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TIN PLATE QUALITY CONTROL IN BRAZIL 1/

by

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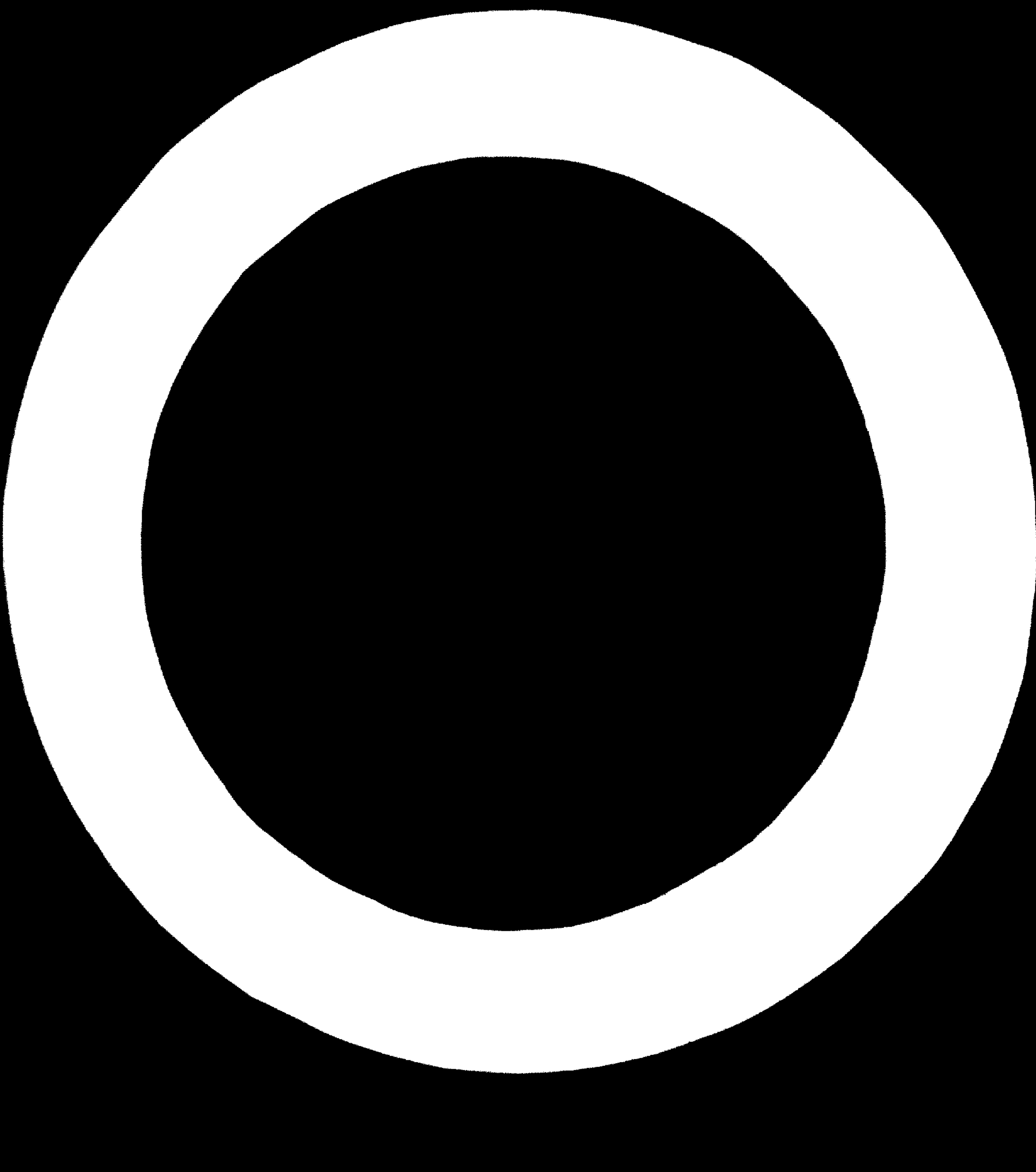

TIN-PLATE QUALITY CONTROL IN BRAZIL

I - General

1. All the tin-plate production in Brazil is accomplished by Companhia Siderúrgica Nacional in its Presidente Vargas Plant located in Volta Redonda, RJ, 120 kilometers away from Rio de Janeiro. Tin plate was first produced in May 1948 using the hot-dip process; Electrolytic tinning was started in January 1956 under a USS Ferrostan licence. In April 1967 the 2nd Electrolytic Tinning Line was started and since then the tin-plate production has been growing thanks to continuous expansions as the table nº 1 shows. The hot dip tin plate production was discontinued in January 1968. The present production puts Brazil among the 12 greatest world producers and the top one in Latin America. The programmed expansions are designed to 620.000 metric tons per year using two additional tinning lines.

