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* STUDY ON IRON AND STEEL INDUSTRY AND REPORT ON MEETING OF EXPERTS HELD IN BOGOTA AND SPONSORED BY THE ECONOMIC COMMISSION FOR LATIN AMERICA AND TECHNICAL ASSISTANCE ADMINISTRATION

VOLUME I

This document by the ECLA Secretariat will be incorporated into the final report on the "Expert Working Group on Iron and Steel Industry in Latin America", to be published jointly by TAA and ECLA. The final report will contain, in addition, the background papers presented by the experts and summaries of the discussions

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CHAPTER I. STUDY ON IRON AND STEEL INDUSTRY AND REPORT ON MEETING OF EXPERTS SPONSORED BY THE ECONOMIC COMMISSION FOR LATIN AMERICA AND TECHNICAL ASSISTANCE ADMINISTRATION

INTRODUCTION

The first industry systematically studied by the Economic Commission for Latin America, has been iron and steelmaking.[1]

The following considerations have influenced this preference:

a) The importance of iron and steelmaking for the economic development of the countries;

b) The interest in the industry shown by several Latin American governments, which has resulted in the formulation of several projects during the last half century, and

c) The frequency of discussions without uniform criteria, regarding the advantage or disadvantage of installing such an industry in specific countries.

In order not to unduly extend the scope of this survey, the analysis has been restricted to seven countries of the region, in which either an integrated steelmaking industry exists or which possess, according to a preliminary investigation, the best possibilities for the establishment of such an industry. These countries are Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

The investigation has been directed towards five main objectives:

a) Analysis of the evolution of consumption and supply of iron and steel products;[2]

b) Study of the hypothetical costs of steel production in selected Latin American countries. These would be compared with hypothetical production costs in industrialized countries and with prices of imported steel as delivered to Latin American markets;

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[1] The study on productivity of labour in the textile industry of five countries of Latin America, undertaken in 1951, refers only to some special aspects of textile industry.

[2] For the purpose of this paper, and all documents related to the Meeting in Bogota, the expression "steel products" refers to products of the rolling mill and the primary transforming industries. It excludes, therefore, the steel contained in manufactured goods, equipment, etc.

/c) Approximations of

c) Approximations of the investments necessary for establishing integrated steel plants, appropriate to the size of the respective markets, in the locations mentioned in paragraph b); [1]

d) Technical problems hindering the development of the steelmaking industry in the region; and

e) Structure of the existing metallurgical industry, and its relation to manufacturing activity in general.

Preliminary Results of the Survey

For the analysis of the points covered by paragraphs 2) and e), official statistics of the different countries have been used. For studies on questions relating to paragraphs b), c) and d), it became necessary to investigate the relative importance of various local factors: reserves of raw materials, their grades and locations, wage rates, sizes of markets, etc.

The preliminary investigation indicated that some problems faced all seven countries; other problems applied only to several of them; and finally that there were certain difficulties applying exclusively to the industry of some specific country.

Despite the fact that several problems uncovered by the analysis are of a definite economic character (for example, production costs and investments in steel plants) all of them are related to technical matters, since the steelmaking process affects the structure of costs. The choice of the process is determined by several factors of which the most important are, on one hand, the available raw materials, and on the other, the market, the type of products, their sizes the respective total amounts, and the end use which will be given to them by the customers.

It is evident that similarities in market structure are much greater between the seven Latin American countries, than between the markets of any one of them and those of an industrialized country. Concerning raw

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[1] A steel plant which produces at least a part of the necessary raw materials, and manufactures pig iron, steel ingots and steel products, is called "integrated".

/materials, there

materials, there are many special problems in the region, a few applying exclusively to Latin America while others are also frequently found in other countries. The variety of cases is so large that, in order to encompass them all, it is necessary to resort to the knowledge and experience accumulated in those countries which have a well-developed steel industry.

The main conclusions of the study can be summarized as follows:

1. Analysis of consumption in Argentina, Brazil, Colombia, Cuba, Chile and Mexico, shows that during most of the past twenty-five years, almost all of them have been unable to obtain the steel products which they needed. Instead, they secured only such amounts as their capacity to import would permit them to buy abroad, supplemented by existing local steel production. The majority of the countries whose markets have been investigated show deficits in their supply of steel products.

2. The size of the plant is the single most important bearing on costs. If the scale of operation is small, the costs and the investment per unit of production are high and productivity is low.

3. The consumption rates of even those Latin American countries using the largest amount of steel, are too small to justify the installation of modern specialized plants capable of taking advantage of all the improvements which increase productivity.

4. Regarding costs, a detailed analysis of the influence of the most important factors affecting Latin American steel industry, has been prepared. For that purpose, plants have been hypothetically assumed, of sizes appropriate to the respective markets in different Latin American countries, and their costs compared with plants of the same sizes but located in Sparrows Point, United States. In this comparison, results have generally been favourable for Latin America.

In reality, the steelmaking plants in the industrialized countries, and especially in the United States, are much larger and their costs, therefore, are smaller than those which have been calculated for the Latin American plants. Nevertheless, with the exception of Peru and Venezuela, these differences are compensated by the higher transport cost of steel from the industrialized countries to the Latin American

/markets.

markets.

5. The aforementioned exceptions of Peru and Venezuela occur with hypothetical plants of 150 and 300 thousand tons respectively of annual capacity. The disadvantages of these countries can probably be eliminated and the steel cost reduced if, as an alternative, production of pig iron on a bigger scale, for export, is envisaged.

6. In all cases which have been analysed, even in those which would result in high costs, local production of steel in Latin America, would result in a substantial saving of foreign exchange per unit of steel manufactured.

7. Steelmaking is a heavy industry and requires large investments. The capital intensity is such that four or five units of investment are required to obtain one unit of production.[1] This relation generally prevails whether the plant mines its own raw materials, or purchases them.

8. As is well known, since iron and steelmaking is a basic industry, it requires a high investment per product or, in other words, has a relatively low product per unit of capital. Objections against establishing such industries in Latin America have generally been based on this fact. However, it must be remembered that iron and steelmaking are activities which are basic to many other transforming industries, in which the product per unit of investment is much higher. It is, therefore, necessary to appraise the joint problem. Moreover, the establishment of the steelmaking industry in Latin America has generally been the result of the need to substitute imports by local production, in order to permit a faster increase of the national income than the capacity to import would permit. Consequently, it has

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[1] The scarcity of steel, which has been a consequence of developments after July 1950, has resulted in a considerable increase in steel prices, which has not been followed, in the same degree, by a rise in capital good prices. Therefore, if these price relations are calculated for any period after 1950, the investment coefficient will show lower figures than those presented here. It is possible that once the new steelmaking facilities, which are being constructed in many countries, start operation, the relative position of the prices of steel products and of capital goods will come back to the position of 1948. The data of this paper have, therefore, not been altered but it should be emphasized that they seem to depict the most unfavourable situation which can arise from the capitalization of the steel industry.

/to be admitted

to be admitted that in order to secure certain substitutions of imports, investments may have to be made, with a lower product per unit of capital than the average of the investments prevailing in the economy.

1. Fuel Problems

a) In most Latin American countries, with probably the sole exception of Colombia, known coal reserves are scarce;

b) Few of the known deposits contain coking coals;

c) Several of the good coking coals of Latin America are difficult to wash, because the ashes they contain are finely disseminated. This means an increase in the cost of washing, or, alternatively, of high transportation costs of the coal, and operation costs of the blast furnace.

d) The raw materials which exist in Latin America and can be used for blending to improve the coking property of coals, or as substitutes for coke making, are little known in general. Their properties and possible applications have not been sufficiently investigated.

e) The distances between coal mines and steel plants, are generally excessive and produce an increase in the cost of pig iron, although the influence of this loss varies as between the different countries.

f) Quality limitations in the coke which can be manufactured with local raw materials without increasing fuel cost excessively, in several of the countries of the region, has resulted in some instances in the limitations of the height of the blast furnaces, which in turn, reduces their productivity.

g) Some of the coals, blending materials or substitutes for coal known in Latin America, have such a high sulphur content, that either the possibility of their utilization has been excluded altogether, or the operating costs of the blast furnace have been substantially increased.

2. Technical Problems Caused by the Composition of the Iron Ores

Problems posed by the quality or availability of iron ores, are considerably less important than those resulting from fuels. Latin

/America in

America in general, is rich in high-grade ore, and is at present one of the most important exporters. Nevertheless, the following difficulties can be mentioned, which originate from the composition of some ores.

a) In at least four countries (Argentina, Brazil, Chile and Mexico) steel plants have to use iron ores with phosphorus content which do not correspond exactly to the limits customary in the steel refining processes of more industrialized countries. The phosphorous content is too high for the basic open-hearth process, which is used for the production of 95 per cent of the steel of the United States, and too low for the basic converter process (Thomas), widely used in the European continent. In such cases it then becomes necessary to incur additional expenses, be they for eliminating the excessive phosphorous content, or recovering it for agricultural fertilizers.

b) In two of the countries rather unusual percentages of certain impurities appear: arsenic in Mexico and titanium in Chile.

c) Since each of the integrated plants has few alternative sources of iron ore supplies, the possibility is eliminated of blending various ores, as is frequently practised in industrialized countries. This complicates the design and operation of Latin American steel plants, which in any event have to produce a wider assortment of different steel qualities, in order to cover as substantial a part as possible of the country's steel necessities.

3. Transportation Problems

The production of one ton of pig iron requires four to six tons of raw materials, depending on the grade of the latter. Transportation of raw materials therefore becomes an important part of total production costs, and jointly with the transportation of the finished products to the markets, determines the location of the plant. In some of the countries especially in Brazil, Colombia and Mexico, distances are large, transportation difficult, and steel consumption is relatively scattered. This explains why Brazil and Mexico have built more than one steel plant, in spite of the fact that the resulting reduction in scale of operations increases costs. As has been stated, not even their total market would be sufficient to justify large-scale modern plants which alone ensure the maximum productivity found in industrialized countries.

A special technical problem seems to exist, therefore, in Latin America, which consists in finding iron and steelmaking processes, which could attain a higher productivity with small scale operations. Such processes would find suitable application in isolated regions in some of the aforementioned countries. In addition they would permit the establishment of small steelmaking industries in other countries of the region, which have not been included in this survey since the small size of their markets would result in excessive cost of steel produced under classical processes.

4. Technical Problems Arising from the Uses of Steel

In countries where the steel transforming industries have not been developed, the largest proportion of the metal is used in the building industry. In such a case,.the main quality requirements which steel has to satisfy are resistance and ductility. Chemical composition becomes of almost no importance. The requests made by some consumers that such building materials should conform to narrow variations of chemical compositions, unnecessarily increase production costs, and result in a higher cost of steel for all consumers. It may also induce unnecessarily high investments in additional plant facilities.

In view of the rapid growth of steelmaking in Latin America in recent years, it seems advantageous to establish, as soon as possible, standards and specifications for such steels as are being produced. When preparing these standards, consideration should be given to the use to which the steel will be applied, the existing raw materials and facilities, and the avoidance of unnecessary increases in production costs.

The conclusions of ECLA's preliminary studies, especially concerning the considerable number of technical problems which tend to increase the costs of Latin American steel production, suggested that great advantage could be derived from a meeting of experts. An agenda could be submitted

/to them,

in [illegible] containing the largest possible number of the aforementioned [illegible]

[illegible] IRON AND STEEL INDUSTRY IN LATIN AMERICA, HELD IN [illegible]

[illegible] United Nations Technical Assistance Administration and the [illegible] Colombia had taken into consideration the results of the [illegible], they offered their co-operation for the meeting of the "First Expert Working Group on Iron and Steel Industry in Latin America", which was held in Bogota in October 1952. The meeting convened under the joint auspices of ECLA and TAA; the Government of Colombia acted as host and generously provided for the material success of the meeting.

The meeting was opened on 13 October by His Excellency the President of Colombia, Dr. Roberto Urdaneta and adjourned on 31 October by the Chairman, Dr. Roberto Jaramillo Ferro, General Manager of the Paz de Río company of Colombia.

One hundred and seventeen experts participated in the meeting[1] and eighty-two background papers were contributed.[2] The participants and the authors of the papers were chosen from nineteen different countries.

In the opening session Dr. Roberto Jaramillo Ferro was elected Chairman. Seven Vice-Presidents were nominated, one corresponding to each of the Latin American countries which participated in the meeting.[3]

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[1] Annex I contains the list of participants.

[2] The names of the authors and the titles of the papers appear as Annex II.

[3]

Argentina:	Engineer Augusto Legrand, Sociedad Mixta Sidérúrgica Argentina.
Brazil:	Engenheiro Eduardo Pyles Lozano, Companhia Mineraçais do Brasil.
Chile:	Engineer Danilo Vucetich, Compañía de Acero del Pacífico, S.A.
Colombia:	Dr. Joaquín Prieto Isaza, Empresa Siderurgica Nacional de Paz de Río S.A.
Mexico:	Engineer Alfredo González Ballesteros, Compañía Fundidora de Hierro y Acero Monterrey S.A.
Peru:	Engineer, Alfonso Ballón, Departamento de Siderurgia, Corporación Peruana del Santa
Venezuela:	Engineer Argenis Gamboa, Ministerio de Minas e Hidrocarburos.

/The substantive

The substantive matters dealt with have been summarized in chapters III, IV and VI of this report, and included:

a) Fuel problems:

Washing of coal, improvement of coking [illegible] of poorly coking coals, substitutes of [illegible] for manufacture of metallurgical coke;

b) Iron ore reduction problems:

Comparative advantage of the use of better coke in blast furnaces contrasted with increased costs of coal washing; economic problems of the charcoal blast furnace; reduction of iron ore by processes other than the blast furnace.

c) Steelmaking problems:

Comparative costs of different steelmaking processes; alternative processes to the rolling mill which combine higher productivity with low-scale operations; range of application of steels made by different kinds of steel used in various countries.

d) Economic problems:

A special section of the meeting was devoted to the study of four working papers presented by the Economic Commission for Latin America:

Document L.86: "Factors Influencing Iron and Steel Consumption in Latin America";

Document L.87: "Influence of Local Factors on the Iron and Steel Industry in Latin America";

Document L.88 "Structure of the Steel Transforming Industry in Latin America";

Document L.0 : "Brief Outline of Steel Industries in Some Latin American Countries".

The dates at which the various items of the substantive matter were discussed, appear in the agenda attached as Annex III. All discussions took place in plenary meetings. Only three problems which had not been included in the programmed list of substantive matter were presented by

/non-Latin American

non-Latin American experts in committee meetings.[1] Some of the Latin American experts remained in Bogota during the entire meeting. These were called "General Experts", and since they were primarily technicians with managerial positions in their respective industries, they had an over-all knowledge of the problems of the steel industry in their countries. The majority of other participants had specialized knowledge on specific problems. Their attendance was thus primarily for such sessions which discussed the problems of their particular speciality. The presence of the general experts throughout the meetings provided continuity to the debates, especially by maintaining the focus of attention towards the analysis of specific Latin American problems.

The above arrangements, initially intended to set the pattern for the meeting, were not strictly carried out in practice. A considerable number of specialists extended their attendance to many sessions in which problems outside their own speciality were discussed. Most of the time, therefore, in addition to experts who had been invited to deal with certain specific problems of the agenda, an additional group of participants were present, who were technicians of high standing in other specialities. In this way, a series of interesting discussions arose. Experts of the latter type intervened to tell the experiences they had obtained while searching for solutions to similar problems in other fields, and they made suggestions showing ways which were open to new fields of investigation.

As a result, the sessions facilitated the exchange of experience and knowledge, both between participants from different Latin American countries, and between them and experts from other regions.

The conclusion was almost unanimous that the meeting proved of great benefit to the participant members. ECLA and TAA had submitted to the meeting a series of specific questions related to the common objective of finding processes which would permit lower costs of steel production in the region. Within this framework the knowledge of the

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[1] Dr. Raymond Cheradame, France: "Analysis of Coal Washing Methods Based on Coefficient of Imperfection"; Prof. Dr. Durrer, Switzerland: "Notes on the Future Evolution of Iron Production"; and Prof. Bo Kalling, Sweden: "New Process for the Desulphurization of Liquid Pig Iron, Based on the Use of Lima".

/different specialists

different specialists resulted in many valuable suggestions. Their contributions, in addition to conveying definite suggestions for solving some of the Latin American problems, provided inspiration to other technicians to conduct studies which could result in future progress.

Judging by the number of participants, and of papers presented, the meeting was also very successful. To a great extent this was due to the excellent co-operation obtained from universities, research centres, professional associations and many private steel plants. Through consultation with internationally known professional associations, names of the most representative equipment manufacturing firms and consulting engineers were obtained. The co-operation of a considerable number of these equipment manufacturing and engineering firms was then requested and obtained, some of them contributing in the form of working papers, some through actual participation of their officials, or both. This group of private firms, it might be added, provided the meeting with some excellent working material.

The Empresa Siderúrgica Nacional de Paz de Río, of Colombia, contributed with a series of papers prepared by either its own staff, or by the firms that provide it with equipment and technical advice. It also contributed a substantial amount of material help.

Not every problem of interest to the Latin American steel industry was included in the agenda. The restrictions that were imposed resulted from two main factors. For one thing, there was the limitation of time, and the desire that the material under discussion should receive an exhaustive treatment. Secondly, the desire to present the largest possible number of divergent opinions on each topic necessitated the elimination of some agenda items which were considered insufficiently covered by the contributions which were obtained. Such a coverage seemed especially indispensable in those cases in which the analysis was prepared by private commercial sources.

In view of the composition and the organization of the Bogota Meeting, the basic objective was not one of reaching specific agreements nor recommendations. Rather, the primary purpose was to discuss the different problems thoroughly, covering as many angles as possible, but always with the focus directed towards the Latin American industry.

/CHAPTER II.

CHAPTER II. PAPERS AND DISCUSSIONS RELATING TO THE EXPERT WORKING GROUP ON IRON AND STEEL INDUSTRY IN LATIN AMERICA AND THE CONCLUSIONS APPLICABLE TO LATIN AMERICAN COUNTRIES

There are many conclusions which Latin American countries can derive from the papers presented to the Expert Working Group on Iron and Steel Industry in Latin America, and the discussions thereof. In order to avoid a detailed examination of the abundant material, some conclusions have been extracted in the present report. The following is a discussion of certain problems often facing the Latin American steel industries.

This analysis focusses on two main points of view. The first relates to some economic factors and the cost structure of the industry, without considering the specific problems confronting the different countries. The second deals with definite problems related to some countries or existing plants, and presents a review of the information and discussions contributed by the meeting in connection with these particular cases.

1. Conclusions of a General Character

There appears to be a close link between the consumption of steel products and economic development. Document L.86, analyses the factors influencing iron and steel consumption in six countries of the region. It concludes that the majority of them have not been able to obtain the amounts of steel which they have required during most of the past twenty five years, but rather only the amounts which their capacity of import has permitted.

The knowledge of the size of the market appears essential before deciding on the installation of a new steel industry, because of the considerable influence which the scale of operations has on steel costs. It has been common practice in Latin America to base market studies on data of the immediately preceding years. This procedure tends to underestimate the market, in case an unsatisfied demand exists because of limitations in the capacity to import. The consequence of such mistakes may be either the abandonment of the project, due to the high production costs resulting from the small size of plant, or it may result in the installation of units so small that they will again result in high steel costs and make plant expansion almost immediately necessary.

/Document L.86

Document L.86 presents a methodology which throws some light on the size of the potential market of the Latin American countries. Only a few economic data are necessary for any country: national income, imports of capital goods, consumption of cement, etc. If the results show that the availability of steel products is smaller than the estimated potential demand, efforts to increase the supply become very significant.

In document L.87 hypothetical steel production costs have been calculated for one plant located in each of the following seven countries: Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela. The locations which have been chosen usually correspond to sites at which plants are either operating, or where it is contemplated they will be erected. This selection has simplified the amassing of neccesary data. The fact that plants have been hypothetically placed in their respective locations does not imply judgment on the comparative advantages of the place, in relation to others which might exist in the country. The analysis of the paper corresponds to plants of equal size and overall design, 250 thousand tons of finished steel per year, and in addition, all of them are assumed to have an equal degree of mechanization. The figures have either been expressed in values at 1948 prices or in physical units. Following the same procedure and with a minimum of significant data, it is easy to construct for comparative purposes the hypothetical costs corresponding to any other site or project. In addition, the respective annexes explain in detail the methodology which has been followed.

The appreciable number of cases tabulated enables some preliminary comparisons concerning certain factors which influence costs. Among these of major importance may be mentioned the composition of raw materials; distance of their sources to the projected plant; its distance to the local markets, and so forth.

In document L.91, hypothetical costs of other plants located in the same sites have been tabulated. In this paper their size has been adjusted to the dimensions of the respective market. The paper also justifies the choice of size in each particular case. It should be noted that in each of three countries (Colombia, Peru and Venezuela) two plants of different size have been included. The resulting assortment of eleven steel works (including Sparrows Point) have capacites which vary between 50 thousand

/and 1 million

and 1 million tons per year.

The main conclusion of this paper is that the size of plant has an extraordinary influence on costs. It is undoubtedly the single individual factor with the largest bearing on cost formation.

If identical plants to those described for Latin American countries were built on the Atlantic seaboard of the United States, the former group, with few exceptions, would have lower production costs. This comparison, of course, is not realistic because the plants actually existing in the United States are of a larger size and are more specialized. They produce, therefore, at even lower costs than the largest plants which can be justified by markets in Latin American countries. But, if to the cost in the United States, the difference between transportation costs from the United States and from Latin American steel plants to the Latin American markets is added, this addition represents a margin of protection permitting the cost of many Latin American plants to be lower than the "delivered cost"[1/] of the United States plant in their markets.

The above general conclusion does not apply in the particular cases of Peru and Venezuela. For the other countries it applies only insofar as the general assumptions, on which the calculation is based, are fulfilled. In fact, it can be established that for each location there exists a minimum size of the plant, wherein delivered costs would be higher than the delivered cost of imported steel. The size of operation at this limit, depends on the quality of raw materials, haulage distance, wage rates, etc. In general, plants with lower assembly costs [2/] and wage rates, are in a more favourable position to face competition, that is, their operation will still be profitable at a smaller scale.

1/ In order to provide a uniform basis of comparison throughout this analysis, reference will be made to an arbitrary figure which will be called "delivered cost" of imported steel. It corresponds to the hypothetical cost of production of a 1 million ton per year plant, located in Sparrows Point, Maryland, plus the transport cost differentials of finished steel from this plant and from imaginary Latin American plants, to the markets of the latter countries. The justification of this choice, and its comparison with average United States, European or Japanese steel costs and prices, appears in Chapter V.

2/ Mining cost of raw materials plus haulage costs to the plant.

/Among the

Among the examples selected in document L.91, two plants are close to the coast and have relatively low assembly costs and wage rates: Chile and Peru. The first has been scheduled for a production of 230 thousand tons and the second for 150 thousand tons per year. The latter appears with a higher hypothetical cost than the delivered price of imported steel; the Chilean plant produces at lower costs. It can, therefore, be assumed that for Latin American steel plants located close to the seaboard, and with reasonably low assembly costs, the "critical" size of the plant fluctuates between 150 and 230 thousand tons of finished steel per year.

The bearing of certain cost factors on the value of this limit, can be appreciated by the case of a 300 thousand ton plant, which has been imagined in Barcelona, Venezuela. The wage rate there is about five times the rate prevailing in Peru and Chile [1] and combined with lower transportation costs from the United States, the critical size of plant falls above 300 thousand tons per year.

On the other hand, in some special cases the critical size of the plant may be reduced. This happens, for instance, where considerable haulage costs in the interior of the country are added to the usual maritime transportation. Such internal haulage costs increase the margin of protection above the figures granted in the cases of Chile and Peru by maritime transportation. Situations of this type seem to exist in various steel consuming centres of Argentina, Brazil, Colombia and Mexico.

A concrete example of this situation is the Belencito plant in Colombia. Assembly costs there are very low, in fact, the relative position of raw materials makes it one of the most favourable locations in the world. On the other hand, one of the main consumption centres, Bogota, is located in such a way that transportation cost of the imported material constitutes a formidable protection. As a result of the combined action of these two factors, the critical size of the plant falls under 100 thousand tons of steel per year.

Document L.91 shows, in addition, approximate values of the necessary investment, at 1948 prices. Investment requirements are high. They vary

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1/ The average wages paid by the petroleum refineries have been used as a basis for this calculation.

/between

between 491 dollars per ton per year in the 50 thousand ton plant in Chimbote, to 355 dollars in the 850 thousand ton plant which has been imagined in San Nicolás.

It can be gathered from this data that steelmaking is an activity where capital intensity is high, and since capital is a scarce production factor in Latin America, a careful study is indicated before deciding to install a new industry.

Capital is not the only scarce factor in the region. In many countries the availability of foreign exchange to pay for imports represents a similar or even worse problem. The findings of document L.91, are that the hypothetical plants under study would result in an average foreign exchange saving of 54 per cent, compared with the delivered cost of imported steel in the markets of the region. A special mention in the case of Argentina seems justified, since here the calculations are based on the supposition that 100 per cent of the coking coal will be imported. Despite this, however, the saving in foreign exchange would be 52 per cent of the delivered cost of imported steel. Similar results are shown in Peru. Even the small and high cost plant of 50 thousand tons a year would save 60 per cent of exchange.

It can be generalized, therefore, that in countries with some raw materials for steel production, at least iron ore, even the installation of a small plant as in the case of Peru (which is unprofitable if costs are considered) represents a substantial saving of foreign exchange.

The present analysis began by quoting the market investigations of document L.86, which show that in Latin America a shortage of steel frequently exists in relation to potential demand. Such shortages generally result from limitations in the capacity to import. As pointed out in document L.91, however, local production, even on a very small scale, could result in a saving of at least 50 per cent of the foreign exchange to cover the delivered cost of imported steel.

On the other hand, it can be deduced from the same document, as has been done here, that production under a certain scale will result in an increase of cost above the delivered cost of imported steel. Under favourable conditions, this size limit lies about 200 thousand tons per year. Ignoring non-economic motivations for erecting a steel plant, which

/may be

may be of considerable importance in some cases, the decision as to whether it is advantageous to install a steel plant or not in a country with a smaller potential market than 200 thousand, should therefore depend on the relative importance of conserving foreign exchange.

The aforementioned data and conclusions refer exclusively to steel plants based on classical production processes. No consideration has been given thus far to the many methods of iron ore reduction other than the blast furnace. Among these, the following are the most important ones: electric blast furnaces, low shaft furnaces, and the numerous so-called direct reduction methods, which produce in some instances a substitute of scrap and in others some variety of pig iron with special characteristics. In the meeting of Bogota, considerable importance was attached to these methods since in general they require smaller investments and use a larger proportion of manpower.

At first sight they would, therefore, appear to be better adjusted for an adequate utilization of the production factors existing in the region, especially in the case of smaller countries. To begin with, the influence of scale of operation is not as large under these systems as in plants where classical processes are employed.

The cost analyses tabulated in the technical papers have been prepared either on the basis of values or of physical units, but always in comparison with data corresponding to a classical plant. In this way, they can be linked to the rest of the analysis.

It seems necessary, nevertheless, to call attention to two facts in relation with these alternative methods: 1) the use of reduction processes does not eliminate the necessity of a steel plant and rolling mill, and it is precisely the latter which has the greatest influence on variations in cost due to scale of operation; and 2) that in the course of the discussions, doubts were expressed regarding the convenience of installing such methods in countries which are short of capital. Few of these processes have been tested on a commercial scale in the industrialized countries.

Another point seems to flow from these studies, although it cannot be fully substantiated. In countries where there are limitations on the capacity to import, even in those which have a long steelmaking tradition

/like Brazil

like Brazil and Mexico, consumption begins to grow with a much greater impetus, once the local production of flat products starts. The possibility that this may constitute a more general rule seems to be corroborated by figures contained in document L.88, which prove that 60 per cent of the steel used by the steel transforming industries in Mexico consists of flat products. Huachipato in Chile has included the making of flat products since initial operations, and its influence on the market has been remarkable.

A detailed analysis of markets in those countries contemplating a new steel industry, would be useful to clarify the abovementioned relation between steel consumption and local production of flat products. To that effect an analysis of the possibilites of growth of the steel transforming industry would have to be prepared in each case. Such a study has not fallen within the scope of this work.

2. Conclusions Referring to Argentina

Argentina has the highest per capita consumption of steel products in Latin America, 57 kilos per person in 1947-1949. If Argentina's steel consumption is compared with the national income, the steel consumption per 100 dollars of national income is lower than that of Chile, Brazil and Mexico. On the other hand, the correlation prepared in document L.86 with various indicators of economic growth shows that steel consumption has been compressed for several years by limitations in the capacity to import.

The Argentina iron and steel making plan envisages, as a first step, the annual production of from 700 to 750 thousand tons. This figure is slightly lower than the actual consumption, during the latter years, of the products included in the programme.

There have been many discussions as to whether it is justified to install an integrated steel industry in Argentina. The adverse opinions have not been based so much on the disadvantage of investing large amounts of capital, but rather on the assumption that a country devoid of coking coals would produce expensive steel. 1/

1/ Fortunately, the discovery of the rich iron ore deposit of Sierra Grande will eliminate the necessity of also importing iron ore, or, as an alternative, avoid the long railway haulage necessary to transport ore from Zapla to the steelmaking centres.

/The figures

The figures of document L.91 show that a plant of 850 thousand ton capacity in San Nicolas, would have almost exactly the same delivered costs in the Argentine market as imported steels. [1] This would be true even if all the coal necessary for coke production had to be imported, either from the United States or the United Kingdom. According to the same calculations the San Nicolas plant would save between 43 and 55 per cent of the exchange necessary to cover delivered costs of imported steel.

As has been noted, the previous analysis has been based on the assumption that coking coal will be imported. The only important coal formation found so far in Argentina is Rio Turbio, in Patagonia, and corresponds to some highly bituminous non coking variety. Despite the fact that this fuel may be as expensive as imported coal at Rio de la Plata ports, Argentina will probably be interested in utilizing as much of it as possible in order to save foreign exchange. Some papers presented at the Bogota meeting may suggest investigations which can be conducted in order to ascertain how to make metallurgical coke of this coal. Among such documents L.9, L.10 and L.14, refer to a new coal cleaning process called "phase separation". [2] This process blends oil into the coal which serves as a binder during carbonization, and simultaneously ensures a high grade of purity of the coal. According to paper L.14, metallurgical coke is at present being produced from black lignites in Yugoslavia.

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[1] A comparison of the data regarding the size of plant in document L.91, and those of the plan show that the latter contemplates only the production of 500 thousand tons in San Nicolás, whereas the former is based on a capacity of 850 thousand. The conclusions are not affected in this particular case, since the steel plant contemplated in the plan has a certain degree of specialization which reduces costs.

[2] This consists in finely grinding the coal in the presence of water and a small percentage of oil. The oil binds the coal particles together, whereas the ashes remain in suspension in the water. Subsequent centrifugation separates the water from the coal oil pulp.

/Document L.11

Document L.11 refers to processes employed in France to produce good coke from highly bituminous Lorraine coals. Several processes are described which produce coke on a commercial scale, using up to 60 per cent of such non coking coals.

Documents L.12, L.13, L.15 and L.17 describe various processes to improve the coking properties of coals. For example, blends with low volatile coals; chars (low temperature coke) made of non coking coals; asphaltites; asphalts and petroleum residues, appear among the processes which have been studied or applied in other countries. Investigation of such processes would be justified in relation to the Rio Turbio coal. Finally, document L.16 refers to the manufacture of coke exclusively from asphalts or petroleum residues, as practised in Argentina in the zinc refinery of Comodoro Rivadavia. These several alternatives justify the assumption that it will be possible to find the way to utilize a substantial proportion of Rio Turbio coal in the San Nicolas plant.

Should it be unavoidable to resort to imports, part of the coal might be imported from Cerrejón, Colombia, which alternative would result in smaller haulage. Conversely the metallurgical centre which has been envisaged for the south of the country, not far from the Sierra Grande deposit, the relative closeness of the Rio Turbio formation, the Comodoro Rivadavia oil fields and the sub-Andean asphaltites (if there are still substantial deposits available), all justify a much closer investigation of the possibility of using Rio Turbio coal, since it will be considerably cheaper than imported fuel.

In relation to new metallurgical processes, two were discussed in Bogota which may be applied to Argentina. They refer to the most common impurities contained in the iron ore and fuels: phosphorus and sulphur. In regard to phosphorus the European, and many of the United States experts insisted in the advantage of enriching the air of the basic converter with oxygen, as a means: a) of obtaining converter steels of greater purity, equivalent, according to the latest investigations, to those made by the basic open hearth; b) of reducing investment and production costs of the plant; and c) of providing a way to re-melt scrap in the converter, at least in the proportion in which this material is at present being used in Latin America, in open hearth furnaces. In regard to sulphur, which may

/become a

become a problem in the country if petroleum [illegible] are used for making coke, a new process was discussed. Professor Kalling, of Sweden, explained a new method of extracting sulphur from the liquid pig iron, in the presence of lime, in a closed deposit which is rotated at considerable speed. This deposit receives the taps directly from the blast furnace, and is being used at present on a commercial basis in one plant in Sweden and being installed in several others.

