 32, Chapter VII, shows the projected total fixed capital of $3,205,000 which excludes the cost of land ($60,000). Land is not included for the purpose of depreciation as "every fixed asset, with the exception of land, yields a quantity of useful services

[1]John Happel, Chemical Process Economics (New York: John Wiley and Sons, Inc., 1958), p. 3.

and has a limited life."[2] When the plant is depreciated at $332,000 for each of nine years as shown in Table 51 (totaling $2,988,000), a salvage value of $217,000 remains.

Interest

The Nicaraguan caustic soda-chlorine plant will borrow $2,940,000. The owners of the chemical installation will loan the corporation $860,000. These will be classified as subordinated loans and carry a 7 per cent interest rate. Also, $2,080,000 at 6 per cent is to be borrowed from banks, primarily the Central American Bank of Integration.

No payments are to be made on the principal of any loan for the first two years.[3] Thereafter, according to the projected amortization schedule, $490,000 is to be paid on the principal of the loans each year for six years. Simple interest is to be charged on the balances at the end of each year.

Tables 52, 53, 54, 55, 56, 57 and 58 show the interest charges and the principal for each of the first eight years of plant operation. All loans are to be fully paid at the end of the eighth year.

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[2]Conrad Berenson, ed., Administration of the Chemical Enterprise (New York: John Wiley and Sons, Inc., 1963), p. 340.

[3]Since the Nicaraguan chemical plant is in the fundamental category (see Chapter II), the Central American Economic Bank of Integration is permitting the three partners of the Pennsalt Chemical Company, S.A. to recover their subordinated loan capital and interest before repaying the principal of the bank loans. However, the Central American Bank charges annual interest on their loans before payments on the principal begin.

Table 52 indicates the projected operating company is to pay $185,000 in interest on the company's outstanding loans for each of the first two years.[4]

TABLE 52

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--THE CAUSTIC SODA-CHLORINE PLANT, FIRST AND SECOND YEAR OPERATIONS (U.S. DOLLARS)

	Loan Principal Beginning of Period	Applicable Interest Rate	Interest to be Paid
Subordinated loans			
Pennsalt Chemical Corporation	$ 224,400	7%	$ 15,708
Morton Chemical Corporation	459,600	7	32,172
Nicaraguan Development Institute	176,000	7	12,320
Bank loans			
Fixed capital	1,780,000	6	106,800
Working capital	300,000	6	18,000
Total	$2,940,000		$185,000

Source: Table 49.

Table 53 shows an initial payment of $490,000 to reduce the subordinated loans to a balance of $370,000. The full amount of $2,080,000 remains payable to the bank. Since it is assumed that the borrowed capital will be used the third year, a $185,000 interest

[4]In Table 51 this interest is deducted before arriving at the projected profit or loss calculations for the first two years.

TABLE 53

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--
THE CAUSTIC SODA-CHLORINE PLANT, THIRD YEAR
OPERATION (U.S. DOLLARS)

	Original Loan	Third Year Payment	Balance Owed Fourth Year
Payment of Company obligations			
Subordinated loans			
Pennsalt Chemical Corporation	$244,400	$163,334	$ 61,066
Morton Chemical Corporation	459,600	163,333	296,267
Nicaraguan Development Institute	176,000	163,333	12,667
	$880,000	$490,000	$ 370,000
Bank loans			
Fixed capital			$1,780,000
Working capital			300,000
			$2,080,000
Total Loans			$2,450,000
Interest payable (Table 52)			$ 185,000

Source: Table 49.

payment is due at the end of this year. Payments on the principal are also paid at the end of the third year of plant operation.

Table 54 shows that in the fourth year a payment of $490,000 will be made on the loans of the chemical company. With the payment, the subordinated loans are paid in full. In addition to the full payment of the subordinated loans, $12,000 is paid on the working capital loan. This table also shows that approximately $151,000 ($150,701

TABLE 54

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--
THE CAUSTIC SODA-CHLORINE PLANT, FOURTH YEAR
OPERATION (U.S. DOLLARS)

		Interest Payable	
Subordinated Loans	Loan Principal Beginning of Period	Applicable Interest Rate	Interest to be Paid
Pennsalt Chemical Corporation	$ 61,066	7%	$ 4,275
Morton Chemical Corporation	296,267	7	20,739
Nicaraguan Development Institute	12,667	7	887
Bank Loans			
Fixed Capital	1,780,000	6	106,800
Working Capital	300,000	6	18,000
Totals	$2,450,000		$150,701

Table 54--Continued

Payment of Company Obligations			
Subordinated Loans	Loan Balance Start of Fourth Year	Fourth Year Payment	Balance Owed Start of Fifth Year
Pennsalt Chemical Corporation	$ 61,066	$ 61,066	$ ---
Morton Chemical Corporation	296,267	296,267	---
Nicaraguan Development Institute	12,667	12,667	---
Bank Loans			
Fixed Capital	1,780,000	---	1,780,000
Working Capital	300,000	120,000	180,000
Totals	$2,450,000	$490,000	$1,960,000

rounded to the nearest thousand) is paid during the fourth year of plant operation for interest.

The data in Table 55 indicate that approximately $118,000 ($117,600 rounded to the nearest thousand) is paid on an interest charge during the plant's fifth year. (This $118,000 interest charge is recorded on Table 51 as a deduction in arriving at the net profit of $591,000 for the fifth year.)

With a payment of $490,000 in the fifth year, the working capital loan will be fully repaid; a balance of $1,470,000 remains for the fixed capital loans.

TABLE 55

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--
THE CAUSTIC SODA-CHLORINE PLANT, FIFTH YEAR
OPERATION (U.S. DOLLARS)

Interest Payable: Bank Loans			
	Loan Principal Beginning of Period (Table 54)	Applicable Interest Rate	Interest to be Paid
Fixed capital	$1,780,000	6%	$106,800
Working capital	180,000	6	10,800
Totals	$1,960,000		$117,600

Payment of Company Obligations			
	Loan Balance Start of Fifth Year	Fifth Year Payment	Balance Owed Start of Sixth Year
Fixed capital	$1,780,000	$310,000	$1,470,000
Working capital	180,000	180,000	---
Totals	$1,960,000	$490,000	$1,470,000

During the sixth year of manufacture, approximately $88,000 ($88,200 rounded to the nearest thousand) will be paid by the Nicaraguan Chemical Company in interest. Also, $490,000 will be paid on the fixed capital loan leaving a balance of $980,000 at the start of the seventh year. Table 56 summarizes these transactions.

Table 57 shows that a fifth payment of $490,000 will be made to reduce the fixed capital loans. Thus, a balance will remain of

TABLE 56

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--
THE CAUSTIC SODA-CHLORINE PLANT, SIXTH YEAR
OPERATION (U.S. DOLLARS)

Interest Payable: Bank Loans			
	Loan Principal Beginning of Period (Table 55)	Applicable Interest Rate	Interest to be Paid
Fixed capital	$1,470,000	6%	$88,200

Payment of Company Obligations			
	Loan Balance Start of Sixth Year	Sixth Year Payment	Balance Owed Start of Seventh Year
Fixed capital	$1,470,000	$490,000	$980,000

TABLE 57

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--THE CAUSTIC SODA-CHLORINE PLANT, SEVENTH YEAR OPERATION (U.S. DOLLARS)

Interest Payable: Bank Loans			
	Loan Principal Beginning of Period (Table 56)	Applicable Interest Rate	Interest to be Paid
Fixed capital	$980,000	6%	$58,800
Payment of Company Obligations			
	Loan Balance Start of Seventh Year	Seventh Year Payment	Balance Owed Start of Eighth Year
Fixed capital	$980,000	$490,000	$490,000

$490,000 to be paid in the eighth year. Also, during the seventh year, approximately $59,000 ($58,800 rounded to the nearest thousand dollars) is applied to interest charges on the fixed capital bank loan.

Table 58 shows that approximately $29,000 ($29,400 rounded to the nearest thousand dollars) is projected to be paid during the eighth year of the caustic soda-chlorine plant operation. Also, with a final payment of $490,000 the fixed capital bank loan will be retired.

The Payback Period Method

At this point, it will be helpful to show, by the payback period method, the length of time that it will take the Pennsalt

TABLE 58

NICARAGUA: ESTIMATES OF INTEREST AND LOAN PAYMENTS--
THE CAUSTIC SODA-CHLORINE PLANT, EIGHTH YEAR
OPERATION (U.S. DOLLARS)

Interest Payable: Bank Loans			
	Loan Principal Beginning of Period (Table 57)	Applicable Interest Rate	Interest to be Paid
Fixed capital	$490,000	6%	$29,400
Payment of Company Obligations			
	Loan Balance Start of Eighth Year	Eighth Year Payment	Balance Owed Start of Ninth Year
Fixed capital	$490,000	$490,000	$ ---

Corporation, Morton Chemical Corporation and the Nicaraguan National Development Institute to pay the debts of the company and recover the original capital. "The payback period is the number of years it takes the firm to recover its original investment by net returns before depreciation but after taxes."[5] The data from which the payback period was computed are found in the profit and loss statement of Table 51.

Assumptions

Based on the data of Table 51 for the first nine years of operation of the caustic soda-chlorine plant, the following

[5]J. Fred Weston and E. F. Bingham, Essentials of Managerial Finance (New York: Holt, Rinehart and Winston, Inc., 1968), p. 132.

assumptions are made in determining a method of calculating the payback period.

1. The subordinated loans will earn 7 per cent interest until paid. This also applies to the Morton Chemical Corporation for the $420,000 in machinery which they provided.

2. The loans obtained from banks will earn 6 per cent interest.

3. In accordance with the definition of the payback period, all sums shown for depreciation are used in the retirement of debt and for the return of principal.

4. All calculations in the tables which follow are carried to the nearest dollar for the sake of convenience.

The Application

Tables 59, 60, 61, 62, 63 and 64 analyze how the three partners in the Nicaraguan caustic soda-chlorine plant will recover their original investments. These tables also indicate the total net earnings of the caustic soda-chlorine plant and the depreciation charges are sufficient to pay interest on the subordinated loans and the bank loans and settle the company's debt obligations.

Financial operations: first year.--Table 59 shows that during the first year of operation the caustic soda-chlorine plant will experience a net loss of $2,000 after costs of production (overhead and administration), depreciation and interest charges are deducted from gross revenues. However, the $332,000 depreciation charge is

TABLE 59

NICARAGUA: THE COMPUTATION OF THE PAYBACK PERIOD OF THE CAUSTIC SODA-CHLORINE PLANT, FIRST YEAR (U.S. DOLLARS)

	Loan Principal Beginning of Period	Applicable Interest	Interest to be Paid
Loans			
Subordinated (Table 52)			
Pennsalt Chemical Corporation	$ 224,400	7%	$ 15,708
Morton Chemical Corporation	459,600	7	32,172
Nicaraguan Development Institute	176,000	7	12,320
Bank Loans			
Fixed capital	1,780,000	6	106,800
Working capital	300,000	6	18,000
Total Interest			$ 185,000
Gross Sales (Table 51)			$1,542,000
Less: Costs of Production and Depreciation (Table 51)	$1,359,000		
Interest paid (Table 51)	185,000		1,544,000

TABLE 59--Continued

	Loan Principal Beginning of Period	Applicable Interest	Interest to be Paid
Net Loss			$ -2,000
Add: Depreciation (Table 51)			332,000
Applicable for Repayment of Loan Principal			$ 330,000

Payment of Company Obligations

Subordinated Loans	Original Loan	First Year Payment	Balance Owed Second Year
Pennsalt Chemical Corporation	$ 224,400	$110,000	$ 114,400
Morton Chemical Corporation	459,600	110,000	349,600
Nicaraguan Institute	176,000	100,000	66,000
Totals	$ 860,000	$320,000	$ 530,000
Bank Loans			
Fixed capital	$1,780,000		
Working capital	300,000		$2,080,000
Total			$2,610,000

added to the $2,000 net loss figure for a total of $330,000. When this sum is paid on the subordinated loans at the end of the first year of operation, a balance of $530,000 for the subordinated loans remains. Also, at the close of the books for the first year, there will be a cash flow of $330,000.[6]

Nothing has been paid toward the principal of the bank loans although interest has been paid at 6 per cent. No equity funds have been discharged.