2. Besides exerting strong demanding pressure, the Brazilian market is more and more interested in being supplied with tin-plate having thickness smaller and smaller, which is obvious, since can industry is constantly looking for areas with the smallest unit weight. In table 2 we can see the evolution of the basic weight produced in the last 3 years.

3. The present installations in Presidente Vargas Plant allow limited production of tin-plate with minimumthickness of 0.22 mm or 80 lb/bb.

The expansion plan now being carried on to be completed in 1975 contemplates facilities to produce the double reduced type. The actual installations of Presidente Vargas Plant for producing tin-plate are as follows:

a) Eight 200 ton Open-hearth furnaces.

b) Rust. Amco and Morgan soaking pits - 12 two furnace batteries.

c) Reversible Blooming Mill 1016 mm driven by a 6000 HP motor.

d) Three reheating slab furnaces, recuperative 90 ton/h capacity each.

e) Semi-continuous Hot Strip Mill - two roughers and 6 finishing stands.

f) Scale breaker before the 1st. rougher.

g) Two Bliss down coilers.

h) Two sulphuric acid continuous pickling lines 1118 mm and 1219 mm wide.

i) One five stand cold mill with AGC.

j) Two electrolytic cleaning lines.

k) Single stack annealing furnaces with HNX gas.

l) One two stand four high temper mill.

m) Two coil preparation lines with side trimming and welding.

n) Two Ferrostan electrolytic tinning lines.

o) Additional facilities for handling ingots, slabs, coils and finished product bundles.

II - Objective of the quality control as regarding the needs of the market.

4. The Presidente Vargas Plant quality control department has as its main assignment to provide the level of quality required by the tin-plate customers. From the preparation of steel to the final operations, the control

system has been provided to reach that goal. A good technical assistance to the customers is available at all times through specialized metallurgists.

5. The methods and the controls now existing aim to obtain a quality above the present needs of the customer regarding several aspects not thought of yet by the Brazilian customers. In other words, our quality control acts foreseeing future needs that certainly will arise very soon. In fact the customers requirements of tin-plate in Brazil have been guided mostly toward what we could call immediate aspects, or factors that influence in can production in itself:accuracy of dimensions, thickness within range, satisfactory shape for lithography and correct coating weight. Other factors are taken into account only when problems arise in can manufacture: adherence of lackers and paint, poor soldering inadequate surface finishing. Problems concerning corrosion resistance, special surface qualities, surface treatment, etc. are seldom mentioned by the Brazilian market. However since some years ago the Quality Control in the Presidente Vargas Plant is being supplied with the facilities to perform all the necessary tests whether routine or the so called special tests in the Tin-plate Laboratory as it will be seen later in this paper.

6. In the tin-plate quality control we take into account the qualities of the steel base as well as those of the tin coating.

III - Basic steel quality control

7. It is well known that the tin-plate quality depends largely on the base

material - steel used, not only as far as some features regarding ductility and stiffness is concerned but also on some properties related to corrosion resistance. Reaching the last phase of production - the coating application - the steel coils should possess the properties needed for a high quality product. The tin coating over such product will complement the outstanding characteristics of tin-plate: brightness, sanitary appearance, solderability, adequacy to lithographic application, etc.

8. About 95% of the orders are for temper T 3, 4% are for T 2 and 1% for T 1 and T 4. There is a trend to increase production of T 4 plates with less thickness. The steel to provide most of the production of tin plate in Brazil is poured in bottle top moulds 1074x655x1970 mm and the mechanically capped steel ingot weights 10 ton. All processing of the heats is controlled by Metallurgical Observers and their observations are carefully recorded.

9. The specified chemical analysis are given in table 3 and the results of 3 samples obtained during the pouring ingots for temper T 3 are shown in fig. 1. The open hearth practice is performed accordingly approved metallurgical process which results in a very reasonably clean steel. Residual elements are not encountered in the ingot chemical analysis because the use of domestic and segregate scrap in melting.

10. The tin-plate steel quality control proceeds through observations of the reheating conditions of the ingots in the pit furnaces, draft in the blooming mill, rolling temperature, discard of the slab head to eliminate pipe

and excessive segregation, yield control, etc. Slabs are normally scarfed with removal of all visible defects. Most of the time the rate of scarfed area for this kind of steel lies between 15% to 20%. Slabs dimensions vary from 140 x 745 x 4900 mm to 165 x 880 x 4900 mm. and hot rolled strips width vary from 695 mm to 885 mm. The hot rolled strip thickness is 1, 85 mm for light weight tin plate and 2, 00 mm for heavy weights.

11. The hot rolling is carefully controlled all the way from the slab reheating to coiling by Observers and Inspectors. The quality control through the Specification Division establishes furnace temperature, minimum heating and soaking time, finishing and coiling temperatures. Hot rolled steel with uniform grain and structure is obtained since 95% of temperatures recorded are within specified range. To avoid rolled in scale, scratches and damage due to handling the coil surface are closely watched. The Inspection checks the strip for good shape and section profile. The statistical distribution for the profile of the hot rolled strip for tin plate production shows a predominance for the convex profile. The gauge control is performed with X-Ray thickness gauge which is complemented with manual micrometer checks. The range for gauge is 2, 03 ± 0, 13 mm (. 080" ± . 055") or 1, 85 ± 0, 13mm (. 072" ± . 055").