Even if there should not be a considerable increase in sulphur content of the coke, such a process deserves study. This would be specially true for countries where fuel is expensive or scarce, since the operation of blast furnaces with an acid reaction which might become possible with its application, would permit the use of lower temperatures and result in a substantial saving of coke.

3. Conclusions Referring to Brazil

Brazil has the largest steel industry in Latin America. Production of finished steel in 1951 was around 800 thousand tons and projects are under way to increase it up to 1.5 million tons by 1955. Despite these substantial totals, per capita consumption is relatively low, smaller than in Argentina, Chile or Mexico.

Brazil has a long metallurgical tradition, since the rich ores of the State of Minas Gerais have been exploited for many years. Numerous charcoal blast furnaces are in operation, with capacities varying between 100 and 200 tons a day. The latter is probably the largest blast furnace of its type in the world. Since the twenties, steel has also been produced based on charcoal pig iron. Volta Redonda has been operating since 1946, as the only integrated plant using coke blast furnaces; it produces rails and flat products almost exclusively. Among the projects for new industries, or expansion of existing works, the Volta Redonda plant may be mentioned. In 1951 it produced 342 thousand tons of finished steel with one blast furnace of one thousand tons per day capacity. As the first step of its expansion, a second blast furnace is being installed, and it will be followed by a third one, arriving finally at a capacity of a million tons of steel ingots per year.

The Companhia Siderurgica Nacional, owner of Volta Redonda, has been organized by the Government. In addition, there is also a strong government

/influence in

influence in the Companhia Aços Especiais Itabira, which is gradually raising its capacity to reach a production of about 60 to 70 thousand tons of special steels. The remaining production, mainly bars, light structures and tubes, is furnished by private enterprises. Of them, Companhia Belgo Mineira is the most important. Belgo-Mineira, as well as many other firms of the private sector of the industry, are planning expansions which will jointly yield a considerable tonnage. In addition to existing plants, the erection of several new plants with capacities ranging from 200 to 500 thousand tons has been contemplated.

In view of the considerable growth of consumption in recent years, it is probable that all these new facilities will find a ready market as soon as they are ready for operation. Furthermore, in view of the specialization of Volta Redonda, the overall production seems fairly well balanced.

Of all the projects which have been mentioned, for the time being only Volta Redonda will really take advantage of cost reduction through large-scale operations. The smaller plants will inevitably result as higher cost producers, but transportation advantages and the manufacture of special products will add to their profitability.

The only important coking coal formation known in Brazil is Barro Branco, in Santa Catarina.. It presents many mining and washing difficulties. Documents L.2 and L.5 explain in detail how these problems have been faced, so far. The ash content of hand-picked coal ranges from 32 and 34 per cent, and is reduced by washing to 15 or 16 per cent. As a by-product, a low quality coal is obtained with an ash content ranging from 45 to 50 per cent. The cleaner coal is used for metallurgical purposes and the dirtier fraction for boilers and furnaces. In order to reduce the cost of the cleaner coal for the steel industry, it is necessary to find a market for the other fraction.

Documents L.9 and L.14 which refer to coal cleaning through phase separation, may be applied to both fractions of Barro Branco coal. The possibilities of reducing costs of coal transportation, and blast furnace operation, through better washing of the cleaner fraction should be investigated. Studies regarding the dirtier part of the coal should aim at increasing the proportion of total which can be economically employed in the blast furnace.

/Barro Branco

Barro Branco coal has special sulphur problems, which are probably unique in the world. In the veins the percentage of sulphur is around 14 and it drops to about 1.5 in the washed coal, still containing 16 per cent ashes. The sulphur appears in the coal mainly in the form of pyrites and these are contained in the higher specific gravity fractions. If through the phase separation method the sulphur cannot be eliminated to the extent desired, the desulphurization method suggested by Professor Kalling in the meeting should be considered.

It is also necessary to bear in mind that the Barro Branco coal is highly expansive and is a good binder during carbonization. Volta Redonda is at present using blends containing 30 to 37 per cent of Brazilian coal, the remainder being imported high and medium volatile coals. This selection has been necessary to prevent damage to coke ovens which might arise through excessive expansion of the coal. Document L.25 states that the Cerrejon coals in Colombia, on the Atlantic coast, are high volatile fuels which in all probability will be suitable for these blends. The use of Cerrejón coals would also reduce the distance from source to plant.

An analysis of problems of the Brazilian steel industry, necessarily has to include the activity of charcoal blast furnaces. This industry takes advantage of the high grade ores and natural forests of the State of Minas Gerais. The ores are built up by different types of oxides with varying phosphorus contents. The ores also vary as to physical properties and reactivity. These two reasons explain why many of the plants practise selective mining of the ores, although it reduces productivity. This happens mainly in those steel plants which blow their steel in acid converters.

In addition, a substantial part of the indigenous trees of the forests of Minas Gerais, as well as several varieties of eucalyptus which have recently been planted, contain phosphorus in such a proportion that the average of the charcoal comes up to 0.06 per cent. Since all this phosphorus goes into the pig iron, and is additive to that contained in the ores, the aforementioned difficulties increase. In some instances the phosphorus content may become so large that the pig iron would create difficulties even in an open-hearth furnace.

Both in charcoal blast furnaces and in coke blast furnaces where phosphorus content might be high, it would seem justified to investigate

/the possibility

[illegible] of [illegible] (Thomas) steel using oxygen [illegible] mentioned in the case of Argentina. Another solution would [illegible] dephosphorize the steel through the processes of special slags which [illegible] described in documents L.73 and L.79.

Brazil has one of the largest iron ore reserves in the world and even if selective mining continues to be practised as at present, it has adequate reserves for many generations. But, the elimination of difficulties accruing to ores mined with improper selection would represent not only the solution of a problem related to the present steel costs, but also to the conservation of reserves. Document L.33, which describes the sinterization of iron ores for use in the Monlevade charcoal-blast furnaces, jointly with the processes mentioned for elimination of phosphorus, can probably supply the answer to all technical problems which might arise in this connection.

4. Conclusions Referring to Chile

The influence which operations of the Huachipato plant has had on Chilean steel consumption, has been truly remarkable. If this fact is weighed jointly with the findings of document L.86, namely that Chile has long faced a scarcity of steel because of its limited capacity to import, it becomes easy to understand the difficulties of forecasting what the potential market will be in any given situation. It may be said, however, that when the present expansion of the Huachipato plant has been finished, its capacity will probably be suited to the size of the market for several years, and occasionally permit the export of small quantities.

The main fuel problem that Chile faces is the necessity of importing low volatile coals to improve the coking properties of its own fuel. The latter does not present, at first sight, complicated washing problems, but one of the documents submitted to the meeting, L.27 discusses the petrographic composition of the Chilean coal and analyses the injurious effects of some of the constituents on the coking properties. If the conclusions of the aforementioned document are accepted as correct, it becomes necessary to separate the coal in three fractions, as done in Brazil, for which separation there is no equipment available in Chile.

The author of the paper states that the exclusion of certain petrographic elements through grinding and selective screening, followed by washing to

/eliminate fractions

eliminate fractions of higher specific gravity than [illegible].35, subsequently reduces the neccesity to add imported coal of low volatile content.

The considerable amount of imported coal which the Chilean plant is using at present in its blends, is a consequence of limitations in the country's mining capacity. According to tests which have been conducted, the minimum percentage of imported coal (low volatile), used to produce good coke thus far, has been 20 per cent. On the other hand, documents L.13 and L.15, refer to the substitution of low volatile by chars in the coking blends. Both papers agree that the maximum favourable addition of char corresponds to 15 per cent and that after having reached that proportion, the gains produced by char drop off fairly rapidly. In addition, paper L.13 states that the influence of char on improving the coking properties of the coal is a little smaller than that of selected low volatile coal. The small gap which separates the minimum percentage of low volatile coals obtained so far in Huachipato, from the 15 per cent which constitutes the maximum acceptable addition of char, gives rise to the hope that if the quality of the coal is simultaneously improved through the suggestions made in paper L.27, imports of coal for improvement of the coke may eventually be completely eliminated.

Should the corresponding experiments not be completely successful, it should be borne in mind that according to the document L.2, in the Cauca Valley in Colombia, a variety of low volatile coals is available. The substitution of Colombian for United States coal would again decrease transportation distances.

Chile faces two different metallurgical problems. Ores presently used at Huachipato come from El Tofo and have a slightly higher phosphorus content than would be convenient for the basic open-hearth operation. The steel company at present destroys the phosphorus in the slags. Document L.54 presents information regarding a similar problem in Italy, where phosphatic ores (apatites) are added to the burden of the blast furnace, in order to produce a pig iron rich in phosphorus, which can be used for the basic converter process.

Several apatite reserves are known in Chile, and the general scarcity of phosphorus in the soil and of phosphoric fertilizers, seemsto justify the study of this method. The resulting phosphoric slag would represent a

/by-product of

by-product of the steel plant, and reduce its costs. In the course of the discussions it was mentioned that European countries, particularly Sweden, usually phosphorize the pig iron through addition of slags to the blast furnace.

Basic converter steels have a smaller range of application than basic open hearth steels. In order that steels made with phosphorized pig iron might have similar ranges of application, it would become necessary to enrich the air of the basic converter with oxygen.

Another problem which faces the Chilean steel plant is due to a somewhat excessive titanium content in the iron ore. The Chilean technicians attending the meeting studied this problem, with the co-operation of several non-Latin-American metallurgists, in committee meetings outside the regular sessions.

5. Conclusions Referring to Colombia

Although steel consumption has grown considerably in Colombia, its correlation with indicators such as national income, cement consumption and import of capital goods, following the methodology which has been explained in document L.86, suggests that there is a potential unsatisfied demand in the country of about 50 to 60 per cent of the volume of the steel imports of recent years. The plant being built in Belencito, slightly smaller in capacity than the country's present consumption, seems, therefore, of insufficient size. The negative influence which this may have on future production costs will be partly compensated by a favourable combination of raw materials and their locations, which will make Belencito one of the lowest assembly cost plants in the world.

The initial plan of the plant does not include the manufacture of flat products for which there is a market of some 50 thousand tons a year. In agreement with the general conclusions at the end of the first section of this chapter, it might eventually be advantageous to add production of flat products as soon as possible. For certain applications of such products, limitations often imposed by the use of Thomas steel, may be important. Here again, it would be justified to study the advantage of oxygen enrichment.

For the production of some bars, problems arising from the quality of Thomas steel have been solved in Belencito through the addition of an electric steel furnace which also takes care of re-melting scrap. Should the plant be enlarged, as has been said, consideration should be given to the injection of oxygen in order to attain both results, in preference over the addition of a second electric furnace.

Colombia has no fuel problems. It possesses the largest coal reserves known in the region, covering widely varying chemical compositions and coking property. The coke for Belencito will be manufactured from a nearby mine of medium volatile content, which produces good coke without any blending. In several conclusions referring to other countries, exports of coal from Colombia have been mentioned. This country could be of real assistance to the steel industry of other Latin American countries, by preparing an exhaustive study of metallurgical coals which it could deliver. The special necessities of Volta Redonda, San Nicolas, Huachipato, Barcelona and probably also the Pacific coast of Mexico, should be investigated, and at a later stage, the abundant coal deposits of the country searched for adequate types of fuel.

6. Conclusions Referring to Mexico

Of all the countries whose markets were investigated in document L.86, Mexico has experienced the fastest rate of increase in steel consumption. On the other hand, among the various correlations used to approximate the potential demand, the only one indicating the possible existence of a steel shortage was cement consumption. It is possible however that technological changes have reduced the consumption ratio of steel to cement. If any unsatisfied steel demand exists in Mexico, therefore, it should not be significant.

The increase in the availability of steel for consumption, has been due both to increased imports and to the growth of local production. In other words, there is still a sizeable market available for an expansion of the local industry. Mexico's steel industry should, therefore, basically aim to eliminate imports and to satisfy the normal increase of consumption.

In past years, development of the steel industry has been greatly influenced by two factors: first, transportation difficulties in the country, and second, the almost chronic shortage of coking coal. The combination of these two factors has resulted in the two integrated plants working below full capacity. The shortage of coking coal has indirectly given rise to a scrap smelting and steel rolling industry, based on imports of scrap from the United States. The main plant is located close to the border. In addition, a series of small plants which generally smelt and roll local scrap, are located in different parts of the country.

Each one of the existing integrated steel plants has a capacity close to 200 thousand tons of crude steel. If they are profitable in spite of such a small size, it may well be due to their specialization on different lines in such a way that their rolling mills correspond jointly to a larger type of plant and, therefore, each one shows a higher productivity. In addition, for different reasons both have had lower investment costs than those calculated in documents L.87 and L.91. [1]

Mexico is very rich in iron ore deposits and has coal formations of varying coking properties scattered in different regions. Under such conditions, the possibility should be examined of overcoming transportation difficulties and the overload of the railway net which at present serves the integrated plants, by creating new steelmaking centres in other regions. The data contained in document L.91, will probably be useful to appreciate the relative merits of such a decentralization. They supply a methodology to determine possible cost reductions by expanding the existing industry, and conversely cost increases resulting from the installation of several new small plants. It must be borne in mind that total Mexican consumption is still far from the optimum capacity for one large modern plant.

Regarding fuel problems, it can be stated that coking coals of Sabina's formation are among the few in Latin America which can be coked directly without blending. They contain a considerable amount of ash, approximately 32 per cent as mined, and are subsequently washed to bring them down to some 15 to 16 per cent. The resulting coke, therefore, contains about 20 per cent. This figure is high, especially for a country whose transportation system is overloaded. On the other hand, the Mexican iron ores are of a very high grade and it therefore becomes necessary for the coke to contain a certain minimum of ash in order to ensure the necessary slag production. In addition, laboratory tests prove that Sabinas coals develop high expansion pressures during the carbonization process, to such an extent that

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[1] See document L.84, which gives some details regarding the Monclova plant of S.A. Altos Hornos de México.

/according to

according to the experience obtained in similar cases, they are classified as dangerous for the conservation of the ovens. Since there has never been an accident of this type in Mexico, the theory has been advanced that high ash content absorbs the excessive pressure.

All factors considered, it would be interesting for the Mexican industry to investigate the possible advantage of applying the desulphurization method, to which reference has been made in the section related to Argentina, and try to operate their blast furnaces with an acid reaction. For this purpose it would be indispensable that the coal be delivered with less ash. Here again, among many others, the washing methods suggested by document L.9 and L.10, could be investigated.

With reference to new projects in other regions of the country, document L.24 describes a process being developed in Peru, to manufacture metallurgical coke based on anthracite. It might well be that the same process could be applied to Sonora anthracites, should there be any interest in establishing a new metallurgical centre in this State.

Of the work related to metallurgical problems in Mexico, as in Chile, the addition of apatite to the ores of Cerro de Mercado should be considered. Here also, the basic converter blowing of the steel might cause inconveniences regarding quality. However, this problem could probably be solved through oxygen enrichment. Before making any investment in this direction, new specifications for this special type of Thomas steel should be studied and accepted in the country.

It was mentioned several times during the meeting that the Banco de Mexico is studying the establishment of small metallurgical centres in different parts of the country. It has been contemplated to substitute the blast furnace by any other ore reduction process in the corresponding plants, in the hope of finding a method better adapted to local raw materials, and less sensitive to reductions in the scale of operation. Papers referring to nine of these unorthodox methods were presented at the meeting, many of them containing data on their cost structure, either [illegible] or in physical units. The assembled information therefore facilitates the study of the comparative advantage of these processes, as well as their comparison with the classic blast furnaces.

[illegible] regarding

Information regarding a plant producing 12 thousand tons a year of sponge iron, as a substitute of scrap, was of considerable interest to the meeting. The process used is the tunnel kiln, as developed in Canada, and results have been such that the capacity of the plant is being increased to 36 thousand tons a year. This apparently is the first plant in the world to use this process, and also the first one in Latin America to produce steel on a commercial scale by a process different from the blast furnace.

7. Conclusions Referring to Peru

The project of a 53 thousand-ton steel plant being installed in Chimbote using electric ore reduction furnaces, originated during the last war. The use of an electric reduction system was motivated by the fact that the steel plant constituted one of the elements in the large Santa hydro-electric project. Originally the intention was to devote to it a small percentage of the total power and, given the flexibility of this type of reduction furnace it was expected that it could use surplus power whereby the unit cost of electric current would be very low.

For a series of reasons the construction of the hydro-electric plant has been delayed in such a way that the first unit which will start operations, will correspond approximately to the total requirements of the steel plant. Under these conditions, power will not be as cheap as originally envisaged. On the other hand, there is a very good possibility of exporting pig iron to Argentina, taking advantage of regular return freights created by wheat imports. Thus, a project is being studied to erect a 180 thousand ton regular blast furnace in Peru. 53 thousand tons of steel would be produced for local consumption, and the remaining pig iron exported.

If the method for estimating potential markets presented in paper L.86 is applied to Peru, the conclusion arises that this country would require a plant of 150 thousand tons annual capacity of rolled steel. As one concrete example of the form this new demand might take, barbed wire for utilization in the Sierra may be mentioned. Its installation would encourage a substantial increase in the number of sheep.

These data indicate that once the new plant starts production, a certain increase of the market will result, and in order to satisfy local demand, plant expansion will become necessary. This means that it would be

/indispensable to

indispensable to start fairly soon on the second step of the new project, namely the installation of a new blast furnace of the same size, close to the iron ore deposits. In this way, shipping capacity could be fully utilized in both directions.

This analysis is of significance since it takes considerable time to develop coal mining and, therefore a more exact evaluation of the potential steel market seems to be justified.

At this stage it seems premature to apply any conclusions from the technical discussions of the meeting to the Peruvian case. The possibility of making good metallurgical coke with the Santa Valley anthracite, is presently being investigated. For this purpose, the smallest amount of petroleum derivatives should be added to the coal, since the petroleum production of the country has no excess production of asphalts beyond supplying the necessities for road building plans. The process which is being investigated is new and has been explained in documents L.10 and L.24; a semi-commercial plant is being built in Peru at a cost of about 250 thousand dollars. During the discussions in Bogota, no doubts were expressed regarding the possibility of manufacturing coke using this system. However, in agreement with the Peruvian technicians, it was considered necessary to conduct full scale tests of the new coke before designing an adequate blast furnace. This is due to the fact that many characteristics of the new fuel are unknown and no indicator has been developed which would permit a complete clarification, except direct experimentation. Therefore, until these tests have been finished, it will not be possible to decide which of the two possible solutions is more favourable: the 50 thousand ton electric furnace plant or the anthracite coke blast furnace. Should coke blast furnaces be used, the quality of the ore would suggest acid converters, and in order to make the steel usable in most applications, oxygen enrichment could be considered. This would reduce the amount of nitrogen dissolved in the Bessemer steel.

8. Conclusions Referring to Venezuela

In many ways Venezuela occupies a unique position in Latin America. In relation to its availability of steel, and the installation of a steel plant, the most outstanding differences compared to other Latin American

/countries are

countries are the following:

a) No final project exists for the construction of a steel industry;

b) Wage rates rank among the highest in the world. They are, of course, the highest in Latin America, and surpass even those of the United States by approximately 27 per cent. 1/

c) Venezuela has no foreign exchange problems.

Points b) and c) will certainly be valid so long as a high level of industrial activity prevails in the world, and no limitations are established on international trade in petroleum. This analysis refers exclusively to such a situation, since considerations involving variations in world activity are beyond the scope of these documents.

In order to simplify the analysis, steel consumption in Venezuela can be divided into two almost equal groups: a) the petroleum industry, which uses about 250 thousand tons of steel a year, primarily tubes, plates for the working platforms of the Maracaibo Lake, structures, bars, etc.; and b) the rest of the economy, which consumes some additional 250 thousand a year. The latter, with an assortment similar to that found in most Latin American countries, contains a high percentage of steel for the building industry. To these amounts, it would be necessary to add a considerable quantity of steel contained in durable consumer goods, capital goods, etc., which is not included in the present analysis, and has not been considered in any one of the other countries.

Consumption is concentrated in three main markets at close range from the coast. The region around Maracaibo Lake accounts for most of the steel consumption originating from the petroleum industry. A smaller proportion of this industry's total requirements accrues from the Oriente oil fields, in the State of Monagas and Anzuategui. Finally, the cities of Caracas and La Guaira, and the surrounding zone, use most of the steel outside the petroleum sector.

As already stated, Venezuela does not face the serious exchange problems which limit the capacity to import of other countries. Nevertheless, the correlation used for them, if applied to Venezuela, shows that there is an

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1/ By comparing the average wages for petroleum refining in Venezuela, with the average wages of the primary steel industry of the United States.

/unsatisfied demand

unsatisfied demand in the non petroleum sector of consumption which could reach some 310 thousand tons instead of the present 250 thousand tons of real consumption, if the unsatisfied potential demand is added. [1]

Among the natural resources available for steel production in Venezuel the following are worthy of mention:

a) Very large reserves of the highest grade ore, mainly hematites, which are located at the south and east of the Orinoco river close to its confluence to the Caroni. Two of them have been granted in concession to large steel making companies from the United States. Ports, mining facilities, ships and eventually the dredging of the Orinoco are being organized. The ore which the country might need for local production of steel, can be obtained from these sources in a way similar to that by which Chile obtains ores from El Tofo.

b) Some coal deposits now being exploited on a small scale are located close to Barcelona on the Atlantic coast, between La Guaira and the mouth of the Orinoco. Naricual is the most important of them and although they are reputed to be non coking, they may be interesting in view of their vicinity to the asphalt and petroleum fields of Oriente (where the heaviest Venezuelan oil is found), since both these substances may be used as a binder to improve the coking properties of coal, as explained in documents L.11, L.14, L.15, L.17 and L.18. It might not be impossible, therefore, to base something like 80 per cent of the fuel supply of the Venezuelan steel plant on this coal.

Another interesting possibility results from information presented by the Colombian participants namely that the Boyaca formation continues in all its width right to the Venezuelan border. It can, therefore, be expected that it continues also in the latter country on the south-west side of Maracaibo Lake towards the city of Cucuta. An investigation of this formation by Venezuela would seem especially justified if it is considered that the directly

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[1] These findings motivated the inclusion of two plants for Venezuela in document L.91: one of 200 thousand and one of 300 thousand tons.

/coking coal

coking coal to be used by [illegible] belongs to this formation, and that it also includes a substantial variety of coals of other types.

c) Regarding hydro-electric power reserves, preliminary studies have been made for a large plant to be built where the Caroni joins the Orinoco, which could easily supply a potential of one million kilowatts. It is evident that this project will not materialize if other applications for power, in addition to possible consumption of the steel plant, are not developed. In order to evaluate such possibilities, some of the discussions and documents presented to the meeting may be useful. These refer to the comparative advantage of coke and power, based on the relative prices of coke. As a first approximation, it was stated that an electric reduction furnace should only be considered where the price per kilowatt-hour is equivalent or smaller than one sixth of the price of one kilogramme of coke.

d) Venezuela obtains from both of its main petroleum districts substantial amounts of natural and petroleum gas, the majority of which is presently lost to the atmosphere. Consideration has been given to the installation of a small plant using this natural gas for some system of direct reduction. Another method of utilizing it, to which reference was made during the meeting, would be to design a special blast furnace into which petroleum gas would be pressed. The theory was for this gas to perform a substantial part of the heating of the raw material, as electric power does in the electric reduction furnace, and that it should also assist in the indirect reduction of the ore in the upper part of the blast furnace. No blast furnace of this type is known to be working on a commercial scale, but if it were possible to construct it in Venezuela, the saving in coke would be noticeable.

Of course, the best possible location of any steel industry using gas would be close to the Orinoco, not far from the iron ore deposits and a little more than 100 kilometres from the eastern oil fields.

/e) As a

e) As a possible substitute for coal in the production of coke, or as a binder to improve the quality of the coke, Venezuela possesses several important asphalt lakes on the left border of the Orinoco. In this region there are also some petroleum wells producing very high density crudes, whose prices in world markets are lower than those for normal oils. Document L.18 describes an oven being used in Argentina to make metallurgical coke (for the zinc industry), using petroleum residues as raw material. During the discussion of this document, the Venezuelan participants stated that exploitation of the asphalt lake is very difficult on account of the viscosity of the material at the temperatures prevailing. Furthermore, in regard to utilizing the heavy crude petroleum, they estimated that if the carbonization costs were added to the price which can be obtained for its export, the cost of the resulting coke would be higher than that of a coke manufactured from imported coals.

It should be remembered that the possible utilization of natural asphalt depends mainly on the development of a suitable method for its extraction. Such a solution would offer many advantages. During the discussion of different problems of carbonization, it was stated that at present there are coke ovens available with either vertical or horizontal retorts, which permit the manufacture of coke from coal, or liquid petroleum residues alone, or from blends of both in any desired proportion.

Another technical problem resulting from the utilization of these petroleum derivatives is their higher sulphur content. In the sections referring to individual countries, such as Argentina, mention was made of a new desulphurizing process, in which the liquid pig iron is tapped from the blast furnace into a deposit containing lime, and rotated at high speed. It is possible that this process could solve any sulphur problem which might arise in connexion with asphalts and petroleum products.

It was also mentioned during the meeting that since coal and petroleum products can supplement or substitute each other in the manufacture of metallurgical coke, as much research as possible

/should be

should be undertaken in co-operation with the petroleum industry. Initially the countries benefit most from such co-operation would seem to be Argentina and Venezuela.

f) Although they cannot be called a natural resource, mention should be made in this list of return freights from the United States to Venezuela, originating from exports of iron ore. The possibility exists of using these return freights to take coking coal to Venezuela at a low freight rate. Utilization of this possibility would, of course, influence the location of the plant.

Although the classic process received almost no attention in the different studies undertaken in Venezuela for the solution of the steel problem, they will be examined here. This process was the only one used in documents L.87 and L.91 for investigating the cost structures. Of the two possible sources of coke which were studied in document L.87 for Venezuela, only the use of imported coal will be examined, since the manufacture of petroleum coke depends on research which still remains to be done.

In these studies, the price of imported coal delivered to plant in Venezuela was estimated at 13.48 dollars (at 1948 prices) per metric ton, of which 0.60 dollars correspond to handling in the country. If local fuel is used instead of imported coal, its cost on cars at the washery should be around 10 dollars per ton to equal the above price. 1/ This means that only around 6 dollars could be paid for extraction and washing salaries.

If the wage rate of two dollars per hour applied throughout this study to Venezuela, is applied to the mining operation, it becomes evident that coal can be obtained at this price only if the mine is sufficiently mechanized to permit a production per man and per day, of 8 x 2 : 6 = 2.666 metric tons. These production rates are easily obtained in the United States, but Latin American mines usually present difficult geological conditions and are less mechanized. In Mexico, the production per man per day is around 0.9 tons; in Chile 0.6 and even lower figures prevail in Brazil.

1/ The difference, compared with the price of imported coal, has been reserved for transportation, handling, etc.

/Such requirements,

Such requirements, which seem hard to meet, suggest that if a Venezuelan coal deposit is being investigated with the production of coking coal in mind, the study should include mining facilities and obstacles, in addition to properties of the coal. This knowledge is indispensable for a better judgment of the comparative advantages of local production of coal; saving of foreign exchange; employment of local manpower; and certainty of a regular provision of fuel as measured against any possible increase in the cost of the raw materials for the blast furnace.

In documents L.87 and L.91 an imaginary plant located in Sparrows Point on the Atlantic seaboard of the United States was used as a basis for comparison with plants hypothetically placed in different locations of Latin America. From Table 8 of paper L.91 it can be seen that the assemby cost, including scrap, amounts in Barcelona to 27.30 dollars per ton of steel compared with 27 dollars in Sparrows Point.[1] Therefore, if the basic assumptions being used in this paper are sustained, a plant in Venezuela appears to have almost exactly the same assembly costs as one in Sparrows Point.

On the other hand, Venezuela has the advantage of smaller transport costs to its local markets. The value of this advantage has been estimated in paper L.91 as equivalent to 10 dollars per ton, the latter amount constituting a form of protection for the Venezuelan industry. Production in the United States, conversely, has the advantage of lower wage rates, and the bearing of this factor increases with each successive step in steel making, from the raw materials to steel products. In addition, it has the advantage of a larger scale of operations, which results in higher productivity of labour and lower investment costs. Finally, the large markets permit a considerable degree of specialization in United States steel plants.

At the beginning of this chapter, reference was made to an arbitrary basis of comparison called "delivered steel costs". Since selling prices in the United States in the base year 1948 were considerably higher than hypothetical production costs in Sparrows Point, the comparison of Latin

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[1] Sparrows Point with Venezuelan ore; Barcelona with United States coal.

/American costs

American costs with delivered costs of imported steel, therefore contain a certain safety margin. [1]

Table A. Comparison of the Cost per Ton of Steel Produced in Barcelona in Various Sizes of Plants and the Cost of Steel Produced in Sparrows Point at a One Million Ton per Year Plant

(1948 dollars per ton)

Capacity of Plant (thousand tons per year)	Wages in Barcelona a/	Capital Charges in Barcelona b/	Increase over Sparrows Point Plant		
			Wages c/	Capital Charges c/	Total
50	76.60	44.20	63.30	21.50	84.80
150	51.40	42.20	38.10	19.50	57.60
200	42.80	40.60	29.50	17.90	47.40
230	39.40	37.40	26.10	14.70	40.80
300	32.00	34.70	18.70	12.00	30.70
430	27.80	33.20	14.50	10.60	25.10
716	24.20	30.80	10.90	8.10	19.00
850	24.00	31.90	10.10	9.20	19.30

a/ Obtained by multiplying the man-hours per ton shown in Table 11, document L.91, by the Venezuelan wage rates.

b/ Obtained by applying 9 per cent for interest plus amortization, to the investment figures per ton per year, shown in Table 12 of document L.91.

c/ Difference between the data of columns a/and b/, minus the respective costs in a one million ton plant in Sparrows Point.

Table A shows that even the largest plants, 700 to 800 thousand tons per year (which therefore exceed the size of the Venezuelan market), would produce at a cost higher than the delivered cost of imported steel. In other words the disadvantages arising in Venezuela from wages and capital charges in plants of such a size, are too large to be compensated by the lower differential in transport costs.

If instead of basing the comparison on delivered costs it is based on the selling price in the United States in 1948, plus the transport cost differential, the situation seems to change considerably. In this case, profits in the United States have been included, and they raise the margin

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[1] This margin seems indispensable, because, under certain circumstances, steel industries of exporting countries might face the situation whereby it would be more advantageous for them to export at cost price, than to stop operations or reduce production.

/of difference

of difference above cost in Barcelona from 10 to 34 dollars, to compensate for higher wages and capital costs. Of course, this increase eliminates any margin of safety. A difference of 34 dollars would equal the excessive cost of a smaller plant, such as one producing 300 and 400 thousand tons a year.

Returning to Table A, it can be seen that while the cost differences originating from capital charges in the smaller plant only duplicate the figures of the larger one, the cost increases due to wages are approximately seven-fold. An analysis of the papers shows that the rolling mill is responsible for most of the variations in productivity. That is, rolling operations cause most of the increase in wages per ton that occurs in small-scale plants.

This would seem to indicate that if Venezuela wants to operate a plant smaller than 300 to 400 thousand tons per year, without undue increase of cost, alternative processes to the rolling mill should be carefully considered. Documents L.66 and L.68 refer to equipment and processes of this type already being used on an industrial scale in the United States, France, and the United Kingdom. For the time being there seem to be two difficulties: first, they are not yet sufficiently developed to permit their installation in a country where mechanical resources are inadequate; and, second, that there are still many limitations to the type and weight of the profiles which they can produce.

Unorthodox methods of iron ore reduction have, in general, the disadvantage for Venezuela that they use more labour per ton of production than the classical ones. If installed in Venezuela, they would produce at even higher costs than those tabulated in Table A. A possible exception to this general rule might come from the process described in document L.67. This is still being studied and the inventor stated in Bogota that its development would take one more year, prior to which no new information could be disclosed.

There are two other alternatives for Venezuela which should also be explored. The first consists in producing pig iron for export on a large scale. This could eventually be used to cover part of the shortage of ferrous material which is developing in Europe, especially in Italy. If such a possibility is taken advantage of, the cost of pig iron used for Venezuela's industry could be reduced considerably. The second alternative, also aiming

/towards the

towards the creation of a larger market, would be to add to the internal production of Venezuela, the manufacture of petroleum tubes for export. [illegible] could have [illegible] provided from this material.

/CHAPTER III

CHAPTER [illegible]

1. Introduction

According to [illegible] information, Latin America has always been considered a region rich in high-grade, fine quality iron ores, but poor in coal resources in general, and particularly in those suitable for producing good metallurgical coke.[1] In drawing up the agenda for the Bogotá meeting, stress was thus laid on the study of coal and coking problems.