Financial operations: second year.--Projections for the second year of operation show a net profit of $197,100 (see Table 60). Gross sales will rise to $1,780,000 from the $1,542,000 of the first year; costs of production, interest charges and depreciation similarly will increase from $1,554,000 to $1,582,900. For the second year, this study assumes that 100 per cent of the depreciation charge of $332,000 is added to the $197,100 net profit. This total ($529,100) will fully repay the subordinated loans of the Pennsalt Chemical Corporation and the Morton Chemical Corporation leaving a balance of $900 owed to the National Development Institute.

Financial operations: third year.--Table 61 shows at the end of the third year of operation the three major subordinated loans to the company have been fully paid, the working capital loan of $300,000 liquidated, and $435,237 paid on the $1,780,000 fixed capital loan.

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[6]Cash flow is calculated by subtracting the $2,000 net loss from the projected $332,000 depreciation charge for a total of $330,000.

TABLE 60

NICARAGUA: THE COMPUTATION OF THE PAYBACK PERIOD OF THE CAUSTIC SODA-CHLORINE PLANT, SECOND YEAR (U.S. DOLLARS)

	Loan Principal Beginning of Period	Applicable Interest	Interest to be Paid
Loans			
Subordinated (Table 59)			
Pennsalt Chemical Corporation	$ 114,400	7%	$ 8,008
Morton Chemical Corporation	349,600	7	24,472
Nicaraguan Development Institute	66,000	7	4,620
Bank Loans			
Fixed capital	1,780,000	6	106,800
Working capital	300,000	6	18,000
Total Interest			$ 161,900
Gross Sales (Table 51)			$1,780,000
Less: Costs of Production and Depreciation (Table 51)	$1,421,000		
Interest paid (Above)	161,900		1,582,900
Net Profit			$ 197,100
Add: Depreciation (Table 51)			332,000
Applicable for Repayment of Loan Principal			$ 529,100

TABLE 60--Continued

Payment of Company Obligations			
Subordinated Loans	Loan Balance Start of Second Year	Second Year Payment	Balance Owed Start of Third Year
Pennsalt Chemical Corporation	$ 114,400	$114,400	$ ---
Morton Chemical Corporation	349,600	349,600	---
Nicaraguan Institute	66,000	65,100	900
Bank Loans			
Fixed capital	$1,780,000	$ ---	$1,780,000
Working capital	300,000	---	300,000
Total	$2,610,000	$529,100	$2,080,900

TABLE 61

NICARAGUA: THE COMPUTATION OF THE PAYBACK PERIOD OF THE CAUSTIC SODA-CHLORINE PLANT, THIRD YEAR (U.S. DOLLARS)

	Loan Principal Beginning of Period	Applicable Interest	Interest to be Paid
Loans			
Subordinated (Table 60)			
Nicaraguan Institute	$ 900	7%	$ 63
Bank Loans			
Fixed capital	1,780,000	6	106,800
Working capital	300,000	6	18,000
Total Interest			$ 124,863
Gross Sales (Table 51)			$2,054,000
Less: Cost of Production and Depreciation (Table 51)	$1,525,000		
Interest paid (Above)	124,863		1,649,863
Net profit			$ 404,137
Add: Depreciation (Table 51)			332,000
Applicable for Repayment of Loan Principal			$ 736,137

TABLE 61--Continued

Payment of Company Obligations			
Subordinated Loans	Loan Balance Start of Third Year	Third Year Payment	Balance Owed Start of Fourth Year
Nicaraguan Institute	$ 900	$ 900	$ ---
Bank Loans			
Fixed capital	$1,780,000	$435,237	$1,344,763
Working capital	300,000	300,000	---
Total	$2,080,900	$736,137	$1,344,763

For the third year, a net profit of $404,137 is projected. Gross sales revenues will rise to $2,054,000 from $1,780,000 during the second year while costs of production, depreciation and applicable interest charges increase to $1,649,863 from $1,582,900. The percentage increase in gross sales revenues far exceeds the increase in costs of production, depreciation and interest charges.

During the third year, the $332,000 depreciation charge is added to the net profit of $404,137 for a total of $736,137. This sum is used to repay the subordinated loan balance ($900), and the working capital loan ($300,000). Also, the fixed capital loan is reduced to $1,344,763.

Financial operations: fourth year.--At the close of the fourth year of plant operation, an additional $934,314 will be applied to the fixed capital loan; all other interest-bearing obligations have been paid in full (see Table 62).

For the fourth year, a net profit of $602,314 is projected. While gross sales increase each year, the interest charges diminish with the repayment of debt resulting in increased net profits each year. For example, the gross sales revenues will rise to $2,277,000 in the fourth year, an increase from $2,054,000 of the previous year. Although the costs of production, interest charges and depreciation also will increase during the fourth year from $1,649,863 to $1,674,686, the percentage increase in gross sales revenues is much greater.

TABLE 62

NICARAGUA: THE COMPUTATION OF THE PAYBACK PERIOD OF THE CAUSTIC SODA-CHLORINE PLANT, FOURTH YEAR (U.S. DOLLARS)

	Loan Principal Beginning of Period	Applicable Interest	Interest to be Paid
Loans			
Subordinated (Table 61)		P A I D	
Bank			
Fixed capital	$1,344,763	6%	$ 80,686
Total Interest			$ 80,686
Gross Sales (Table 51)			$2,277,000
Less: Cost of Production and Depreciation (Table 51)	$1,594,000		
Interest paid (Above)	80,686		1,674,686
Net Profit			$ 602,314
Add: Depreciation (Table 51)			332,000
Applicable for Repayment of Loan Principal			$ 934,314

TABLE 62--Continued

Payment of Company Obligations			
	Loan Balance Start of Fourth Year	Fourth Year Payment	Balance Owed Start of Fifth Year
Bank Loans			
Fixed capital	$1,344,763	$934,314	$410,449

The $332,000 depreciation charge is added to the $602,314 net profit. The total of these two figures ($934,314) is applied to the fixed capital bank loan.

Financial operations: fifth year.--The projections of Table 63 show all loans of the new chemical plant will have been paid by the end of the fifth year. In addition, the Morton Chemical Corporation has recovered its entire equity capital, the Pennsalt Chemical Corporation has recovered 75.51 per cent of its original equity capital ($263,362 of $348,800 equals 75.51 per cent). The Nicaraguan National Development Institute has recovered 81.79 per cent of its original investment ($263,326 of $322,000 represents 81.79 per cent).[7]

During the fifth year of plant operation, a net profit of $684,373 is projected. Gross sales revenues will be $2,309,000 as compared with $2,277,000 of the fourth year. The interest charges will decrease from $80,686 in the fourth year to $24,627. Costs of sales will remain approximately the same while sales revenues will increase.

Financial operations: sixth year.--Before the end of the second month of the sixth year, operation of the caustic soda-chlorine plant will generate sufficient net profits and cash flows to retire all debts and return the original invested capital to the three

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[7]Computation of the equity capital payments is based on the full payment of equity capital to the Morton Chemical Corporation, with the other two partners receiving equal shares.

TABLE 63

NICARAGUA: THE COMPUTATION OF THE PAYBACK PERIOD OF THE CAUSTIC SODA-CHLORINE PLANT, FIFTH YEAR (U.S. DOLLARS)

	Loan Principal Beginning of Period	Applicable Interest	Interest to be Paid
Loans and Equity Capital			
Bank loans			
Fixed Capital (Table 62)	$ 410,449	6%	$ 24,627
Original Equity Capital (Table 49, Chapter VII)			
Pennsalt Chemical Corporation	$ 348,800	--	---
Morton Chemical Corporation	79,200	--	---
Nicaraguan Institute	322,000	--	---
Gross Sales (Table 51)			
Less: Cost of Production and Depreciation (Table 51)	$1,600,000		$2,309,000
Interest Paid (Above)	24,627		1,624,627
Net Profit			$ 684,373
Add: Depreciation (Table 51)			332,000
Applicable for Repayment of Loan Principal			$1,016,373

TABLE 63--Continued

Payment of Bank Loans and Return of Equity Capital			
	Loan or Equity Balance Start of Fifth Year	Fifth Year Payment	Balance Owed Start of Sixth Year
Bank Loan	$ 410,449	$ 410,449	$ ---
Equity Capital			
Pennsalt Chemical Corporation	348,800	263,362	85,438
Morton Chemical Corporation	79,200	79,200	---
Nicaraguan Institute	322,000	263,362	58,638
Totals	$1,160,449	$1,016,373	$144,076

stockholders of the Pennsalt Chemical Company, S.A.[8] Table 64 shows the calculations for the sixth year. Furthermore, by the end of the sixth year, the three owners will have paid all company obligations, recovered their original equity capital and received collectively a 123 per cent profit on their investment.[9]

During the sixth year of plant production, a net profit of $736,000 is projected. Gross sales revenues will be $2,336,000 in contrast to $2,309,000 in the fifth year. Since all loans will have already been liquidated, no interest charges will be applicable. Costs of sales and depreciation schedules for the sixth year will be the same as those of the preceding year.

Using the payback period method of financial analysis, after six years of operation of the caustic soda-chlorine plant under assumed or projected conditions, all debts are to be settled, the original equity funds returned to the owners and a $923,924 profit made available to the three original partners in the Pennsalt Chemical Company, S.A.

However, the payback period method of capital budgeting has two drawbacks: it ignores income earned after the payback period and

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[8]The projected capital payback for each month is $89,000. (The yearly payback of $1,068,000 divided by 12 months equals $89,000 per month.)

[9]With $1,068,000 available for repayment of equity capital and profits and $146,076 of equity capital outstanding, a balance is left of $923,924 for profit. Seven hundred and fifty thousand dollars cash was invested but $923,924 will remain after payment of the original equity investment and all debts, thus, a 123 per cent profit appears in the sixth year ($923,924 divided by $750,000 equals 123 per cent.)

TABLE 64

NICARAGUA: THE COMPUTATION OF THE PAYBACK PERIOD OF THE CAUSTIC SODA-CHLORINE PLANT, SIXTH YEAR (U.S. DOLLARS)

	Equity Balance Beginning of Period (Table 63)	
Equity Capital		
Pennsalt Chemical Corporation	$ 85,438	
Nicaraguan Institute	58,638	
	$ 144,076	
Gross Sales (Table 51)		$2,336,000
Less: Cost of Production and Depreciation (Table 51)	$1,600,000	
Interest paid (Above)	---	1,600,000
Net Profit		$ 736,000
Add: Depreciation (Table 51)		332,000
Applicable for Repayment of Loan Principal		1,068,000
Available for repayment of equity and profits		$1,068,000
Less: Equity capital outstanding		144,076
Available to stockholders after repayment of original capital		$ 923,924

it fails to consider the interest factor.[10] Both weaknesses arise in this evaluation of the Nicaraguan caustic soda-chlorine plant. Therefore, other financial methods and analytical tools are used which include the internal rate-of-return method, the break-even analysis and the net present value method.