12. After removal of the surface oxide in the continuous pickling line where the strip is treated with sulphuric acid solution, rinsed, dried and oiled the coils are inspected for the quality of the surface and adherence to dimensions.

It is well known that the electrolytic tin coating, or any other metal coating requires the deposit receiving surface to be chemically clean. The Quality Control sets up limits of approval compatible with the adopted industrial process and further operation requirements. We aim to obtain a surface free from any kind of scale, over pickling, solution stains, scratches, slivers, etc. The practice has shown that most of this defects tend to aggravate during the cold reduction, where often strip breaking mostly in the weld area occur. Commonly 1 % of the coils delivered by the pickling lines are rejected and deviated to different uses.

13. The various tin-plate commercial gauges are produced in the cold reduction operation of the pickled coils. The metric system has, by suggestion of Companhia Siderúrgica Nacional, been adopted in the establishment of the commercial tin-plate gauges and base weights by Associação Brasileira de Normas Técnicas (ABNT). This system replaces the British system used heretofore. The standard series shown in table 4 is the result of the first great innovation in the proposed system - changing from the gauge in inches to milimeter. The unit area was the second important innovation.

14. The base box is used in the British system as area which corresponds to 31,360 square inches and is equivalent to 56 sheets of tin plate 20" x 28" or 112 sheets 14" x 20". The weight of the base box is in pounds. A gauge in inches given by the formula below corresponds to a determined base box weight:

$$\text{gauge (inches)} = \frac{\text{base box weight}}{31,360 \times .2904}$$

.2904 is the specific gravity of the sheet expressed in lb/in^3.

Base box weight = gauge x 31, 360 x .2904

The area made up of 100 sheets $1\ m^2$ is the square decameter (dam^2) used as reference in the metric system being introduced.

15. Once the gauge is established it is possible to calculate the weight of $1\ m^2$ of sheet and thence the weight of the dam^2, the specific gravity being $8\ kg/dm^3$ or $8\ kg/m^2$ x mm.

Thus weight of $1\ m^2$ = thickness (mm) x $8\ kg/m^2$ x mm

weight of $1\ dam^2$ = weight of $1\ m^2$ (kg) x 100

Bearing in mind that in Brasil tin-plate packages of any dimension or size was changed from 112 to 100 sheets, we have the expressions:

Area of 1 sheet (A) = width (a) x lenght (b)

Area of 1 package = 100 x a x b

Area of 1 package expressed in dam^2 = Area A expressed in m^2

Weight of 1 package (kg) = A (m^2) x standard weight kg/dam^2

Weight of 10 package bundle = 10 x 1 package weight

Weight of 15 package bundle = 15 x 1 package weight

Those weights refer to nominal sizes; the real weights take into account the tolerances and overrun cuts.

16. As it has been shown the metric system is much more rational and is being adopted by other countries. The recent manual "Tin Mill Products" issued 1968 by AISI mentions the 1000 sheet package. In the continental Europe the tin-plate gauges are stated in mm and are being used as unit of

area 100 lm^2 sheets (Tinplate handbook - Tin Research Institute - 4th adition page 51). The relationships between the areas given by the two systems are:

1 dam^2 = 4, 942 base box

1 base box = 0, 202322 dam^2

In table 5 are shown the relationships between the tin-plate base weights expressed in Brazilian and British Systems.

17. Under the metallurgical viewpoint the cold reduction performs an important role since it changes completely the grain structure of the hot rolled steel. The reduction are sizable, commonly up to 85 % and a large deformation work is produced which elongates the grains in the direction of rolling and breaks them. The steel becomes hardened and brittle, therefore inadequate for tin-plate applications. A heat treatment is necessary to relieve stresses and promote recrystalization of the deformed grains; a subcritical annealing is enough to give back the steel the desired ductility. The greater the cold reduction, the lower the necessary temperature to correct the hardening it brought about. Cold reduction provides furthermore the surface finish adequate to the subsequent processes. All care is exercised to obtain consistent finish, absence of roll marks, good shape and gauge within established tolerances. The subcritical anneal is conducted by stacking 4 coils in a circular furnace,with an inner cover over the coils. Inside the cover and surrounding the coils flows deoxidizing gas, that constitutes a controlled atmosphere to avoid oxidation of steel (HNX) gas. Heating is done to a temperature just sufficient to give the steel the desired hardness.

The cooling down is performed with the cover on and its removal takes place when the temperature falls to 120°C, allowing the unloading of the coils. In this way a steel with recrystallized structure is produced which has the necessary features for bending, drawing and stretching. These properties and other interrelated mechanical properties are designated as "temper".