The relative scarcity of coking coal has been reflected in the existing and projected iron and steel industry in Latin America. Very serious thought had to be given to the selection of plant locations, due to the important bearing on assembly costs of long haulages for fuel. Document L.87 by the Secretariat of the Economic Commission for Latin America analysed the influence of transport on assembly costs in selected examples of plant locations in seven Latin American countries.

Table 1 shows the fuel haulage required per ton of finished steel. Loading and unloading operations, transfers, maritime and river transport, have been converted to the number of kilometre-tons at which a ton of coal could be transported at equivalent cost. The table also shows, in percentages, the origin of the coal.

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[1] The Report on World Iron Ore Reserves and their Utilization in Underdeveloped Areas, prepared by the Secretariat of the United Nations in 1950, makes the following statement on the subject: "Latin America is particularly deficient in coal resources. Mexico alone is known to possess coal of good coking quality. According to the published information, some of the Chilean and Colombian coals, although of a relatively poor quality, are cokeable; those of Brazil are even poorer. The coking properties of coal from Peru have recently been established. The rest of Latin America appears to lack coking coal entirely. The large-scale use of ores for the production of pig iron thus depends on imports of large quantities of coking coals, or, alternatively, on the employment of technique for reducing iron ore which does not involve the use of coal in any form".

/Table 1

Table 1. Origin of Coal Required to Produce One Ton of Steel and Haulage Involved, Expressed in Railway Kilometres per ton

Plant	Haulage	Origin of coal Domestic	Origin of coal Imported
San Nicolas	2,185	...	100 %
Volta Redonda	1,599	30	70
Huachipato	352	85	15
Belencito	39	100	...
Monclova	126	100	...
Chimbote	219	85[a]	15[b]
Venezuela	586	...	100

a/ Anthracites from the Santa Valley
b/ Asphalt pitch

Except in Colombia, fuel haulage for all plants is excessively long, compared with the usual figures in: Belgium, Luxembourg, the United Kingdom, the north of France, the Ruhr Basin, Pennsylvania, etc.[1] Moreover, in only two of the seven countries was it possible to base supply on 100 per cent of domestic coal, although most of them encounter serious difficulties in obtaining foreign eschange.

There were thus two concrete objectives at the Bogota meeting in connexion with fuel problems:

a) To provide information to enable the existing or projected Latin American industry to reduce its fuel transportation costs, and

b) to direct studies and research towards replacement of imported fuels by domestic fuels.

To serve these purposes, a number of widely-differing solutions may be adopted. They range from better coal washing to prevent unnecessary haulage of inert matter, to total or partial replacement of coal by other fuels. Through blends the coking properties of coals can be substantially improved, thus permitting the use of some coals which are

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[1] It should be recalled that these centres were usually formed close to coal producing sources, so that it has become axiomatic to consider that in this industry iron ore is transported to the fuel production centre.

/at present

at present rarely employed (if at all) for metallurgical purposes, on account of their poor coking properties.

During the meeting, the contributions of Latin American participants were mainly confined to descriptions of fuel resources and the coking properties of some coals of the region. The participants from other countries, however, usually explained the methods adopted and the research being conducted in their respective countries. Frequently these were related to specific conditions in Latin America, or to coals similar to those found in the region.

One of the exceptions to the preceding general rule, which should be mentioned, is document L.2, presented by Mr. Thomas Fraser, of the United States Bureau of Mines. In the course of several technical assistance missions to the region, he has probably become one of the persons best acquainted with Latin American coal problems.

2. Coal Reserves in Latin America

According to document L.2, the practice of European geologists, who first explored the coal reserves of the region, of classifying coals according to their geological age, relegated those of Asia and the Western Hemisphere to a low category. More intensive study of these formations has shown considerable variations in the coals; their characteristics range from lignites to anthracites, depending on the extent to which local tectonic action has influenced the rate of carbonization. The ample extent of coal bearing formations throughout the Andean region, can leave no doubt of the presence of considerable reserves in the region as a whole. The wide variety of coals found in the few areas so far investigated, indicates that within Latin America sufficient coking coal will be found to supply the modest requirements of its infant iron and steel industries.

Latin American experts presented papers describing some deposits and mining methods; in other cases information on washing and washability of coals of the region was submitted. These papers were: L.5, Brazil; L.6, Chile; L.7, Paz de Río zone, Colombia; L.8, Mexico; L.10, Washing of Santa anthracites, Peru; L.23, Cauca Valley, Colombia; L.25, Cerrejón, Atlantic coast of Colombia. With the exception of Colombia, this information was confined almost exclusively to coals for use in the respective iron and steel industries. In the case of Colombia, reference was made to coals

/which could

which could be exported for the [illegible] other Latin American countries. Although some of these papers referred to more than one item on the agenda, only those parts relating to coal formations will be discussed at this stage, leaving other problems to be examined later.

Document L.5 mentions some 20 million tons of coking coals in the State of Parana, Brazil. This coal is not being used due to a high sulphur content, which being in organic form cannot be eliminated.[1] The Santa Catarina region supplies all metallurgical coal worked in Brazil. This deposit consists of narrow seams, separated by rock intrusions of varying thickness and is therefore expensive to work. The hand-picked coal averages a content of 34 per cent ash and 10 to 14 per cent of sulphur, but although ash is reduced through washing to 18 per cent and sulphur to 1.75 per cent, the elimination of these impurities increases costs. Reserves of this type of coal are estimated at 500 million tons, and in view of their exceptional coking properties can be used as a blending material to improve fuels having poorer coking properties. This explains why, in spite of the fact that the features of the deposit and the washing problems are exceedingly difficult, Mr. Fraser states in paper L.2:

> "Notwithstanding all these technical difficulties, the exceptionally strong coking quality of this coal, its adequate reserves and its strategic location with respect to the tremendous deposit of high-grade iron ore of Brazil, may well place the Barro Branco coal among the most important coking coal reserves of the world in the years to come."

Paper L.6 describes the metallurgical coal in the Gulf of Arauco, in Chile. This fuel has a low sulphur and ash content and is easy to wash. It has two drawbacks: first, its coking power is low and needs to be improved with 20 or more per cent of low volatile coal (which has not yet been found in Chile), and second, the mines are located under the sea, so that operating costs are fairly high.

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[1] The reference to desulphurization made later in this paper changes this situation entirely, so that this coal might, possibly be added to [illegible] potential reserves for steelmaking.

/Present workings

Present workings are from 4 to 6 kilometres off the coast. Total reserves have been very conservatively estimated at some 260 million metric tons, of which 55 per cent is composed of the coking coals described, and the remaining 45 per cent is non-coking. There are also extensive coal deposits of poorer quality in the country, ranging from sub-bituminous to lignites,[1] which are quite unsuited for use in the iron and steel industry. These reserves according to some estimates, raise total figures to nearly 4,000 million tons.

Paper L.8 refers to the coal found in Mexico. It describes deposits of the Sabinas and Saltillito formations in Coahuila, which at present supply the entire consumption of Monterrey and Monclova. Reserves are estimated at between 1,250 and 2,000 million tons, almost all of which is good coking coal. The ash content of run-of-mine coal ranges between 22 and 32 per cent, and is washed to 15-16 per cent, while the sulphur content is low, ranging from 1.1 to 1.3 per cent. This coal produces excellent coke without blending.[2] Reference is made to the Oaxaca deposit, situated some 350 kilometres south of Mexico City, and relatively close to iron ore deposits. Reserves are here estimated at some 100 million tons of coal, of varying volatile matter content: some of these coals have good coking properties. This fuel has a high content of finely dispersed ash, which poses serious problems to the conventional washing processes.[3] Finally, this paper describes deposits of anthracite coals in the State of Sonora, which are estimated to contain not less than 22 million tons, with about 10 per cent of ash. As there are also

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1/ According to the classification of the United States Association for Testing Materials.

2/ According to current laboratory experiments, this coal should expand so much during coking that it has been classified as dangerous to the oven walls. In practice no accidents have occurred, so far, and the theory has been advanced that this might be due to the remaining ash which may absorb the pressure.

3/ It is likely that the method of washing coal by phase separation, described in paper L.9, could be used successfully here, whether or not in combination with the manufacture of coke briquettes using the Convertol process described in document L.24.

high-grade iron ores in this State consideration has been given to the installation of a new steelmaking centre, using these anthracites for the blast furnace, either directly in lumps, or pressed into briquettes.[1]

Paper L.7 estimates Colombia's total coal reserves at 40,000 million tons, of which 1,900 million have been found within a radius of 40 kilometres from the steel plant at Belencito. Due to differences in tectonic action in various parts of this formation, coals are found with widely varying properties. They range from high bituminous non-coking coals to low and medium volatile, strongly coking coals which could be used as blending materials to improve other coals. A mine having a reserve of some 200 million tons of directly coking coal has been opened close to the iron ore at Paz de Rio. This fuel can be easily washed to obtain 8 to 9 per cent of ash coal, with sulphur under 1 per cent and with 85 per cent recovery. Due to its geographical location and high transportation costs, this fuel can for the time being only be used in Colombia. It should be noted that in the Cucuta region, these formations seem to extend into the State of Zulia, close to Lake Maracaibo in Venezuela. As the formation contains a large variety of coals, it would not be surprising if Venezuela also finds good coking coal deposits in that region.

Document L.24 describes Colombian coals from the Cauca Valley, in the region close to Cali, with reserves estimated at some 400 million tons of recoverable coal. This fuel normally has a fairly high ash content, so that it would need washing. Otherwise, it contains widely varying types of coal with different quantities of volatile matter. Incidentally, the samples from some mines correspond closely to the famous Pocahontas No. 3 coal in the United States, while others are sub-bituminous non-coking coals.

It was revealed during the discussions that Colombia is taking steps to develop mining and preparation of these coals to export them. Chile's iron and steel industry might be one of the purchasers of fuel of the high coking type. Again, if Mexico should build an iron and steel

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[1] The convertol system, referred to in document L.24 could also probably be applied successfully in this case.

/centre to

centre to the southwest of the Federal District, based on Oaxaca coals, a market might be established there for some varieties of coal from the Cauca Valley.

Document L.25 describes Colombian coals from Cerrejon, in the Guajiras peninsula on the Atlantic seaboard. These are high bituminous non-coking coals with a low ash content, from 2 to 6 per cent and very low sulphur content. Reserves developed so far, are estimated at some 36 million tons. It was mentioned during the discussions that Brazil might gain by substituting up to 50 per cent of the coals which it imports, for Cerrejon coal, thus reducing the distance from mine to plant. Similarly, if Venezuela should be unsuccessful in its search for coking coals, it might cover part of its requirements with this Colombian coal, coking of which might be achieved through blending.

On the basis of this information it appears that Latin America's coal reserves are not entirely negligible. Colombia is undoubtedly the most richly endowed country in this sense, and could well supply several Latin American countries with the appropriate coals for their blends. Naturally the various possibilities mentioned here should be submitted to that essential research which alone can determine the real possibilities. The potential objectives, should all the tests prove successful, would be those indicated in Table 2.

Table 2. Modifications in Coal Supplies Permitting a Greater Use of Latin American Fuel

Plant	Haulage distance		New element in fuel	
	According to Table 1	According to conclusions of this discussion		
San Nicolas	2,185	1,940	40% Cerrejon	60% Pocahontas
Volta Redonda	1,599	1,300	30% Barro Branco	70% Cerrejon
Huachipato	352	258	15% Cauca	85% Gulf of Arauco
Belencito	39	39	100% Colombian	
Monclova	126	126	100% Mexican	
Chimbote	219	219	85% Anthracite	15% Venezuelan asphalt
Barcelona	586	632	100% Zulia	
Barcelona	586	419	70% Cerrejon	30% Asphalt
Average	729	614		

Apart from reductions in the haulage distances indicated in Table 2, fulfillment of the programme outlined above would provide a greater

/assurance of

assurance of supply and would increase inter-regional trade by some twelve million dollars in terms of 1948 prices.

3. Coal Washing

This section reviewed present or planned coal washing practices in the iron and steel industry of the region, discussion being based mainly on information provided by Latin American participants. Some participants from outside the region, generally those connected with engineering firms which construct or design washing equipment, described some of this equipment, almost all of which is already in industrial operation, and referred to its possible application to Latin American coals. There were two exceptions to this general rule: firstly, the description given in document L.1 of the methods of calculation known as the "coefficient of imperfection" used in France to select the type of machine best suited for obtaining certain results when washing coals. The problems thus posed may consist in separating various fractions of different specific gravities and for different sizes; secondly, documents L.9 and L.10 refer to a new washing process known as phase-separation.

The discovery of the so-called "coefficient of imperfection" was first divulged at the Congress on Coal Preparation in Paris, 1950. Subsequent studies and practical corroboration thereof, have led to confirmation of the theory's validity. This consists, briefly, in the statement that each washing process can be characterized by a certain coefficient, independent of the type of coal and the density adopted for the separation. In other words, for every type of apparatus working under good conditions there is very little difference in the deviation of particles on either side of the desired line of separation.1/ Based on the average results which formed the basis for establishing the coefficients for each type of apparatus, calculations can be made which are of undoubted industrial value; first in determining the sizes which provide the maximum yield, and secondly to compare the yields in each of the various possible processes, in relation to the washing cost.

1/ The lower the deviation of the coal particles which pass to the ash fraction, the higher the yield; and inversely, the lower the deviation of particles rich in ash which fall within the coal fraction, the cleaner the product.

/These calculations

These calculations were evolved in Europe in view of the fuel shortage, due to which seams are mined which would not be worked in countries with a better supply. This makes it essential to clean coals both easy and difficult to wash, the separation not being confined to two fractions only (coal and waste), but to two or more coal fractions with different ash contents, in addition to waste.

The way in which the ash is dispersed determined the ease with which coal can be washed. In some cases seams consist of two clearly different fractions, one of combustible matter with very little ash, and the other with a high ash content and with little coal. Such coals are easy to wash, and they are most frequently mined in the United States, Germany and the United Kingdom. "Integral" washers can be advantageously used for them; they treat run-of-mine coal, that is without separating the various sizes, yielding only two products: coal and tailings.

In other coals, the ash is finely and unevenly dispersed, so that there is a whole range of intermediate products between clean coal and waste. In these cases, in order to obtain a suitable fuel it is necessary: a) to separate two or more fractions having different ash contents (and therefore different specific gravities), and seek suitable applications for each fraction, or b) to crush the larger fragments, which have an excessive amount of ash, to sizes in which a reasonable proportion of acceptable coal particles appear. A combination of these two processes is a common feature in Europe. In Latin America a typical example is Brazil where coal is separated into metallurgical and steam fuels, and tailings (see documents L.2 and L.5)

Only the metallurgical coals found in Chile, Colombia and Peru are easy to wash and can efficiently be prepared into two fractions. Those in Argentina, Brazil and, in a smaller degree, Mexico, are difficult to wash. Washing here may include the acquisition of more than one type of coal and a substantive amount of crushing.

Document L.27 analyses the influence of coke ash constituents on the blast furnace operation cost and yield. Theoretical considerations, supported by operational statistics for the Huachipato blast furnace, demonstrate that the small amount of ash which appears in coal fractions with a specific gravity over 1.35, reduces the coking quality of the coal. Similar petrographic studies if carried out among other metallurgical coals in Latin America, might well prove the advantage of extracting certain components of the ash. Thus it may become indispensable that even coals classified as "easy to wash" should be separated into more than two fractions.

Papers L.1 and L.3 point out that there is more precise separation of the fractions when coals over 8 millimeters are washed by heavy media apparatus. Document L.4 describes one of the latest designs which can be adapted for producing either two or three fractions.

For grains between 0.5 and 10 millimeters, documents L.1 and L.3 recommend jigs with filter beds as the best solution. If separation at high density should be required, then a feldspar bed is recommended (specific gravity 2.7), while for separation at lower densities ceramic cubes (specific gravity 2.2) are sufficient. For grains under 0.5 millimeters either froth flotation or cyclones can be used. The latter up to specific gravities of 1.75.

Two different tendencies appear to exist in Europe dealing with the treatment of fines. The first, which prevails in the United Kingdom and the Netherlands, seeks to find ways of floating ever-larger grains. The second, predominating in France and Germany, tends to improve mechanical washing in order to achieve efficient separation with ever-finer grains.

Documents L.9 and L.10 refer to a new coal preparation process, called "phase separation". It consists of grinding the coal finely in water and some 3 to 4 per cent of oil. The oil adheres to the clean coal surfaces, thereby resulting in the formation of pulp. The water tends to desintegrate the ashes (usually clays) and to detach them from the coal. Centrifugal force separates water with the ash in suspension from the oil-coal pulp. If it is intended to coke the clean

/coal, the

coal, the oil can be so selected as to improve the coking properties.

Document L.2 describes Latin American coal formations as well as washing capacity and processes best suited to some of the metallurgical coals. It analyses particularly the sulphur problem of the Brazilian Barro Branco coal, which is probably unique in the world. The hand-picked coal has a very high sulphur content (10 per cent) and about 32 per cent ash. Washing of the coal to 15 per cent ash fortunately reduces the sulphur, mainly made up of pyrites, to about 1.5 per cent. As regards the sulphur, attention should be directed to a new desulphurization process of liquid pig iron, described in another section of this paper. If the economics of this new process are satisfactory, many of the limitations imposed by the sulphur content on the adaptability of fuels to the blast furnace, may be set aside. This would apply, possibly to the Parana coals in Brazil and also to some petroleum derivatives which can be used to improve the coking properties of coals.

4. Suitability of Coals for Producing Good Metallurgical Coke

Document L.11 states that despite all the research on the subject, the process by which coal is transformed into coke is yet unknown. There is still no definite answer to this question in spite of all the work done by the large number of research workers. Numerous indices and measurements of arbitrarily selected factors have been compiled, but they have proven insufficient to provide a comprehensive explanation. Meanwhile it is impossible to state why a coal or a blend swells, nor why a coke cracks. Much less can there be any a priori conclusion as to whether or not a coal or a blend will produce a satisfactory coke.

Knowledge regarding the properties of a certain coal can only be attained in an empirical way. The only way to know the type of coke which can be produced by a given coal or blend, is actually to make the coke. Furthermore, before reaching a decision concerning the utility of a certain fuel for a steel industry, or even as regards the coking

/plant, it

plant, it is necessary to obtain a considerable amount of data and indices concerning some properties of the resulting coke. These are hardness, physical resistence to pressure and friction, and in many cases, the facility with which the coke reacts with the iron ore.

A large number of indices and measurements concerned with fuels have been laid down with the object of obtaining an advanced idea of their behaviour in the blast furnace. They have been drawn up through experience and may pre-determine the results which may be expected from treating other coals.

Paper L.11 describes the experiments made in France in this connexion. L.16 analyses similar work in the United States using a small 200 kilogramme test oven, and refers to the correlation of the data obtained from such experimental ovens to large-scale operation.

Paper L.11 also draws attention to the exceptionally high-grade ores in some of the Latin American countries - especially when compared with those usually found in France - which justify lower standards for coke quality.

Documents L.7, L.19 and L.91 outline the search for coking coals both in Colombia and Chile, the process described in paper L.16 having been used for this purpose. Discussions of these papers referred to the conditions which a good sample must fulfil. The doubt arose whether the samples of Naricual coal (Venezuela), fulfil these conditions. The conclusions concerning the coking properties of Naricual coals are therefore also doubtful.

The difficulty arising from a selection of different indices and measurements in various countries, also became evident in the course of discussions. For instance, it was pointed out that French research workers encountered difficulty in interpreting the results of measurements using the Gieseler plastometer.

/Document L.27

Document L.27 relates petrographic analysis made with Chilean coals describing the unfavourable influence on coking properties of some of the components, such as fusinite, and carbonaceous schist. The latter is contained in certain fractions of the ashes. Hundreds of tests, conducted at Huachipato, have proved that the elimination of these petrographic elements through grinding and selective screenings and of the portion of the ashes containing most of the carbonaceous schist, considerably improves the coking properties of Chilean coal. The above information can probably be considered as a beginning towards clarification of the mechanics of the coking process.

A method based on similar considerations is described in paper L.11. The Sovaco-Burstlein process consists of grinding the coal followed by screening, to eliminate certain petrographic fractions. The remainder is crushed to adequate sizes.

Document L.12 states that if difficulties exist for obtaining the proper blending materials to improve the quality of coke made from certain coals, the following alterations may be tried in the coking process: a) washing the coal, b) changing the size of the grain, c) altering carbonization temperature or d) changing loading methods and the bulk density of the charge. Paper L.16 adds to this list the acceleration of heating of the charge in the oven as particularly beneficial for poorly coking coals with high volatile and oxygen content. For such coals, paper L.11 described the process used at Thionville, in France, where 67 per cent of low coking high-volatile coal (Lorraine) is used. Results here improve when crushing to 7 to 15 mm. is effected at the precise moment the coal is used, so as to reduce oxidization.

/5. Coking of Coal

5. Coking of Coal and Blends of Coal

There are very few metallurgical coke plants which produce coke from one single type of coal without resorting to blends. Document L.12 points out that only 10.5 per cent of the 86 important coking plants operating in the United States in 1949 were using only one type of coal. 5.8 per cent of the total were using high volatile, the remainder employed medium-volatile coal. Document L.15 defines the purpose of such blends. The properties sought are usually strength and size of the coke, although in a few cases the blends are made to reduce the content of certain suitable components (see also document L.12). The most notable phases which take place during the coking process are swelling and fluidity. The first, when excessive, may endanger the oven walls, while the second largely determines the strength and size of the coke.

Low and medium volatile coals are usually considered to be good for coking, with higher volatile coals at the other end of the scale. Nevertheless, high volatile coals are often blended into the former in order to improve fluidity. In some cases suitable compression within the oven may offset certain deficiencies of fluidity.

It is not surprising, therefore, that in Latin America, only Mexico and Colombia are able to use a single type of coal. The necessity for blending in the other countries creates a serious problem since the coals for this purpose have to be imported. As stated elsewhere, the great variety of coals which exist in Colombia, may justify the expectation that the steel industries of most of the region can be supplied from this source with fuel suited for specific blending purposes, thus obviating imports from outside Latin America.

Blends are thus being used in the regions as follows: in Brazil, where the Barro Branco coal is too expansive, high volatile coals are added; in Chile, the local high volatile coal is blended with low volatile and good coking imported fuel; in Peru, the addition of asphalt or petroleum derivatives to anthracites is planned. The extent to which Argentina's Rio Turbio coals will be used has not yet been made public. Composition of the coal suggests the following possibilities of blends; a) low volatile good coking coals with char made of Rio Turbio coal, b) with asphaltite with petroleum derivatives, or c) combinations of some of these coal additions.

/6. Improvements in

6. Improvements in Coking Through Addition of Char, of Anthracite or Coke Breeze

According to document L.16, the addition of around 5 per cent of fine anthracite coke (below 0.4 mm) hinders the shrinking of coke during the contraction stage in the oven. Coke of larger dimensions can thus be obtained if the coal has good coking properties. The same addition can produce a satisfactory coke from poorly coking coals, given sufficient fluidity. According to this paper, coke granules in larger sizes, such as 5 mm., are always harmful.

In France, on the authority of document L.11, very good coke is being made by the "Carling" method, using a large proportion of poorly coking Lorraine coal. Thus a well known coking coal and fine coke breeze are being added. Alternatively, document L.12 states that the addition of coke or anthracite breeze to high volatile coals has not given good results in the western United States. Sawdust has also been used to reduce contraction, with similar results to those obtained when using anthracite or coke dust.

According to papers L.12 and L.15, some high volatile coals found in the western United States have great fluidity, in this case the addition of 15 to 20 per cent of low temperature coal (char) produces a much stronger and larger coke. L.12 compares the beneficial action of char and low volatile coals, providing charts in which the effect of these additions on the properties of the resulting coke are shown. It is thus possible to determine which are the respective amounts necessary to obtain certain results.

It is assumed that the action of char, completely devoid of fluidity, consists in providing surfaces for the plastic adherence of the coal. This enables a strong weld to be effected in contrast to what occurs when using coke or anthracite breeze. In the later stages of the process, the char hampers contraction, thus contributing towards the formation of a larger coke.

In papers L.11 and L.14, it is explained that the chars are also used as blending elements together with other components, both with Lorraine coals and with the black lignites of Yugoslavia. The manufacture of coke from the latter involves a complicated procedure, to be discussed later. Up to 65 per cent of Lorraine (high volatile, poorly coking) coals are blended with

/ 25 per cent

25 per cent of high volatile good coking coal of great fluidity and 15 per cent of fine char (of which between 45 and 75 per cent is below 0.5 mm.) The resulting product, though inferior to other blends used in France, has given fairly good results in the blast furnaces.

Paper L.13 enters into a brief history and description of the progress achieved during half a century of research on char production for blending purposes. The statement that char does not need to be made of the same coal used as a basis for the manufacture of coke, aroused much interest. Conversely, it seems that high volatile non-coking coal is more advantageous due to its lack of adherence during the plastic period of its carbonization.

This statement is of interest to Chile, which might probably reduce, or even eliminate, imports of low volatile coals by adding up to 15 per cent of char, preferably made with non-coking high volatile coals, to its non-coking coals. Such fuels constitute one of the veins in its deposits and have to be mined simultaneously.[1] Similarly, if the research on the Rio Turbio coals should fail to find a way of using them for the manufacture of metallurgical coke, Argentina would always be able to add to improved blends of imported coals, up to 15 per cent of Rio Turbio char, after suitably washing the coal. This possibility might be extended to other high volatile poorly coking coals, such as Colombia's Cerrejón coal. It is almost certain, judging from French experience with inferior coals, that a blend of about 60 per cent of such poorly coking coal, with 15 per cent of char from the same source, plus 25 per cent of some coal with greater fluidity from another source, could be used. Venezuela provides one instance.

Finally, paper L.12 also mentions the good results obtained in the western United States by adding up to 20 per cent of petroleum coke breeze taining 8 per cent residual volatile matter. The resultant coke is ightly less porous than if made from straight coal, but it gains onsiderably in size and strength, while improvements are discernible even with very small additions of petroleum coke.

7. Use of Pitch, Asphalts and Petroleum Derivatives in Coke Manufacture

Document L.12 presents some of the results obtained in the western United States through addition of coal tars and pitches to the coke blend. Size, strength and stability of the coke increase until the addition of

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[1] They are used as steam coals at present

/these binders

these binders reaches a certain limit, ranging between 10 and 15 per cent. Paper L.15 states - and this was confirmed during the discussions - that the coke plant itself seldom produces more than 2 to 3 per cent of suitable coal pitches and tars, so that this method of improving the coke usually has very limited applications in Latin America. According to paper L.15, the effect of these coal tar or petroleum products consists of increasing fluidity during the plastic phase. A lack of fluidity is the main obstacle to producing good quality coke with high oxygen content coals. This theory agrees with document L.12 that the beneficial effect of these semi-solid additions culminates at around 15 per cent and declines rapidly thereafter.

Paper L.17 describes a number of tests connected with blends of 70 per cent Chilean high volatile coking coals and 30 per cent Argentine asphaltite. By increasing the fluidity of the Chilean coal in this way, the coking properties of the blend are clearly improved. A second series of experiments with asphaltite blends was conducted with strongly coking North American coals. In every case a larger sized coke was obtained; this took the form of blocks having a fairly hard structure and appeared to be well fused during coking. In one of these tests, low volatile coal was used which had a high carbonization pressure. The addition of asphaltite reduced the carbonization pressure to a point where there was little danger of damage to the coke ovens. Here again the product improved in quality compared with coke made with unblended coal.

Papers L.14 and L.24 refer to coal briquettes made with binders derived from coal or petroleum. These briquettes can then be carbonized directly to produce coke, or transformed into semi-coke (char) which is fully carbonized in a second stage. The two coals referred to in these two documents, each fall into one extreme classification, both from the point of view of volatile content matter and of geological age. The first paper deals with brown and black Yugoslav lignites, blended with tar or petroleum pitch, while the second refers to a blend of Peruvian meta-anthracites with the same binders. The processes usually entail the washing of the coal by means of the phase separation system, the briquetting of the blend and its subsequent carbonization. Special ovens

/with retorts

with retorts, in which hot gas circulates to step up heating of the charge, are described. The oil, used in the phase separation to help in binding the briquettes, may be transformed in the oven into aromatic hydrocarbides of enhanced value. The briquettes form a hard coke, of uniform size, fine grain and a satisfactory porosity, if judged by the relationship between the size of the pore and thickness of the dividing walls. As mentioned in paper L.24, this process has been used successfully in Yugoslavia to produce lignite briquettes for metallurgical coke. The same process is being developed in Peru in connection with meta-anthracites. The coke briquettes obtained in the laboratory are of satisfactory appearance, although their suitability for the blast furnace is not yet known. For this reason a plant on a semi-commercial scale is under construction at Chimbote, with a view to producing enough briquettes conduct full scale blast furnace tests.

Paper L.18 describes the manufacture of metallurgical coke from petroleum derivatives, as practised in Argentina for zinc smelting. Between 23 and 25 per cent of the petroleum is converted into good metallurgical coke, while the remainder is recuperated either as liquid or gaseous by-products.

During the discussion on this paper, the following statements were made: a) that blends of coal with certain petroleum derivatives produce good cokes in almost any proportion; b) that there is no danger of liquid fractions leaking off vertical coking ovens, so long as the proportion of petroleum derivatives is kept below 30 per cent. Where higher percentages of petroleum derivatives are employed, it would be advantageous to use horizontal ovens, such as those described in paper L.18. There are thus installations available which can be adapted to any proportion of the basic raw materials for coke manufacture; c) that these conclusions open up a broad field for regional cooperation between the petroleum and iron and steel industries. Some delegates suggested that a close future cooperation be established between the petroleum and steel industries for coke research.

Within a relatively short period, industrial centres should grow up around Latin American iron and steel plants. They will require fuel,

/therefore by-products

therefore by-products of a plant based on petroleum derivatives would soon find useful applications, and the possibilities of partially or entirely basing output on petroleum derivatives should not be rejected without careful study. Many local factors will have to be considered in each case, among which transport plays an important role.

Since petroleum production and refining, in Latin America, does not occur near coal producing centres, the possibility arises for reducing assembly costs and, in addition, improving the quality of coke by basing the supply of the coke plant on both fuels. For instance, in Argentina the possibility of utilizing Rio Turbio coals for coke would be worth examining. The following possibilities should be studied in the same connection: a) blends with char; b) blends with asphaltites (deposits of which are found at the foot of the Cordillera de los Andes), and c) blends with petroleum residues from Comodoro Rivadavia. As the iron ore deposits of Sierra Grande are relatively close to Rio Turbio, it should be quite feasible to establish an iron and steel industry with low assembly costs in southern Argentina - providing the experiments for producing a good coke with products in that region were successful. Something similar might be attempted in Venezuela, which has high volatile non-coking coal beds at Naricual. The addition of petroleum residues, heavy crude oil and asphalts from the many deposits of this product might almost certainly lead to the production of satisfactory metallurgical coke with low assembly costs.

8. Use of Natural Gas in Blast Furnaces

Venezuela, with its great wealth of iron ore and a relatively large market for steel products (already exceeding 500 thousand tons a year, including tubing for the petroleum industry) has a serious problem to supply fuel for a steel plant. In addition to the previous solutions, it might be worth while to consider a blast furnace, similar to the classical type, using coke as fuel and as reducing agent, but supplemented by the injection of petroleum or natural gas under pressure. The gas might be regulated to perform the bulk heating and the indirect reduction. Perhaps a blast furnace of this type could operate at the low coke rate customary in electric reduction furnaces. This possibility is worth investigating, as no coking coal deposits have so far been found

/in Venezuela, whereas

in Venezuela, whereas large quantities of natural gas from the petroleum wells are being wasted only a hundred kilometres from the iron ore deposits.

9. Influence of Quality of Coke on the Operating Costs of the Blast Furnace

Papers L.26 and L.27, study the effect of the ash content of coke on the operation costs of the blast furnace.

Paper L.26 starts from the hypothesis that the composition of all the coal and ash is uniform, and analyses the effect on cost per ton of pig iron as a result of the following factors, which have opposite effects: on the one hand, the additional cost of reducing the ash content of the coke through better washing of the coal and, on the other, the reduction in operating costs of the blast furnace due to the use of cleaner coke. Paper L.27 refers to the special case of Chilean coking coals and its conclusions might apply to other Latin American coals, although the author has not so far reached this stage. L.27 establishes first that the combustible matter and the ash are not of uniform composition and that certain fractions of these coals and ashes contain components adversely affecting the quality of the coke. A comparison of the cost involved in extracting these elements, is presented, with the economy in blast furnace operating costs which might ensue from using the resultant better quality coke.

Paper L.26, described the more usual process and the calculation presented therein, if applied to a hypothetical example, should be effected for each plant and for each blend of coal, before deciding upon a policy regarding the ash content to be tolerated in the coal. Reasoning is advanced, and formulae proposed, for establishing the degree to which a lower ash content in the coke results in its cost increase. Factors are listed which influence the operating cost of the blast furnace and vary with the purity of the coke. The degree to which these costs decrease in relation to the progressively lower ash contents in the coke is established, and three fundamental reasons for this reduction are underlined: a) coke consumption per ton of pig iron is reduced in view of the greater content of combustible matter; b) limestone consumption is reduced; c) daily output of the blast furnace increases without a disproportionate rise in operating costs. This is because a blast furnace can receive a uniform amount of coke daily, no matter what its ash content.