[10]Weston, op. cit., p. 132.

The Internal Rate-of-Return Method

A discounted cash flow method, the internal rate-of-return, will also be used to determine the profitability of the Nicaraguan plant. This method considers the revenues from a project and the time value of money.

The Cash Flow

Before the internal rate-of-return method can be used, the cash flows to be generated during the first nine years' operation of the chemical installation must be computed. Defined as "the net proceeds before depreciation but after taxes that result from a project," the cash flow generated must be computed for use in the internal rate-of-return method.[11] Since no taxes will be levied on the projected "integrated" chemical industry, the yearly cash flow consists of the net profits and the depreciation charges generated. Tables 65 and 66 show the estimated cash flows for each of the first nine years. The cash flows projected are derived by subtracting the annual costs of production and interest charges from the gross sales revenues.

The Application

The interest rate-of-return is defined as "the interest rate that equates the present value of the expected future receipts to the cost of the investment outlay."[12]

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[11] Ibid., p. 131.

[12] Ibid., p. 133.

TABLE 65

NICARAGUA: ESTIMATES OF CASH FLOW--THE CAUSTIC SODA-CHLORINE PLANT, FIRST FIVE YEARS OF PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Gross sales (Table 33)	$1,542	$1,780	$2,054	$2,277	$2,309
Less: Costs of production (Table 37)	1,027	1,089	1,193	1,262	1,268
Interest charges (Table 51)	185	185	185	151	118
Total costs of production and interest	$1,212	$1,274	$1,378	$1,413	$1,386
Projected Cash Flow	$ 330	$ 506	$ 676	$ 864	$ 923

TABLE 66

NICARAGUA: ESTIMATES OF CASH FLOW--THE CAUSTIC SODA-CHLORINE PLANT, SIXTH THROUGH NINTH YEAR OF PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	Sixth Year	Seventh Year	Eighth Year	Ninth Year
Gross sales (Table 33)	$2,336	$2,336	$2,336	$2,336
Less: Costs of production (Table 37)	1,268	1,268	1,268	1,268
Interest charges (Table 51)	88	59	29	---
Total costs of production and interest	$1,356	$1,327	$1,297	$1,268
Projected Cash Flow	$ 980	$1,009	$1,039	$1,068

Although the internal rate-of-return is found by trial and error, an arbitrarily selected 16 per cent interest rate is used to compute the present value of the cash flows.[13] Table 67 shows the calculations in the application of determining the internal rate-of-return.

Using the total cash flow projections for the first nine years of production (see Tables 65 and 66) and the original investment figure of $3,265,000, a 16 per cent interest factor for the Nicaraguan

[13]The 16 per cent rate is shown as a 16 per cent interest factor in Table A--Present Value of $1.

P. Hunt, C.M. Williams and G. Donaldson, Basic Business Finance (Homewood, Ill.: Richard D. Irwin, Inc., 1958), p. 490.

TABLE 67

NICARAGUA: THE INTERNAL RATE-OF-RETURN CALCULATIONS EVALUATION OF THE NICARAGUAN CAUSTIC SODA-CHLORINE PLANT (U.S. DOLLARS)

	Year	Cash Flow
Investment = $3,265,000	1	$ 330,000
	2	506,000
	3	676,000
	4	864,000
	5	923,000
	6	980,000
	7	1,009,000
	8	1,039,000
	9	1,068,000
	9**	277,000

16 Per Cent			18 Per Cent		
Year	IF*	Present Value	Year	IF*	Present Value
1	.86	$ 283,800	1	.85	$ 280,500
2	.74	374,440	2	.72	364,320
3	.64	432,640	3	.61	412,360
4	.55	475,200	4	.52	449,280
5	.48	443,040	5	.44	406,120
6	.41	401,800	6	.37	362,600
7	.35	353,150	7	.31	312,790
8	.31	322,090	8	.27	280,530
9	.26	277,680	9	.23	245,640
9**	.26	72,020	9**	.23	63,710
Present value		$3,435,860			$3,177,850
Net present value		$ 170,860			$ -(87,150)

*IF = Interest Factor.

**The internal rate-of-return method includes the salvage value of the chemical plant. (The cost of the land is included in the figure of $277,000.)

caustic soda-chlorine plant gives a present value of $3,435,860 or a net present value of $170,860.

Thus, even with a 16 per cent interest factor, which is high, the present value is higher than the cost figure. Therefore, a higher interest rate, 18 per cent, is used in order to equate the present value of the flows from the investment with the cost. It is "the interest rate that brings about this equality which is defined as the internal rate-of-return."[14] When an 18 per cent interest factor is used, as shown in Table 67, the present value of $3,177,850 is less than the investment. In this instance, the chemical installation will have a negative net present value of $87,150. Therefore, to obtain a better approximation of the internal rate-of-return, a 17 per cent interest factor has been extrapolated from the 16 and 18 per cent interest rates and recorded on Table 68.

A 17 per cent rate of interest gives the chemical installation a present value of $3,290,780 or a positive net present value of $25,780. Therefore, the internal rate-of-return, the net present value, of the Nicaraguan caustic soda-chlorine plant is greater than 17 per cent but less than 18 per cent.

Break-even Analysis

Break-even analysis is a financial tool which can be used to demonstrate the profitability of the Nicaraguan caustic soda-chlorine plant. Break-even analysis can be defined as "a formal profit-planning

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[14]Weston, op. cit., p. 134.

TABLE 68

NICARAGUA: A 17 PER CENT INTEREST FACTOR, THE INTERNAL RATE-OF-RETURN METHOD, THE CAUSTIC SODA-CHLORINE PLANT (U.S. DOLLARS)

17 Per Cent		
Year	IF*	Present Value
1	.85	$ 280,500
2	.73	369,380
3	.62	419,120
4	.53	457,920
5	.46	424,580
6	.39	382,200
7	.33	332,970
8	.29	301,310
9	.24	256,320
9**	.24	66,480
Present value		$3,290,780
Net present value		$ 25,780

*IF = Interest Factor.

** The internal rate-of-return method includes the salvage value of the chemical plant. (The cost of the land is included in the figure of $277,000.)

approach based on established relations between costs and revenues. It is a device for determining the point at which sales will just cover total costs."[15] Therefore, to illustrate the profitability of the caustic soda-chlorine facility, break-even figures are presented for the first, third, fifth, seventh and ninth years of production.

[15] Ibid., p. 64.

First Year's Operation, the Caustic Soda-Chlorine Plant

Table 69 depicts a breakdown of the fixed, variable and total costs of the chemical installation for the first year of plant operation.

Direct supervision, insurance, depreciation (on plant and equipment) are among the fixed costs of the proposed plant. In addition, all expenses of administration, salaries of the executive staff, the office supplies and telephone expenses, entertainment, legal and auditing costs are considered fixed. The interest charge on the debt and all sales expenses are treated as fixed with the exception of a miscellaneous sales expense of $6,000 which is variable. Other variable costs are those of raw materials, semiskilled labor and utilities.

Some expenses are treated as fixed and variable.[16] For example, maintenance costs are assumed to be 20 per cent fixed and 80 per cent variable; expenses of production control are shown as 50 per cent fixed and 50 per cent variable; social security and pension expenses are prorated 22 per cent and 78 per cent respectively; finally, plant overhead is shown as an 80 per cent fixed expense and 20 per cent variable expense.

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[16]National Development Institute, Caustic Soda, A Manufacturing Opportunity in Nicaragua, op. cit., p. 41.

TABLE 69

NICARAGUA: ESTIMATES OF FIXED, VARIABLE AND TOTAL COSTS, THE CAUSTIC SODA-CHLORINE INSTALLATION, FIRST YEAR PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	Fixed Costs	Variable Costs	Total Costs
Production			
Raw materials	$---	$244	$ 244
Labor: semiskilled	---	33	33
Maintenance	31	124	155
Control	7	7	14
Direct supervision	23	---	23
Utilities	---	340	340
Insurance	18	---	18
Social security--pension	10	35	45
Plant overhead	36	8	44
Depreciation	332	---	322
Total	$457	$791	$1,248
Administration			
Salaries	$ 48	$---	$ 48
Entertainment	9	---	9
Materials, telephone	4	---	4
Legal and auditing	22	---	22
Total	$ 83	$---	$ 83
Sales			
Salaries	$ 17	$---	$ 17
Travel	5	---	5
Miscellaneous	---	6	6
Total	$ 22	$ 6	$ 28
Finance			
Interest	$185	$---	$ 185
Total	$185	$---	$ 185
Grand Total	$747	$797	$1,544

Source: Tables 38, 39, 40 and 51.

Based on the data of Table 69, Figure 4 depicts a basic break-even chart.[17] During the chemical installation's first year of operation, this figure shows that the break-even point is 13,903 metric tons whereas only 13,885 metric tons are projected to be sold.[18] Therefore, there will be an approximate loss of $2,000.

As the break-even analysis is based on a per unit basis, a better understanding of this loss can be obtained by presenting a breakdown of the variable, fixed and total costs and revenues of the tonnage sold on a per unit basis. It is assumed that 13,885 metric tons of Nicaraguan chemicals will be sold during the first year for $1,542,000.[19] Thus, the operating company will receive an average of $111.06 per metric ton ($1,542,000 divided by 13,885 metric tons). Fixed costs per metric ton will amount to $53.80 ($747,000 divided by 13,885 metric tons). In Figure 4, the fixed costs of $747,000 are represented by a horizontal line, that is, they are the same regardless of the numbers of units produced. Variable costs (see Table 69) total $797,000 or $57.40 per metric ton produced and sold ($797,000 divided by 13,885 metric tons). Therefore, with variable costs of $57.40 per metric ton and fixed costs of $53.80 per metric ton, it can