18. Because of the reasonable correlation between temper and hardness, the Quality Control approves or refuses each coil, according to the 30-T Rockwell hardness produced. We use the ranges T 1 to T 6 to report the temper. In table 6 are given the temper ranges that are characteristics of tin-plate, expressed in 30-T Rockwell surface hardness. In table 7 examples are given for various applications of the many types according to hardness. In Brazil we produced the T 5 and T 6 types only experimentally in two heats, contemplating the near future installations of beer can factories.

19. The broad perspectives open to CSN in the tin-plate market by the future expansions of its plant led the Company to include a continuous annealing line in its expansion program, which will make possible greater productivity and more uniform annealing. A temper already called internationally TU capable of being used in place of the T-4, T-5 and T-6 types can then be produced.

20. After annealing the steel is temper rolled. The aim of this rolling is to make the steel surface conditions uniform, bring greater stiffness to the

sheets and improve shape. Although the reduction is small, about 1% to 2%, the temper rolling avoids surface problems - fluting and stretching strain - which normally appear on the dead-annealed steel surface. The hardness specification for the tin-plates is very important and should be the result of complete discussion between the can makers and the contact metallurgist. When we say hardness we mean not only the ranges of hardness expressed by the range T 1 to T 6, but the group of characteristics and properties that give the steel the most desirable stiffness. Besides being important to better shape the temper rolling imparts the bright or matte finish to the steel surface. The 1st stand rolls provide the small reduction and those of the second stand the desirable brightness. If the coil leaves the temper mill smooth, the strip after tin coated shows a specular brightness that gives better appearance, an important factor in tin-plate applications. For matte finish the strip is less bright and blasted rolls are used in 1st and 2nd stand. Continually the brightness of the strip is controlled by means of surface roughness check performed with the help of an instrument called profilometer. We specify the following ranges for black plate roughness:

Matte finish - 20/50 microinches (AA)

Bright finish - 15 microinches (AA) max.

The temper mill rolls are controlled likewise. After temper rolling, follows the side trimming of the coils; that being the last operation the steel undergoes before tin coating, so the next operations constitute the tin coating processes.

IV - Tin coating quality control

21. Two fundamental requirements are necessary for a coating within the adequate quality pattern: good condition surface coils and tin electro-plating technique. On entering the electrolytic tinning line the coils are supposed to present a surface quality pattern warranted by inspections made in various important locations not only by quality control personnel, but also by the operation personnel.

22. For production of a tin coating according to the required specifications the Presidente Vargas quality control has available a Tin-Plate Laboratory, 200 m^2 total area, where the following equipment is at hand in different rooms:

Sample Room - Shear, press for punching samples, Rockwell superficial hardness machine, profilometer and reflectometer.

Routine Tests Room - Coating Bendix instrument, centrifuge, PH equipment, oven, distiller, 2 precision scales, hidrophyl balance for oil film, glasses, solutions, etc.

Special Tests Room - Pickle lag test instrument, electro-stripper, electrophotometer and equipment for iron solution test, circulation cell, Bendix instrument, oven, fume hood, glasses, solutions and bottles.

Complementing the laboratory there are: Offices for Chief of Inspection, Chief Chemist room, sanitary room and store room.

23. The tin plating processing control consists in the determination of the chemical solutions used in the many units of the Ferrostan lines; alkaline cleaning, electrolytic pickling, electrolyte, drag out solution and surface chemical treatment. The Testers also record all the data that interest the electrolytic tinning line operation such as: solutions temperatures, electric currents voltages, current density, polarity being used, strip speed, etc.

24. The control of quality in the finished product consists of random selection of full size sheets for visual inspection. These sheets are the source of samples in convenient sizes for routine and special tests. The following tests are considered routine: tin coating weight determination, hardness of the finished product and rate of discoloration, in samples taken every hour; oil film every 4 hours; surface roughness generally every 2 hours or more, depending on the requirements.

25. The coating is determined in samples 25,8 cm^2 (4 in^2) punched from samples sheared at right angles to the direction of rolling, in the center and edges of the strip, by the Bendix method, with frequent checks using other methods. The electrolytic tinning lines of Presidente Vargas Plant at Volta Redonda, are able to produce any class of coating including differential coatings. However, according to the market demands the average production for classes are as follows(average of 55,000 t production):

Class	%	Class	%
10	11,5	75	2,5
25	54,4	100	3,4
50	28,2	100/25	-

Fig. 2 shows the distribution of the coating weights figures being produced, as example, in the two classes of higher production - nº 25 and nº 50.