/The algebraic

The algebraic addition of the two groups of resulting figures, shows the over-all economic effect of coal washing, compared with operating costs of the blast furnace for different degrees of coke purity. If this addition is expressed graphically, it resembles a parabola, with the apex at the point marking the most favourable ash content in the coke. Once this is known, it is easy to determine the percentage of ash which can be tolerated in the coal.

Paper L.27 begins, as stated earlier, by determining the pernicious effects of certain petrographic components and ash fractions. It first establishes that by screening the grains below 1.5 millimetres, a large part of the harmful petrographic elements can be eliminated. Reference is then made to some of the fractions of intermediate density which should be eliminated because they contain an excessive amount of a certain type of ash, adverse petrographic elements, and sulphur. Apparently the effect of the two former elements consists in impeding perfect impregnation and welding of the surface of the coal particles with the binding bitumens. Using statistics for tests made at Huachipato, a correlation is established between the ash content of the coke, its strength and size. This relationship, in turn, is changed into a coefficient which expresses the ratio between the ash content in the coke and the proportion of low volatile imported coal essential to produce coke of a certain quality.

Paper L.27 then analyses the cost increase of the remaining coking coal, after separation of the harmful fractions. Such an increase, even in the extreme case where the fractions eliminated from the coke have no commercial value at all, is compared with the substantial economies which would result in blast furnace operation. This paper ends by establishing that the reduction in ash and sulphur, within the proposed degree, would not create any difficulty of insufficient slag in the blast furnace.

CHAPTER IV. CONCLUSIONS RELATING TO PROGRESS IN IRON AND STEEL METALLURGY APPLICABLE TO LATIN AMERICAN COUNTRIES

I. FOREWORD

Notwithstanding the short period available to the organizers and participants for the preparation of this meeting, a considerable number of ideas were exchanged.

North American and European participants provided the necessary experimental data regarding either installations in current operation, or the different experiments with new processes which are now being carried out. The Latin American countries drew the attention of the world to their first efforts in the field of metallurgical production, with the aim of developing iron and steel products as a basis for industrial development, an indispensable factor in social and human progress.

The discussions focussed interest on technical problems, which stem from the nature of raw materials, as well as from prevailing economic conditions, both by reason of the frequent transport difficulties and of the varied needs of transforming industries from the standpoint of quantity and quality. Emphasis was likewise laid on the fact that since the Latin American countries cannot now equip their iron and steel industries with domestic capital goods, for the time being they must resort to imports, paid for in foreign exchange, to provide the main part of their new equipment. If advantage is to be taken of the very latest details of technical progress, such expenditure may involve very high sums for a great deal of mass production equipment. For instance, at present, it is difficult to imagine any one of the Latin American countries purchasing equipment for blast furnaces with a daily production capacity of 1,500 tons, in addition to all the latest improvements, such as, for example, high-pressure equipment; nor similarly, is it conceivable that the industry of the region could acquire large continuous strip mills, requiring considerable supplies of metal and a substantial volume of demand, with an annual production around one million tons of finished products.

These considerations make it necessary for the Latin American countries to stagger their purchases insofar as possible, adapting them to a general plan that can be developed in successive stages. However, since they are not at present in a position to take advantage of the appreciable drop in costs - which has occurred in other countries through the introduction of

/the mass

the mass production methods referred to above - the Latin American countries tend to view with preference all modern methods which might prove suitable for adaption to their raw materials and which would allow them to obtain low costs by introducing technical innovations. However, broadly speaking, the opportunities for experiments in Latin America are limited, so that the countries of the region must resort to the older iron and steel producers for assistance, and study, together with steel experts from the United States and Europe, the results which can be obtained in factories or pilot plants outside Latin America.

It is undoubtedly true that the new problems thus raised, will awaken the attention of the older countries, leading research into new fields, with results which should prove beneficial to the entire world.

II. GENERAL SUMMARY OF FINDINGS

1. Reduction of Iron Ores

The first problem for any potential iron and steel producer, particularly in view of the general shortage of scrap iron for resmelting, is to obtain iron from the different ores available. This is the fundamental task of an iron and steel industry even when the product thus obtained is associated with other useless or harmful materials (Carbon, Sulphur, Phosphorus) requiring subsequent refining. Professor Robert Durrer, in an outstanding paper (document L.45), to which frequent reference will be made, mentions the Catalan Hearth. It is interesting to observe that the present method for mass production of iron from ores - the blast furnace, with all its latest improvements - is no more than the logical outcome of a routine, experimentally acquired as a result of the fortuitous discovery of iron production by methods such as the Catalan Hearth. The Chinese had certainly gone further in analysing the problem, as Professor Durrer points out; many centuries ago they had already reduced iron oxide by using coal and had adopted a system of reduction in externally heated containers, thus splitting up the operation more efficiently than it is done by the blast furnace. The Hoganas process and the Tunnel-kiln (Ontario - Cavanagh) are simple variations of this process. Because the systematic analysis, thus begun, was not continued, and because the results obtained by the blast furnace proved economically profitable, this latter method, involving a complex series of different operations, has prevailed until now. However, although it is often felt that it would have been preferable to spend money directly on blast furnace research rather than on dispersed experiments of many kinds, in our opinion the study of methods such as Electric Reduction, Krupp-Renn, Wiberg-Söderfors, Avesta-Domnarvet and Basset, and so on, (which actually involves a breakdown of the blast furnace processes into some of its components) has served perhaps unwittingly, but most usefully, to increase knowledge in this field.

Despite the progress of research, the experts are far from unravelling the complexity of these operations and from determining the reciprocal influences of the different factors at play between the outlet and the tap-hole of the blast furnace, equipment which simultaneously performs the following operations:

-Drying and possibly decarbonization of the load;
-Partial indirect reduction of the oxides by gases;
-Direct reduction by contact with coal;
-Fusion of the iron and the gangue;
-Desulphurization; and lastly,
-Production of molten iron at an adequate temperature.

Analytic controls of the materials and of the gases at different heights, controls of temperature by thermo-couples likewise at different heights, and the study of pressures, also at different stages, have all been completed and yet no sensational results were obtained. New and recent methods of research, such as those involving the utilization of isotopes, may perhaps increase our knowledge to a small extent, particularly in the case of sulphur; but it still remains true that we are as yet unable to split up the operations of the blast furnace into their primary elements. It is therefore felt that any new method, involving some of the reactions occurring in the blast furnace, should be carefully observed since it may provide a new element for the study of the blast furnace itself. This is why it is intended to consider all these methods, taking into account that one of the essential principles, emphasized during the meetings, was that good quality mineral coal (or even charcoal) is a valuable material of considerable use in reducing iron ore; therefore, it should not be used merely for the production of heat by combustion (as is partly the case in the blast furnaces). This principle is valid in most Latin American countries and also in many other parts of the world, particularly Europe.

2. Transformation of Pig Iron into Steel

At the present time, since liquid pig iron is the principal source of iron - scrap is in short supply and intermediary products, such as sponge iron, have not yet been developed on a practical basis - it may be assumed that the different techniques for the production of steel are all vainly based on the utilization of liquid pig iron.

The main refining problems arise from the sulphur and phosphorus content. If it is felt that it is too costly to remove the sulphur in the blast furnace by appropriate preparation of the slag, there are other satisfactory desulphurization processes such as those utilizing soda or lime (Kalling). Moreover, every basic steel furnace can be used for desulphurization.

As far as phosphorus is concerned, it is practically impossible to avoid in the pig iron furnaces the incorporation of almost all the phosphorus contained in the burden. At present, moreover, no really practical method of dephosphorizing is known other than the use of basic slag, generally in steel furnaces. It would appear that the minerals called pure hematite, a low phosphorus ore, are becoming increasingly rare; hence, the methods for steel refining with basic slags have been highly developed in the course of the past few years, leaving acid processes well behind. These latter, however, would still appear applicable in certain Latin American countries, where there are ores with a low phosphorus content.

Broadly speaking, the refining processes can be divided into three main categories:

- Refining in a basic or acid open-hearth furnace;
- Refining in a basic or acid converter;
- Refining in a basic or acid electric furnace.

However, there is one factor to which attention should be drawn, which is the marked interest shown during the meeting for converter research studies, and particularly for basic (Thomas) converters. This would appear to stem fundamentally, in view of recent experiments from the use of oxygen-enriched air, which would seem to permit the elimination of difficulties generally acknowledged in the Bessemer and Thomas processes, namely:

- Excessively high nitrogen content of the steel;
- The impossibility of ~~re~~-smelting large quantities of scrap; and
- In the basic process, the need for a minimum phosphorus content in the ore.

This renewed interest in converter methods, and particularly for the basic ores, has even been observed in the United States. The cost of the dephosphorization operation (document L.77) in the large basic open-hearths, is by no means negligible, particularly when the phosphorus content is somewhat high.

Thus, after a brilliant start with converter processes (Bessemer and Thomas) in the nineteenth century, and later an eclipse of these in favour of the open-hearth furnaces for mass production, there is now a tendency to return to the earlier processes, this new attitude being prevalent throughout the whole world. In fact, it often occurs in industry that technical innovations or economic improvements (in this case, cheap oxygen), enable a return to processes which were formerly popular but which were temporarily replaced by others while awaiting certain technical progress. In handling liquid pig iron, the converter process is obviously extremely simple. Similarly, and for the same reasons, there may later be a return to the hearth smelting furnaces (Martin or electric), if new processes for the extraction of iron from ore, producing solid scrap (sponge iron, for instance), come into industrial use.

There would also appear to be another tendency, namely, a certain opposition to the extension of the Duplex process, although the Bessemer acid converter is still the largest producer of scrap for open-hearth furnaces. This trend probably arose as a result of actual achievements or from hopes based on the use of new processes, especially of oxygen. This would include, for instance, prior desilication of the pig iron before it is placed in the furnace, and decarbonization in the furnace. In addition, the more usual Duplex - the Bessemer converter and open-hearth furnace - is costly, both from the standpoint of installation and operation, requiring the construction of two steel mills and involving iron losses in both procedures. Methods based on a single steel mill thus seem to be far more attractive.

3. The Shaping of Steel

3. The Shaping of Steel

The essential purpose of the meeting was the production of pig iron and crude steel, so that less attention was given to the transformation of the metal into marketable products. However, the more interesting data assembled on finishing will be found summarized below.

Rolling techniques for steel transformation are well known and their choice depends on the purpose in view. Unfortunately, for medium or small sized plants, such as are required for supplying the Latin American markets, the rolling mills - which embody the latest improvements and lead to the lowest costs - are generally too large.

It is nevertheless necessary to economize in labour as far as possible, since wage levels in under-industrialized countries tend towards higher or more normal levels once a plant is installed, and moreover skilled rolling-mill labour is always difficult to find.

Logically, optimum yield should involve the use of favourable local conditions for certain products and the specialization of individual factories in the manufacture of one particular product at a low cost price. Such logical principles, however, can only be applied when transport facilities are sufficiently improved to allow an easy exchange of goods between countries or within the limits of the same country. In this connexion, it seems that transport by water should be more widely employed than at present.

For the time being each Latin American factory is seeking, whenever possible, to combine the production of a series of goods which are necessary for the development of basic industries.

The rolling mills are essentially dependent on the quantity of metal available to them, and on the range of products which it is proposed to manufacture, as well as their respective annual output.

Attention should be drawn to the difference between heavy products manufactured directly from hot ingots, thus saving a substantial amount in calories,and lighter products, rolled on small mills requiring intermediary re-heating for the semi-finished products. A new factory should, in the first place, equip itself ideally for the manufacture of larger sized products, and also for semi-finished products which can be used, for instance, by re-rolling mills. Later, when further developments take place in the mill, a larger degree of finishing can be envisaged, including vertical concentrations and even the production of finished goods, thus avoiding unnecessary transport charges.

Reference will be made, incidentally, to the advantages offered to the rolling mills of medium size factories by the converter process, which allows for quasi-continuous operations and therefore provides the rolling mills with a regular supply of hot ingots, as compared with too large a bulk of material from open-hearth operations.

Interesting data on all these subjects were submitted to the meeting in documents L.53, L.57, L.61, L.74, and also in the reports regarding the plants being erected at Paz de Río and at Chimbote.

Document L.66 provides up-to-date information relating to continuous steel casting by the Rossi-Junghaus method. It would appear that this very interesting experiment cannot as yet be considered for industrial operation. Hourly output of steel by this method is limited, and precise data on costs are still lacking. However, this possibility should be studied carefully, particularly in connexion with plants equipped with electric steel furnaces of the bascule type which allow the pouring out of small quantities of steel.

Document L.67, commented by its author, Mr. Cavanagh, outlines a unique process (already described in an earlier publication) involving the use of a tunnel-kiln for the direct manufacture - starting from iron powder - of variable density ferrous products. This would appear to offer an interesting means for producing special steels, but not as yet for mass production. The process should be envisaged in a plant where the nature of the raw material allows economic use of the tunnel-kiln reducing system.

Lastly, document L.68 describes the new Ugine-Sejournet "extrusion" process. As the process mentioned above - although it is intended for a different field - this method can be adapted for the manufacture of high quality steel products by extrusion rather than by rolling. It has the advantage of lending itself economically , with small capital investments, to the shaping of small quantities of metal, and is therefore of interest to small mills.

/The question of

The question of ore reduction (Chapter I) broadly outlined above, will now be considered in detail.

III. DETAILED EXAMINATION OF IRON ORE REDUCTION METHODS

1. The Standard Blast Furnace and the Low-Shaft Furnace

The classical blast furnace and its derivatives, the charcoal blast furnace and the oxigen enriched low-shaft furnace, together with the electric furnace, appear to be the only methods which can be used in integrated plants requiring a total annual production of some 100,000 tons or more of metal. These methods will be examined below.

The other reduction methods considered by the meeting, may, in some cases, be of genuine interest either in view of the utilization of raw materials with unusual characteristics, or in view of the production of metals with certain specific features, or, lastly, in order to ensure supplementary production of metal for a given mill. These other methods will likewise be considered below.

The classical blast furnace appears to provide the best solution for the reduction of ores, provided good coking coals are available.

In some cases, where iron ore is being exported, it would appear more profitable to obtain coking coals abroad and use the classical blast furnace technique rather than resort to untested ad hoc solutions.

However, an extremely high production capacity needed for the quota in optimum conditions - 1,500 tons of pig iron per day - is hardly attainable in Latin America. It is therefore necessary to produce about 800 to 1,000 tons per day, the lowest limit which may be adopted at present for new coke blast furnaces. This calls for a plant with an annual ingot production of 300,000 to 400,000 tons in the first stage, followed later by an expansion programme likely to raise it to 600,000 to 800,000 tons.

For the combined reasons of inadequate coke supplies and excessively high production in such a unit, the installation of blast furnaces of this type, even if possible, can be envisaged only in a limited number of locations.

Consequently, while maintaining the blast furnace principle, it is necessary to study, separately or simultaneously, the following points:

/ i) Modifications in the

i) Modifications in the blast furnace, to allow the use of a fuel manufactured from non-coking or poorly-coking coal; or

ii) The preparation of the raw materials for the blast furnace burden, in order to adapt them to low value fuels; or

iii) Research directed to discovering techniques which will facilitate the manufacture of fuels replacing coke in the blast furnace, obtained from raw materials which, thus far, have not really been considered as coking materials.

These questions will be considered in the light of the document submitted (L.52).

a) As it is essentially the large dimensions of the blast furnace which make it necessary to use metallurgical coke, it is natural that smaller-size furnaces be used when the quality of the fuel differs widely from that of coke. Thus, if charcoal is employed, any apparatus with a daily production capacity of over 150 tons is practically out of the question. If prevailing conditions make charcoal necessary (documents L.31, L.32, L.74), it would be advisable to attempt to group the manpower servicing the furnaces adequately, so that they may attend several units simultaneously and so take advantage of devices for labour saving.

Attention should likewise be drawn to the principle of a furnace with a low shaft which may be adapted to the use of fuels other than ordinary coke (documents L.36, L.40, L.45). However, since these are only normal furnaces divided in the middle, top gases of an extremely high temperature would be obtained, unless special measures were taken as a precaution, such as enriching the blast with oxygen, thus concentrating the high temperature zone in the lower part of the furnace and allowing the gas to escape at an adequate temperature. Certain experts fear that indirect reduction by CO is less developed in the low-shaft apparatus than in the conventional, atmospheric blast furnace. This would lower the rate of utilization of carbon for the reduction of the ores within the furnace. Even were that true, this excess energy would reappear finally in the form of a richer blast-furnace gas, and this inconvenience might be accepted, since it would represent the price paid for using low-grade fuel. A better use could be found for the escaping gases than mere heating; for instance, they could be transformed by synthesis in chemical plants, since their composition would be very different from that of the gas escaping from ordinary furnaces.

However, this technique of low-shaft furnaces is as yet in its earlier stages. There is only one fact which seems to have been definitely recognized: according to the experience at Oberhausen (Germany), low-shaft furnaces can operate satisfactorily with fine ore and coke of about one inch size.

It is generally assumed that in this type of furnace, char which cannot be used in the classical blast furnace, would be satisfactorily utilized. It is also believed that anthracite fines could be used, since, although admittedly with poor results, they have already been used in certain furnaces for the manufacture of pig iron. Some Latin American countries would thus be able to use these opportunities, especially countries having coal which may be transformed into char or anthracite coke. It will shortly be possible to test these fuels in an experimental low-shaft furnace at Liege, built by the "Comité International du Bas Fourneau" (document L.40), which is expected to begin operations early in 1953. It is even hoped to go further, certain members of the Comité being eager to experiment with coals which differ even more widely from coke. A German firm (Klockner-Humboldt) (document L.36) has also experimented in this field, and advocates the utilization of low-grade coals agglomerated with fine ores. At Liege, in addition, experiments were made with a hot-air cupola (document L.40), and very poor quality coal, with a 35 per cent ash content. The Liege low-shaft furnace programme is also scheduled to carry out systematic research in the use of very low-grade fuels and fine ores.

It would be unwise at the present time to base an industry on low-shaft furnaces of this type, particularly because they involve the building of an oxygen plant. However, this technique has brought forward such interesting possibilities that it would perhaps be advisable to wait a few months for the results of the first experiments at Liege before taking any decision one way or another.

The importance for Latin America of the research possibilities connected with the installation of pilot plants in the older industrialized countries should be stressed here. The international low-shaft furnace undertaking, resulting from the initiative of the Organization for European Economic Co-operation (OEEC), is open to all Latin American countries wishing to join it.

/ It would in

It would in any case be wise to point out that in the event of building new blast furnaces or low-shaft furnaces, the possibility of adapting high pressure should be taken into account. Several plants in the United States and in Europe show a tendency towards this technique. The reduction processes can only be made easier by it, and the decline in the volume and consequently in the speed of the gas, lowers the amount of dust, while at the same time there is a definite trend towards production increases.

b) Throughout the world, what is known as the "preparation of the blast furnace burden" that is the crushing, enriching and agglomeration of fines, has been carefully studied and appreciable progress made. However, broadly speaking, enriching is not indispensable in Latin America where rich ores are available.

One of the most striking examples of success in this field of preparation is that of the synterization process adopted in Brazil, the products obtained being loaded into charcoal blast furnaces (document L.33). By this means, optimum conditions for the use of the charcoal blast-furnace technique seem to have been attained, resulting in the maximum possible saving of this fuel. Fairly accurate knowledge has thus been obtained of the limits of the economic use of charcoal.

In order to simplify the operation of the blast furnace, and thus to save fuel, the use in the burden of the aforementioned technique should be considered. It consists in loading the low-shaft furnaces with some type of previously prepared ore, like sinter or agglomerates of fuel and fine ores. p Previous coking of the agglomerates in the form of briquettes is envisaged. This simultaneously increases their hardness, avoids the need for the furnace to act as a dehydrating and possibly decarbonazing agent, and may actually bring about a partial reduction of the ore. It is certain that the shorter the furnace, that is to say, the shorter the time available for the passage of the burden, the greater is the need to introduce materials which can easily and rapidly react. The intimate contact in these briquettes between the materials to be reduced and the reducing agent, can only favour the reaction. There is no need to enter into additional details regarding the advantages and facilities of the preparation of the blast furnace charges, particularly as regards the passage of gases.

/c) The different

c) The different experiments to manufacture coke substitutes were detailed in the first part of the meeting's report. For the present, it should be sufficient to indicate, as above, that in many cases the adoption of low temperature char, differing appreciably from ordinary coke may be made acceptable by the utilization of a low-shaft furnace. Crushing of the low-grade coke is thus avoided, owing to the fact that the burden is lower.

A few comments remain to be made before the end of this chapter. Frequently and justifiably, attention is drawn (document L.45) to the "useless ballast" in the blast furnace, consisting of the considerable amount of nitrogen blown in with the oxygen. It should however be noted that this is not as detrimental as it would appear on first sight, since it seems to have been noted that with oxygen-enriched air, indirect reduction is less active, and since the temperature of the escaping gases at the outlet of a normal furnace is low. The latter fact implies that the nitrogen ballast carries little heat to the outlet of the furnace. The poor quality of the gas escaping at the outlet, due to a high nitrogen content, is perhaps a hindrance; however, though these gases are too poor to be carried any distance, they can nevertheless be used for different purposes in the iron and steel mills themselves (document L.58). It should be remembered that the thermic yield of the blast furnace improves in step with the reductibility of the ores. The richness of the ore is not the only factor to be taken into account (document L.52). Thus, properly prepared sinters of the Brazilian "canga" and the Lorraine "minette", are particularly well adapted to use in blast furnaces. Moreover, the basic burden, particularly when using self-fluxing ores, requires less cooling of the blast furnace, and so improves its thermic yield.

If the choice remains open, it may be more advantageous to treat the hard silica ores, which are difficult to reduce, in electric furnaces, providing the cost of energy is adequately low.

It should also be recalled that the low shaft furnace is an interesting attempt to separate the different factors used in the blast furnace, since actually only the lower part of the blast furnace is retained. Moreover, since the apparatus is small, the experiments should be less expensive than in a blast furnace, and high pressure may be more easily applied in

/conjunction with

conjunction with the use of oxygen. Experiments consisting in injecting gases and gaseous hydro-carbonates at different heights into the blast furnaces might also be attempted; nor would it be unrealistic to consider the eventual application of ultra-sounds, with a view to speeding up the reactions. The behaviour of sulphur might likewise be studied and the documentation already acquired completed with experiments designed to relieve the blast furnace of its desulphurization functions.

Research in connexion with blast furnaces can also be performed by the use of the motion picture, as has already been done notably by the United States Steel Corporation.

Finally, the attention of steel specialists should be drawn to the economic advantages connected with a rational utilization of slag. Recent experiments have shown the possibility of extracting alumina from slags which have a high content of this material.

2. The Electric Furnace

Operation of the electric pig iron furnace was mainly limited, until recently, to the Scandinavian countries, where there is a shortage of coking coal but also vast hydro-electric resources. These furnaces are now operating successfully and it may be expected that, like their forerunners - the blast furnaces -, they may shortly profit from certain improvements in details, thus enabling them to maintain the full value of existing installations. Documents L.37, L.38, L.45, L.48, L.49, provide valuable data on electric furnaces.[1] Such furnaces fulfil only a part of the normal functions of the blast furnace, but in a different manner, that is they effect direct reduction of the iron oxides by contact with reducing coal, there being practically no indirect reduction. Heat is indirectly provided by electricity and not directly by coke, as in the case of blast furnaces. The hearth is low and the escaping gas does not contain a nitrogen balast, but a high carbon-monoxide content, and a high temperature. It is therefore true to say that a blast-furnace charge in an electric furnace gives off seven times less gas than in a blast furnace. But in the blast furnace, about 25 per cent of the low-grade gas is employed directly in the apparatus itself, being used in the cowpers. Lastly, the heating power of the gas in the electric furnace is 2.1/2 to 3 times higher than that of the blast furnace and its temperature four times

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[1] Document L.82 covers a different subject which is not dealt with in this report, namely synthetic pig-iron produced from scrap.

/higher. On

higher.

On balance it will be noted that for one ton of pig iron, all things being equal, the blast furnace gives off 1.7 times more gas calories than does the electric furnace. This figure is far less impressive than the preceding volume's relationship might indicate. (For the utilization of blast-furnace gas, see document L.58).

Broadly speaking, for ores with a 50 per cent to 60 per cent Fe content, carbon consumption in electric furnaces is half what it would be in a blast furnace, averaging a total of about 2,700 KW per ton of pig iron. Here likewise, adequate preparation of the blast furnace burden, that is drying, decarbonization, etc., may cause a substantial reduction in the consumption of electric power. Just as in the case of blast furnaces, it may be possible to suppress the desulphurization operation in the electric furnace to reduce the amount of limestone in the burden, and consequently the quantity of slag, simultaneously reducing kilowatt consumption. To that purpose, desulphurization must then be performed on the liquid pig iron, outside the furnace. The most attractive feature of the electric furnace is that instead of high-grade carbon (coke or charcoal), low-grade coal and possibly even lignite can be used (document L.37). The electric furnace also has the advantage of being able to use fine ores, since the problem of the porosity of the charge does not arise as it does in the blast furnace. On the other hand, the unit capacity of these apparatus is nowhere near that of the blast furnaces; it has risen from 100 to 150 tons daily, at present 200 ton furnaces are being built, and it is hoped to be able to go as far as 300 to 400 tons.

In each instance studied, it would be wise to take into account all the data of the problem and particularly to compare the relative prices of electricity and coke. A preliminary estimate, which is generally accepted, indicates that if a kilogramme of coke costs five to six times the price of one KWH, the use of an electric furnace is feasible. It is all the more practicable if, as indicated above, the ores to be treated are unsuitable for a blast furnace.

It appears, however, according to the documents presented at the meeting, that different raw materials, either ore or fuels, may behave differently in the electric furnaces and therefore require special

/installations adapted

installations adapted to their characteristics. Before taking any decision, it would be wise to carry out experiments in existing installations, using the raw materials which are being contemplated in each case.

It should be remembered that slag leaves the electric furnace in a liquid form just as does the pig iron, so that in certain instances its valorization can be envisaged, as with blast furnaces.

The examination of the other reduction methods may begin by the Krupp-Renn process.

3. Other Reduction Processes

The Krupp-Renn (document L.39) process, as compared with the blast furnace, reduces the iron directly, without desulphurization, and without reduction of the manganese which is transferred into the slag. Partial fusion only is allowed to take place, that is to say it is interrupted at the stage when it reaches the lower part of the blast furnace. The mixed products, that is the slag and the pig iron, are cooled and thereafter collected in a solid state, requiring separation by crushing and magnetic sorting.

The ferrous product thus obtained is in lenticular form and is subsequently re-smelted. About 80 per cent of the phosphorus from the ore passes into these lenses.

This process makes use of a technique which is no longer in the experimental stage, although its application is still limited.

It also enables practically all the iron to be extracted from ores with a high silicon content and limited possibilities of enrichment, without the addition of limestone. These ores could not be treated in the blast furnace because of the excessive amount of coke which would be required. On the other hand, this process does not appear suitable for basic ores. Coal with a high ash content can be used in place of blast-furnace coke, but it should be observed that only fixed carbon is active in the reduction. High volatile coal is therefore unsatisfactory for this process. It is estimated that for each ton of "lenses" made from a 60 per cent ore, coke breeze consumption would be 500 to 600 kilogrammes or its equivalent in fixed carbon, and 75 to 100 kilogrammes of coal breeze would have to be used for heating.

The above data enable conclusions to be drawn regarding the applicability of the Krupp-Renn process, which is probably limited in Latin America.

/The Basset

The Basset process (document L.42), as compared with the blast furnace, shows rather unique features. It produces liquid pig iron without silicon and a solid basic slag, while the desulphurization operation is fully performed. It represents so to speak, the lower part of a blast furnace working with an extremely high lime-silicon ratio. Reduction is accomplished, as in the Krupp-Renn process, by mixing carbonated fuel with the iron ore.

The solid slag is in fact a Portland cement clinker and thereby renders the process economical since the fuel consumption is substantial. In addition to the reducing carbon, heat is provided by burning coal, oil or gas. The temperature of the escaping gas is very high, so that some recovery of heat could perhaps be made.

One condition seems essential, namely, that the raw materials have a sufficiently low alumina content to ensure that the clinker contains no more than about 6 per cent of alumina.

It might be worth while to study this process and improve on it, as it could well provide a satisfactory solution for treating certain fine, rich ores, found in Latin America.

Moreover, the two industries with which it is associated - iron and cement- are developing simultaneously in regions which are being industrialized.

The different methods for sponge iron production which were discussed at the meeting, are as follows:

The Wiberg-Söderfors process (document L.47) which, during the past few years, has profited from the progress in the manufacture of heat-resistant steels required for the ventilators used to circulate hot gases.

As compared with the blast furnace, it only fulfils the task of reducing the ore in a hearth by means of reducing gases. The nitrogen ballast is avoided by producing the gas in a carburettor fed with water and carbon, and heated by electricity.

The proportion of hydrogen and carbon-oxide must be very carefully regulated.

This process calls for either a 65 per cent ore broken up into pieces of 25 mm. to 80 mm., or a good 65 per cent to 67 per cent sinter. These ores should be resistant to crushing; for instance, the El Pao ore would not be suitable.

/ For a ton

For a ton of 81 per cent sponge iron, it is estimated that 225 kilogrammes of coke and 1,140 KWH would be consumed. The use of natural gases would allow a reduction in coke consumption.

The phosphorous in the ore passes into the sponge. Desulphurization does not take place, but by consuming 60 kilogrammes of dolomite per ton of sponge the sulphur content of the fuel could be neutralized.

The resulting sponges thus far have only been used as high-grade scrap. Production units are turning out 20 to 30 tons daily; the output cannot be increased because of problems connected with the sections of the gaseous flows. The estimated cost of a plant producing 20,000 tons annually is 800,000 dollars.

The above data indicate the limitations inherent in the use of this process, and before any decision is taken, the raw materials available should be experimented with, on existing equipment.

The Avesta-Domnarvet process (document L.46) does not use electric current as did the old Avesta process; it consumes 500 to 550 kilogrammes breeze per ton of 90-95 per cent sponge iron, starting from an ore of about 60 per cent Fe content. The process relies on direct reduction by contact and, therefore, fulfils only one of the functions of a blast furnace. No desulphurization takes place; this must consequently be carried out in an auxiliary furnace, consuming an average of 20 kilogrammes of coke breeze, 30 kilogrammes of lime and 100 Kilowatts per ton of sponge.

One of the advantages of the process is that it can make use of anthracite fines and low-volatile coal. The ore must be broken up in pieces of less than 25mm., but if it is too fine, a previous pelletization is preferable.

The process has not yet been introduced on an industrial scale. The equipment should be quite cheap but the size of the rotary kilns appears to be necessarily limited, so that a production of more than 15 to 20 tons daily per unit is not possible. This process is of undoubted interest to certain Latin American countries, but it might be wise, before any decision is taken, to await the results of a plant operating commercially. Such a plant would allow experiments to be made with the raw materials whose use interests those countries possessing rich ore fines and low-volatile coal

/ or anthracite

or anthracite waste.

The United States Bureau of Mines (document L.44) process, which also was a rotary kiln, seems to have been used more for purposes of studying the ores than for industrial operation. As in the preceding case, it only performs one of the tasks of the blast furnace, though, with the addition of dolomite, desulphurization may also be carried out. This process consumes about 500 kilogrammes of coke breeze per ton of metal produced from a 60 per cent ore, but in addition it requires gas for heating purposes. The technique appears to have been fully investigated and is ready for use; its application is nevertheless limited to ores of a certain composition, which can be enriched at least to a certain extent, the separation of the silica taking place after the sponge iron has been manufactured. Difficulties arise in connexion with certain types of ores. The cost of a two-furnace installation producing 100 tons of sponge iron daily is estimated at 700,000 dollars.

The Ontario-Cavanagh (tunnel-kiln) process is a variation of the Hoganas process. It would appear to be suitable for limited production, particularly if tunnel-kilns are already installed. This process is particularly indicated for the production of iron powder, and might be successfully used with certain rich and small size ores of Latin America. However, it seems to require a fairly high-grade carbon. Daily production of a complete installation is estimated at 30 tons.

Data on comparative costs of the various reduction processes, which would have to be reviewed for adaptation to conditions prevailing in the respective countries, are indicated in document L.62.

Other methods of extracting iron from ore are constantly being studied. As most of them are still in the laboratory or experimental stage, no useful purpose is served by mentioning them. It should, however, be pointed out that if satisfactory means of direct gaseous reduction could be found for fine, rich ores, avoiding the use of high grade coal, such a solution would be enthusiastically received by the Latin American countries where these ores occur.

The results obtained by the Wiberg-Söderfors method are undoubtedly of interest. The studies made in this connexion concerned principally with optimum proportions of hydrogen and carbon-monoxide to be used, might serve

/as a

as a basis for the possible use of hydrogenated reducing gases in low-shaft furnaces.