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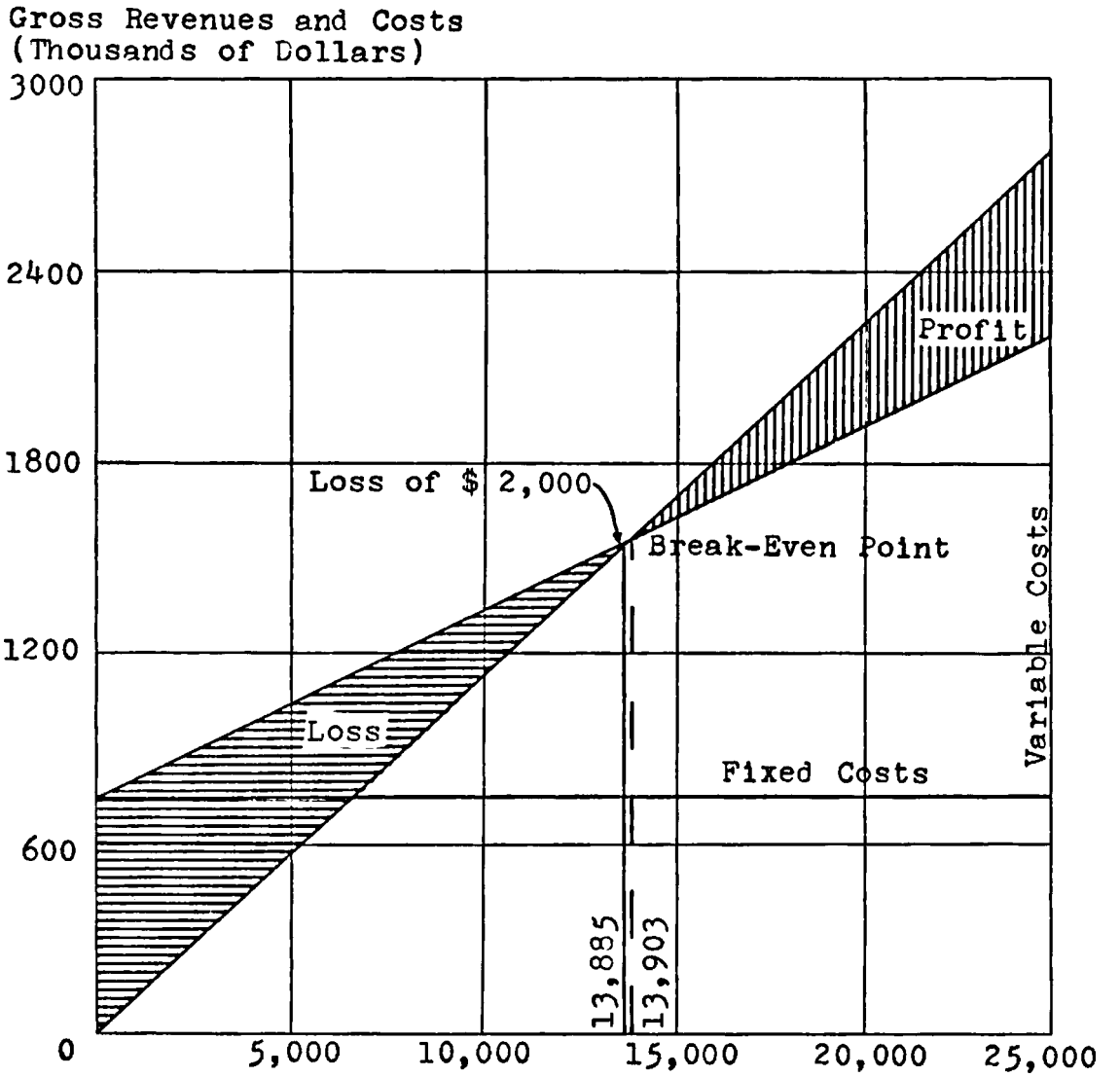
[17]This figure is presented on a unit basis; the metric tons produced and sold are shown on the horizontal axis and the gross sales revenues and total costs are measured on the vertical axis. This arrangement is used in all break-even charts in this section.

[18]The projected sale of 13,885 metric tons of Nicaraguan produced chemicals is presented in Table 34.

[19]The projected sales revenue of $1,542,000 for the first year of plant operation is presented in Table 51.

Nicaragua: A Projected Break-Even Chart; The Caustic Soda-Chlorine Plant--First Year of Plant Operation



(Figure 4)

be seen that it costs $111.20 to produce each metric ton during the first year. However, with the operating company receiving $111.06 per metric ton, a loss is sustained of $.14 per metric ton produced and sold, a loss of $2,000 for the chemical company.

Third Year's Operation--the Caustic Soda-Chlorine Plant

During the third year of the chemical installation's operation, variable costs are projected to increase to $960,000 while fixed costs will reach $750,000. Fixed costs in the third year are only $3,000 greater than those of the first year. More insurance coverage is necessitated by an increased raw material supply. Table 70 presents a breakdown of fixed, variable and total costs for the third year of plant operation.

Based on the data of Table 70, Figure 5 presents a break-even analysis for the caustic soda-chlorine plant's third year of operation.

Figure 5 shows a break-even point of approximately 13,700 metric tons of chemicals; however, it is projected that 18,946 metric tons of chemicals will be produced and sold by the Nicaraguan plant during the third year of plant operation.[20] Therefore, a profit of $344,000 is depicted in Figure 5.

During the first year of plant operation, 18,946 metric tons of chemicals are projected to be sold for $2,054,000 (see Table 51). The operating company estimates that the chemicals will sell for an

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[20]The projected sales of 18,946 metric tons of Nicaraguan produced chemicals is presented in Table 34.

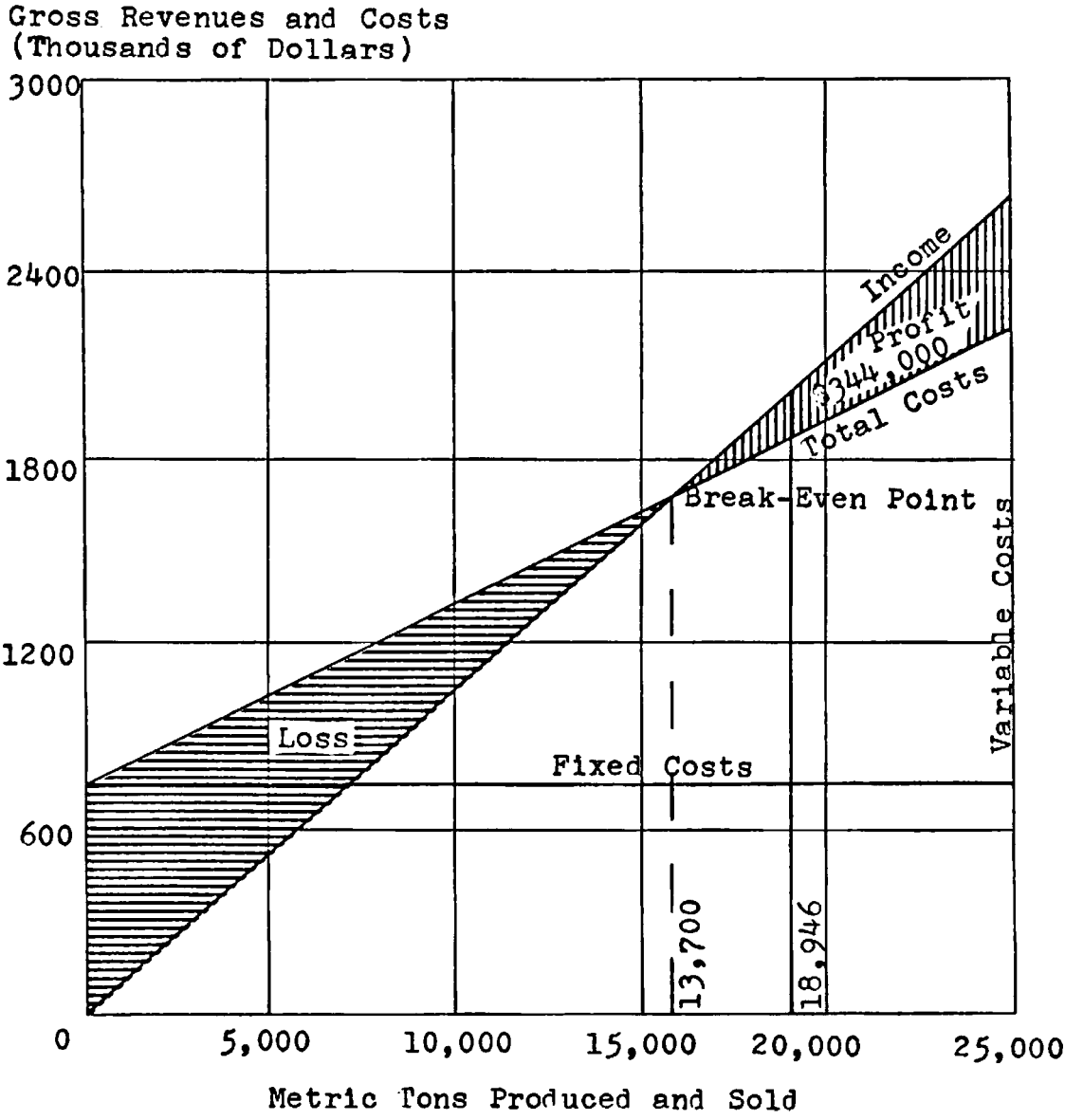
TABLE 70

NICARAGUA: ESTIMATES OF FIXED, VARIABLE AND TOTAL COSTS, THE CAUSTIC SODA-CHLORINE INSTALLATION, THIRD YEAR PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	Fixed Costs	Variable Costs	Total Costs
Production			
Raw materials	$---	$308	$ 308
Labor: semiskilled	---	33	33
Maintenance	32	128	160
Control	7	7	14
Direct supervision	23	---	23
Utilities	---	435	435
Insurance	20	---	20
Social security--pension	10	35	45
Plant overhead	36	8	44
Depreciation	332	---	332
Total	$460	$954	$1,414
Administration			
Salaries	$ 48	$---	$ 48
Entertainment	9	---	9
Materials, telephone	4	---	4
Legal and auditing	22	---	22
Total	$ 83	$---	$ 83
Sales			
Salaries	$ 17	$---	$ 17
Travel	5	---	5
Miscellaneous	---	6	6
Total	$ 22	$ 6	$ 28
Finance			
Interest	$185	$---	$ 185
Total	$185	$---	$ 185
Grand Total	$750	$960	$1,710

Source: Tables 37, 38, 39 and 51.

Nicaragua: A Projected Break-Even Chart; The Caustic Soda-Chlorine Plant--Third Year of Plant Operation



(Figure 5)

average price of $108.41 per metric ton ($2,054,000 divided by 18,946 metric tons). The fixed costs will amount to $39.59 per metric ton of chemicals produced ($750,000 divided by 18,946 metric tons). Variable costs will amount to $50.67 per metric ton of chemicals produced ($960,000 divided by 18,946 metric tons). Therefore, with fixed costs of $39.59 per metric ton, the cost of each metric ton of chemicals produced during the third year is $90.26.

Hence, with a projected average selling price of $108.41 per metric ton, a profit of $18.15 per metric ton ($108.41 minus $90.26) is anticipated. Accordingly, a total profit of $344,000 (18,946 tons x $18.15 per metric ton) for the third year's operation is projected in Table 51 which also shows the profit and loss data for the other years of operation.

Fifth Year's Operation--The Caustic Soda-Chlorine Plant

During the fifth year, variable costs are expected to increase to $1,028,000 while fixed costs decrease to $690,000. The fixed costs in the fifth year are $60,000 ($750,000 minus $690,000) less than those of the third year, a decrease generated by decreased interest payments. Increased raw materials and power needs for expanded production will raise the variable costs from $960,000 to $1,028,000, an increase of $68,000 from the third year. Table 71 presents a breakdown of fixed, variable and total costs for the fifth year of plant operation.

Based on the data of Table 71, Figure 6 presents a break-even analysis for the caustic soda-chlorine plant's fifth year of operation.