26. The determination of hardness in finished product aims to control at all times the hardness level delivered to the market and establish correlations with the values produced after temper rolling. It has been observed that generally the final hardness is 2 to 4 points higher. The discoloration is determined after heating the sample in oven at 210ºC for 20 minutes, the result being expressed in grades ranging from 1 to 10 according to the seriousness of the oxidation obtained. Normally our values are situated between 0 and 2 in this scale. The oil film is determined in a test sample similar to that used for coating through the use of the hidrophyl balance. Cotton seed oil is used and the present specification asks for .05/.15 g/bb. The surface finish is checked using the profilometer and reflectometer. The established specifications call for 15 microinches - AA maximum for the bright finish and 50 maximum for the matte finish.

27. In addition to the routine tests previously mentioned the Tin Plate Laboratory carries on many other special tests for research and data collection for more complete knowledge of the product. In the actual stage of development of the Brazilian can industry, as it has been said previously, the market is not yet exacting as to limits of specifications. The Quality Control antecipated to the consumer demands since the Laboratory is being equiped through the years. The special tests actually performed are: pickle lag, iron solution value, alloy layer, solderability, tin grain size

and determination of the best conditions for electroplating by use of a circulation cell. Eventually tests for adherence of paints and lacquers are made.

V - Final inspection and more prevalent defects

28. The finished tin plates are checked for surface defects, shape and dimensions. The tolerances for variation in either weight, gauge, width and length ot out-of-square and shape are established by Brazilian standard PB-52. The width is supplied with 3 mm overrun and can vary from 3 to 6 mm above the nominal. The length is supplied with 4 mm overrun and a variation from 4 to 7 mm above nominal is accepted. This standard stablishes as tolerance in gauge variation $\pm$ .025 mm ($\pm$ .001''). In Presidente Vargas Plant, however, tolerances of + .020 mm (+ .0008'') and -.018 mm (-.007'') are adopted. There is possibility of complying with orders with restrictive tolerance for gauge. The tolerance for out-of-flatness is 3 mm (1/8'').

29. In Brasil 3 classes of quality are delivered to the market according to final inspection. This system makes possible to meet customer's variable requirements with maximum utilisation for the products obtained. These quality classes are: Standard quality (QP) -This quality is produced in the electrolytic tinning line running at normal work speed. The permanent inspection eliminates the serious defects. If stored and used in normal conditions the sheets can be lacquered of lythographed on the whole of its surface. The coating weight, hardness, dimensions (gauge, width and

length) and surface finish (matte or bright) according to the order, we warranted as well as to absence of holes. The standard quality corresponds to the international unassorted. Second quality (SQ) - This quality comprises the sheets rejected by the inspection in the tinning line due to surface, on the basic steel or coating, and shape defects,which hinder them from entering the standard quality. The coating weight, hardness, dimensions and surface (matte or bright) are warranted according to order as well as the absence of holes. The tolerances for shape are less restrictive than as to Standard Quality. Third Quality (TQ) - This quality covers sheets that present more serious defects. They can be used in all its extension but are not guaranteed as to lacquer and lytographic works. The third quality sheet may have holes and normally come from manual sorting operation. Dimensions, class of coating, surface finish (matte or bright) are warranted and as far as hardness is concerned this applies only yo T-3 type. In the first 4 months of 1970 the shipments of tin plate were as follows:

Standard quality (PQ)	86,0%
Second quality (SQ)	10,0%
Third quality (TQ)	4,0%

30. As it hapens in all industrial production, mainly steel products, defects occur in the material throughout the processing lines. Although all steps are taken as soon as possible to deviate the material not meeting the necessary requirements or even scrapping the parts that cannot be used, the product submitted to final inspections normally shows defects that downgrade it.

In our plant the most common defects existing in tin plate are concerned with surface or shape or are due to poor handling. The defects due to internal conditions of the steel are not numerous.

31. Below are the most commonly found defects that depending on their seriousness generally downgrade the product from QP to SQ or TQ: slippage, pincher, grease, wavy edge, roll marks, scale, slivers, abrasion, scratches rusty, pick-up, undue handling, dents, holes, anode streakes, stains, wrinkles, etc. The Quality Control Metallurgists are constantly studying and investigating the defects that are discussed in daily meetings with the operation personnel in the lines of greater importance for the quality. The defective lots are separated and treated specifically at disposition meetings. Monthly and biweekly reports are prepared with basis on the daily reports, for detailed knowledge of the quality levels obtained. These levels are compared with the expected levels previously scheduled. Whenever some drift from the expected value is detected, the Quality Control investigates the reasons for the variation and indicates the probable or real causes for the downgrading of quality. A catalogue of tin plate defects was gathered, the pages of which are the samples themselves showing the defects, its name and sources, for personnel training and guideline.

VI - Technical assistance to the customers

32. The technical assistance to the customers is provided through special or routine visits made by a Metallurgist or eventually by the Tin Plate Final Inspection Head. To know the customer's needs, technical requirements and

problems arising from the use of products is the main objective of the visits. This information is reported to the plant. Based on these reports the Quality Control takes the necessary actions involving either itself or the operation. The complaints are sent either by way of Sales or through the Metallurgists and a report covering all the information necessary to a complete investigation of the material by the Quality Control is produced.