An important statement on desulphurization was made to the meeting by Professor Kalling.

4. Desulphurization

As was mentioned repeatedly above, there is a growing tendency to separate the functions of the blast furnace. Its desulphurization function, requiring basic liquid slag, all too frequently increases the weight of the burden excessively, through the addition of considerable quantities of limestone. The increase in the amount of slag similarly increases coke consumption. Therefore, in many steel mills, desulphurization is performed with sodium carbonate. But this process is rather expensive; on the other hand, large scale desulphurization by the simple addition of lime and pulverized carbon seems quite economic. This is what Professor Kalling has done by using a pig iron ladle constructed so that it can be placed on the bearings, sealed hermetically, and made to stand a fairly rapid giratory movement. The results obtained are undoubtedly excellent and the process can eventually be used for all sulphurous, liquid pig iron, either produced by a blast furnace, a low shaft furnace or an electric furnace.

Studies on desulphurization by limestone have also been carried out recently in Great Britain where interesting results appear to have been obtained.

It was believed useful to go into detail on this subject and that of the reduction of iron ores, as it evoked considerable interest among the participants.

Whatever the interest in all the special reducing processes enumerated above, it is nevertheless true that at the present stage of technical development none of them can be used for mass production purposes. For the establishment of new industries or expansion of existing plants the blast furnace is still the best solution. It is possible that the low shaft furnace may, in the near future, show results which will enable it to develop, particularly owing to the fact that it utilizes very low grade fuel. Although it also involves the simultaneous construction of an oxygen plant it does have the advantage of being able to use the oxygen continuously so that the cost of this gas is consequently lowered.

/The electric

The electric furnace, on the other hand, is a provisional if not a final solution in some cases, and is valuable where cheap electricity is available. Moreover, as already noted, it is expected that substantial improvements will shortly be made in this technique.

IV. DETAILED EXAMINATION OF STEELMAKING PROCESSES

The broad findings which appear to have been formulated as regards steelmaking will now be indicated. During the discussions it was pointed out that in view of the relative shortness of scrap, the interest in Latin America concentrates mainly in the refining of pig iron produced in blast furnaces or electric furnaces.

It is not proposed to repeat the details of well known manufacturing processes which in any case were carefully and fully outlined:

- Basic open-hearth furnace (document L.77);
- Acid open-hearth furnace (documents L.64 and L.72);
- Basic Bessemer converter (documents L.51 and L.63), and
- Acid Bessemer converter (document L.65).

Several documents dealt with the electric steel furnace, specially L.38, L.52, L.53, L.55 and L.56. The latter four, in fact, are concerned with possible combinations of steelmaking processes in relation to Latin American needs.

Documents L.73 and L.79 deal essentially with the substantial improvements made in Thomas steel techniques, while document L.71 describes an example of the manufacture of a high quality Thomas product (rails). Documents L.54, L.59 and L.60 examine individual cases which have occurred in three existing Latin American steel mills.

We will limit ourselves here to the following comments:

1. Basic Open-Hearth Furnace

The basic open-hearth furnace has been considerably developed; with a view to reducing the low cost of the process, the size of the furnace was substantially increased, so that the installation requires very powerful and expensive handling apparatus. Rich fuel, if possible gas or petroleum, must also be available.

The increase in the phosphorus content of the ore, and consequently of

/the pig

the pig iron, observed throughout the world, prolongs the refining process.

In using the Duplex process (Bessemer-acid and basic open-hearth) the steel acquires a high nitrogen content.

On the other hand, the "ore process" in which a substantial proportion of iron ore is placed in the charge, enables direct utilization of ore which delivers the necessary amount of oxygen, so that up to 10 per cent of the steel can be obtained from ore thus reduced directly. The use of very large furnaces cannot be envisaged in Latin America, but units from 80 to 150 tons and more would be suitable and the use of the ore process would be advantageous.

2. Basic Electric Furnace

The basic electric furnace, thanks to the judicious use of the ore and of the oxygen, has for some years been utilized in the same way as the open-hearth furnace for refining pig iron. It may provide an excellent solution in regions where electricity is cheap, or where rich fuel is in short supply and expensive.

3. Acid Open-Hearth and Electric Furnaces

The acid open-hearth furnaces and electric furnaces are limited in their utilization to the manufacture of special products. They require raw materials containing no sulphur and no phosphorus, and therefore cannot be used unless good quality scrap and hematite pig iron are available. The scrap can be provided in a liquid state by some other apparatus such as the basic converter. In this case, however, instead of envisaging a Duplex system consisting of a converter and of an acid open-hearth furnace, and since a high quality product is aimed at, it would probably be better to employ the Ugine-Perrin treatment, by an aluminous slag (document L.79), used directly on the products of a basic apparatus such as an open-hearth, electric furnace or converter.

4. Converter Processes

Lastly, the converter processes, basic Thomas or acid Bessemer, interested the Latin American participants generally, in view of their flexibility, of the moderate scale of production which they allow and which are well adapted to the requirements of Latin American steel mills,

/and also

and also of the low installation costs which they involve.

In this connexion, it should be pointed out that the extensive auxiliary services for a Thomas steel mill (basic Bessemer) often causes potential unnecessary concern. Dolomite requirements are smaller by weight for instance, than those of an open-hearth steel mill of the same capacity. Brick presses and bottom-making machines are not essential, while excellent results have been obtained with rammed linings, especially for small converters of less than 20 tons.

Lime furnaces are still essential, but both the open-hearth or electric steel mills must also frequently be fed with lime. Moreover, it is possible, and it has even been proved, that the use of oxygen facilitates the utilization of crushed limestone in the Thomas, instead of lime.

Slag-crushing workshops are not essential, uncrushed slag having a good market value.

It is certain, however, that the Bessemer acid steel mill has lower installation and operation costs, but it requires a non-phosphoric pig iron.

In mills having several blast furnaces the low phosphorus ore, if any exists, can be reserved for one of the furnaces, and a part of the production can thus be treated directly by the acid Bessemer process, the higher phosphorous pig iron being refined in a basic furnace (or converter) with or without duplexing.

5. Treatment of Medium Phosphorus Ores

As regards the problem of phosphorus, various other solutions might be envisaged.

It may be said that blowing with an oxygen-enriched blast enables at present low phosphorus content (more than 0.150 per cent) pig iron to be treated in a basic converter, which may be modified if necessary.[1]

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[1] Thus the conversion process used at Linz (Austria) involves the use of a full bottom apparatus, pressure oxygen being injected at the top. At the Huckingen mills (Germany) a slightly different solution has now been adopted(document L.55).Lastly, other experts suggest the use of tilting furnaces with blast tuyeres, which would be a cross between converters and open-hearth furnaces.

/Another means

Another means of avoiding duplexing was proposed for low phosphorus steel (document L.79). This consists in mixing the steel with a Perrin dephosphorizing synthetic slag. The process would appear to be applicable only to rimmed steels, the cost of smelting the slag being unknown; but this suggestion, however, should be kept in mind. If the pig iron has already a phosphorus content, for instance, of 1.3 per cent, and if ordinary steel is to be manufactured, it might be worth while to re-burden the blast furnace with a part of the re-circulating Thomas slag in order to obtain a phosphorous content of 1.7 per cent to 1.8 per cent in the pig iron. This operation is not expensive if the normal burden of the blast furnace includes limestone, which in this case would be replaced by the lime in the slag. Broadly speaking, it may be assumed that 100 kilogrammes of Thomas slag contains as much lime as 100 kilogrammes of limestone, and requires only 20 extra kilogrammes of coke, while 10 kilogrammes of iron and 3 to 4 kilogrammes of manganese can be recovered, making the operation remunerative.

Another solution (see document L.54) consists in adding natural phosphates to the burden, particularly when these phosphates contain iron. This may lower their commercial value for other purposes, but increases it as far as their use in a blast furnace is concerned. In this case, and if these phosphates are cheap, it might be worth while to raise to the minimum required for Thomas blowing (1.7 per cent to 1.8 per cent), the phosphorus content of a burden which otherwise may contain as little as 0.5 per cent or 0.6 per cent . The slag thus obtained is useful as a fertilizer, and the value of the phosphorus contained in the phosphates is thus increased.

If a normal Thomas pig iron is thus available without recourse to oxygen, and if it is desired to produce a few special steels, then one could either:

- Add to the steel mill the limited equipment which would be necessary for refining the steel through the addition of aluminous Perrin slag, thus producing high grade killed steels; o
- Increase the steel mill by an open-hearth furnace or an electric furnace, which would thus enable the re-smelting of the scrap.

./6. Utilization

6. Utilization of Oxygen

The security and the flexibility required are fully assured by the addition of an oxygen plant which enables any pig iron [1] to be converted, while also facilitating re-smelting of the scrap and preventing the presence of nitrogen and phosphorus in the steel (document L.73), that is to say giving the steel mill and the converter the possibilities open to an open-hearth steel mill.

Research (see document L.79) directed to reducing losses in metal and making the best use of the converters, has increased the value of these methods [2] involving their use.

Similarly, the latest developments of the basic Thomas process are also in part applicable to the acid Bessemer. Reference should be made to a Duplex combination not mentioned during the plenary meetings, but which may lead to interesting developments. This is the duplex Bessemer-Thomas [3] process, to be used in conjunction with oxygen for pig iron with a low phosphorous content. The pig iron is first blown in the economic acid converter until it is decarbonized completely, with the addition of oxygen which enables crap to be added, and likewise ensures the final temperature required for pouring. The intermediate product obtained is then passed in a basic converter placed nearby, which plays the same part as a normal Thomas converter using a second basic slag (possibly sodic), when the Thomas operation is carried out with two slags. Since the metal remains in the basic converter for only a very short time, the wear and tear of the operation is very limited. Dephosphorization is also carried out with oxygen-enriched blast. The dephosphorizing slag may be prepared beforehand.

A similar process and a very economic one (since the two types of equipment - acid or basic converters - hardly differ except in the nature

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[1] By enriching the air blown into the converter by 32-35 per cent, pig iron with less than 0.2 per cent phosphorus content can be refined in a Thomas converter.

[2] It should be observed that contrary to an opinion recently set forth, the enrichment in O_2 of the blast in the basic converters does not seem to be particularly harmful to the lining.

[3] Indicated by the Institut de Recherches de la Sidérurgie, France.

/of the

of the linings), would moreover be extremely flexible. If required, and according to the nature of the blast-furnace charge, the following processes could be utilized:

- Straight acid Bessemer, or
- Straight basic Bessemer, or
- The abovementioned combination of acid and basic Bessemer.

As a result of the possibilities offered by the use of oxygen, a new and very important field of work is provided for converter steel mills. In setting out installation projects, however, it would be desirable to study the amount of oxygen consumption envisaged in the first place, as well as the distribution of this consumption throughout the day and the intermediary stocks required.

The cost of a cubic metre of oxygen may very well vary from 1 to 6, according to the size of the installation and the regularity of the flow. It is indicated that whenever possible, consumption in the steel mill should be combined with that elsewhere, thus increasing the total volume of oxygen required. In the future, the low-shaft furnace may possibly fill the role of a supplementary oxygen consumer.

Too many details may have been given here regarding the new prospects open to the converter process, although it seems that this subject was of great interest to the experts at the meeting.

Intentionally, no cost estimates have been given, since it was considered that the purpose of this paper was merely to discuss techniques; at all events, costs may differ widely in different instances. Those interested in new techniques should estimate the cost of their own projects, on the basis of their detailed knowledge of prevailing conditions.

N.B. The documents submitted to the Iron and Steel Meeting under the numbers L.75, L.76, L.78, L.80 and L.90, were not referred to in the above comments, since they deal with interesting but very specific subjects, not directly concerned with the commercial production of steel.

Other documents which are not mentioned are concerned with economic and social problems.

CHAPTER V. ECONOMIC FACTORS AFFECTING THE CONSUMPTION AND PRODUCTION OF IRON AND STEEL IN LATIN AMERICA

1. Introduction

The economic discussions which took place at the Bogota meeting were essentially devoted to the investigation of three subjects, on which papers were prepared by the Secretariat of the Economic Commission for Latin America, namely:

1. The evolution to-date of steel consumption in the principal Latin American countries, and factors which have influenced it (document L.86). [1]
2. The role played by steel consuming and producing industries in the economies of Latin American countries (document L.88). [1]
3. The influence of locational factors, including size of markets, on the economics of steel production in certain Latin American countries and locations (documents L.87 and L.91). [1]

Those three subjects are clearly inter-related. On the one hand, in view of the great importance of economies of scale in steelmaking, production costs depend essentially on the present and potential size of the markets. On the other, steel consumption and the development of the steel transforming sector of industry depend on the price at which steel can be supplied and consequently on costs of production.

In addition to these Secretariat papers, which are mainly concerned with locational factors, the technical section contains various documents submitted by the experts, which show cost and investment figures in relation to plants using unorthodox methods of iron ore reduction.

The studies presented to the Bogota meeting represent the beginning of a systematic examination of the abovementioned problems. [2] Before yielding definite conclusions, they should be considerably amplified. Nevertheless, even at this early stage, the methods of analysis which were

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[1] Document included as an annex to the present report.

[2] Mention should be made, however, of a stimulating analysis of some aspects of steelmaking in Latin America included in World Iron Ore Resources and their Utilization, United Nations, New York, 1950.

/developed and

developed and some of the tentative findings may be integrated in a presentation of the principal economic factors affecting iron and steel consumption and production in Latin America. This is the purpose of the following pages.

2. National Income and Steel Consumption

The close link existing between the economic development of a region and its consumption of steel is well known:

a) On the one hand, considerable amounts of steel are indispensable for the development of industry and agriculture, transport and building. Steel is either used directly, in the form of steel products as they come from the steel mills, or indirectly, in the form of capital goods.

b) On the other hand, economic development, with its consequent improvement in living standards and in the level of savings of the population, necessarily brings about an increase in the demand for steel, which is an indispensable component of almost all capital and durable consumer goods and of certain non-durables. Moreover, as national income increases, the portion of it which can be saved and invested should also normally increase. 1/ Inasmuch as capital goods contain more tons of steel per dollar of value than consumer goods, total consumption of steel should be expected to increase more rapidly than national income.

Graph A, which shows steel consumption per capita plotted against per capita national income for a series of Latin American countries, demonstrates the strong positive correlation existing of 0.898.

The more than proportionate increase in steel consumption which takes place as national income increases can be seen from Table 1, which shows the number of kilogrammes of crude steel consumed per 100 dollars of

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1/ This is true at least until the country concerned has saturated itself with "heavy" capital goods such as railroad equipment, motor cars, equipment for heavy industry, etc. Thereafter, with a more intensive development of aeroplanes precision equipment, electrical machinery, etc., a relative decrease in steel requirements may result. This trend may be noticed in the United States.

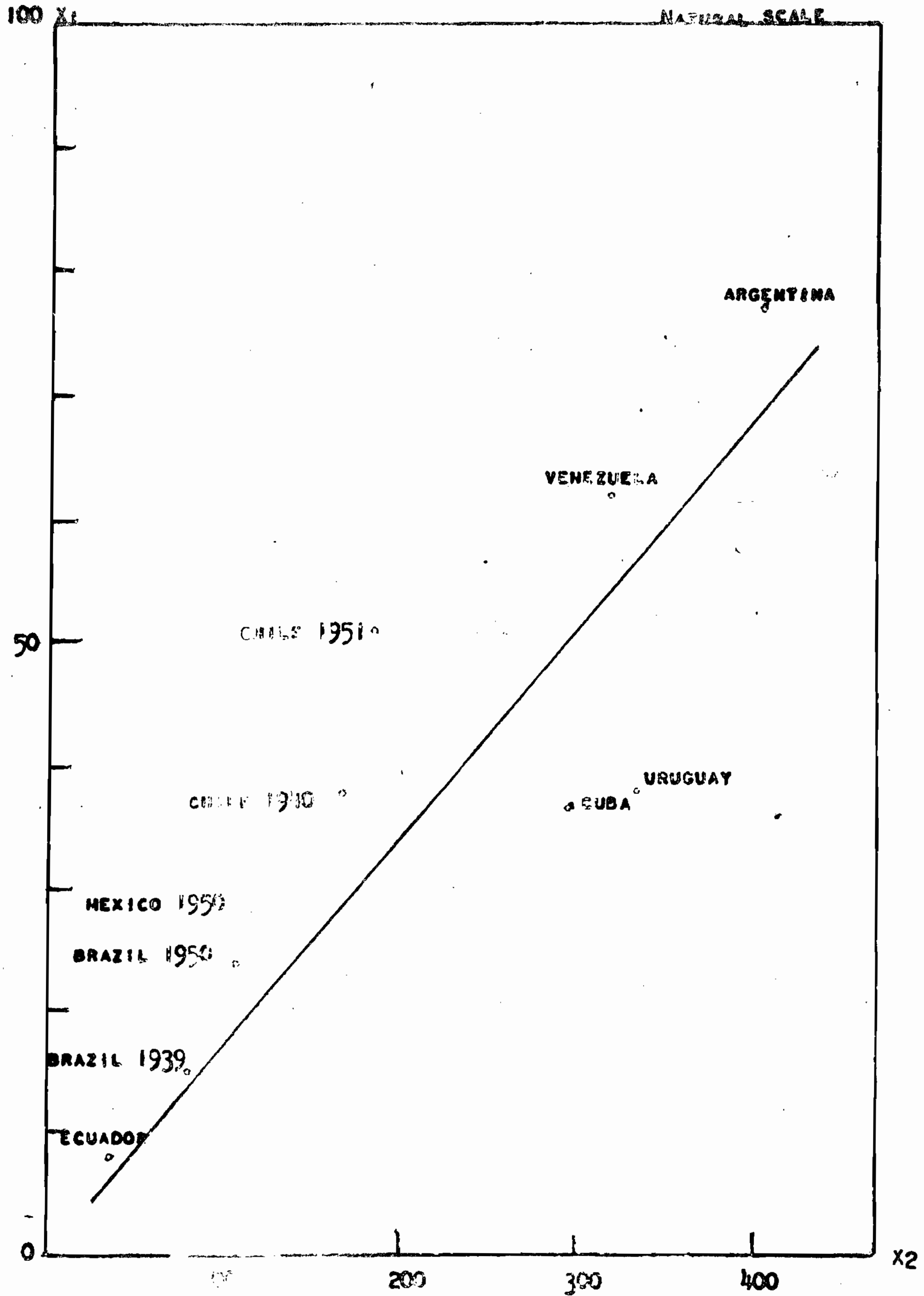
/national income.

CHART A

LATIN AMERICA

RATIO OF PER CAPITA STEEL CONSUMPTION TO INCOME

X_1 : STEEL CONSUMPTION (KILOGRAMMES PER CAPITA)
X_2 : INCOME (1949 DOLLARS PER CAPITA)



ECONOMIC COMMISSION FOR LATIN AMERICA, UNITED NATIONS national income. Only three Latin American countries, Chile, Brazil and Mexico, consumed more than 20 kilogrammes of crude steel per 100 dollars of national income, and for the two latter countries, this occurred only in recent years when they had developed a domestic steel production. For the economically developed countries shown, conversely, the corresponding consumption ratio varied between 30 and 60 kilogrammes. It should be noted, however, that the figures of Table A represent the consumption of iron and steel products only. The low consumption in underdeveloped countries reflects the fact that they purchase considerable amounts of steel contained in manufactured products imported from industrialized countries. The steel content of such manufacture is ignored in statistics covering production and imports of steel products, throughout these papers.

Obviously, the level of the national income is not by any means the only important factor which affects the quantity of steel consumed in a country. The comparison between parts A and B of Table 1 shows this clearly. For a given level of national income, the degree of industrialization is an essential factor.

/Table 1.

Table 1. Relationship Between Steel Consumption and National Income

Countries	Years	National income per capita (1949 US$)	Steel consumption per capita (kgs. of crude steel equivalent)	Steel consumption in kgs. per 100 US$ of national income
A) Latin American countries				
Ecuador	1947-1949	40	8	20
Bolivia	1947-1949	55	5	9
Guatemala	1947-1949	77	8	10
Brazil	1939	90	15	17
Mexico	1939	95	14	15
Peru	1947-1949	100	10	10
Brazil	1950	112	24	21
Mexico	1950	121	28	23
Colombia	1947-1949	132	16	12
Chile	1940	170	38	22
Chile	1951	190	50	26
Cuba	1947-1949	296	37	12.5
Venezuela	1947-1949	322	62	19
Uruguay	1947-1949	331	38	11
Argentina	1947-1949	404	77	19
B) Other countries				
India and Pakistan	1946	50	3.6	7.2
Austria	1947-1948	146	58	40
Italy	1947-1948	212	47	23
Poland	1947-1948	242	70	29
South Africa	1949	264	110	42
Czechoslovakia	1947-1948	320	180	56
Western Germany	1950	350	205	59
France	1947-1948	462	166	37
Belgium-Luxembourg	1947-1948	625	234	37
Australia	1946	640	207	32
United Kingdom	1947-1948	730	252	35
Sweden	1947-1948	770	292	38
United States	1949	1,453	443	30

Sources: European Steel Study in the Setting of the World Market, U.N. National and per Capita Incomes in Twenty Countries, U.N., 1949. Economic Survey of Europe in 1949, U.N. Economic Commission for Europe, 1950. Monthly Bulletin of Statistics of the United Nations. National Statistics.

/Table 2

Table 2, which is based on figures contained in document L.88 shows the progressive increase in importance of steel transforming industries, concurrent with higher levels of income and of industrialization.

Table 2. Importance of Industrial and Iron and Steel Manufacturing Sectors at Various Levels of Economic Development

Country	Years	(1) National income per capita (approximate figures) 1949 US$	(2) Percentage of Total value added in manufacturing industries represented by values added in iron and steel transforming industries	(3) Percentage of total population employed a/ in manufacturing industries	(4) Percentage of total employment in manufacturing represented by employment in iron and steel transforming industries	(5) Percentage of total population employed in iron and steel transforming industries
Colombia	1945	100	6.8	1.2	8.3	0.10
Chile	1948	200	10.7	2.7	12.8	0.35
Argentina	1946	290	11.5	6.0	16.2	0.97
United States	1947	1,450	25.7	9.9	26.6	2.64

Source: Industrial Census of respective countries.

a/ Includes workers and employees.

It appears, on the basis of employment figures, that the iron and steel transforming sector grows more rapidly than the others. Thus, the importance of steel transforming industries in the economy of the country increases very rapidly.

Exact figures on the consumption of steel products by steel transforming industries are not available for Latin American countries. If one bears in mind, however, that according to the same report consumption of the iron and steel transforming industries alone already amounts to 30 to 40 per cent of the total consumption of ferrous products in Mexico, the impact of industrial development on steel requirements in Latin American countries is clearly seen.

/3. The

3. The Requirements, Availabilities and Shortages of Steel in Latin America

Paper L.86 includes a detailed examination of the evolution of the consumption of steel products in six important Latin American countries: Argentina, Brazil, Chile, Colombia, Cuba and Mexico. It contains an analysis of such factors as national income, capacity to import, imports of investment goods, building activity and consumption of cement which can be presumed to be linked with the demand for and supply of steel, and for which quantitative information is available. Fairly definite conclusions emerge from the consideration of this paper. Even at present relatively low levels of economic development, actual steel consumption in Latin American countries is distinctly lower than their requirements, the main limiting factor being the shortage of foreign exchange. Developments easing this stringency, including the creation of domestic sources of steel, tend to increase consumption substantially.

The main reasons supporting this conclusion are the following:

1. The countries considered show a remarkably close correlation over the last twenty-five years, between their imports of steel and their total importing capacity. 1/ During this period, there have been important economic changes, and some of these countries have carried fairly far a process of economic development which has increased the demand for steel. The fluctuations of steel imports generally have been somewhat greater than those of total imports. This appears clearly in Graph 11 of document L.86. The reason for this is to be found in the inelastic character of the other imports. 2/ Because of the general stagnation or occasional

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1/ For the definition of importing capacity, see document L.86

2/ In the case of Chile, it appears that iron and steel imports have a higher elasticity in relation to total imports than imports of foodstuffs, textiles, chemicals and fuel. Among the main groups of imports, only capital goods have a higher elasticity than iron and steel.

/decline, in the

decline, in the importing capacity of many Latin American countries since 1925, there has been a gap in steel availabities which has only begun to be filled by those countries which have developed their domestic steel production.

2. Graph A shows clearly the higher steel consumption in those countries with a domestic source of this metal. Almost all countries whose steel consumption exceeds the levels shown by the regression line between steel consumption and national income, have a steel production of their own, to supplement imports. [1] Venezuela is an exception to this point, and in addition it is the only country in Latin America with no balance of payments problems. Mexico, Brazil and Chile, for example, produce steel domestically and it is thus interesting to note that their steel consumption increased by 60, 32 and 100 per cent respectively, in the decade following 1939-1940. During this interval, the per capita national income of these countries increased only moderately, some 22, 12 and 27 per cent respectively.

In order not to be limited to only one indicator, namely, per capita national income, an analysis has also been made of the relationships between steel consumption on the one hand, and imports of capital goods and consumption of cement on the other, the two latter being closely related with the level of investments. A high multiple correlation coefficient has been observed and a regression formula calculated, [2] to which the different levels of the above quantities in selected Latin American countries can best be fitted. From this formula a "calculated" or theoretical level of steel consumption for every combination of levels of national income, imports of capital goods and consumption of cement can be derived.

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[1] This is also true of such non Latin American countries as Italy, Austria, Poland and South Africa, where levels of per capita national income are of the same order of magnitude as those of Latin American countries, and for which data on steel consumption have been given in Table A 1.

[2] For details, see paper L.86.

/Table 3

Table 3 shows these calculated consumption levels, together with the actual steel consumption levels for the same years. An additional column, expressed in percentages of the calculated levels, shows the departure of actual consumption from them. It will be observed again that the positive deviations correspond to the countries which have developed domestic steel production facilities, and also that they are greater in the post-war years when these facilities have become more important.

3. Although it is difficult to compare potential demand for a commodity with its actual consumption, in certain cases the evidence of shortage of steel can be adduced in Latin America. Thus, notwithstanding the considerable increases in the production of steel in Brazil in recent years, a rationing system is still in force for the products of Volta Redonda.
Given a limited import capacity for a Latin American country, and assuming no compression of foreign purchases of non-steel items, [1] import controls would be necessary to permit larger imports of certain types of steel. Those which are indispensable to satisfy increasing or newly arising demands linked, for instance, with industrialization, would have to take place at the expense of other steel products which are less urgent. Rails and accesories for example, have been adversely affected, as indicated in Table 4. As a result, this has led to inadequate maintenance standards. Finally, the consumption of steel has tended to decrease in Latin America, throughout the last twenty-five years, both in aggregate and for specific products when compared with the evolution of a series of indicators of economic growth. A detailed study of this phenomenom will be found in the section dealing with demand factors which have influenced the evolution of steel consumption in six Latin American countries.

There thus appears to be little doubt that steel continues to be in short supply for Latin America. It has been observed that there is a close link between steel imports and total capacity to import; that imports still

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[1] Despite the fact that iron and steel products represent in general only 3 to 6 per cent of total imports.

/accounted for

accounted for two thirds of Latin American steel consumption in 1951, even though Latin America's importing capacity is limited; and that there have been marked increases in steel consumption by those Latin American countries which have developed a steel production of their own. All these observations support the belief that steel consumption in most Latin American countries would, other things being equal, increase and develop considerably faster if steel production facilities were created or amplified. [1]

Table 3. Calculated and Actual Steel Consumption per Capita in Certain Latin American Countries

(In terms of kilogrammes of crude steel equivalent)

Countries	Years	Calculated steel consumption	Actual steel consumption	Percentage deviation of actual consumption from calculated level
Brazil	1950	18	24	+ 33
Mexico	1950	21	28	+ 33
Chile	1951	38	50	+ 32
Argentina	1947-1949	64	77	+ 20
Brazil	1939	13	15	+ 15
Mexico	1939	14	14	0
Venezuela	1947-1949	67	62	- 7
Ecuador	1947-1949	9	8	- 11
Cuba	1947-1949	42	37	- 12
Guatemala	1947-1949	12	8	- 33
Colombia	1947-1949	23	16	- 30
Uruguay	1947-1949	54	38	- 30
Bolivia	1947-1949	9	5	- 44
Peru	1947-1949	16	10	- 38

Thus, Latin America's outlook for steel must take the following factors into consideration:

1. Steel is short at present in most countries of the area;
2. Population is increasing rapidly: 2.25 per cent yearly on the average;

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[1] Already Latin American per capita steel consumption has increased by one quarter - from 21.6 kilogrammes in terms of crude steel to 27.2 - between 1945-1948 and 1949-1951 (and by one half between 1945-1948 and 1951). These rates of increase are exceptional, but a regular yearly increase of 6 per cent in total consumption in all underdeveloped countries has been considered as a realistic (though high) assumption in a recent study of the Economic Commission for Europe.

/3. Even

3. Even at the relatively slow pace of economic development which has prevailed in recent years and which, it is hoped, will be accelerated in the future, real national income per capita increases at a rate of 2 to 2.5 per cent yearly. It has been shown that, as a result of the higher proportion of investment, the demand for steel generally increases more rapidly than national income;
4. It is to be expected that the present trend towards industrialization prevailing in most of the countries will continue, and probably at a faster rate. Industrialization, again, requires additional consumption of steel.

It thus seems clear that, unless a major world depression takes place, Latin American demand for steel in future years will be considerably above present levels of consumption. It also appears that satisfaction of this demand is indispensable to the industrial development of the region.

4. Characteristics of Steelmaking Processes

Essential supplies of steel may be drawn from two sources; imports or local production. The unfavourable development of importing capacity already mentioned precludes a substantial increase in steel imports for many countries. On the other hand, the majority of Latin American countries, and among them all the major steel consumers, possess at least some of the resources which are necessary for steelmaking. [1] In fact, Latin America possesses about 20 per cent of the world reserves of economically exploitable iron ore. It is also the region of the world which has the highest per capita reserves of iron ore in terms of Fe content: 37 tons per capita, as against a world average of 11 tons.

a) Characteristics of the classical steelmaking process

Before discussing the respective advantages of domestic steel production in Latin America as against imports of this metal, attention should be drawn to certain technological characteristics of the steelmaking process which have considerable bearing on costs.

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[1] For a description of Latin American steelmaking resources, see annexed documents L.0 and L.87.

/Table 4.

Table 4. Evolution of the Share of Rails and Accesesories in the Consumption of Steel in Latin America

(Percentage of total apparent consumption of steel represented by rails and accessories)

Country	1925-1929	1945-1949
Argentina	15.5	5.7
Brazil	26.7	14.1
Chile	22.0	11.5
Colombia	26.3	5.5
Mexico	17.9	12.8

1. To begin with, steelmaking is a heavy industry. Among the various characteristics generally recognized in defining a heavy industry, the most important one here is the great weight of the raw materials necessary to produce steel, in relation to the cost of the product. Typically, about six tons of materials, such as two to three tons of iron ore, about two tons of coal and more than one ton of other materials (scrap, fluxes, fuel oil, etc.), are necessary to produce one ton of finished steel, at present worth about 120 dollars. At the existing plants or at the sites which have been considered in this study, the number of ton-kilometres of transport [1] required in order to assemble these materials may vary between 800 and 5,000 for ore and coal alone. As a result, transport costs of raw materials represent an exceptionally high proportion of the total cost of steel. The percentage corresponding in Latin America varies between 5 and 10 per cent for plants which are particularly favourably placed in relation to raw materials, and 15 to 25 per cent for the others.

2. An immediate consequence of the abovementioned characteristic is the strong influence of plant location on steel costs. The distance over which raw materials have to be carried, and even more important, the means of transport, whether rail, road, inland waterway or maritime, greatly influence costs. A study made by the Economic Commission for Latin America on the costs of production of steel in

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[1] In equivalents of railway ton-kilometres.

/certain Latin

certain Latin American locations (document L.87), shows that total transport costs per ton of finished products vary from 4 to 15 dollars. To this should be added the cost of transporting finished steel to the consumer markets.

3. Comparisons of capital investment for different industries are difficult to make, in view of differing valuation methods. In any event, the capital which must be invested in order to produce a certain value added, is relatively high for steelmaking, in comparison with other important industries.

4. Investment costs in steelmaking are very strongly affected by the size of the production unit. Rolling operations are particularly influenced by size, since they can be performed by a variety of methods. Some utilize relatively rudimentary equipment and a considerable amount of labour whereas others are highly mechanized, use less labour and require very complex pieces of equipment. Certain modern equipment, such as a continuous wide strip mill, can only be used for producing at a level of one million tons a year. The savings in total production costs brought about by more complex and more productive pieces of equipment depend of course on the relative costs of capital, labour and raw materials. As an example, Graph B, based on study L.91, shows the variations in the total costs of producing one ton of a given assortment of finished steel in Sparrows Point, in plants ranging from 50 thousand to one million tons of annual capacity. It will be noted that costs are cut by more than half between the smallest and the largest plants.