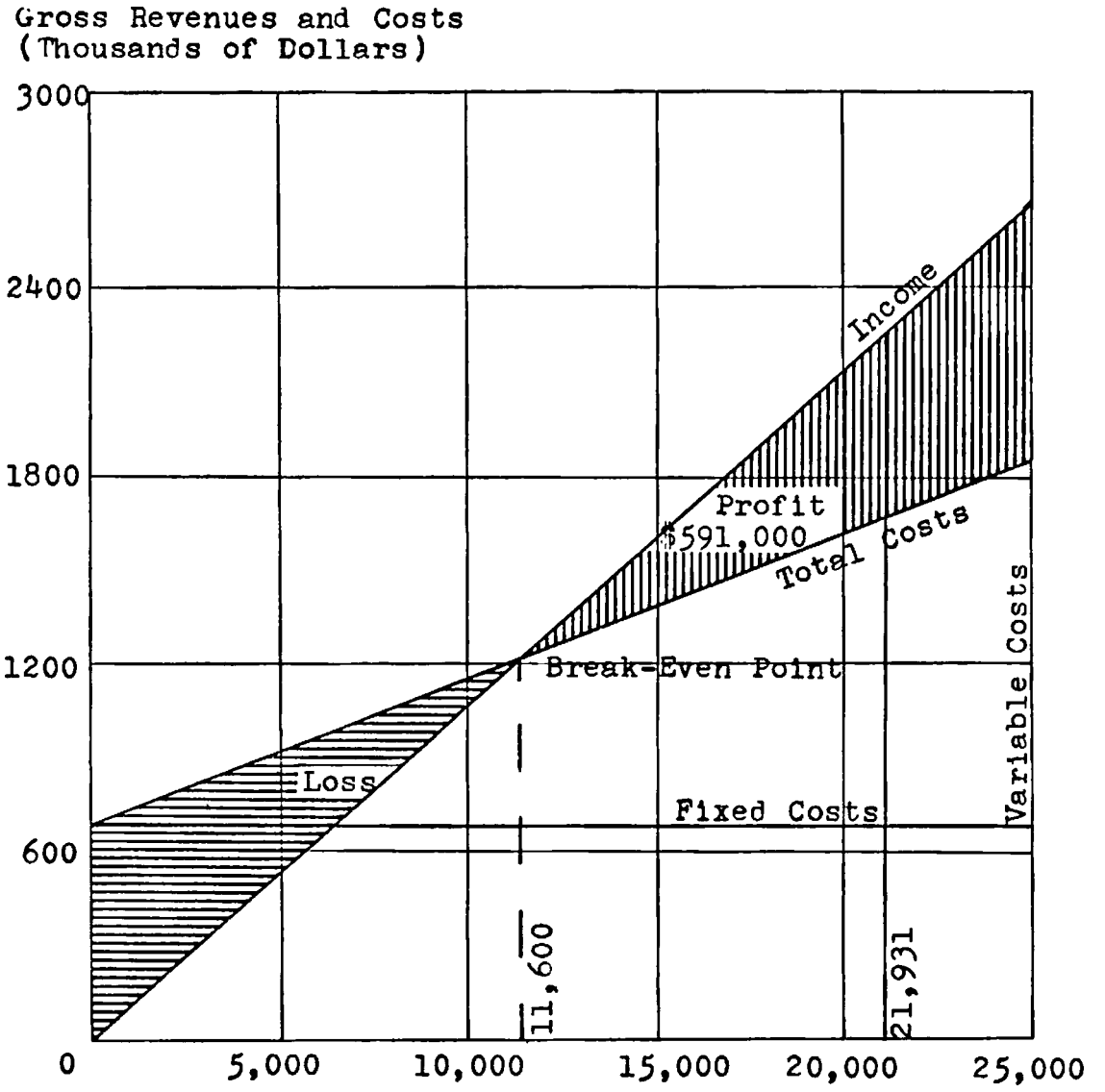
TABLE 71

NICARAGUA: ESTIMATES OF FIXED, VARIABLE AND TOTAL COSTS, THE CAUSTIC SODA-CHLORINE INSTALLATION, FIFTH YEAR PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	Fixed Costs	Variable Costs	Total Costs
Production			
Raw materials	$---	$ 336	$ 336
Labor: semiskilled	---	33	33
Maintenance	33	131	164
Control	7	7	14
Direct supervision	23	---	23
Utilities	---	471	471
Insurance	21	---	21
Social security--pension	10	35	45
Plant overhead	36	8	44
Depreciation	332	---	322
Total	$462	$1,021	$1,483
Administration			
Salaries	$ 48	$ ---	$ 48
Entertainment	9	---	9
Materials, telephone	6	---	6
Legal and auditing	22	---	22
Total	$ 85	$ ---	$ 85
Sales			
Salaries	$ 19	$ ---	$ 19
Travel	6	---	6
Miscellaneous	---	7	7
Total	$ 25	$ 7	$ 32
Finance			
Interest	$118	$ ---	$ 118
Total	$118	$ ---	$ 118
Grand Total	$690	$1,028	$1,718

Source: Tables 37, 38, 39 and 51.

Nicaragua: A Projected Break-Even Chart; The Caustic Soda-Chlorine Plant--Fifth Year Of Plant Operation



(Figure 6)

Figure 6 shows a break-even point of approximately 11,600 metric tons of chemicals. However, it is projected that 21,931 metric tons of chemicals will be produced and sold by the Nicaraguan chemical installation during the fifth year of operation.[21] Therefore, a profit of $591,000 is depicted in Figure 6.

During the fifth year of plant operation, 21,931 metric tons of chemicals are projected to be sold for $2,309,000 (see Table 51). Based on these data, the chemicals will sell for an average price of $105.28 per metric ton ($2,309,000 divided by 21,931 metric tons). Fixed costs amount to $31.46 per metric ton ($690,000 divided by 21,931 metric tons), and variable costs will be $46.87 per metric ton ($1,028,000 divided by 21,931 metric tons). Therefore, the total costs of each metric ton of chemicals produced during the fifth year is $78.33.

With an average selling price of $105.28 per metric ton, a profit of $26.95 per metric ton ($105.28 minus $78.33) is effected. Hence, the profit of the fifth year's operation will approach $591,000 (21,931 metric tons x $26.95). This profit of $591,000 is shown in Table 51.

Seventh Year's Operation--the Caustic Soda-Chlorine Plant

During the seventh year of the chemical plant's operation, variable costs and fixed costs are projected to be $1,028,000 and

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[21]The projected sale of 21,931 metric tons of Nicaraguan produced chemicals is presented in Table 34.

$631,000 respectively. Table 72 summarizes the fixed, variable and total costs for the seventh year.

TABLE 72

NICARAGUA: ESTIMATES OF FIXED, VARIABLE AND TOTAL COSTS, THE CAUSTIC SODA-CHLORINE INSTALLATION, SEVENTH YEAR PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	Fixed Costs	Variable Costs	Total Costs
Production			
Totals--Table 71	$462	$1,021	$1,483
Administration			
Totals--Table 71	85	---	85
Sales			
Totals--Table 71	25	7	32
Finance			
Interest--Table 51	59	---	59
Grand Total	$631	$1,028	$1,659

It is assumed the variable costs will remain constant for the fifth through the ninth years of production.[22] Fixed expenses will decrease by $59,000 between the fifth and seventh year because of a decrease in interest payments.[23]

[22]Table 51 indicates gross sales revenue remain constant for the sixth through the ninth year of plant operation with only a small increase of $25,000 in the gross sales revenues between the fifth and sixth year of plant operation.

[23]An interest charge of $118,000 is projected to be paid in the fifth year while $59,000 is projected for payment in the seventh year.

Based on the data of Table 72, Figure 7 presents a break-even analysis of the seventh year's operation.

In this figure a break-even point of approximately 10,750 metric tons of chemicals is shown; however, it is projected that 22,216 metric tons of chemicals will be produced and sold by the Nicaraguan chemical plant during the seventh year of operation.[24] Therefore, a profit of $677,000 is shown in Figure 7.

During the seventh year of plant operation, 22,216 metric tons of chemicals are projected to be sold for $2,336,000 (see Table 51). Based on these data, the chemicals will sell for an average price of $104.68 per metric ton ($2,336,000 divided by 22,216 metric tons). The fixed costs amount to $28.28 per metric ton of chemicals produced ($631,000 divided by 22,216 metric tons). Variable costs amount to $46.06 per metric ton of chemicals produced ($1,028,000 divided by 22,216 metric tons). Therefore, with fixed costs of $28.28 and variable costs of $46.06 for each metric ton of chemicals produced during the seventh year is $74.34.

A profit of $30.34 per metric ton is projected on the basis of an average selling price of $104.68 ($104.68 minus $74.34). Hence, the profit of the seventh year's operation will reach approximately $677,000 (22,216 metric tons x $30.34). Table 51 contrasts these data with the figures from the other years of plant operation.

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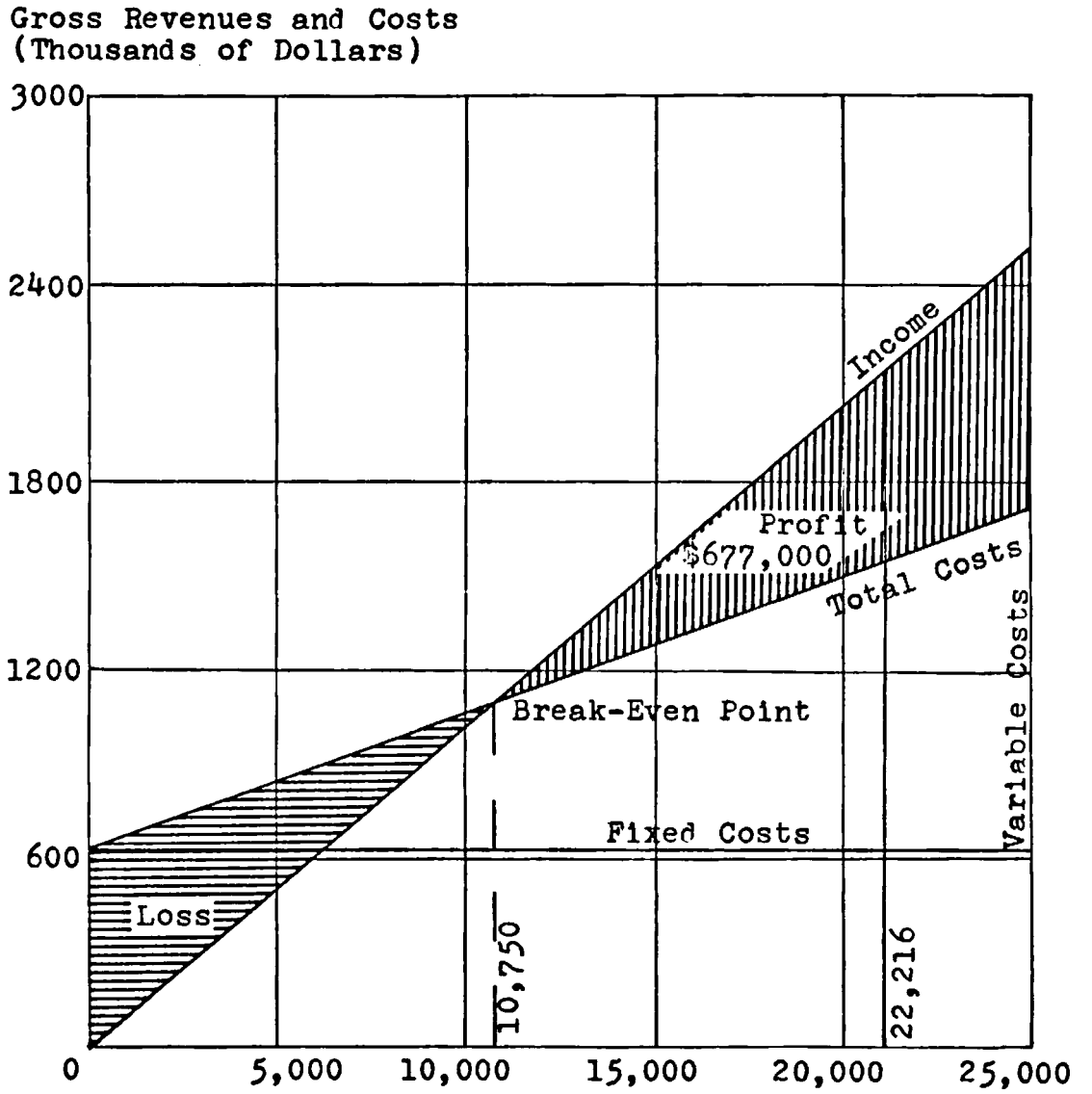
[24]The projected sale of 22,216 metric tons of Nicaraguan produced chemicals is presented in Table 34.