33. In 1969, for a total production of 228, 964 tons there were 131 claims, representing less than 0. 4% of the total sales and 4 complaints. Most of the claimed material is sold again to less critical uses. The main reasons for claims were: oxidation due to water seepage, excessive or inconsistent hardness, lack of identification, solderability, coating weight, gauge vatiation and excessive oiling.

VII- Prospects for the future of tin plate in Brazil and recommendations

34. The tin plate production is growing in Brazil as may be seen in table 1 and shall continue growing since its field of application are likely to expand. The larger consumer, as in all other countries, is the can industry, that supply containers for food and other products. Although meeting competition from other packing products, mostly plastics and cardboard, the possibilities for tin plate in Brazil will increase, due principally to the start of canned beer production in the near future. Likewise, in the field of soft drinks there is much to be explored. Canned fruit for export as well as canned instant coffee productions are both on the increase.

35. The trend of the market is to call for gages smaller and smaller; In this way Companhia Siderúrgica Nacional plannes its expansion in this field including facilities to produce the double reduced tin plate, adopting initially a Combination Mill. It is programmed a continuous Annealing Line and the nº 3 Electrolytic Tinning Line, that however can be changed to a Tin Free Steel Production Line.

36. Our relationship with the customers are the best possible and we feel that in developing countries like Brazil the tin plate problems should be considered as a whole; the conditions of the producing plant and the can manufacturers being jointly analysed. For example, a highly desirable step, interesting the nation is the standardization of the cans to make possible the utmost productivity.

37. Considering that it's raw material - tin plate - comes from a costly and complex industry, the can making equipment in developing countries should be designed having in mind the highest productivity of the steel industry. In this way the utilization of patterns sheared from coils of maximum width at the tinning lines should be encouraged. Tin plate with quality features adequate for use in automatic high speed can manufacturing lines are recommended to be produced. The existing or future installation should be able to produce tin plate meeting the four requirements which we consider to be basic: a) correct dimensions and gauge; b) shape adequate to lithography; c) temper necessary to mechanical forming; d) correct coating weight.

38. Also important additional requirements should be object of attention of the Quality Control no matter the market requests, since tin plate is a vital product involving public health. For this reason the producing plants must be equipped with a Tin Plate Laboratory where studies and investigations are carried out for knowing the product to continuously improve its quality and to gather data contemplating future phases of development of this important branch of the industrial activity.

39. Attached are seven photographs to illustrate the activities of Companhia Siderúrgica Nacional regarding tin plate production and quality control:

Photo 1 - Mechanically capped steel ingots pouring

Photo 2 - 5 Stand cold strip mill with AGC system

Photo 3 - General view of 2nd Electrolytic Tinning Line and entry side of the nº 1 line

Photo 4 - Exit side of the 2nd Electrolytic Tinning Line

Photo 5 - Tin Plate Laboratory - Samples room

Photo 6 - Tin Plate Laboratory - Chemical analysis

Photo 7 - Tin Plate Laboratory - Equipment for pickle lag test

Fig. 3 is the distribution for hardness after annealing of the coils intended for T 3 temper.

TABLE 1 - Tin plate production in Brazil

YEAR	PRODUCTION-metric tons			% Electrolytics
	Hot Dip	Electrolytics	TOTAL	
1948.....	6 319	-	6 319	-
1949.....	20 496	-	20 496	-
1950.....	37 186	-	37 186	-
1951.....	43 545	-	43 545	-
1952.....	42 162	-	42 162	-
1953.....	40 414	-	40 414	-
1954.....	41 226	-	41 226	-
1955.....	37 830	-	37 830	-
1956.....	55 248	21 651	76 899	28, 2
1957.....	38 226	25 720	63 946	40, 2
1958.....	24 004	55 381	79 385	69, 8
1959.....	22 464	67 474	89 938	75, 0
1960.....	13 911	80 167	94 078	85, 2
1961.....	16 846	115 881	132 727	87, 3
1962.....	17 418	121 111	138 529	87, 4
1963.....	30 898	130 794	161 692	80, 9
1964.....	34 742	110 576	145 318	76, 1
1965.....	26 769	143 515	170 284	84, 3
1966.....	30 121	140 505	170 626	82, 3
1967.....	10 680	196 032	206 712	94, 8
1968.....	-	209 196	209 196	100, 0
1969.....	-	228 964	228 964	100, 0

TABLE 2 - Percent distribution of the base weights produced in Brasil

BASE WEIGHT		1967	1968	1969	1970
kg/dam^2	lb/bb				3 months
≤ 200	≤ 90	6	17, 8	26, 5	34, 1
216	95	5, 3	6, 4	9, 1	10, 1
224	100	66, 4	58, 1	50, 3	43, 0
240	107	20, 2	16, 7	13, 0	11, 7
> 240	>107	2, 1	1, 0	1, 1	1, 1