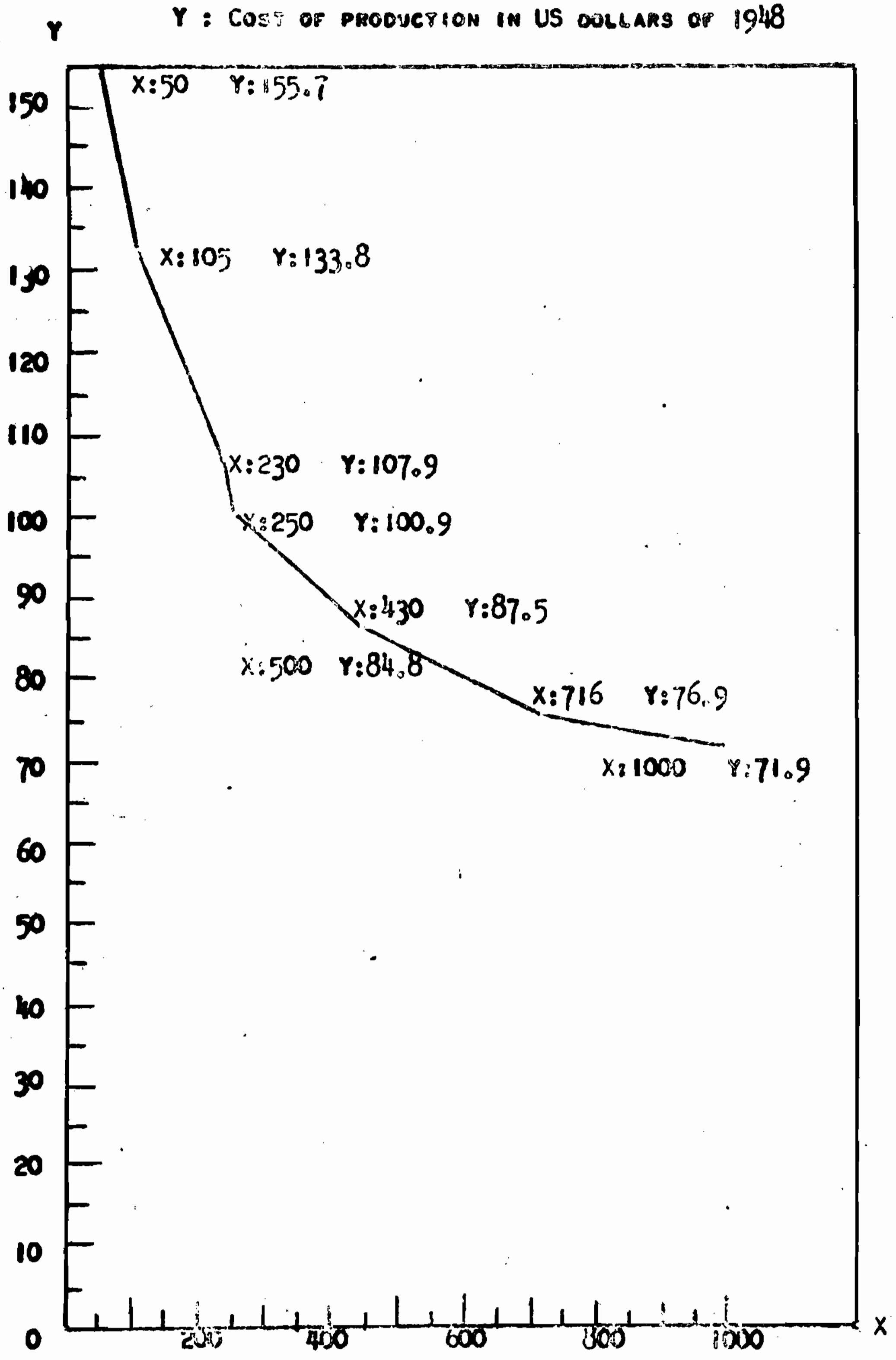
Economies of scale and the type of finished products greatly influence rolling operations. As a result of impressive advances during recent decades in methods of fabricating flat products (plate, sheet, strip, tinplate, etc.), the effect of size is more pronounced for these items than for sections. The advantage of building production units as large as the market would allow, combined with the relatively high investment per ton referred to above, tends to make essential investments very high. Investment costs for a modern plant may easily total hundreds of millions of dollars.

/b) Alternative

CHART B

RELATION BETWEEN SIZE OF PLANT AND COST OF PRODUCTION OF FINISHED STEEL IN SPARROWS POINT CONDITIONS

X : CAPACITY IN THOUSAND TONS OF
FINISHED STEEL PER YEAR
Y : COST OF PRODUCTION IN US DOLLARS OF 1948



ECONOMIC COMMISSION FOR LATIN AMERICA, UNITED NATIONS.

b) Alternative processes for steel production

The technical part of the report includes a thorough examination of alternative processes either available, or being developed for the production of iron and steel. They are mainly concerned with iron ore reduction by means other than the blast furnace, and, in a lesser degree, with rolling of steel by means other than usual blooming and rolling mills. The product obtained from some of these iron ore reduction methods is a kind of pig iron; in other cases it can only find application as a substitute for scrap. The steelmaking process to be used for refining the resulting primary metal depends on its special characteristics. Usually one of the well-known steelmaking processes is used, although document L.67, refers to a reduction process in which refining of steel becomes unnecessary.

Unorthodox methods are especially appropriate to certain raw materials: hydro-electric power; other natural resources; and yield specific end-products. They lead to considerable variations in the costs of finished steel, and still more so in the levels of specific investments. According to document L.62, production costs for pig iron may vary in the four reduction methods considered, [1] from 28 to 45 dollars per ton, whereas investment per ton-year produced may vary from 25 to 100 dollars.[2] Production costs of ingot steel vary, for the six processes considered, according to document L.56, between 240 and 290 dollars per ton, [3] assuming that pig iron and scrap are uniform in price. Although similar figures are not available for rolling operations, the utilization of such methods as continuous casting of billets, or extrusion of finished shapes, may bring about considerable variations in production costs and in investments per ton per year, particularly for relatively small operations.

Some of the alternatives to classical steelmaking and iron ore reduction methods, like low-shaft furnaces, direct reduction methods, utilization of oxygen in steelmaking and continuous casting and extrusion, require less

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[1] Blast furnace, electric smelting furnace, sponge iron furnace and tunnel kiln.

[2] Under conditions prevailing in Canada, during 1948.

[3] Open-hearth furnace, converter and open-hearth furnace, converter and electric arc furnace, oxygen converter (P.O. steel), Duplex converter - open-hearth furnace and Duplex converter - electric arc furnace. Under conditions prevailing in Western Germany during 1952.

/capital investment

capital investment although they may reduce the productivity of labour. They therefore seem much better adapted to small scale operations in underdeveloped countries than to the classical processes.

The discussions were mainly concerned with the classical processes: blast furnaces, steel plants and rolling mills. This preference results from greater knowledge of these processes, and the abundant publications covering costs and investments in their various steps. Cost and investment estimates have been prepared for some of the alternative methods, usually as comparisons with a standard blast furnace plant of a given size. Since the cost structure for the classical process has been investigated in seven Latin American countries, figures referring to the other processes may thus be related to conditions prevailing in the region.

Document L.91 assumes that the Latin American classical plants, chosen as examples, will cover the total potential demand for the respective countries. If the markets of a given country are strongly decentralized, and transportation facilities limited (as in the case of Brazil and Mexico), the advantage of installing more than one production centre should be examined. In such case the small size of the local markets in each centre might make one of the alternative methods more desirable.

Situations may arise in which haulage costs to certain regions become so high as to completely upset the usual pattern of comparative advantages. One case of this type is explained in document L.82, which describes a plant recarburizing steel scrap into pig iron, in an electric furnace, which has been profitably operating for years in Bogota. It might well be that in extreme cases like this, a small and therefore usually unprofitable plant using an alternative reduction method could become a factor stimulating economic development of an isolated zone. In order to determine the possible advantages of such an industry, a market study of the region would be indispensable. Here, again, the methodology followed in document L.86 would be helpful.

A lively discussion arose regarding the advisability of using these unorthodox methods, especially since they have scarcely been tested on a commercial scale. It was pointed out that in Latin America, where capital is scarce, there are risks in investing in processes not yet adequately developed. However, the prospects for their further use in industrialized countries seems remote, since the latter use the capital-intensive classical methods. Since the new processes are labour-intensive, they would therefore initially seem to be more applicable to Latin America.

From all the discussions, it became evident that these alternative methods must receive a detailed examination, before final judgment is passed on the advisability of installing a steel industry in a new country or region. This becomes particularly necessary if small scale operations result in excessive costs under classical processes.

5. Analysis of Some Important Factors Relevant to the Economics of Ateelmaking in Certain Latin American Locations

The degree of scarcity of resources and the balance of payments situation

The relative economic advantages of steel production in Latin America, compared with steel imports, follow below.

Whether steel production in a given location is more advantageous to a country than imported steel, depends largely on the resources utilized for domestic steel production. Steel production might or not, involve the utilization of resources which might otherwise be put to use for the increase of production of exportable commodities for which there is a market abroad, or for the substitution of another type of imports.

In the first case relative costs of production and of imports of steel are relevant. In the second case, additional criteria must be taken into account. This situation does in facti arise in many Latin American countries because:

a) Considerable unused resources exist, and steel production could add to the total income of the country without detracting from the potential production of commodities earning foreign exchange;

b) Inelastic world demand for many commodities exported by the area is such that a greater volume of exports would not substantially add to foreign exchange reserves; or because

Contrary to many industrialized countries, productive resources are not utilized fully in several Latin American countries. In the majority of them, considerable amounts of underemployed manpower exist. Although unemployment

/is often

is often hidden both in rural and in urban districts, there is little doubt that there is a great reserve of unused labour throughout the region. The experience acquired from setting up steel plants in a number of Latin American countries in recent years shows that, within a moderate period of time, manpower can be trained to perform the tasks required in steel works. Insofar as raw materials are concerned, as has been mentioned already, considerable reserves of iron ore exist. In many cases the iron ore reserves could not be exploited because of the heavy costs involved in shipping this relatively cheap material to possible importers. This applies to an even greater extent to other resources such as, limestone, hydro-electricity or natural gas. However, it is a fact that many Latin American countries draw the bulk of their foreign exchange from selling a very limited number of commodities representing an important source of total world supply. Since world demand for such products is inelastic, the total potential export earnings, and consequently the capacity to import, are limited and cannot be increased substantially by using resources which might alternatively be used for steelmaking.

The creation of a local steel industry can provide a substitute for imported steel, and also add to the national income. Conversely, such an industry might utilize scarce resources better fitted for exporting readily marketable products, or substituting for other important imports. Additions to national income can be done internally by using resources which would otherwise remain unemployed, and externally by reducing import requirements without affecting potential export proceeds. If steelmaking makes use of scarce resources, it must be considered as an alternative to other types of activity and not additive.

The problems involved in allocating scarce resources are many. They are outside the scope of this report, as they were outside the scope of the Bogota meeting.

The Economic Commission for Latin America has however presented some absolute and comparable figures reflecting costs of producing steel, in different locations and on varying scales. Both in and outside Latin America, costs calculated by this method may be used to determine the economic advisability of establishing a steel industry as compared with continued or increased imports of steel. Such an examination must, of course, take into

/consideration many

consideration many other factors which are not directly linked with economies of steel production but which are relevant to the basic problem. These include the balance of payments situation, the possibility of increasing production of exportable goods and of marketing them; costs of producing exportable commodities or other import substitutes; and the relative capital intensities of various productive activities.

Comparison of steel production costs in Latin America and in the United States

1. Method, assumptions, and examples selected

The method followed by the Economic Commission for Latin America is explained in detail in papers L.87 and L.91, which should be considered jointly. It consists . detailed examination of the different cost components of steel production at its varying stages of pig iron, crude and finished steel. To calculate production costs of steel in several Latin American countries, and in one North American location, the following influences should be considered:

a) Cost, quality and location of raw materials;
b) Costs of labour and capital; and
c) Size of the market.

In every case, production costs are classified into purchased raw materials, labour, capital, and "other", the latter item including overhead. However, steel industries often exploit their own coal, iron ore and limestone mines. An alternative breakdown of production costs is therefore offered for "integrated plants" operating their own mines. Total costs have then been broken down into purchased raw materials (mainly scrap and a part of fuel), transports, labour, capital and other costs.

A certain number of general assumptions had to be made in order to ensure the comparability of cost calculations as between the various locations. The most important ones are enumerated below:

1. The plants installed are assumed to be identical in the various locations studied. In fact, the greater part of the study (document L.87) refers to the establishment of costs for plants producing 250 thousand tons of finished products per year. Document L.91 examines the influence of variations in size of plant on costs, and here again technological factors are supposed to be identical in all locations. All plants are presumed to function

/at 100

at 100 per cent capacity.

2. Given the mode of transport, transport costs per ton-kilometre are assumed to be equal. [1] Transport tariffs, which are influenced strongly by open and hidden subsidies, have been ignored since they are often determined by non-economic factors.

3. Productivity of labour is assumed to be equal in all locations. This, of course, may not exist for a newly installed industry until the end of a certain "breaking in" period of several years. On the other hand, experiences in recently established steel industries in Latin America indicate that this hypothesis is not altogether unrealistic.

4. In view of the extensive mechanization of operations in open-cast work, extraction costs of iron ore and limestone are assumed to be equal in all locations.

5. It is assumed that coke is made, as far as possible, from domestic coals and blending materials. Costs of coals have been estimated on the basis of the thickness of the veins, other geological conditions and productivity of mining in the respective country. Costs of imported coals and blending materials are mostly those which prevailed in 1948 on the international markets.

6. Availability of purchased scrap equal to 10 per cent of crude steel production and worth 90 per cent of the price of pig iron, has been assumed throughout.

7. Cost of steelmaking equipment is assumed to be equal in all Latin American locations and 20 per cent higher than in the United States. Interest and amortization are assumed to be equal to 9 per cent of the total cost of the equipment in Latin America and to 8 per cent in the United States. No allowance was made for taxes or profits.

8. Certain minor elements of cost are either assumed to be equal in terms of dollars or in terms of physical units. For others, reasonable variations have been assumed to take local conditions into account.

1/ Estimates of the actual cost of transport of bulk raw materials in the United States have been used.

/9. The

9. The assortments of finished steel products turned out by all the plants were assumed to be identical in percentage distribution and typical of the demand for standard products of a Latin American country. [1] The quality is also equal throughout.
10. All prices relate to the average of the year 1948.
11. As a result of the adoption of the aforementioned assumptions, costs could be calculated directly in dollars for all items except labour.

Exchange rates have only been used when converting wages prevailing at different locations, into a common currency. Since the final aim of the study is to throw some light on the comparative advantage of producing steel locally, or importing it, the exchange rates applicable to steel imports in 1948 have been used throughout for the conversion of wage costs.

Locations of hypothetical plants for which cost analyses have been made include each of the seven Latin American countries selected for this study. Most of these locations correspond either to the site of existing plants or to the site of planned steel mills, thereby making data more readily obtainable. Where the site was that of an existing plant, the hypothetical productive unit is usually different in size from the existing one, so that the calculated costs will probably not coincide with those actually prevailing.

The only difference between the equal size plants is that linked with the process of steelmaking utilized, the process selected depending on the qualities of locally available ores:

a) Open-hearth furnaces.
b) A combination of 80 per cent basic open-hearth capacity with 20 per cent Bessemer capacity, and
c) A combination of Thomas converters with electric furnaces.

In a further stage (document L.91), plants of different sizes are taken into account. The size of the plant appropriate to a given location was estimated on the basis of apparent steel consumption in the corresponding country during 1947. A downward adjustment of some 20 per cent was made to take into account the fact that no matter how diversified a single plant is,

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[1] This distribution is given in document L.87, Table 8.

/it cannot

it cannot produce the total assortment of finished steel products used by a given country. If it is borne in mind that Latin America's steel consumption in 1947 has invariably been surpassed in later years, and also that this consumption would increase beyond the present levels if local production was established, the use of these hypotheses for size of plants tends to give excessively high cost estimates for Latin America. This selection would only affect costs of the smaller countries to which reference is made in the following lines. In the case of each of the larger countries, Argentina, Brazil and Mexico, transport difficulties have motivated the erection of more than one plant, with an even smaller capacity than those considered in document L.91.

Since the cost estimates based on 1947 consumption figures were too high, cost and investment estimates for larger plants have been prepared and tabulated for Colombia, Peru and Venezuela which had no domestic sources of steel in 1947. The corresponding capacities have been chosen on the basis of the finding in paper L.86, namely, the level to which short-term consumption might be expected to rise, assuming that local production is developed. 1/

Generally, cost calculations were based on the maximum utilization of domestic raw materials in every country. However, in many cases, imports of coking coal, covering either part or total requirements, had to be assumed.

The locations selected and the productive capacities are summarized in Table 6. It should be noted that for Argentina, three different sources of iron ore were taken into account: domestic Zapla and Sierra Grande ores, and imported Brazilian Itabira ores. The resulting cost variations are considerable and should be borne in mind when examining the Argentine situation. In analysing the influence of size upon costs, only the use of Sierra Grande ore has been contemplated.

1/ These capacities correspond approximately to 80 per cent of the apparent consumption given by the relationship between steel consumption on the one hand, with national incomes, imports of capital goods, and cement consumption in the four countries which have a steel industry.

/Table 6.

Table 6. Latin American Steelmaking Locations, Raw Materials and Processes Selected for Cost Analysis of L.87 and L.91

Country	Location of steel plant	Origin of iron ore	Origin of coking coal	Steelmaking processes	Annual capacity (tons of finished steel
Argentina	San Nicolas	a) Zapla (Arg.) b) Itabira (Brazil) c) Sierra Grande (Arg.)	Imported from the United Kingdom or South Africa	Basic open-hearth	850,000
Brazil	Volta Redonda	Lafaieta (Brazil)	70% imported from U.S. 30% Santa Catarina (Brazil)	80% Basic open-hearth 20% Acid Bessemer	716,000
Chile	Huachipato	El Tofo (Chile)	85% Arauco Bay (Chile) 15% imported from U.S.	80% Basic open-hearth 20% Acid Bessemer	230,000
Colombia	Belencito	Paz de Rio (Colombia)	Paz de Rio (Colombia)	Basic Bessemer (Thomas) Electric furnace for scrap smelting	105,000 250,000 a/
Mexico	Monclova	Cerro de Mercado (Mexico)	Durango (Mexico)	Basic open-hearth	430,000
Peru	Chimbote	Marcona (Peru)	85% Anthracite from Santa (Peru) 15% imported asphalt	80% Basic open-hearth 20% Acid Bessemer	50,000 150,000 a/
Venezuela	Barcelona	El Pao (Venezuela)	a) Domestic petroleum or asphalt residues b) Imported from U.S. (West Virginia)	80% Basic open-hearth 20% Acid Bessemer	200,000 300,000 a/
United States	Sparrows Point	El Pao (Venezuela)		80% Basic open-hearth 20% Acid Bessemer	1,000,000

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a/ For explanation of alternative capacities used in the cases of Colombian, Peruvian and Venezuelan plants, see previous page.

/2. Results

2. Results of Analysing the Examples Selected

Details covering calculations of production costs are shown in documents L.87 and L.91, and need not be repeated here. The quantitative data shown in the documents are only valid for the assumptions described. They should therefore be considered only as an example of the economic suitability of the various countries for steelmaking.

It is important to note, however, that the methodology followed permits a full quantitative analysis of the influence upon comparative production costs of the main factors affecting them.

a) Thus, from the examples chosen, it can be seen what the respective assembly costs are. They represent an important factor of the cost of steel, due to the considerable bulk of the materials concerned, and also because the most important coal and iron ore deposits are seldom located close to each other. Assembly costs depend on the quality of the raw materials, their mining costs, and costs of haulage to the plant. They therefore determine the location of the plant, jointly with transportation costs of finished steel to the market. Table 7 compares the assembly costs for the locations selected in Latin America, with those corresponding to Sparrows Point. It can be seen that in general, assembly costs are substantially higher in Latin America (Colombia being an exception) than in the best known steel producing centres of the world, namely, Australia, Birmingham (Alabama), Luxembourg, Ruhr, etc.

/Table 7.

Table 7. Assembly Costs for Selected Latin American Locations

(1948 dollars, indices, and percentages)

Plant	Assembly costs: Dollars per ton of pig iron	Assembly costs: Indices: Sparrows Point = 100	Assembly costs as per cent of finished steel costs in plants appropriate to size of markets
San Nicolas, Argentina a/	66.75	246	
San Nicolas, Argentina b/	42.74	158	
San Nicolas, Argentina c/	33.88	125	39
Volta Redonda, Brazil	37.33	138	44
Huachipato, Chile	23.05	85	29
Belencito, Colombia	17.62	65	22
Monclova, Mexico	26.74	99	32
Chimbote, Peru	18.80	69	20
Barcelona, Venezuela d/	21.68	80	18
Barcelona, Venezuela e/	26.40	98	22
Average f/	26.26	96	
Sparrows Point g/	27.14	100	37

a/ Zapla ore.
b/ Itabira ore.
c/ Sierra Grande ore.
d/ Coke made from asphalt or petroleum residues
e/ Coke made from imported coal
f/ Arithmetic average, considering: in Argentina, Sierra Grande ore; in Venezuela, use of coke from imported coal.
g/ Venezuelan ore, West Virginia coal.

In this connexion, it appears that the highest assembly costs in Latin America correspond to those locations which have been selected close to major markets: Buenos Aires and Rosario in Argentina, Sao Paulo and Rio de Janeiro in Brazil. In Chile, Colombia, Peru and Venezuela, locations closer to the raw materials have been selected and therefore the assembly costs appear lower. Mexico occupies an intermediate position in this respect, since the location of the plant falls within a triangle whose vertices consist of the principal markets, the iron ore and the coal deposits.

/Table 8.

Table 8. Theoretical Steel Production Costs in Latin America as Affected by Various Locational Factors

(Dollars at 1948 values)

Plant	Production cost at various locations as affected by cost and trade of raw materials			Cost and prices of steel in the United States, plus transport cost differentials to Latin American markets f/	
	Equal plants of 250 thousand tons capacity per year		Capacity of plants appropriate to size of markets a/ e/	Delivered cost of imported steel from Sparrows Point	Average price of "Composite Finished Steel" in Pittsburgh 1948 b/
	Wage rates and capital charges equal to U. S. figures	Wages and capital charges at local rates a/			
Chimbote, Peru	93	82	90	86	110
Huachipato, Chile	94	84	84	89	111
Belencito, Colombia	81	76	76	88	108
Barcelona, Venezuela c/	105	117	105	82	106
Monclova, Mexico	99	90	83	84	108
Volta Redonda, Brazil	114	102	85	86	110
San Nicolas, Argentina d/	119	105	92	91	115
Average	101	93	88	87	109
Spread as percentage of average	37%	37%	33%	-	-
Sparrows Point, Maryland, U.S.	100	100	72	-	-

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a/ The respective local wage rates and capital charges have been used.

b/ The assortment has certain resemblance with the programme envisaged for the Latin American plants.

c/ Using imported coal.

d/ Using Sierra Grande ore.

e/ Size of plants: Chimbote 150,000; Huachipato 230,000; Belencito 250,000; Barcelona 300,000; Monclova 430,000; Volta Redonda 716,000; San Nicolas 850,000; Sparrows Point 1,000,000.

f/ To prices and costs in United States, the respective transport costs to the Latin American markets have been added, and the transport costs of Latin American plants to their markets have been subtracted.

/b) Wage

b) Wage rates are another factor of locational character. Their influence increases as conversion proceeds from iron ore into finished steel.

Table 8 compares the estimated costs of steel produced in hypothetical Latin American plants, with a hypothetical plant at Sparrows Point. Column 2 shows the estimated costs obtained in plants of equal size if local wage rates are considered in the calculations. In column 1, the same data are given but using United States wage rates and capital costs. The figures in column 3 correspond to cost estimates for plants of sizes appropriate to the Latin American markets, using local wage rates. The figures in column 4 represent the estimated costs of one million ton a year plant located at Sparrows Point, plus the transport cost differentials to Latin American markets. 1/ These figures have been termed "delivered costs of imported steel". Finally, the data of column 5 results from adding to the 1948 steel prices in the United States, the transport cost differentials to the Latin American markets. 2/ Such data have been called "delivered price of imported steel".

c) The first column of Table 8 shows, therefore, the variations in costs resulting from purely natural and geographical factors, such as location, and quality and cost of raw materials. The assumptions are that all the plants are of equal size and that the price of labour and capital are equal to those in the United States. It can be seen that the spread in costs of finished steel amounts to 37 per cent of the average.

1/ Transport costs of finished steel from the United States centres (Sparrows Point or Pittsburgh, whichever is selected) to Latin American markets, minus the transportation costs from the Latin American steel plants to their respective markets.

2/ These prices correspond to the series "Composite Finished Steel", compiled and published by the *American Metal Market*. It represents the weighted price of an assortment similar to the programme of the Latin American plants. For transport differentials see note 1/.

/On the

On the other hand, the Latin American locations taken as a whole (to the extent that average figures are significant) have production costs determined by purely geographical considerations, which are practically equal to those corresponding to the Atlantic seaboard of the United States.[1]

d) The above comparison is relevant for the long-term evaluation of the importance of Latin American locations, when, as a result of accelerated economic growth it might be assumed that costs of labour and capital would tend to equalize between Latin America and the more industrialized countries. For short and medium-term prospects, the lower and variable costs of labour in Latin America and the higher rates of interest must be taken into account. If this is done, the picture shown in column 2 of Table 8 emerges. Here again, costs are very diversified, but due to the considerably lower labour costs, Latin American locations as a whole appear in a more favourable light. Thus, the unweighted average for the seven locations is 7 dollars below the Sparrows Point figures.

e) Again, the costs of equal size plants, would be relevant to a study of the advantages of steel production in Latin America if the erection of optimum size plants could be justified. This could be achieved either from heavier steel consumption, or as a result of an intra-regional economic integration. Since this is not the case at present, however, a realistic examination of the problem involves some consideration of costs in plants appropriate to the size of Latin American markets.

The corresponding calculations are included in document L.91, and the respective costs of production of finished steel appear in column 3 of Table 8. Because of the considerably smaller size of individual Latin American markets compared with that in the United States, the influence of the size factor greatly increases Latin American costs while moderately reducing the spread, in view of the fact that plants which have the highest raw materials costs face

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[1] On the assumption of the utilization of Venezuelan ore in Sparrows Point.

the largest domestic markets, and vice versa. [1] The average of Latin American figures gives a production cost which is higher by 16 dollars or 22 per cent than the unchanged Sparrows Point figure.

f) Manpower, raw materials and capital resources necessary for steelmaking are all scarce, and could be used in alternative production to strengthen foreign exchange reserves, either by export - expansion or import - substitution. Thus the merits of domestic steel production as against imports of this metal must be measured by the differential between production costs in the respective Latin American countries (calculated as described above) and imported costs of foreign steel.

Leaving aside unpredictable considerations of commercial policies of the potential steel exporters, and assuming that "normal" profits are equal in Latin America and elsewhere, [2] production costs in Latin America should be compared with

a) The cost of production abroad; and
b) The price at which a similar assortment of steel was sold in the exporting countries during the base year 1948.

In both cases, account has to be taken of differences between transport costs of the finished product, from the Latin American and the foreign plant. Simplifying further, the foreign costs with which comparisons may be made can be assumed to be those delivered from Sparrows Point to the Latin American market.

The exact study of comparative advantages would involve a detailed examination of the transport costs of the finished steel to all the main consuming centres of the countries considered. This may require a determination of several centres of consumption. This has not been done in document L.87, nor is it believed that (except perhaps for Brazil, Colombia and Mexico) it is indispensable for the presentation of a methodology. It may be assumed, roughly, in order to take into account the transport costs of the finished product, that they are 9 to 12 dollars higher for Sparrows

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[1] Venezuela is an exception to this rule.

[2] This of course is not necessarily the case.

/Point steel

Point steel than for local steel in the cases of Venezuela, Colombia and Mexico; 13 to 15 dollars in the cases of Chile, Peru and Brazil, and 19 dollars in the case of Argentina. These are the figures which have been used for the preparation of column 4, Table 8. The comparison between columns 3 and 4 of Table 8 indicates the influence of all the principal factors (raw materials, labour and capital costs, size of plant, and transport of finished products).

Here again considerable differences exist between the advantages and disadvantages of the various locations, some of them showing lower costs for the domestic product and some showing higher. All in all, the average of the seven Latin American countries is slightly below the delivered cost of imported steel.

If instead of comparing costs in selected Latin American sites with those obtained in an imaginary one million-ton plant in Sparrows Point, the average selling prices in the United States are used, the situation changes substantially. Column 5 of Table 8 shows the corresponding figures. The average "delivered selling price" of imported steel would be 21 dollars (24 per cent) higher than the average cost of the Latin American locations. Variations in costs are considerable, so much so, that in spite of the favourable average, at least one of the plants appears to be unprofitable.

Comparisons between the last three columns of Table 8 do not necessarily indicate whether steel should be produced in Latin American locations, even on the assumption of the scarcity of productive resources and the possibility of utilizing them for other foreign currency earning purposes. Compared, however, with similar figures corresponding to other industrial or agricultural investments, they would assist in deciding as between two or more activities making claims upon these same resources.

In addition, document L.86 shows that considerable discrepancies exist between the abilities of different Latin American countries to supply their markets through imports of steel. In some of them, there have been no shortages in imports of steel resulting from insufficient foreign exchange, whereas in others the limitations have been drastic. In the same document, a methodology has been developed which indicates whether or not there are steel shortages and, to a certain extent, attempts to estimate the unfilled demand. The problem of increasing steel supplies seems more urgent in those countries where shortages have been more pronounced; in some countries

/it would

it would be difficult to increase steel supplies by means other than local production.

The Effect of Steel Production on the Balance of Payments

It has been noted that many productive resources are not scarce in Latin America and that manpower can often be utilized in steelmaking without adversely affecting the balance of payments. It has been mentioned also, that in many countries the possibility of improving the balance of payments by increasing foreign exchange earning is limited. The method of cost calculation devised in documents L.87 and L.91 analyses the advantages to be gained by establishing steel plants in the light of such considerations. Obviously, the degree to which resources are scarce, and to which they can be utilized as foreign currency earners (alternatively to steelmaking) varies from country to country, and cannot be examined in detail here. An extreme case however may involve the assumption that all home resources are not scarce and that they would be unemployed if steel production were not developed. 1/

On the other hand, capital and imported raw materials are obviously scarce, and must be paid in foreign currencies, as must a certain portion of overhead and other costs. Inasmuch as documents L.87 and L.91 include a breakdown of production costs from raw materials to finished steel, it is thus possible to separate scarce and non-scarce factors throughout the entire production process. A calculation can be made of the proportion of the cost of finished steel which corresponds to scarce factors. These proportions are shown in Table 9. The degree to which steel production in various Latin American locations involves the utilization of scarce factors, or expenditures in foreign currencies, 2/ can in turn be compared with the delivered cost of imported steel (third column). The figures show that in every Latin American location steel production represents a considerable

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1/ It should be emphasized that the assumption of non-scarcity of domestic resources is applicable with varying degress of strickness to each country, particularly insofar as domestic fuel is concerned. Whereas in Brazil it may be assumed that metallurgical fuel would not be mined if there were no steel plants within the country, this is not the case for Chile where metallurgical fuel is extracted from the same mines as other fuel and would find an alternative utilization if it were not used in steel plants.

2/ The two concepts - scarcity and expenditure in foreign currency - do not correspond strictly, the second one being more limited than the first. For instance, capital is always scarce, but all of it should not necessarily come from abroad. The calculation commented upon should therefore be considered an extreme example.

/saving in

saving in foreign exchange if compared with imports of steel, and is an addition to the total natural income, in view of utilizing factors which would otherwise remain unemployed. Again, it should be emphasized that this is but an extreme example. Many factors of production (including manpower, coal, and in certain cases ores) may be scarce or adequate, foreign exchange earners or non-foreign exchange earners, depending upon their particular circumstances.

Table 9. Proportion of Latin American Finished Steel Costs [a] that Have to be Paid in Foreign Exchange

(Dollars at 1948 value and percentages)

Plant	Proportion of cost (Per Cent)	Expenditures (Dollars)	Production cost at Sparrows Point, plus transport cost differentials to Latin American markets d/
San Nicolas b/	57	52	91
Volta Redonda	48	41	86
Huachipato	44	36	89
Belencito	45	34	88
Monclova	44	31	84
Chimbote	47	41	86
Barcelona c/	43	45	82

a/ See document L.91, Table 14. It has been estimated that the following part of costs of integrated plants (mining themselves the main raw materials) have to be paid for in foreign exchange:

Imported fuel	100 per cent
Ferroalloys	50 per cent
Wages and salaries	5 per cent
Miscellaneous	33 per cent
Capital charges	75 per cent

b/ Using Sierra Grande ore.

c/ Using coke from imported coal

d/ To estimated Sparrows Point costs at plant, transport costs to the Latin American markets have been added, and the transport costs of Latin American plants to their markets have been substracted.