Nicaragua: A Projected Break-Even Chart; The Caustic Soda-Chlorine Plant--Seventh Year of Plant Operation



(Figure 7)

Ninth Year's Operation--the Caustic Soda-Chlorine Plant

In this study, the ninth year of operation of the Nicaraguan caustic soda-chlorine plant is considered the last year for which depreciation is charged.

During this last year of the Nicaraguan plant's operation, variable and fixed costs are projected to be $46.06 and $25.63 per ton respectively. Table 73 presents a synopsis of the fixed, variable and total costs. Variable costs are again assumed constant for the fifth through the ninth year. Fixed costs also remain constant for the ninth year excepting interest payments since all company debts are fully paid during the eighth year.

Figure 8 gives a break-even analysis for the caustic soda-chlorine plant's ninth year of operation. The break-even point is depicted at approximately 10,000 metric tons although projected production and sales are set at 22,216 metric tons of chemicals.[25] For this reason, a profit of $736,000 is depicted in Figure 8.

During the ninth year of operation, 22,216 metric tons of chemicals are projected to be sold for an average price of $104.68 per metric ton (the same as in the seventh year) for a total of $2,336,000. Fixed costs amount to $25.63 per metric ton of chemicals ($572,000 divided by 22,216). The variable costs remain at $46.06 per metric ton as in the seventh year. Therefore, with fixed costs at

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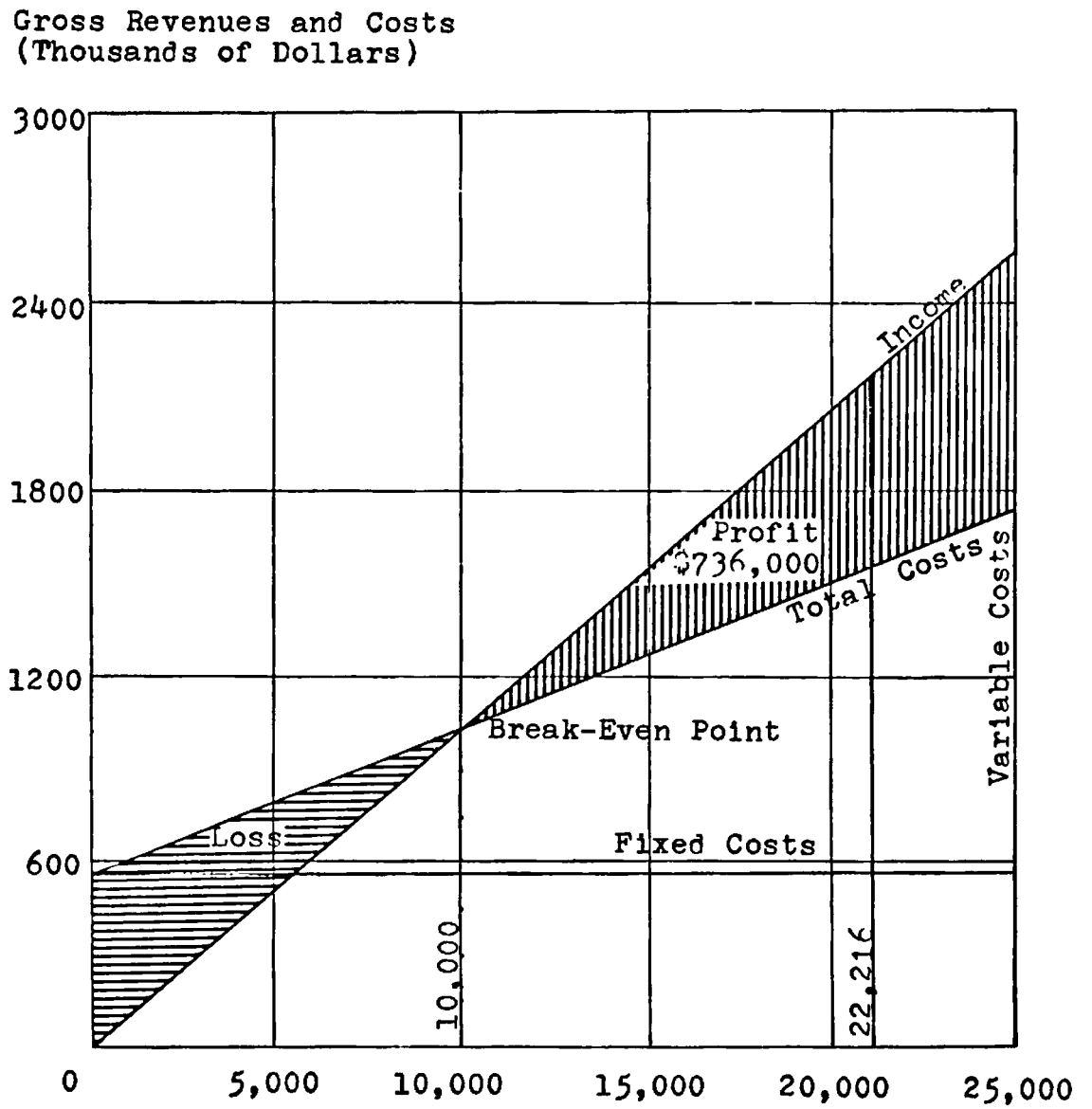
[25]The sale of 22,216 metric tons of chemicals is assumed constant for the sixth through the ninth years of plant operation. See Table 51.

TABLE 73

NICARAGUA: ESTIMATES OF FIXED, VARIABLE AND TOTAL COSTS, THE CAUSTIC SODA-CHLORINE INSTALLATION, NINTH YEAR PLANT OPERATION (IN THOUSANDS OF U.S. DOLLARS)

	Fixed Costs	Variable Costs	Total Costs
Production			
Totals--Table 72	$462	$1,021	$1,483
Administration			
Totals--Table 72	85	---	85
Sales			
Totals--Table 72	25	7	32
Finance			
Interest--Table 51	---	---	---
Grand Total	$572	$1,028	$1,600

Nicaragua: A Projected Break-Even Chart; The Caustic Soda-Chlorine Plant--Ninth Year Of Plant Operation



(Figure 8)

$25.63 and variable costs of $46.06 per metric ton, the cost of each metric ton produced during the year is $71.69.

An average selling price of $104.68 per metric ton yields a profit of $32.99 per metric ton ($104.68 minus $71.69). Hence, the projected profit of the ninth year's operation is approximately $736,000 (22,316 metric tons x $32.99). The profit of $736,000 is depicted in Table 51.

The Net Present Value Method

Definition

The fourth method of investment evaluation used in this study of the Nicaraguan caustic soda-chlorine installation is the net present value method. This analysis attempts to determine the present value of all cash inflows and outflows connected with the prospective investment in the C.A.C.M. chemical plant.[26]

The net present value of an investment is the result of a comparison of the present value of the returns of the investment (positive or negative) and the present value of the costs or the investment's capital requirements. "The present value of an investment may be described as the maximum amount a firm could pay for the opportunity of making the investment without being financially worse off."[27] Of the

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[26]Erich A. Helfert, Techniques of Financial Analysis (Homewood, Ill.: Richard D. Irwin, Inc., 1967), p. 158.

[27]Harold Bierman and Seymour Smidt, The Capital Budgeting Decision (New York: The Macmillan Company, 1966), p. 29.

four criteria used in this study, the net present value method is the most theoretically correct and precise for evaluating an investment.[28]

Relative Merits of the Net Present Value Method vs. Break-even Analysis

Although this study uses break-even analysis to show the projected profitability of the Nicaraguan caustic soda-chlorine plant, it is simply "an oversimplified tool which may give a birds'-eye view of a situation, but it should be used with caution."[29] "In break-even analysis, profits are a direct function of output--changes in markets, buying conditions, costs, or organization of production are not taken into consideration."[30]

While break-even data help to emphasize the fact that the new C.A.C.M. caustic soda-chlorine plant should be profitable, the principal function of break-even analysis is in comparing different investment alternatives not in determining profit maximization.[31] The other three methods emphasize profit maximization.

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[28]H. Bierman, C.P. Bonini, L. E. Fouraker, and R. K. Jaedecke, Quantitative Analysis for Business Decisions (Homewood, Ill.: Richard D. Irwin, Inc., 1965), p. 354.

[29]I. L. Lyons and M. Zymelman, Economic Analysis of the Firm (New York: Pitman Publishing Corporation, 1966), p. 105.

[30]Ibid.

[31]Ibid., p. 106.

Relative Merits of Net Present Value Method vs. the Payback Period Method

Unlike the net present value method, the payback period method does not consider the time value of money. It is primarily concerned with the size of the cash flow. However, in judging the utility of this financial method, some important factors which are not considered in the method are:

> . . . the length of life during which the cash flow is generated (the economic life of the project) and the specific pattern of cash flows, that is, whether these flows are even during the life of the investment or whether they occur unevenly. Thus, the economic growth of a project is the balanced result of all of these factors, while the payback device averages the cash inflows regardless of the economic life, and compares this average annual cash flow to the net investment.[32]

For instance, if investment "A" requiring a capital outlay of $100 has the following return

Year 1--$96
Year 2--$ 1
Year 3--$ 1
Year 4--$ 1
Year 5--$ 1

it would be equally ranked with investment "B" which also requires a capital outlay of $100 but yields a profit of $1 in each of the first four years and $96 the fifth year.

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[32]Helfert, op. cit., pp. 154-55.

Relative Merits of the Net Present Value Method vs. the Internal Rate-of-Return method

The net present value method is preferred to the internal rate-of-return method for two reasons.[33] First, focused on the rate of return which yields a zero net present value, the latter method does not consider the absolute dollar size of the net present value. For example, in choosing between two investments, one which yields 50 per cent on an outlay of $50,000 and one which yields 45 per cent on $100,000, the first investment would be deemed superior to the second. However, the reverse could be true if all factors remain constant.

Another reason the net present value method is preferred to the internal rate-of-return method is that periods of net cash returns, alternating with periods of net cash investments, could yield more than one discount rate which might discount the net present value to zero.[34]

The Marginal Cost of Capital as the Discount Rate

One way of determining the discount rate uses marginal costs of capital as the discount rate.[35] The marginal costs of capital then represent the weighted average costs of the installation's capital based on the optimum capital structure or optimum ratio of debt to the firm's equity.

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[33]The internal rate-of-return method is also referred to as the "investor's method," the "discounted cash flow method," or the "internal yield method." Helfert, op. cit., p. 163.

[34]Bierman and Smidt, op. cit., pp. 48-49.

[35]Ibid., p. 143.

If capital could be borrowed for the Nicaraguan chemical plant at 5 per cent, the marginal cost of capital would not be 5 per cent but a privileged borrowing rate made possible by an equity cushion which should cost more than 5 per cent. Since there are no empirical data on the market value of the equity of the Pennsalt Chemical Corporation, S.A., the weighted average capital costs of the corporation cannot be empirically determined.[36]

The Default-free Discount Rate

Another method of determining the discount rate to be used requires that a pure rate of interest or a default-free rate of discount be used.[37] This could be determined empirically by taking treasury debt obligations of different maturities and weighting the different maturities which span the entire life of the investment with the portion of the investment recovered in each year.