TABLE 3 - Chemical Analysis specification ranges

TEMPER	C	Mn	P max	S	Al
T1	.03/.05	.25/.35	.015	.025	.03/.07
T2	.05/.08	.30/.40	.015	.040	-
T3	.07/.10	.35/.45	.015	.050	-
T4	.09/.12	.40/.50	.015	.050	-

TABLE 4 - Tin plate base weights and thickness accordingly Associação Brasileira de Normas Técnicas (ABNT)

Thickness mm	kg/m^2	kg/dam^2
0,14	1,12	112
0,16	1,28	128
0,18	1,44	144
0,19	1,52	152
0,20	1,60	160
0,21	1,68	168
0,22	1,76	176
0,24	1,92	192
0,26	2,08	208
0,27	2,16	216
0,28	2,24	224
0,30	2,40	240
0,32	2,56	256
0,34	2,72	272
0,38	3,04	304
0,44	3,52	352
0,50	4,00	400
0,56	4,48	448

TABLE 5 - Relationship between Brazilian and British Systems for tin plate base weights

Thickness mm	Base Weight kg/dam^2	BRITSH SYSTEM BASE WEIGHT Exactly lb/bb	Approximately lb/bb	in
0, 14	112	49, 9	50	.0055
(0, 15)	(120)	53, 5	55	.0060
0, 16	128	57, 1	-	-
(0, 17)	(136)	60, 6	60	.0066
0, 18	144	64, 2	65	.0071
0, 19	152	67, 8	-	-
0, 20	160	71, 3	70	.0077
0, 21	168	74, 9	75	.0082
0, 22	176	78, 5	80	.0088
(0, 23)	(184)	82, 1	-	-
0, 24	192	85, 6	85	.0093
(0, 25)	(200)	89, 2	90	.0099
0, 26	208	92, 7	-	-
0, 27	216	96, 3	95	.0104
0, 28	224	99, 9	100	.0110
(0, 29)	(232)	103, 4	103	.0113
0, 30	240	107, 0	107	.0117
0, 32	256	114, 1	115	.0126
0, 34	272	121, 3	122	.0134
0, 38	304	135, 6	135	.0148
0, 44	352	157, 0	155	.0171
0, 50	400	178, 4	175	.0193
0, 56	448	199, 8	195	.0215

TABLE 6 - Temper designation for tin plate

Temper designation	Rockwell - 30 T
T1	46 - 52
T2	50 - 56
T3	54 - 60
T4	58 - 64
T5	62 - 68
T6	68 - 73

TABLE 7 - Tin plate temper designation and examples of usage in Brasilian market.

TEMPER	Characteristic	Example of usage
T1	Deep drawing	Sardine cans, sprays, nozzles, etc.
T2	Deep to moderate drawing	Meat rectangular cans, rings, plugs, paste cans, etc.
T3	General purpose	Can ends and bodies, crown caps, etc.
T4	General purpose, with increased stiffness	Large cans, more resistant bodies, panels, etc.