Relative Capital Intensity of Steelmaking and of Other Productive Activities

Capital is a scarce factor of production in all Latin American countries. As a consequence, the productivity of capital in steelmaking as against other activities should be studied carefully. It has already been noted that steelmaking has a high capital intensity relative to other activities.

/Table 10.

Table 10. Investment Coefficients [a] Corresponding to Steelmaking in Various Locations

Plant	Erection of new plants appropriate to the size of the markets
San Nicolas [b]	4.9
Volta Redonda	4.8
Huachipato	4.9
Belencito	4.5
Monclova	4.8
Chimbote	5.4
Barcelona [c]	4.9
Sparrows Point	5.2

[a] Ratio between investments necessary to produce a certain quantity of steel and value added by the production process.

[b] Using Sierra Grande ore.

[c] Using coke made from imported coal.

In other words the relationship between capital investments, and the value added to raw materials in the corresponding productive process (investment coefficient), is relatively high.

Investment coefficients for various Latin American locations and sizes of plant are shown in the first column of Table 10. The values vary considerably, although remaining above a typical figure for other manufacturing activities, which would be between 2 and 3. This drawback of steel production should be borne in mind when examining the problem of the economic advisability of the setting up of steel plants. This becomes especially relevant for countries where domestic capital is very scarce, and credits from international lending agencies have to be used for other projects related to economic development.

In several Latin American countries, and in four of the locations studied (Volta Redonda, Huachipato, Belencito and Monclova) important steelmaking plants already exist. The marginal capital coefficients giving the relationship between the additional capital necessary to increase production and the resulting value added, should be examined. The figures used in L.91 do not permit an analysis of this type, but it should be remembered that expansion thus far made in Latin American steel plants has resulted in a decrease of investment per unit of production.

It should not be forgotten that the establishment of a domestic source of steel is often a pre-requisite for the development of steel transforming industries which are less capital intensive than steelmaking. Thus it can be seen from document L.88 that the relationship between investment coefficients in steelmaking (taken as 100), and in various sectors of the steel transforming industry are as follows:

Percentage of Capital Coefficients in Steel Transforming Industries in Relation to Capital Coefficient in Steelmaking, the Respective Value of the Latter Being 100

	Brazil 1949	Chile 1948	United States a/ 1945
Primary transformation of steel (wire, screws, tubes, drums, etc.)	52	92	..
Mechanical industries	30	53	46
Transport equipment industries	83	75	32

a/ Combined coefficient for steelmaking and primary transforming industries.

Limitations of time have prevented the preparation of a study on the combined investment problem of steelmaking and steel transforming industries, whose importance is brought out by the preceding figures.

The capital costs used in document L.87 correspond to the utilization of new and very modern equipment, and could be reduced substantially if the utilization of second-hand equipment were considered. Such a solution would also reduce the absolute bulk of the investments which, independently from considerations of the productivity of capital, may prove a deterrent to the setting up of steel plants. 1/

6. Other Factors Affecting the Economics of Steelmaking in Latin America

The nature and scope of the studies presented in document L.87 and L.91 have limited the number of cases examined, and of cost comparisons made. It should be remembered, however, that the cases studied are only taken as

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1/ It may also be borne in mind that for many Latin American countries, the foreign exchange saving effect of capital investment in steel production as compared with other activities, may be more important than the relationship between capital and value added. A comparison between the savings in foreign exchange which could be obtained with the investment of a certain amount of capital in a variety of sectors should complement the figures of Table 10.

/examples of

examples of costs corresponding to steel production in selected Latin American countries and elsewhere. No doubt, a careful examination of additional factors would be indispensable in order to form a complete opinion on the problem of costs within any given Latin American country, and of their comparison with the costs of imported steel.

1. Specialization of Production

Production costs would be considerably reduced if, instead of plants turning out an assortment of finished products wide enough to cover almost all the needs of a country, consideration was given to the setting up of specialized plants. An important reduction in costs could be obtained if production was limited, for instance, only to sections (bars, shapes, wire rods, possibly rails), to flats (plate, sheet, tinplate), and also possibly to tubes or, at a later stage, to alloy steels. For the major consuming countries, such specialization may take place within the country itself. For the others it would only be conceivable if some degree of intra-regional integration takes place.

The considerable economies of scale connected with the production of flat products, which is not conceivable in small hand operated mills, would be optimum only on continuous wide strip mills producing more than one million tons of finished products a year. It could therefore be more readily attained if an almost complete integration took place in South America, inasmuch as consumption of flat products in the area during 1950-1951 was only some one million tons.

A reduction in the cost of steel production in Peru could be obtained if substantial quantities of semi-finished products (as pig iron or crude steel) were exported, for instance to Argentina. This fact, together with the abovementioned benefits deriving from specialization, points to the necessity of considering at some stage at least a partial Latin American integration in the field of steel production and trade.

2. Factors Affecting the Cost of Imported Steel

Throughout document L.91 the foreign production centre analysed for purposes of cost comparisons with Latin American locations, is a plant at Sparrows Point, Maryland, operating with imported Venezuelan ore. In addition to the costs of production in this location, and the transport

/costs to

costs to Latin America, other factors can strongly affect the cost of imported steel to Latin American countries. Such factors include production costs in other locations outside Latin America; the transport costs connected with them; and the pricing policies of exporters.

a) Costs of production of steel in various locations outside Latin America

The same factors as those influencing costs of Latin American steel production should be borne in mind for other countries, except perhaps alternative reduction processes. The application of these processes to industrialized regions which already possess abundant "classical" steelmaking equipment and operate on a large scale, appears more remote than in Latin American countries which are not yet equipped and have smaller markets.

It is impossible to give detailed considerations here of the relative costs of steel production in various North-American, European and possibly Japanese locations. It should, however, be borne in mind that production costs of the hypothetical plant in Sparrows Point, using exclusively Venezuelan ore, are not truly representative of typical production costs in the United States. It is more than probable that the costs calculated in document L.91 for the Sparrows Point Plant are higher than the average United States costs. On the one hand the capital charges taken into account are higher than those corresponding to existing United States installations, many of which are completely amortized and almost all of which have been built at a time when the costs of equipment were considerably lower than now. On the other, assembly costs of raw materials for Sparrows Point are higher than average United States costs. The difference may be of the order of 5 to 10 United States dollars per ton, at 1948 prices.

When comparing the United States and other main producing areas, reference may be made to recent studies of the United Nations Economic Commission for Europe, concerning competition between European, North American and Japanese steel in third markets. The conclusion was drawn that, on the whole, European steel production costs are competitive with those in the United States and in Japan. Europe may have an advantage for merchant products (bar, shapes, etc.) and a disadvantage in flats.

/Turning now

Turning now to specialization, this involves an advantage for non-Latin American producers. United States plants and an increasing number of European plants (particularly since the creation of the European Coal and Steel Community) can specialize and thus reduce costs. The United States has held an important cost advantage over Europe, and over Latin America (unless some intra-regional integration takes place) in flat products. Some 63 per cent of the latter are produced on continuous wide strip mills in the United States. Flats represented more than one quarter of Latin American consumption of steel in 1951, and the proportion should increase substantially as industrialization progresses. In view of the fact that Europe is also equipping itself at present with numerous wide strip mills, imports of flat products may well remain more advantageous for many Latin American countries than local production.

b) Price policies and transport costs

So far consideration has only been given to steel production costs in the United States and in Europe, and not to the price at which it may be sold to Latin American importers. Apart from one fact already mentioned, namely that profit rates considered to be "normal" are smaller outside Latin America than within the region, two other factors considerably influence the cost of imported steel. These are the pricing policies of steel exporters, and transport costs of finished steel. An examination of pricing policies cannot be included here, and little speculation may be undertaken as to how they may affect the cost of steel imported into Latin America in the future.

Actually, considerable differentials have been observed in the past. European exporters (who accounted for 70 to 80 per cent of Latin American imports in the thirties and for about two-thirds at present), tended in general to quote exports below home-market prices before Word War Two especially during the depression years. Conversely, in post-war years when steel has generally been scarce, considerably higher prices were quoted for exports than for deliveries to the European home market. A detailed examination of

/quotations of

quotations of various European countries and of United States is available in a recent study of the United Nations Economic Commission for Europe.

A reasonable supposition to be made is that world market prices will continue to exceed home-market prices so long as steel remains scarce. However, the considerable increases in steelmaking capacity taking place in the United States and in Europe, and the possible return of a seller's market when rearmament demand slackens, could well result in a decline of export prices.

Throughout 1948, the base year used for these calculations, steel prices in the exporting countries remained high, as did prices in Latin America. In order to obtain a basis for comparison more realistic than cost estimates for Sparrows Point, the average United States prices were chosen for an assortment similar to that imagined as a programme for the Latin American locations. The figures correspond to the series entitled "composite finished steel", prepared by the American Metal Market, plus transport cost differentials as explained elsewhere in this report. The final total obtained is substantially higher than the "delivered costs" from the hypothetical Sparrows Point plant.

No consideration has been given in this study to the commercial policy of importing countries, nor to the protection which domestic steel may derive from customs duties or other discriminatory practices. On the whole, it appears from Table 8 that many Latin American steel locations might not require any tariff protection, except perhaps for a few initial years where productivity will be below traditional producing centres. 1/

Insofar as transport costs, particularly maritime freight rates, are concerned, their variations are often more pronounced than world price fluctuations. For this reason, and in view of the impossibility of taking account of such factors as the existence of return freights, congestion of ports and demurrage charges, etc., the allowance made for them in the preceding chapter should be considered as indicative only.

1/ This applies to steelmaking only. The question of the relative costs of production and of imports for steel transforming industries and of the corresponding commercial policies would require a special investigation.

/In making

In making comparisons between delivered costs from Sparrows Point, and from the United States and European production centres, the following considerations should be borne in mind:

a) In relation to the principal United States producing centres located inland and particularly to the midwestern mills, Sparrows Point has a definite freight advantage, since it is closer to the port of export. In the case of the inland plants, compared with Sparrows Point, there are lower freight charges for delivery of ores to plant. The higher charges for transferring the steel to port [1] offset this advantage. Thus, Sparrows Point is most probably no worse on the whole than typical United States producers. The comparison of Latin American costs with costs of steel imported from Sparrows Point, therefore appears to be justified.

b) Insofar as comparison between steels imported from Europe and the United States is concerned, it is understood from the study by the Economic Commission for Europe that freight costs from European ports, and from ports located on the Atlantic seaboard of the United States, are of the same order of magnitude. The fact that Europe and the United States have approximately the same production costs has already been mentioned.

3. Factors not Directly Linked to Relative Costs of Production, nor to Imports

In addition to the considerations already mentioned, which directly affect costs of steel production, and of steel imports into Latin America, a certain number of other aspects may be borne in mind. Three important ones will be mentioned hereunder:

Regularity of the volume of steel supplies

The capacity to import of many Latin American countries is not only limited, but in addition may fluctuate widely, depending upon changing levels of world economic activity. Fluctuations in demand for, and in prices of raw materials are usually more pronounced than fluctuations in world income or production. A local steel industry producing most of a country's requirements, would also serve to reduce the dependency upon foreign exchange

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[1] In 1948 the cost of rail haul from Pittsburg to New York was of the order of 12 dollars per ton.

/reserves as

reserves as a means of buying imported steel. Thus, part of the influence of international economic fluctuations would be eliminated. [1]

This is particularly important for countries developing steel transforming industries, since they will require a regular supply of steel in order to prevent idle manpower and equipment in periods of slack demand.

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[1] From 1928 to 1952 Argentine and Brazilian steel consumption fell more than three times.

/CHAPTER VI.

CHAPTER VI. CONCLUSIONS RELATING TO QUALITIES AND SPECIFICATIONS FOR STEEL PRODUCTS

INTRODUCTION

The term "steel" covers a wide range of iron products containing small proportions of a series of other elements, which give them different properties as regards tensile strength, suitability for hot or cold working, resistance to temperature changes, shock strength and so on. Consequently, not all steels are suitable for a given purpose, and inversely, a widely varying range of steel types may be used in a large number of different ways.

Steel standards and specifications are used to avoid the necessity for direct contact between consumer and steel manufacturer in establishing the properties of a given product.

Potential variations in steel composition and properties are such that it is essential to have a reasonable degree of uniformity between qualities made in different iron and steel plants. Such specifications are in no way intended to serve as a guide to inexperienced designers, but rather so that the consumer may verify to what extent materials can be adapted to the specific aim in view.

In highly industrialized countries, specifications usually set fairly narrow limits for impurities in steel. This is due to the considerable benefits accruing to consumers from their respective mass production methods, which become applicable if the differences in properties of similar types of steel are reduced to the closest limits. Variations in the properties of steels are, on the other hand, much less important if the metal is transformed on a smaller scale. Within certain limits, therefore, there would be some justification for the Latin American steel industry to allow slightly wider tolerancies for impurities in steels to be used within the region.

Some of the properties and composition of finished steels are imposed by the nature of the raw materials used, whereas others depend on the process selected for refining the steel, or on the heat and mechanical treatment employed during the final stages of production. Discrepancies

/in the

in the degree of accuracy used in obtaining most of these factors have pernicious effects which can be offset to a greater or lesser degree by means of special treatments; but these treatments, in keeping within the small range controls for the content of certain components, usually increase the production cost of the steel.

For these reasons the agenda of the Bogota meeting included a section on the study of the Latin American market as regards the types of steel required and the possibilities of suppying such requirements through existing or projected industries. During the course of the discussions, the view was expressed by several participants that, since local markets have a great number of characteristics in common, it would perhaps be convenient to adopt immediately standard steel specifications in the seven countries now producing or planning to produce steel, and also to try and ensure that these standards were adopted for the rest of Latin America.

Six pertinent papers were presented to the meeting, two of them by Latin American authors. Of these, one (document L.80) describes the specifications and limits laid down in a given plant to control the proportions of the various components, during the course of manufacture. The second (document L.78) is a detailed comparison of specifications accepted in a number of Latin American countries and in the more industrialized countries. Of the papers presented by non Latin American participants, document L.70 deals with control of quality during production processes at the plants, while L.76 explains the reasons for adopting different standards for various types of specifications in two highly industrialized countries, viz., the United Kngdom and the United States. A further paper (document L.75) explains to what degree some "minor elements" influence the characteristics of plain carbon steels. The last, document L.71, refers to a special problem, manufacture of steel rails by the Thomas process in France, this subject being of particular interest for Latin America in view of the phosphorous content of several deposits.

General Classification of Specifications and Their Usage

It may be concluded from the aforementioned papers, and in particular from document L.76, that the following criteria are usually considered in

/order to

order to lay down standard specifications: a) mechanical properties, b) chemical composition, c) response to heat treatment.

The determination of one or more of the criteria laid down in the specifications is essential to ensure that the steel will conform to the required standard. For instance, for a steel sold on the basis of mechanical properties, it will be necessary during the refining process to control the chemical composition, as this is the only existing guide to know whether the finished steel is likely to comply with the requirements as regards its mechanical properties.

Based on these factors, there exist three large groups of specifications:

a) Those specifying mechanical properties only;
b) Those specifying chemical composition only, and
c) Those specifying both mechanical properties and chemical composition.

Some other factors are included in each group, but these three main sub-divisions constitute the most important classification. One such factor, mention of which should not be omitted, is the relationship between specifications prepared according to the criteria given above and the method of steel refining employed. For many applications, steel produced by a certain method is prescribed, or alternatively, there are two or more different specifications, according to which refining process has been used. This is due to the fact that, with the present development of techniques, the various steel manufacturing processes result in the inclusion of relatively constant proportions of minor impurities. The mention of the process, therefore, automatically sets certain limits.

a) Specifications Based on Mechanical Properties

This group is confined to carbon steels produced by hot rolling, and, in very small degree, to those which are cold rolled. It is under these specifications that the bulk of the tonnage used is produced and sold, while the mechanical tests prescribed have been designed especially to reproduce the conditions to which the steel will be subjected in practice.

All these specifications include tensile and ductility tests. To meet the combination of minimum tensile strength and minimum ductility, the steel manufacturer has to control de carbon content. The minimum is governed by the tensile strength and the maximum, by the ductility. It is also necessary to control the manganese, the other alloys, and the finishing temperature in the rolling mill.

Steels forming the high-tensile group are seldom specified on the basis of mechanical properties alone, as there are at least three ways of increasing tensile strength, each of them resulting in a different type of steel. These are: a) simply to increase the carbon content; b) to increase the content of allying elements, and c) by cold working.

b) Specifications Based on Chemical Composition Only

In this group is included predominantly the steel intended for secondary transformation, in contrast to the previous group, which is used almost exclusively for structural work. As regards these specifications, there is a difference between the practice in United States on one hand and Europe on the other, due to the size of the markets. In actual practice if a steel is to be bought on the basis of chemical compositions alone, the content of the various elements must be known fairly accurately if the mechanical properties of the product are to be in any way predictable. This applies particularly to carbon content. The permitted limits are generally narrower than those which can economically be obtained in the steel mill from heat to heat. For instance, if a 0.3 carbon steel has been ordered, the consumer needs to be certain that it will not vary beyond 0.27 and 0.32 per cent carbon, otherwise tensile strength or ductility will be affected. This range is almost equivalent to what may be expected as the variation from heat to heat. Due to the heterogeneous nature of the steel it is inevitable that an occasional heat will fall outside these limits. A study of United States specifications shows that this drawback is overcome by having a series of specifications with contiguous carbon ranges, so that a heat which is outside the limits fixed for one specification may fall within those of another.

This practice leads to the establishment of a large number of specifications, and is only feasible where there is a substantial market, as in United States.

In the United Kingdom, the use of chemical composition alone, as regards carbon steel, is confined to the manufacture of sheet, strip and

/wire, particularly

wire, particularly when these products are cold rolled. The standards laid down establish fairly broad limits for the carbon content, but this is probably due to the fact that in Great Britain cold rolling is generally done by other companies which fix their own specifications for their contracts. In any case, it is always possible to influence the mechanical properties of steels, for which specifications have been based on the chemical composition alone, by varying the heat treatment during the subsequent elaboration process.

The above applies to steels for use in cases where mechanical strength is the main consideration, but there is also a wide field for using those in which the most important property is ductility. Such are the steels used for pressings and deep drawing. Up to the present no mechanical testing method has been developed for determining the amenability of a steel for processes other than the simplest cold forming operations. The chemical composition of the steel is probably the weightiest single factor, and, generally speaking, the more drastic the deformation process, the lower must be the carbon content. The close control of the chemical composition is therefore essential, and this explains the large number of specifications for very low carbon steels calling for a strict control during refining processes.

c) Specifications Based on Both Mechanical Properties and Chemical Composition

In the highly industrialized countries the specifications based on mechanical properties, combined with limits for impurities, cover a large proportion of the steel made, probably greater than the proportion covered by specifications based on mechanical properties alone.

There has been considerable discussion for many years as to the really fundamental limits for impurities, such as phosphorus and sulphur. Whatever criterion is adopted in this matter, there will always be, in practice, the occasional heat which is outside the set limits. These can often be accepted by the purchasers when the manganese content and the heat treatment to which the steel is to be subjected are taken into account. This should not, however, be used as an argument for gradually increasing the acceptable limits.

/As regards

As regards impurities, the slag content should also be considered; this rarely appears in norms, except perhaps in some general statement to the effect that the steel should be clean.

Steels for welding purposes comprise a group which falls within this type of specification. According to document L.78, such steels should be defined by their mechanical properties, limits being also set for the contents of carbon, silicon and degrees of purity as regards phosphorus and sulphur. According to L.75, the purity of the electrode has more influence on the welding strength than that of the pieces to be joined, as the composition of the metal of the "bead" is more important than that of the pieces themselves, and most of the metal for this bead comes from the electrode.

Bases for Standardization and Specifications in Latin America

Probably over 70 per cent of the steel used in the region is intended for direct use in railways or construction work, while only a small part is intended for subsequent elaboration in transforming industries. Specifications based on mechanical properties are obviously sufficient for the first group, with the possible exception of welding steels.

As regards the group used by industries, it should be borne in mind that the information transcribed above from document L.76, concerning the fact that the method on which the United States A.S.T.M. [1] specifications are based, leads to the formation of an excessive number of groups of steel, many of which can have no application on smaller markets, even those of the United Kingdom, for example.

On the other hand, the raw materials found in many of the countries do not facilitate economic production of steels in open-hearth furnaces. This process is the most widely used in the United States, and on it most of their standards are based. Those raw materials are, however, suitable for producing almost equivalent steels made by other methods, such as the converter with oxygen enrichment, one of which will shortly be installed in Brazil.

There are also Latin American raw materials useful for the production of other types of steels, with somewhat more rigid applications such as

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1/ The American Society for Testing Materials.

/ordinary Bessemer

ordinary Bessemer and Thomas steels, although it is open to doubt whether these steels are adaptable to certain uses which impose severe conditions on the material. An example of this position is described in paper L.71, dealing with the efficient use of Thomas steel rails in France. In connexion with this same subject, it was pointed out during the Bogota meeting that in the United Kingdom, for many years, preference has been given to rails made of Bessemer steel, which have given very good results, and are now becoming too expensive because of the scarcity of suitable ore.

Due to the combined action of such factors as the small size of the markets, the structure of the steel transforming industries, and the restricted sources of raw material, it was the opinion of many of the participants, both from the region and the more highly industrialized countries, that the Latin American countries might do well to establish their own standards for the qualities and types of steel they produce. There would therefore appear to be some justification for calling a meeting, to be attended by the respective governments and the representative organizations of consumers and producers of iron and steel, in order to study and propose specifications which could be adopted by all the countries in the region, and at which the particular conditions described above would be taken into account.

At such a meeting, an excellent basis for discussion would be the material contributed in papers L.75, L.76, L.78 and L.80, as well as transcriptions of the relevant debates during the sessions of the Bogota meeting.

ANNEX I A LIST OF LATIN AMERICAN EXPERTS PARTICIPATING IN THE MEETING

Name and country	Institution or firm	Dates of attendance October	Dates of attendance November
Argentina			
Martijena, Teniente Coronel Armando	Director Altos Hornos de Zapla Fabricaciones Militares Cabildo 65 Buenos Aires	12	4
Llorens, Ing. Emilio	Consulting Economist General Lavalle 125 Temperley Buenos Aires	19	5
Legrand, Ing. Augusto	Sociedad Mixta Siderúrgica Argentina Viamonte 542, Ier. piso Buenos Aires	21	4
Brazil			
Lanari, Prof. Amaro	Escuela Politécnica Universidad de Sao Paulo, representing the Associaçao Prasileira de Metais Praza Fermando Prestes 110 Sao Paulo	13-26	
Macedo Soares e Silva, General Edmundo de	Presidente Companhia Aços Especiais Itabira 12 Avenida Nilo Peçanha Rio de Janeiro	27	4
Pyles Lozano, Engenheiro Eduardo	Companhia Mineraçais do Brasil Rua Senador Queiroz 667 Sao Paulo	11-26	
Pinto Da Veiga, Colonel Osvaldo	Chief, Raw Materials, Companhia Siderúrgica Nacional 13 Avenida 13 Maio Rio de Janeiro	20-26	

/Costa Lino

Name and country	Institution or firm	Dates of attendance	
		October	November
Costa Lino, Engenheiro Jorge	Chief Metallurgist Altos Fornos da Companhia Siderúrgica Nacional 13 Avenida 13 Maio Rio de Janeiro	20-31	
Villela, Engenheiro Tarciso	Cost Accountant Companhia Siderúrgica Nacional 13 Avenida 13 Maio Rio de Janeiro	19	1
Paiva Abreu, Dr. Alvaro de	Chief Laboratorio da Producao Mineral, Departamento Nacional da Produçao Avenida Pasteur 404 Rio de Janeiro	13-22	
Prado Uchoa, Engenheiro **Martinho**	Consulting Engineer Avenida Cidade Jardim 138 Sao Paulo	13-31	
Anawate, Prof. Henrique	Escola de Engenharia Universidade do Rio Grande do Sul Porto Alegre	19	1
Chile			
Vucetich, Ing. Danilo	Administrator, Altos Hornos de Corral Compañía de Acero del Pacífico Bandera 80 Santiago	15	4
Canguilhem, Ing. Héctor	Laboratorio Metalúrgico Compañía de Acero del Pacífico Bandera 80 Santiago	12	4
Peralta Martínez, Dr. Ing. Orlando	Observer Avenida Caracas # 23-36 Bogotá, Colombia	13-31	

/Albala, Ing.

Name and country	Institution or firm	Dates of attendance	
		October	November
Albala, Ing. Américo	2° Superintendente Departamento de Coquería Compañía de Acero del Pacífico Bandera 80 Santiago	12	4
Colombia			
Ospina Hernández, Dr. Mariano	General Secretary of the Meeting		
Jaramillo Ferro, Dr. Roberto	Manager Empresa Siderúrgica Nacional de Paz de Río, S.A. Bogotá	13	5
Ceballos, Dr. Juan de Dios	Manager Instituto de Fomento Industrial Bogotá	13	5
Villaveces, Dr. Carlos	Ministro de Fomento Bogotá	13	5
Noguera, Dr. Rodrigo	Ministro de Minas y Petróleos Bogotá	13	5
Córdoba, Dr. Jaime	Secretario Técnico Presidencia de la República Bogotá	13	5
Llorente, Dr. Rodrigo	Subsecretario de Asuntos Económicos Ministerio de Relaciones Exteriores Bogotá	13	5
Recio, Dr. Marino	Coordinador de Programas Ministerio de Fomento Bogotá	13	5
Velásquez, Dr. Jorge	Manager Siderúrgica de Medellín	13	5
Alvarez Cerón, Dr. Julio	Universidad Industrial de Santander	13	5

/Fajardo, Dr.

Name and country	Institution or firm	Dates of attendance	
		October	November
Fajardo, Dr. Leonardo	Facultad de Química Universidad Nacional Bogotá	13	5
Prieto, Dr. Joaquín	Assistant Manager Empresa Siderúrgica Nacional de Paz de Río, S.A. Bogotá	13	5
Cock, Dr. Julián	Manager Instituto de Fomento Eléctrico Bogotá	13	5
Alvarado, Dr. Benjamín	Assistant Manager Empresa Siderúrgica Nacional de Paz de Río, S.A. Bogotá	13	5
Vargas, Dr. Alberto	Assistant Manager Instituto de Fomento Industrial Bogotá	13	5
Uribe, Dr. Silvano	Ministerio de Minas y Petróleos Bogotá	13	5
Caballero Escobar, Dr. Enrique	Asociación Nacional de Industriales Bogotá	13	5
Jaramillo, Dr. Enrique	Manager Siderúrgica del Muiña	13	5
Garcés C., Dr. Bernardo	Empresa Siderúrgica Nacional de Paz de Río, S.A. Bogotá	13	5
Jaramillo, Dr. Jorge	Manager Talleres Centrales Bogotá	13	5
Suárez, Ing. Ramón	Empresa Siderúrgica Nacional de Paz de Río, S.A. Bogotá	13	5
Wokittel, Ing. Robert	Consultant Avenida Caracas 33-29 Bogotá	13	5
Bruckmann, Dr. K.	Universidad Nacional de Bogotá	13	5

/México

Name and country	Institution or firm	Dates of attendance	
		October	November
México			
Aramburu, Ing. Marcelo	Departamento de Investigaciones Industriales Banco de México México, D.F.	13	4
Cortés Obregón, Ing. Salvador	Departamento de Investigaciones Industriales Banco de México México, D.F.	10	4
Marín Gonzalez, Ing Manuel	Departamento de Investigaciones Industriales Banco de México México, D.F.	11-31	
Araiza, Ing.Evaristo	Vicepresidente Compañía Fundidora de Hierro y Acero de Monterrey, S.A. México, D.F.	23-30	
Gonzalez Ballesteros, Ing. Alfredo	Assistant Superintendent Departamento de Altos Hornos Compañía Fundidora de Hierro y Acero de Monterrey, S.A. Monterrey, Nueva León	14	3
Morales, Ing. Narciso	Compañía Fundidora de Hierro y Acero de Monterrey, S.A. Monterrey, Nueva León	16-30	
Sada, Ing. Pablo M.	General Superintendent Altos Hornos de México,S.A. Monclova, Coahuila	19-26	
Gonzalez Vargas, Ing.F.	Departamento de Investigaciones Industriales Banco de México México, D.F.	19-26	
Garza Sada, Ing.Bernardo	Hojalata y Lámina,S.A. Monterrey, Nueva León	19-24	

/Chávez, Ing.

Name and country	Institution or firm	Dates of attendance	
		October	November
Chávez, Ing. Servando	Metallurgist Paicaví 140-8 Concepción Chile	17-28	
Perú			
Salazar, Ing. Luis	General Manager Banco Minero del Perú Lima	11-20	
Ballon, Ing. Alfonso	Director del Departamento de Siderurgia, Corporación Peruana del Santa Lima	18-26	
Venezuela			
Avendaño, Lic. Hernán	Departamento de Investigaciones Económicas Banco Central de Venezuela Caracas	15	4
Otero, Ing. Andrés Germán	Departamento de Investigaciones Económicas Banco Central de Venezuela Caracas	19-26	
Lara Labrador, Dr. Bernardo	Director Corporación de Fomento Caracas	15-29	
Croce, Sr. Francisco	Observer Consejo de Economía Nacional Caracas	20-31	
Pacanis, Sr. Luis Carlos	Observer Gerente de Servicio Técnico Corporación Venezolana de Fomento Caracas	15-19	
Alamo, Sr. Antonio	Observer Sindicato Venezolano de Hierro Caracas	19-26	

/Gamboa, Sr.

Name and country	Institution or firm	Dates of attendance	
		October	November
Gamboa, Dr.Argenis	Ministerio de Minas e Hidrocarburos Caracas	18	5
Mendoza, Sr. Eugenio	Sindicato Venezolano de Hierro Av. Vollmer N° 1 Caracas	19	4
Paradisi, Dr. Carlos	Director del Departamento de Minas - Ministerio de Minas e Hidrocarburos Caracas	12-22	
Sturgeon, Mr. John	Observer Comité de Desarrollo Industrial Creole Petroleum Corp. Apartado 889 Caracas	11-18	
Roncayolo, Dr. Luis A.	Director Sindicato Venezolano de Hierro Av. Vollmer N° 1 Caracas	13-31	
Boulton, Mr. Henry L.	Consejo de Economía Nacional Caracas	21-26	
Sherover, Mr. Miles M.	Presidente Siderúrgica Venezolana,S.A. "Sivensa", Caracas	19-24	
Vollmer, Dr. Alberto	Director Sindicato Venezolano de Hierro Av. Vollmer N° 1 Caracas	19-24	
Lobo, Señor David	Asesor Técnico Corporación Venezolana de Fomento Caracas	15	5

/ANNEX I B

ANNEX I B — LIST OF EUROPEAN AND NORTH AMERICAN EXPERTS PARTICIPATING IN THE MEETING

Name and country	Institution or firm	Dates of attendance	
		October	November
Belgium			
Coheur, Monsieur P.	Directeur du Centre National de Recherches Metallurgiques 4 Place d'Italie Liège	11	3
Charlier, M. Pierre	Ateliers de Construction Electrique de Charleroi Charleroi	13-31	
Canada			
Cavanagh, Mr. P.E.	Ontario Research Foundation 43 Queen's Park Toronto 5.	8-30	
France			
Allard, M. Marc	Directeur Adjoint de l'Institut de Recherches de la Siderurgie 185 Rue du Président Roosevelt Saint Germain-en-Laye S. et O.	11	7
Boutigny, M.	Directeur de la Societé Stein et Roubaix 24 Rue Erlanger Paris 16 e.	13-29	
Cheradame, M.Raymond	Directeur Général Adjoint Centre d'Etudes et Recherches des Charbonnages de France 9 Avenue Percier Paris 8e.	10-21	
Decherf, M, Edouard	Empresa Siderúrgica Nacional de Paz de Río 42 Avenue George V Paris 8e.	11	5

/Schereschewsky, M.F.

Name and country	Institution or firm	Dates of attendance	
		October	November
Schereschewsky, M.F.	Ingénieur des Mines 7 Rue de Madrid Paris 8e.	12	5
Palmé, M. Jean	Ingénieur de la Societé Nationale des Chemins de Fer Français 191 Rue Lafayette Paris 10e.	11	4
Belugou, Monsieur	Observer Ing. Principal Centre d'Etudes et Recherches des Carbonnages de France 9 Avenue Percier Paris 8e.	13-19	
Mercier, Monsieur A.	Directeur Général de la Societé d'Etudes et d'Enterprises Siderurgiques 15 Rue Pasquier Paris 8e.	11	4
Perin, Monsieur Gabriel	Alsthom 38 Avenue Kléber Paris 16e., France	11	5
Richards, Monsieur R.S.	Etablissement Delattre et Frouard Réunis 39 Rue de la Bienfaisance Paris 8e.	15	2
Turpin, M. Jacques	Societé de Preparation Industrielle des Combustibles 45 Rue St. Honoré Fontainebleau (S et M)	11	2
Jung, Monsieur R.L.	Alsthom 38 Avenue Kléber Paris 16e.	11	5
<u>West Germany</u>			
Baum, Dr. Ing. Kurt	Consulting Engineer Paneuropéenne d'Installation d'Equipments Industriels 29 Graf Bernadotte Strasse Essen	10-22	

/Bulle, Dr.