Application

Since the chemical installation is projected to require a single investment to be made at the beginning of the time period, it is not necessary to discount separate investment outlays for calculation of the net present value of the cost of the investment.

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[36]To obtain the weighted average cost of capital, the cost of debt weighted by the portion of debt in the capital structure and the cost of equity weighted by the market value of the equity in the capital structure would have to be known.

[37]Bierman and Smidt, op. cit., pp. 48-49.

Also, since the investment is not structured to make multiples of the present plant possible, the net present value method is somewhat simplified. For instance, the C.A.C.M. trade area does not warrant a plant that would merely duplicate or multiply the original project by some multiple. Therefore, the marginal efficiency of capital in the Nicaraguan caustic soda-chlorine facility has to be based on the net present value of the proposed investment because there are no alternative capital investments. It is either all or none.

The Capitalization Formulae

Table 68, page 174, depicted that the net discounted rate of return over the life of the investment was greater than 17 per cent. It was shown that a return of more than 17 per cent reduced the net present value to zero. However, the marginal efficiency of capital must be computed precisely.

To solve for a precise marginal efficiency of capital, capitalization formulae are presented which are basic to the net present value method. The only importance of the first formula is to yield the quasi rents or Q_t which, in this study, are merely the net cash flows produced by the project. The calculated Q_t is then used in the third formula.

The first formula is:[38]

$$Q_t = p_t(q_t)q_t - E_t(q_t).$$

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[38]Friedrich and Vera Lutz, The Theory of Investment of the Firm (Princeton: Princeton University Press, 1951), p. 12.

The symbols of the formula may be defined as:

1. Q_t stands for the quasi rent of a unit period of time.
2. $p_t(q_t)$ equals the market price of the product.
3. q_t represents the number of units of output produced and sold in the unit period.
4. $E_t(q_t)$ equals the "variable" or operating costs (exclusive of depreciation and of interest charges on the cost of the fixed equipment); it is a function of the number of units of output produced in the unit period.

A second formula is also used. This is:

$$C = \frac{c_1}{(1+i)} + \frac{c_2}{(1+i)^2} + \frac{c_3}{(1+i)^3}$$

The symbols of the formula may be defined as:

1. C = the present discounted value of the capital investment.
2. i = market rate of interest.
3. c_1, c_2 and c_3 = the capital outlay flows during the period of plant construction.

The third formula which is used for a precise marginal efficiency of capital is:[39]

$$V = \frac{Q_4}{(1+i)_4} + \frac{Q_5}{(1+i)_5} \cdots \frac{Q_n}{(1+i)_n} + \frac{S_n}{(1+i)_n}$$

The symbols of the formula are defined as:

1. V = the present discounted value of the capital project.
2. Q_4, = the quasi rent in the fourth time period with Q_5 = the quasi rent in the fifth time period, etc.

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[39] Ibid., p. 13.

3. i = market value of interest and risk.

4. S = scrap value.

5. n = the year of operation.

A final equation is established whereby the third formula is set equal to the second one; "r" is the rate of discount--the marginal efficiency of capital--which reduces "V" equal to "C." From the equation

$$C = \frac{c_1}{(1+r)} + \frac{c_2}{(1+r)^2} + \cdots \frac{c_n - 1}{(1+r)^{n-1}} + \frac{c_n}{(1+r)^n} + \frac{S}{(1+r)^n},$$

the value of "r" can be determined by substituting the cash flow figures from Table 65. The resulting equation is

$$3{,}265 = \frac{330}{(1+r)} + \frac{506}{(1+r)^2} + \frac{676}{(1+r)^3} + \frac{864}{(1+r)^4} + \frac{923}{(1+r)^5} + \frac{980}{(1+r)^6} + \frac{1009}{(1+r)^7} + \frac{1039}{(1+r)^8} + \frac{1068}{(1+r)^9} + \frac{277}{(1+r)^9}$$

The binomial theorem algebraically reduces this equation to:

$$3{,}265r^9 + 29{,}055r^8 + 144{,}394r^7 + 260{,}802r^6 + 377{,}364r^5 + 355{,}197r^4 + 211{,}238r^3 + 69{,}407r^2 + 4688r - 4407 = 0$$

This polynomial equation of the ninth degree and integral coefficients may now be denoted by f(r). See Appendix B. Since f(r) is the equivalent of the equation above, a solution of f(r) = 0 will be the marginal efficiency of capital.

Since the solution must be between .17 and .18, an iterative technique known as the "Binary Chop" can be applied.[40] The

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[40]Richard A. Dean, Elements of Abstract Algebra (New York: John Wiley and Sons, Inc., 1966), p. 166.

calculations were performed by a 1620 IBM computer; a copy of the "print-out," showing the program and the solution process, may be found in Appendix C.

The binary chop method requires the selection of a starting point and an increment. The starting point of "r" was set at .17 and the increment was denoted by Δ 01. The computer was to evaluate f(.17) and

1. add the increment to the starting point if $f(.17) > 0$,
2. subtract the increment from the starting point if $f(.17) < 0$, or
3. stop the program if $f(.17) = 0$.

The computer was then instructed to divide the increment by 2 and, using $f(.17 \pm .005)$ as the new starting point, repeat the program. Since the computer's accuracy is limited to eight significant figures, f(r) = 0 when r = .17371318. Therefore, the marginal efficiency of capital is approximately 17.371318. This 17.371318 per cent marginal efficiency of capital carries the formulae to their logical conclusion by subtracting from "V," the gross present value of the chemical installation, the net present value of the cost of the project to yield a net present value of the Nicaraguan caustic soda-chlorine plant of zero.[41]

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[41]It must be noted that the owners of the Nicaraguan caustic soda-chlorine plant will receive a 17.371318 per cent return over the life of the project. However, no franchise, equipment, property or corporate taxes are to be paid on the C.A.C.M. "integrated" chemical industry. Also, because of the nature of the industry, the loans of the Central American chemical installation will carry an approximate 7 per cent interest rate even though the current market rate of interest for industrial loans in Nicaragua is 12 to 14 per cent.

The conclusions of this study are presented in Chapter IX.

CHAPTER IX

CONCLUSIONS

The subject of this dissertation is the feasibility of establishing a profitable caustic soda-chlorine plant in Nicaragua during the period of 1966-1970. More specifically, an attempt has been made to determine if the proposed "integrated" caustic soda-chlorine chemical installation which would serve the Central American Common Market trade area could be profitably established.

The objective has been to analyze preliminary feasibility studies of the United Nations, governmental and semi-governmental agencies of the United States and of the nations of Central America which were conducted during the 1960's. Also cited were studies made by the Nicaraguan National Development Institute to investigate whether Nicaragua has the natural, human and financial resources for caustic soda-chlorine production. Primarily, this study's interest has been focused on the feasibility reports of the Institute in an attempt to determine the chemical plant's potential profitability. Simultaneously, this research has provided some empirical projections on the financial returns which the owners of the chemical installation may realize.

The investigation begins with a brief description of factors which characterize the Central American economies. Also, the incentives offered by the C.A.C.M. treaties are discussed in regard to

their role in the successful development of an "integrated" chemical industry. It was seen that the philosophy of the various integration treaties has produced an economic climate conducive to "integrated" industries including a Nicaraguan chemical facility.

Chemical product projections showed that the production of caustic soda, chlorine and their by-products is a basic element in the development of a chemical complex serving the entire Central American chemical market. From an analysis of raw materials and production requirements, it was seen that Nicaragua possesses the necessary raw materials, resources and personnel for operation of a caustic soda-chlorine plant.

The impetus behind the new chemical plant, the Nicaraguan National Development Institute, was also discussed. Thus, Nicaragua has a financial semi-governmental institute which seemingly has adequate financial resources, easy access to additional resources, a staff and authorization to provide the projected caustic soda-chlorine plant with complete financial backing; therefore, there should be no reason to experience a lack of capital for the chemical plant. The Institute has a good record of promoting and assisting new industries in Nicaragua with its technical knowledge and financial resources.

Attention then focused on the demand for caustic soda, chlorine, hydrochloric acid, hydrogen and sodium hypochlorite in the Central American Common Market and their projected prices. A demand exists in Central America for the products. Projections based on studies by the United Nations and the Nicaraguan National Development

Institute indicates the new chemical installation should be able to sell all or most of its productive capacity. An added assurance for adequate sales is that the proposed prices of the five chemicals are less than the historical prices paid by the Central American nations for imported chemicals.

In view of the fact that a demand does exist, production costs, capital investment, productive capacities and projected sales revenues are presented. Projected empirical data on the costs of production show that the proposed chemical plant can produce chemicals at a reasonable unit cost and that, except for the first year, a profit is projected from the sale of the products. During the first year, a small loss of $2,000 is projected. However, economies of scale should yield a net profit of $174,000 for the second year with the profits increasing each year of plant operation until the ninth year when a net profit of $736,000 is anticipated.

Examination of the proposed means of financing reveals the Central American Bank for Integration will be the main source of the necessary debt capital. However, the Nicaraguan National Development Institute intends to enlist the Pennsalt Chemical Corporation of the United States as the principal stockholder and thereby gain technical knowledge necessary to make the chemical installation functional. The Morton Salt Corporation of the United States will also participate in the undertaking. With the monetary backing of these groups the financial plan appears workable and feasible.

In Chapter I the hypothesis to be proven in the study was stated as "the Nicaraguan caustic soda-chlorine plant can be profitable." The results of the study indicate that this supposition is plausible. It has been demonstrated that Nicaragua has the raw materials and resources required for caustic soda-chlorine production. Also, Nicaragua will enjoy economic privileges, bestowed by the C.A.C.M. organization, which will facilitate development of her "infant industry." Capital and technical assistance are available. Finally, there exists a demand in Central America for the chemical products of the proposed plant.

The financial tools and the break-even analysis indicate that the Nicaraguan caustic soda-chlorine plant would be a profitable investment. The internal rate-of-return method showed that the proposed chemical plant would have a net present value greater than zero even at a 17 per cent interest rate factor. The net present value method shows a positive net present value when a 17 per cent interest rate is used. Also, the net present value method shows that the Nicaraguan caustic soda-chlorine chemical plant's marginal efficiency of capital will be approximately 17.371318 per cent.

The discount rate used in the net present value method theoretically should be based on the lowest possible capital investment for the firm, i.e., the marginal cost of capital in an assumed optimum capital structure. However, using the actual rate rather than the marginal cost of capital and the present capital structure rather than the optimum capital structure would be a more realistic approach since

it might not be possible to obtain an optimum capital structure. Therefore, the proportion of equity in the project, if less than optimum, could affect the rate of interest charged on the debt portion of the capital structure of the firm. However, the investment projected can be justified not only when the low theoretical cost of capital is used but also when the higher actual cost of capital (as in this case) is used.

As discussed in Chapter VIII, the proposed owners are to invest $750,000 in the projected chemical plant for equity. The cost of the chemical plant has been established as $3,265,000. If the costs of capital are weighted, $750,000 represents approximately 23 per cent of the total cost. Therefore, the debt portion is approximately 77 per cent. Assuming a 7 per cent interest rate is applied to the debt capital of the chemical facility, equity funds could be capitalized at 50 per cent to yield an average weighted cost of capital of less than 17 per cent. For example: if the

Debt is:	.07 x .77 =	.0539
Equity :	.50 x .23 =	.1150
Average weighted cost of capital		.1689

If the equity is capitalized at a rate of 50 per cent, the actual average cost of capital should approximate 17 per cent. At a 25 per cent rate of return, the weighted average cost of capital would be approximately 11 per cent.