Name and country	Institution or firm	Dates of attendance	
		October	November
Bulle, Dr. Ing. Georg	Gutehoffnungshütte Oberhausen A.G. Work Sterkrade Oberhausen-Sterkrade.	15-29	
Johannsen, Dr. Ing. F.	Institut für Metallhüttenwesen und Elektrometallurgie Bergakademie Clausthal Clausthal-Zellerfeld 1	19-25	
Krebs, Dr. Ing. E.	Obering der Hüttenwerke Rheinhausen A.G. Rheinhausen	20-30	
Walde, Dr. Ing. H.	Direktor der Demag- Elektro Metallurgie A.G. m.b. H.Karlsruhe	20-27	
Wasmuth, Dr. Habil W.R.	Observer Ferrostal, Essen	11	5
Norway			
Ydstie, Mr. B.	Elektrokemisk S.A. 10 Park Avenue New York, N.Y.	13-30	
Sem, Mr. M.O.	Elektrokemisk S.A. 10 Park Avenue New York, N.Y.	18-30	
Sweden			
Kalling, Prof. Bo	Director of Research Stora Kopparbergs Bergslags Aktiebolag Domnarvet	13-25	
Switzerland			
Despres, Monsieur Jean R.	International Labour Office Géneva, Switzerland	9	1
Durrer, Prof. Robert	Managing Director Louis de Roll Iron Works Limited Gerlafingen, Switzerland	16-22	

/United Kingdom

Name and country	Institution or firm	Dates of attendance October	November
United Kingdom			
Saniter, F., Esq.	The United Steel Companies Ltd. 17 Westbourne Sheffield 10, England (British Iron and Steel Federation)	11	5
Waring, H.W.A., Esq. C.M.G., A.C.A.	Director Industry Divisions Economic Commission for Europe Palais des Nations Géneva, Switzerland	18	5
United States			
Buehl, Dr. Rusell C.	Bureau of Mines, Region VIII U.S. Department of the Interior 4800 Forbes Street Pittsburgh 13, Pa.	19	1
Buell, Mr. William C. Jr.	Arthur G. McKee and Company 2300 Chester Avenue Cleveland, Ohio	13-29	
Fraser, Mr. Thomas	Bureau of Mines U.S. Department of the Interior Washington 25, D.C.	12-22	
Fitterer, Mr. G.R.	Dean, The Engineering School University of Pittsburgh 106 State Hall Pittsburgh, Pa.	19-25	
Boulger, Mr. Francis	Metallurgist Battelle Memorial Institute Columbus, Ohio	19-29	
Collester, Mr. M.D.	Arthur G. McKee and Company 2300 Chester Avenue Cleveland, Ohio	13-22	
Khalife, Sr. Miguel	Mexico Refractories Company Mexico, Missouri	11	5

/Newhall, Mr.

Name and country	Institution or firm	Dates of attendance	
		October	November
Newhall, Mr. H.S.	Pittsburgh Lectromelt Furnace Corporation P.O. Box 1257 Pittsburgh, Pa.	18-26	
Ospina, Sr. Alfonso	Observer Pittsburgh Lectromelt Furnace Corporation P.O. Box 1257 Pittsburgh, Pa.	14	5
Powell, Dr. A.R.	Koppers Co.Inc. Koppers Building Pittsburgh 19, Pa.	9-24	
Philbrook, Prof. W.O.	Carnegie Institute of Technology Schenley Park Pittsburgh 13, Pa.	18-26	
Price, Mr. J.D.	The Colorado Fuel and Iron Corporation Pueblo, Colorado	9-23	
Ramseyer, Mr. C.F.	Ramseyer and Miller Inc. 11 West 42nd. Street New York 18, N.Y.	20-28	
Storms, Mr. F.H.	Vice-President Iron Minas Company of Venezuela Apartado 2271,Caracas	16-30	
Schlesinger, Mr. K.	Observer United Engineering and Foundry Company Pittsburgh, Pa.	19-27	
Woodhead, Mr. Robert	McNally Pittsburg Manufacturing Corp. Pittsburgh, Pa.	14-26	
Abbey, Mr. Robert	General Refractories Co. 1520 Locust St. Philadelphia, Pa.	16-31	
Italy			
Indaco, Ing. Dr. Francisco	Observer Engineer of TECHINT, Compagnia Tecnica Internazionale Paseo de la Reforma 107 México, D.F. Mexico	19	4

ANNEX II LIST OF DOCUMENTS AND TECHNICAL PAPERS PRESENTED TO THE EXPERT WORKING GROUP ON IRON AND STEEL INDUSTRY IN LATIN AMERICA

Number	Author and Title of the Document
L.0	Ramón Suárez, Colombia. Brief Outline of Steel Industries in some Latin American Countries.
L.1	R. Cheradame, France. Considerations on Coal Washing in Europe and its Possible Applications to Latin American Coals.
L.2	Thomas Fraser, United States. Problems in the Preparation of Metallurgical Coal in Latin America.
L.3	J. Turpin, France. Modern Techniques and Installations for the Mechanical Treatment of Coal by the "Societé de Préparation Industrielle des Combustibles".
L.4	J. Griffen, United States. The Tromp Heavy Media Coal Washing Process.
L.5	A. Paiva Abreu, Brazil. Notes on the Production of Metallurgical Coal in Brazil.
L.6	A. González, Chile. Description of Chilean Coals Used in the Steel Industry.
L.7	J. A. Prieto I., J. A. López T., P. Alvarado and V. Suárez H., Colombia. Problems Related to Colombian Coal Used for Steel Making.
L.8	S. Cortés Obregón, México. The Coal Used in the Mexican Iron and Steel Industry.
L.9	Walter Vogel, Chile. New Procedures for Reduction of Impurities in Coals with Finely Distributed Ashes.
L.10	K. Baum, Western Germany. The Washing of Peruvian Anthracite Fines.
L.11	R. Cheradame, France. Utilization of High Volatile French and Saar Coals for the Production of Metallurgical Coke. Application of the Conclusions to Latin American Coals.
L.12	J. D. Price, United States. The Blending of Western Coals for the Production of Metallurgical Coke.
L.13	J. D. Price, United States. Low Temperature Char as a Substitute for Low Volatile Coal in the Production of Metallurgical Coke.
L.14	K. Baum, Western Germany. The Manufacture of Metallurgical Smelting Carbon from Non-coking Coals.

/L.15

L.15 A. R. Powell, United States. Improving Coking Qualities of Coal by Addition of Various Materials.

L.16 A. R. Powell, United States. Correlation of Small-scale Carbonizing Tests with Commercial Coke-oven Results.

L.17 A. R. Powell, United States. Argentine Asphaltites as Blending Materials for Poorly Coking Coals.

L.18 M. D. Curran, United States. The Utilization of Petroleum Pitches and Asphalts for the Production of Metallurgical Coke.

L.19 J. A. Prieto I., J. A. López T., B. Alvarado and V. Suarez H., Colombia. Coking Properties of the Coal for the Steel Industry in Colombia.

L.20 S. Cortés Obregón, Mexico. Manufacture of Metallurgical Coke in Mexico.

L.21 A. Albala, Chile. Metallurgical Cokes from Chilean Coals.

L.23 A. Varas Martínez, Colombia, and T. Fraser, United States. Development of the Cauca Valley Coals.

L.24 K. Baum, Western Germany. Production of Blast Furnace Coke with Peruvian Anthracites.

L.25 S. Mewhirter, United States. The Cerrejón Coal Mining Project.

L.26 J. D. Price, United States. Coal Washery Performance as Related to Blast Furnace Costs.

L.27 Walter Vogel, Chile. The Influence of Ash Content on the Hardness of Cokes Made from High Volatile Coals.

L.29 B. Alvarado, Colombia. Iron Ores for the Colombian Steel Industry.

L.31 L. Ensch, Brazil. Pig Iron Production in Blast Furnaces Using Charcoal.

L.32 D. Vucetich, Chile. Operation of the Charcoal Blast Furnace at Corral Using Mixtures of Metallurgical Coke and Charcoal.

L.33 F. J. Pinto de Souza, Brazil. The Sintering Plant of Monlevade.

L.36 G. Bulle, Western Germany. Notes on Production of Pig Iron.

L.37 H. Walde, Western Germany. Progress in the Manufacture of Pig Iron and Ferro-alloys with the Low-shaft Electric Furnace.

L.38 H. S. Newhall, United States. Making of Steel in Electric Furnaces.

/L.39

L.39 F. Johannsen, Western Germany. The Krupp-Renn Process.

L.40 M. Allard, France. The Low-shaft Blast Furnace.

L.42 K. Jensen, Denmark. The Basset Process for the Production of Pig Iron in Rotary Kilns.

L.44 Dr. R. C. Buehl, United States. Production of Sponge Iron in a Rotary Kiln at Temperatures Below the Fusion Point of the Material.

L.45 R. Durrer, Switzerland. Considerations on the Development of the Production of Iron.

L.46 B. Kalling, Sweden. The Rotary Kiln Processes for Sponge Iron, Developed at the Avesta Iron and Steel Works and the Domnarfvet Iron and Steel Works, Sweden.

L.47 J. Stålhed, Sweden. Production of Sponge Iron According to the Wiberg-Soderfors Method.

L.48 A. Ballon, Peru. The Electric Reduction Furnace.

L.49 M. Ø. Sem, Norway. Electric Smelting of Pig Iron.

L.51 E. Decherf, France. Manufacture of Thomas (Basic Converter) Steel.

L.52 Wm.A. Haven, United States. Selections of Steelmaking Processes and of Locations for Integrated Iron and Steel Works.

L.53 C. Ramseyer, United States. Comparative Investment Costs for Different Steelmaking Processes.

L.54 Societá ILVA, Italy. Use of Phosphorus Ores for the Production of Pig Iron for Transforming into Steel by the Thomas Process.

L.55 G. Bulle, Western Germany. Steel Production in Latin America.

L.56 E. Krebs, Western Germany. The Balance of Materials and the Economic Comparison of the Different Steelmaking Processes.

L.57 R. L. Jung, France, Considerations concerning the Choice of Electrical Equipment for the Iron and Steel Plants of Paz de Rio (Colombia) and Chimbote (Peru).

L.58 G. Perin, France. The Problem of Energy in Steel Plants.

L.59 A. González Barragán and N. Morales, Mexico. The Duplex Steelmaking Process at Monterrey.

L.60 H. Canguilhem, Chile. The Acid Bessemer Process in Huachipato (Chile).

L.61 A. Mercier, France. Details of a Steel Plant for a Non-steel Producing Country.

L.62 P. E. Cavanagh, Canada. Approximate Comparative Production Costs and Investment Requirements of the Standard Blast Furnace, Electric Smelting Furnace, Sponge Iron Furnace and Tunnel Kiln Sponge Iron Furnace.

/L.63

L.63 E. Decherf, France. Considerations Regarding the Construction of the Thomas Steel Plant of the Paz de Rio Company and the Costs of Production of Steel.

L.64 G. R. Fitterer, United States. Economics of the Modern Acid Open-hearth Practice.

L.65 W. O. Philbrook, United States. The Acid Bessemer Process.

L.66 T. Y. Wilson, United States. Continuous Casting of Steel by the Rossi-Junghans Process.

L.67 P. E. Cavanagh, Canada. Variable Density Steels. (Reprinted from <u>The Iron Age</u>, January 24-31, 1952.)

L.68 J. Sejournet, France. Notes on the Ugine-Sejournet Extrusion Process.

L.69 B. Kalling, Sweden. Desulphurization of Pig Iron with Pulverized Lime in Rotary Kilns.

L.70 G. Weston, and R. L. Richards, United Kingdom. Standardization in Relation to Control in Steel Production.

L.71 J. Palmé, France. Thomas Steel Rails in France.

L.72 G. R. Fitterer, United States. Acid Open Hearth Products.

L.73 P. Coheur, Belgium. Thomas Steel with Low Nitrogen and Low Phosphorus Content.

L.74 A. Lanari, Brazil. Brief Account of Iron and Steel Production Processes Used in Brazil.

L.75 F. Boulger, United States. Some Effects of Minor Elements on the Characteristics of Plain Carbon Steels.

L.76 G. Weston and G. R. Bolsover, United Kingdom. The Control of Composition During Steelmaking.

L.77 W. C. Buell, Jr., United States. Basic Open-hearth Steelmaking Practice in the United States of America.

L.78 F. Frick, Chile. Notes on Specifications of Steels for Different Uses.

L.79 M. Allard, France. Perrin Process for Converter Steel Making.

L.80 O. Herrera, Chile. Specifications of the Products Made by the Cía. de Acero del Pacífico (Huachipato, Chile).

L.81 International Labour Office, Switzerland. Some Aspects of Labour Problems in the Iron and Steel Industry.

L.82 R. Jaramillo and J. A. Prieto, Colombia. Steel Scrap Recarburation to Produce Pig Iron in Electric Furnaces.

L.83 M. Arámburu, Mexico. Consumption of Iron and Steel Products in Mexico.

L.84 P. Sada, Mexico. Some Notes on the Organization of Monclova Steel Works.

L.86 ECLA SECRETARIAT. Factors Influencing Iron and Steel Consumption in Latin America.

/L.87

L.87	ECLA SECRETARIAT. Influence of Local Factors on the Iron and Steel Industry in Latin America.
L.88	ECLA SECRETARIAT. Structure of the Steel Transforming Industry in Latin America.
L.90	Kurt Bruckmann, Colombia. Possibilities of Applying Ultrasonics to the Iron and Steel Industry.
L.91	ECLA SECRETARIAT. Influence of the Size of the Markets on Iron and Steel Industry in Latin America.

/ANNEX III.

ANNEX III. AGENDA

First Meeting: 13 October - 4 p.m.

1. Inaugural address by his Excellency the President of the Republic of Colombia.
2. Address by the Executive Director of the Expert Working Group on Iron and Steel Industry in Latin America.

Second Meeting: 14 October - 11 a.m.

1. Introductory Statement by the Executive Director.
2. Election of Chairman.
3. Election of Officers
4. Discussion of Method of Procedure.

Third Meeting: 14 October - 3 p.m.

Item I.A.1. FUELS Reduction of Coal Impurities

Discussion of the following papers:

ST/TAA/CON.4/L.1 ST/ECLA/CONF.1/L.1	Considerations on Coal Washing in Europe and its Possible Applications to Latin American Coals. by R. Cheradame
ST/TAA/CONF.4/L.2 ST/ECLA/CONF.1/L.2	Problems in the Preparation of Metallurgical Coal in Latin America by T. Fraser
ST/TAA/CONF.4/L.3 ST/ECLA/CONF.1/L.3	Modern Techniques and Installations for the Mechanical Treatment of Coal by the "Societé de Préparation Industrielle des Combustibles" by J. Turpin

Fourth Meeting: 15 October - 9 a.m.

Item I.A.1. FUELS Reduction of Coal Impurities (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.4 ST/ECLA/CONF.1/L.4	The Tromp Heavy Media Coal Washing Process by J. Griffen
ST/TAA/CONF.4/L.5 ST/ECLA/CONF.1/L.5	Notes on the Production of Metallurgical Coal in Brazil by A. Paiva Abreu
ST/TAA/CONF.4/L.6 ST/ECLA/CONF.1/L.6	Description of Chilean Coals Used in the Steel Industry by A. González, presented by B.Leuschner

/Fifth Meeting:

Fifth Meeting: 15 October - 3 p.m.

Item I.A.1. FUELS Reduction of coal impurities (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.7 ST/ECLA/CONF.1/L.7	Problems Related to Colombian Coal Used for Steel-making. by J.A.Prieto I., J.A.López T., B.Alvarado and V. Suárez H.
ST/TAA/CONF.4/L.8 ST/ECLA/CONF.1/L.8	The Coal Used in the Mexican Iron and Steel Industry. by S. Cortés O.
ST/TAA/CONF.4/L.10 ST/ECLA/CONF.1/L.10	The Washing of Peruvian Anthracite Fines. by K. Baum

Sixth Meeting: 16 October - 9 a.m.

Item I.A.2. FUELS Production of Coke from Poorly Coking Coal and Substitute Fuels

Discussion of the following papers:

ST/TAA/CONF.4/L.11 ST/ECLA/CONF.1/L.11	Utilization of High Volatile French and Saar Coals for the Production of Metallurgical Coke. Application of the Conclusions to Latin American Coals. by R. Cheradame
ST/TAA/CONF.4/L.12 ST/ECLA/CONF.1/L.12	The Blending of Western Coals for the Production of Metallurgical Coke. by J. D. Price
ST/TAA/CONF.4/L.13 ST/ECLA/CONF.1/L.13	Low Temperature Char as a Substitute for Low Volatile Coal in the Production of Metallurgical Coke. by J. D. Price
ST/TAA/CONF.4/L.14 ST/ECLA/CONF.1/L.14	The Manufacture of Metallurgical Smelting Carbon from Non-coking Coal. by K. Baum

Seventh Meeting: 16 October - 3 p.m.

Item I.A.2. FUELS Production of Coke from Poorly Coking Coal and Substitute Fuels (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.15 ST/ECLA/CONF.1/L.15	Improving Coking Qualities of Coal by Addition of Various Materials by A. R. Powell
ST/TAA/CONF.4/L.16 ST/ECLA/CONF.1/L.16	Correlation of Small-scale Carbonizing Tests with Commercial Coke-oven Results. by A. R. Powell

/ST/TAA/CONF.4/L.17

ST/TAA/CONF.4/L.17 ST/ECLA/CONF.1/L.17	Argentine Asphaltites as Blending Material for Poorly Coking Coals. by A. H. Powell
ST/TAA/CONF.4/L.18 ST/ECLA/CONF.1/L.18	The Utilization of Petroleum Pitches and Asphalts for the Production of Metallurgical Coke. by M.D. Curran, presented by J. Sturgeon

Eighth Meeting: 17 October - 9 a.m.

Item I.A.2. FUELS Production of Coke from Poorly Coking Coal and Substitute Fuels (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.19 ST/ECLA/CONF.1/L.19	Coking Properties of the Coal for the Steel Industry in Colombia by J.A.Prieto I., J.A.López T., B.Alvarado and V.Suárez H.
ST/TAA/CONF.4/L.20 ST/ECLA/CONF.1/L.20	Manufacture of Metallurgical Coke in Mexico by S. Cortés O.
ST/TAA/CONF.4/L.21 ST/ECLA/CONF.1/L.21	Metallurgical Coke from Chilean Coals. by A. Albala
ST/TAA/CONF.4/L.24 ST/ECLA/CONF.1/L.24	Production of Blast Furnace Coke with Peruvian Anthracite by K. Baum

Ninth Meeting: 17 October - 3 p.m.

Item I.B.1. IRON ORE REDUCTION Economics of the Blast Furnace

Discussion of the following papers:

ST/TAA/CONF.4/L.26 ST/ECLA/CONF.1/L.26	Coal Washery Performance as Related to Blast Furnace Costs by J. D. Price
ST/TAA/CONF.4/L.27 ST/ECLA/CONF.1/L.27	The Influence of Ash Content on the Hardness of Cokes Made from High Volatile Coals by W. Vogel, presented by B. Leuschner
ST/TAA/CONF.4/L.23 ST/ECLA/CONF.1/L.23	Development of the Cauca Valley Coals by A. Vargas M., and T. Fraser, presented by A. Vargas
ST/TAA/CONF.4/L.25 ST/ECLA/CONF.1/L.25	The Cerrejón Coal Mining Project by S. Mewhirter, presented by A. Vargas

/Tenth Meeting

Tenth Meeting: 21 October - 9 a.m.

Item I.B.2. IRON ORE REDUCTION The Charcoal Blast Furnace

Discussion of the following papers:

ST/TAA/CONF.1/L.32 ST/ECLA/CONF.1/L.32	Operation of the Charcoal Blast Furnace at Corral Using Mixtures of Metallurgical Coke and Charcoal by D. Vucetich
ST/TAA/CONF.4/L.33 ST/ECLA/CONF.1/L.33	The sintering plant of Monlevade by F.J.Pinto de Souza, presented by B.Leuschner

Eleventh Meeting: 21 October - 3 p.m.

Item I.B.3 IRON ORE REDUCTION Methods of Reducing Ores Otherwise than in Blast Furnaces

Discussion of the following papers:

ST/TAA/CONF.4/L.37 ST/ECLA/CONF.1/L.37	Progress in the Manufacture of Pig Iron in Rotary Kilns by H. Walde
ST/TAA/CONF.4/L.48 ST/ECLA/CONF.1/L.48	The Electric Reduction Furnace by A. Ballón
ST/TAA/CONF.4/L.49 ST/ECLA/CONF.1/L.49	Electric Smelting of Pig Iron by M. O. Sem
ST/TAA/CONF.4/L.38 ST/ECLA/CONF.1/L.38	Making of Steel in Electric Furnaces by H. S. Newhall

Twelfth Meeting: 22 October - 9 a.m.

Item I.B.3. IRON ORE REDUCTION Methods of Reducing Ores Otherwise than in Blast Furnaces (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.45 ST/ECLA/CONF.1/L.45	Considerations on the Development of the Production of Iron by R. Durrer
ST/TAA/CONF.4/L.36 ST/ECLA/CONF.1/L.36	Notes on the Production of Pig Iron by G. Bulle
ST/TAA/CONF.4/L.40 ST/ECLA/CONF.1/L.40	The Low-shaft Blast Furnace by M. Allard
ST/TAA/CONF.4/L.39 ST/ECLA/CONF.1/L.39	The Krupp-Renn Process by F. Johannsen

/Thirteenth Meeting:

Thirteenth Meeting: 22 October - 3 p.m.

Item I.B.3. IRON ORE REDUCTION Methods of Reducing Ores Otherwise than in Blast Furnaces (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.46 ST/ECLA/CONF.1/L.46	The Rotary Kiln Processes for Sponge Iron, Developed at the Avesta Iron and Steel Works and the Domnarvet Iron and Steel Works, Sweden by B. Kalling
ST/TAA/CONF.4/L.47 ST/ECLA/CONF.1/L.47	Production of Sponge Iron According to the Wiberg-Soderfors method by J. Stålhed
ST/TAA/CONF.4/L.42 ST/ECLA/CONF.1/L.42	The Basset Process for the Production of Pig Iron in Rotary Kilns by K. Jensen, presented by A. Mercier
ST/TAA/CONF.4/L.44 ST/ECLA/CONF.1/L.44	Production of Sponge Iron in a Rotary Kiln at Temperatures Below the Fusion Point of the Material by R.C. Buehl

Fourteenth Meeting: 23 October - 9 a.m.

Item I.C.1. STEEL MAKING AND FINISHING Comparison of Economics of Different Processes of Steelmaking

Discussion of the following papers:

ST/TAA/CONF.4/L.65 ST/ECLA/CONF.1/L.65	The Acid Bessemer Process by W.O. Philbrook
ST/TAA/CONF.4/L.77 ST/ECLA/CONF.1/L.77	Basic Open-hearth Steelmaking Practice in the United States by W. Buell Jr.
ST/TAA/CONF.4/L.64 ST/ECLA/CONF.1/L.64	Economics of the Modern Acid Open-hearth Practice by G.R. Fitterer
ST/TAA/CONF.4/L.51 ST/ECLA/CONF.1/L.51	Manufacture of Thomas (Basic Converter) Steel by E. Decherf

Fifteenth Meeting: 23 October - 3 p.m.

Item I.C.1 STEEL MAKING AND FINISHING Comparison of Economics of Different Processes of Steelmaking (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.54 ST/ECLA/CONF.1/L.54	Use of Phosphorus Ores for the Production of Pig Iron for Transforming into Steel by the Thomas Process by Societa ILVA, Italy, presented by M. Allard

/ST/TAA/CONF.4/L.79

ST/TAA/CONF.4/L.79 ST/ECLA/CONF.1/L.79	Perrin Process for Converter Steel Making by M. Allard
ST/TAA/CONF.4/L.72 ST/ECLA/CONF.1/L.72	Acid Open-hearth Products by G.R. Fitterer
ST/TAA/CONF.4/L.73 ST/ECLA/CONF.1/L.73	Thomas Steel with Low Nitrogen and Low Phosphorus Content by P. Coheur

Sixteenth Meeting: 24 October - 9 a.m.

Item I.C.1. STEEL MAKING AND FINISHING Comparison of Economics of Different Processes of Steelmaking (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.55 ST/ECLA/CONF.1/L.55	Steel Production in Latin America by G. Bulle
ST/TAA/CONF.4/L.56 ST/ECLA/CONF.1/L.56	The Balance of Materials and the Economic Comparison of the Different Steelmaking Processes by E. Krebs
ST/TAA/CONF.4/L.53 ST/ECLA/CONF.1/L.53	Comparative Investment Costs for Different Steelmaking Processes by Ramseyer and Miller, presented by C. Ramseyer
ST/TAA/CONF.4/L.61 ST/ECLA/CONF.1/L.61	Characteristics of a Steel Plant for a Steel Non-producing Country by A. Mercier

Seventeenth Meeting: 24 October - 3 p.m.

GENERAL SUBJECTS AND CELEBRATION OF THE ANNIVERSARY OF THE UNITED NATIONS

ST/TAA/CONF.4/L.62 ST/ECLA/CONF.1/L.62	Approximate Comparative Production Costs and Investment Requirements of Different Processes by P.E. Cavanagh
ST/TAA/CONF.4/L.74 ST/ECLA/CONF.1/L.74	Brief Account of Iron and Steel Production Processes Used in Brazil by A. Lanari

Address in commemoration of United Nations Day by His Excellency the Minister of Foreign Affairs of Colombia, Dr. Juan Uribe Holguín.

Acknowledgment on behalf of the Secretary General of the United Nations, by Dr. Raymond Etchats, Resident Representative for Colombia of Technical Assistance Administration of the United Nations.

ST/TAA/CONF.4/L.84 ST/ECLA/CONF.1/L.84	Some Notes on the Organization of Monclova Steel Works by P. Sada

/Eighteenth Meeting:

Eighteenth Meeting: 28 October - 9 a.m.

Item I.C.1 STEEL MAKING AND FINISHING Comparison of Economics of Different Processes of Steelmaking (continuation)

ST/TAA/CONF.4/L.52 ST/ECLA/CONF.1/L.52	Selections of Steelmaking Processes and of Locations for Integrated Iron and Steel Works. by Wm. A. Haven
ST/TAA/CONF.4/L.60 ST/ECLA/CONF.1/L.60	The Acid Bessemer Process in Huachipato by H. Canguilhem
ST/TAA/CONF.4/L.59 ST/ECLA/CONF.1/L.59	The Duplex Steelmaking Process at Monterrey, by A. Gonzalez Ballesteros and N. Morales presented by A. Gonzalez Ballesteros
ST/TAA/CONF.4/L.57 ST/ECLA/CONF.1/L.57	Considerations Concerning the Choice of Electrical Equipment for the Iron and Steel Plants of Paz de Rio (Colombia) and Chimbote (Perú), by R.L. Jung
ST/TAA/CONF.4/L.90 ST/ECLA/CONF.1/L.90	Possibilities of Applying Ultrasonics to the Iron and Steel Industry. by K. Bruckmann

Nineteenth Meeting: 26 October - 9 a.m.

Item I.C.2 STEEL MAKING AND FINISHING Alternative methods to the Rolling Mill for Finishing Steel

Discussion of the following papers:

ST/TAA/CONF.4/L.66 ST/ECLA/CONF.1/L.66	Continuous Casting of Steel by the Rossi-Junghans Process. by T.Y. Wilson, presented by R.C.Buehl
ST/TAA/CONF.4/L.67 ST/ECLA/CONF.1/L.67	Variable Density Steels (Reprint in English from *The Iron Age*) by P.E. Cavanagh
ST/TAA/CONF.4/L.68 ST/ECLA/CONF.1/L.68	Notes on the Ugine-Sejournet Extrusion Process by J. Sejournet, presented by F. Schereschewsky
ST/TAA/CONF.4/L.81 ST/ECLA/CONF.1/L.81	Some Aspects of Labour Problems in the Iron and Steel Industry by the International Labour Orrice, presented by J-P. Despres

Twentieth Meeting: 29 October - 9 a.m.

Item I.C.3. MAKING AND FINISHING OF STEEL Range of Application of Steels Made by Different Processes.

Discussion of the following papers:

ST/TAA/CONF.4/L.75 ST/ECLA/CONF.1/L.75	Some Effects of Minor Elements on the Characteristics of Plain Carbon Steels by F. Boulger

/ST/TAA/CONF.4/L.70

ST/TAA/CONF.4/L.70 ST/ECLA/CONF.1/L.70	Standardization in Relation to Control in Steel Production by G.E. Weston, presented by F. Saniter
ST/TAA/CONF.4/L.78 ST/ECLA/CONF.1/L.78	Notes on Specifications of Steel for Different Uses by F. Frick, presented by B. Leuschner
ST/TAA/CONF.4/L.76 ST/ECLA/CONF.1/L.76	The Control of Composition during Steelmaking by G.E. Weston, presented by F. Saniter
ST/TAA/CONF.4/L.80 ST/ECLA/CONF.1/L.80	Specifications of the Products Made by the Cía. de Acero del Pacífico (Huachipato, Chile) by O. Herrera, presented by H. Canguilhem

Twenty-First Meeting: 29 October - 3 p.m.

Item I.C.3. STEEL MAKING AND FINISHING Range of Application of Steels made by Different Processes (continuation)

Discussion of the following papers:

ST/TAA/CONF.4/L.71 ST/ECLA/CONF.1/L.71	Thomas Steel Rails in France by M. Palmé
ST/TAA/CONF.4/L.58 ST/ECLA/CONF.1/L.58	The Problem of Energy in Steel Plants by G. Perin
ST/TAA/CONF.4/L.82 ST/ECLA/CONF.1/L.82	Steel Scrap Recarburation to Produce Pig Iron in Electric Furnaces by R. Jaramillo and J.A. Prieto presented by J.A. Prieto
ST/TAA/CONF.4/L.63 ST/ECLA/CONF.1/L.63	Considerations Regarding the Construction of the Thomas Steel Plant of the Paz del Rio Company and the Costs of Production of Steel by E. Decherf
ST/TAA/CONF.4/L.83 ST/ECLA/CONF.1/L.83	Consumption of Iron and Steel Products in Mexico by M. Aramburu

Twenty-Second Meeting: 30 October - 9 a.m.

Item II. B. ECONOMIC PROBLEMS

Discussion of the following papers:

ST/TAA/CONF.4/L.87 ST/ECLA/CONF.1/L.87	Influence of Local Factors on the Iron and Steel Industry in Latin America by the ECLA Secretariat, presented by B. Leuschner and H. Yanes

/Twenty-Third Meeting:

Twenty-Third Meeting: 30 October - 3 p.m.

Item II.B.1. ECONOMIC PROBLEMS

Discussion of the following papers:

ST/TAA/CONF.4/L.87 ST/ECLA/CONF.1/L.87	Influence of Local Factors on the Iron and Steel Industry in Latin America (continuation) by the ECLA Secretariat, presented by B. Leuschner and H. Yanes
ST/TAA/CONF.4/L.91 ST/ECLA/CONF.1/L.91	Influence of the Size of of the Markets on Iron and Steel Industry in Latin America by the ECLA SECRETARIAT, presented by by B. Leuschner and H. Yanes.

Twenty-Fourth Meeting: 31 October - 9 a.m.

Item II.A. FACTORS DETERMINING THE CONSUMPTION OF IRON AND STEEL IN LATIN AMERICA

Discussion of the following paper:

ST/TAA/CONF.4/L.86 ST/ECLA/CONF.1/L.86	Factors Influencing Iron and Steel Consumption in Latin America . by the ECLA SECRETARIAT, presented by P. Vuscovic

Twenty-Fifth Meeting: 31 October - 3 p.m.

Item II.C. TRANSFORMING INDUSTRY

Discussion of the following paper:

ST/TAA/CONF.4/L.88 ST/ECLA/CONF.1/L.88	Structure of the Steel Transforming Industry in Latin America by the ECLA Secretariat, presented by A. Stakhovitch

Closing of the Work Meetings:

1. Closing address by the Chairman of the Working Group, Dr. Roberto Jaramillo Ferro, Paz de Río, Colombia.
2. Words of acknowledgment by Mr. Schreschewsky, Chambre Syndicale de la Sidérurgie Francaise, France.
3. Words of acknowledgment by Mr. F. Saniter, The United Steel Companies, Ltd., United Kingdom.
4. Farewell address by Mr. R.C. Buehl, U.S. Bureau of Mines, United States.
5. Farewell address by General E. Macedo Soares e Silva, Companhia Aços Especiais Itabira, Brazil.
6. Closing address by the Executive Director of the Working Group, Mr. B. Leuschner.