Debt:	.07 x .77 =	.0539
Equity:	.25 x .23 =	.0575

Average weighted cost of capital	.1114

Although this study has demonstrated that a Nicaraguan caustic soda-chlorine plant can be both feasible and profitable, further research in several areas appears warranted. More attention should be given to exploring the unit costs of chemical production at various operational levels of plant capacity. Additional research could be done on the demand for caustic soda, chlorine and the by-products which may be created by new Central American industries which will require Nicaragua's chemical products as inputs. However, in its approach to proving that a Nicaraguan caustic soda-chlorine plant can be profitably operated, this study may be helpful for financial analysis of other "integrated industries" in Central America and other developing nations.

APPENDIX A

CENTRAL AMERICAN CHEMICAL PRODUCTS: NOMENCLATURA ARANCELARIA UNIFORME CENTROAMERICA (NAUCA)

511-03-00

Soda hydroxide (soda or caustic soda)

Soda hydroxide
Soda lye
Sodium lye
Soda alcohol
Caustic soda, liquid or solid

512-09-01

Camphor (natural or artificial) and its derivatives (which are not included elsewhere).

Camphor, artificial or synthetic
Camphor, natural
Bromocamphor
Chlorocamphene
Camphene

512-09-03

Halogen derivatives from hydrocarbons, not included elsewhere.

Bromoform
Bromonitromethane
Bromostyrolene
Allyl Bromide
Chlorobenzene
Chlorofluoromethanes
Chloroform
Chloromethane
Chloronitrobenzene
Chloronitromethane
Chloronitroluene
Acetylene Chloride
Benzene Chloride
Bornyl Chloride
Ethyl Chloride
Methylene Chloride

Methyl Chloride
Vinyl Chloride
Chloronitrobenzene
D.D.T. (without preparation)
Ethylene Dibromide
Dichlorobenzene
Dichloronaphthalene
Ethylene Dichloride
Propylene Dichloride
Epichlorhydrin
Ethyl Bromide
Ethyl Chlorocarbonate
Ethyl Chloroformiate
Ethyl Chloride
Flouranthrene
Hexachlorobenzene
Hexachlorocyclohiexane
Benzene Hexachloride
Hydromercuridibromofluoreocein
Metachlorophenol
Metadichlorofenzene
Metaoxychlor
Methoxy D.D.T. (Pure)
Monochlorobenzene
Monochloroethylene
Monochloronaphthalene
Octochloronaphthalene
Orthochlorophenol
Orthodichlorobenzene
Parachlorophenol
Paradichlorobenzene
Pentachlorophenol
Perchlorothylene
Polychloronaphthalenes
Tetrachloroethylene
Carbon Tetrachloride
Trichloroethylene
Iodoform
Iodonitromethane
Iodotrinitromethane
Ethyl-iodide
Methylene Iodide
Methyl Iodide
Tetramethylammonium Iodide

512-09-12

Aminophenols, not included elsewhere.

Aminophenols

Beta-naphthylamine
Diaminophenols
Diethylaminonitrosophenol
Diphenylamine
Diphenylcarbazide
Diphenylguanidine
Diorthotolyldiguanidine
Monoamino Diphenylamines
Orthotolylbiguanidine
Parathion
Tetramethyl Diaminobenzophenones
Tetryl
Thiodiphenylamine

599-02-00

Insecticides, fungicides, disinfectants, including sheep and cattle dressings and similar preparations.

This item covers preparations, which must be mixtures, but excludes solutions, dilutions and suspensions of single chemical compounds in a liquid unless the liquid plays an active part in the preparations. This item also excludes (1) separately defined chemical compounds, (2) medicaments, (3) fumigants, (4) deodorizers, and (5) disinfectant soaps.

Colza oil, in mixtures used in agriculture or horticulture.
Creosote oil, disinfectant mixtures containing D.D.T. in mineral oil solutions.
Copper acetate, containing insecticidal and fungicidal mixtures.
Copper aceto-arsenite, containing insecticidal mixtures.
Fenic acid, in mixed preparations.
Tick insecticides.
Anti-cryptogamous mixtures.
Antiformina.
Antilarvicos.
Anti-parasite liquids (used in dipping cattle).
Calcium arsenate, containing insecticidal and mixtures.
Lead arsenate, containing insecticidal mixtures.
Sodium arsenate in mixed preparations.
White arsenate in mixed preparations.
Sulphur, prepared as an insecticide or fungicide.
Grease, banding, for fruit trees.
Poisoned bait.
Rat poison.
Chloroform.
Chlordane, prepared as insecticide.
Chlorobenzene, in mixed preparations.
Copper (tick).

Creoline.
Cresol, in mixed preparations such as disinfectants.
Cockroach insecticides.
Methoxy.
D.D.T., prepared as an insecticide.
Disinfectants, excluding soap and medicaments.
Phenol, a carbolic acid disinfectant.
Phenoline.
Flit, exterminators of animal pests.
Fly-tox--Fly paper.
Formaldehyde (disinfectant or insecticide).
Formaline--prepared as a disinfectant or insecticide.
Ant poison, prepared as a disinfectant or insecticide.
Fumigants, not including those which are combustible.
Fungicides.
Ant insecticides.
Methoxychlor, prepared as an insecticide.
Sprays, insecticidal and fungicidal.
Lysol.
Plant hormones, weed-killing.
Moth balls.
Nicotine, containing insecticide mixtures.
Fly paper.
Parathion, prepared as an insecticide.
Pentachlorophenol, prepared as a fungicide.
Pyrethrum, containing insecticide mixtures.
Powers, insecticidal and fungicidal.
Squill, used as rat poison.
Rotenone, containing insecticidal mixtures.
Saprol, a tree poison.
Copper sulphate, containing insecticidal and disinfectant mixtures.
Nicotine sulphate, in mixed preparations.
Poison for animal pests.
Tobacco dust, mixed with other substances and used in agriculture and horticulture.
Tobacco insecticidal mixtures containing Two- and Four-D weed killer.
2, 4, 5, Trichlorophenol prepared as fungicide.
Paris green, prepared as insecticide.
Weed-killing preparations.
Gnat poisons.

APPENDIX B

DERIVATION OF f (r)

1. $$3265 = \frac{330}{(1+r)} + \frac{506}{(1+r)^2} + \frac{676}{(1+r)^3} + \frac{864}{(1+r)^4} + \frac{923}{(1+r)^5} +$$

$$\frac{980}{(1+r)^6} + \frac{1009}{(1+r)^7} + \frac{1039}{(1+r)^8} + \frac{1068}{(1+r)^9} + \frac{277}{(1+r)^9}$$

2. $$\frac{3265}{1} = \frac{330(1+r)^8+506(1+r)^7+676(1+r)^6+864(1+r)^5+923(1+r)^4}{+980(1+r)^3+1009(1+r)^2+1039(1+r+1068+277}{(1+r)^9}$$

3. $$3265(1+r)^9 = 330(1+r)^8+506(1+r)^7+676(1+r)^6+864(1+r)^5$$

$$+923(1+r)^4+980(1+r)^3+1009(1+r)^2+1039(1+r)$$

$$+1345$$

4. $$3265[1+(1^9)r+(2^9)r^2+(3^9)r^3+(4^9)r^4+(5^9)r^5+(6^9)r^6+(7^9)r^7+$$
$$(8^9)r^8+r^9] = 330[1+(1^8)r+(2^8)r^2+(3^8)r^3+(4^8)r^4+(5^8)r^5+$$
$$(6^8)r^6+(7^8)r^7+r^8] + 506[1+(1^7)r+(2^7)r^2+(3^7)r^3+(4^7)r^4+$$
$$(5^7)r^5+(6^7)r^6+r^7] + 676[1+(1^6)r+(2^6)r^2+(3^6)r^3+(4^6)r^4$$
$$+(5^6)r^5+r^6] + 864[1+(1^5)r+(2^5)r^2+(3^5)r^3+(4^5)r^4+r^5]$$
$$+923[1+(1^4)r+(2^4)r^2+(3^4)r^3+r^4] + 980[1+(1^3)r+(2^3)r^2$$
$$+r^3] + 1009[1+(1^2)r+r^2] + 1039[1+r] + 1345$$

5. $3265[1+9r+36r^2+84r^3+126r^4+126r^5+84r^6+37r^7+9r^8+r^9] =$
$330[1+8r+28r^2+56r^3+70r^4+56r^5+28r^6+8r^7+r^8] + 506[1+7r+21r^2$
$+35r^3+35r^4+21r^5+7r^6+r^7] + 676[1+6r+15r^2+20r^3+15r^4+6r^5+r^6]$
$+ 864[1+5r+10r^2+10r^3+5r^4+r^5] + 923[1+4r+6r^2+4r^3+r^4]$
$+980[1+3r+3r^3+r^3] + 1009[1+2r+r^2] + 1039[1+r] + 1345$

6. $3265+29,385r+117,540r^2+247,260r^3+411,390r^4+411,390r^5+$
$274,260r^6+117,540r^7+29,385r^8+3265r^9 = 330+2640r+9240r^2$
$+18,480r^3+23,100r^4+18,480r^5+9240r^6+2640r^7+330r^8+506+$
$3542r+10,626r^2+17,710r^3+17,710r^4+10,626r^5+3542r^6+506r^7+$
$676+4056r+10,140r^2+13,520r^3+10,140r^4+4056r^5+676r^6+$
$864+4320r+8640r^2+8640r^3+4320r^4+864r^5+923+3692r+5538r^2$
$+3692r^3+923r^4+980+2940r+2940r^2+980r^3+1009+2018r+1009r^2+$
$1039+1039r+1345$

7. $3265r^9+29,055r^8+114,394r^7+260,802r^6+377,364r^5+355,197r^4$
$+211,238r^3+69,407r^2+4688r-4407 = 0$

APPENDIX C

THE COMPUTER PRINT-OUT

```
PDO FORTRAN CLT2
START

-6600      R=.17
-6624      DECR=.01
-6648      PRINT 21
-6660   21 FORMAT (//5X,1HR,12X,3HANS//)
-6734   11 ANS=3265.*R**9+29055.*R**8+114394.*R**7+260802.*R**6+377364.
             *R**5
-7022      ANS=ANS+355197.*R**4+211238.*R**3+69407.*R**2+4688.*R-4407.
-7262      PRINT 1, R, ANS
-7298    1 FORMAT (F10.8,3X,F10.5/)
-7338      IF (ANS)2, 4, 3
-7394    2 R=R+DECR
-7430      DECR=DECR/2.
-7466      GO TO 11
-7474    3 R=R-DECR
-7510      DECR=DECR/2.
-7546      GO TO 11
-7554    4 STOP
-7566      END

END PROCESSING
START

LOAD SUBROUTINES
PDQ FIXED FMT SUBROUTNS 11/63
LOAD DATA
```

R	ANS
.17000000	-209.33580
.18000000	371.34740
.17500000	74.25820
.17250000	-69.19750
.17375000	2.11230
.17312500	-33.64660
.17343750	-15.79340
.17359375	-6.84710
.17367188	-2.36880

R	ANS
.17371094	-.12860
.17373047	.99160
.17372071	.43180
.17371583	.15180
.17371339	.01190
.17371217	-.05810
.17371278	-.02320
.17371309	-.00520
.17371324	.00340
.17371316	-.00140
.17371320	.00100
.17371318	-.00020
.17371319	.00030
.17371319	.00030
.17371319	.00030
.17371319	.00030

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