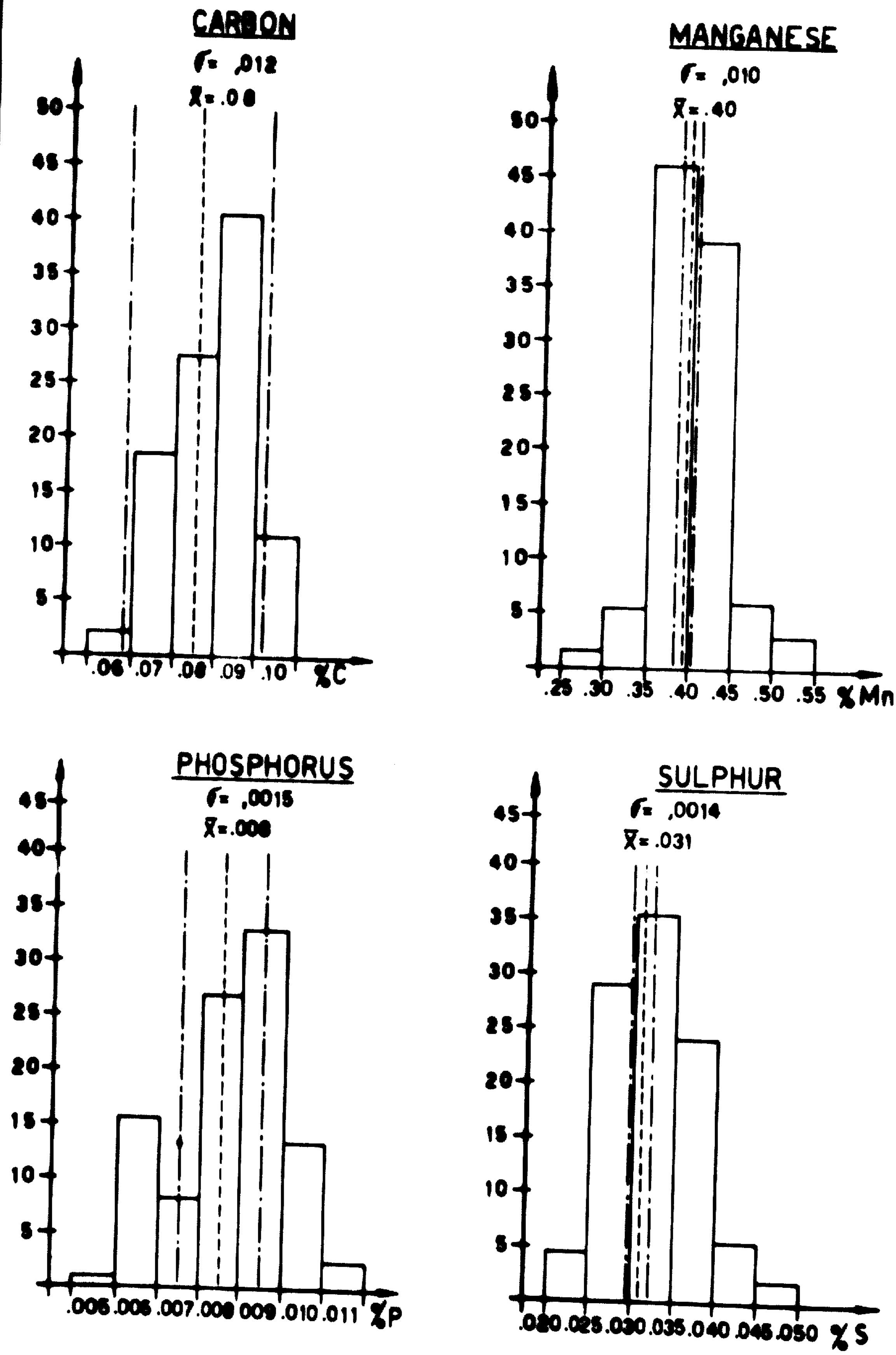

Fig.: 1 - Ladle chemical analysis in 200 heats for T3 tin plate.

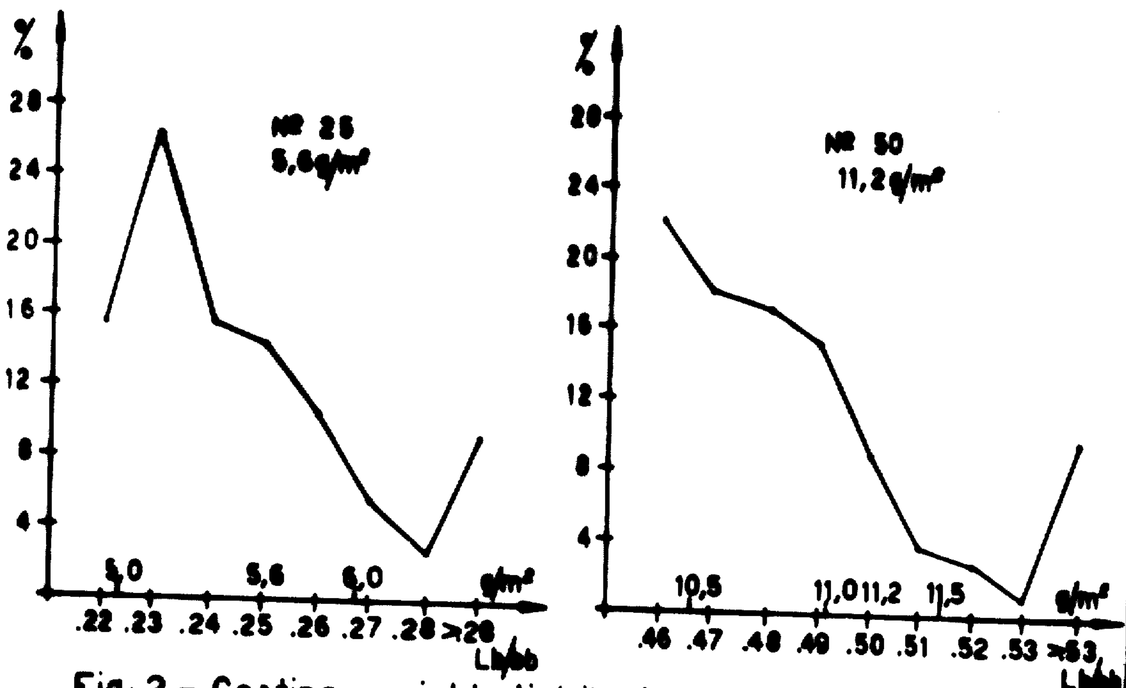

Fig.: 2 - Coating weight distribution for nº 25 and 50 tin plate.

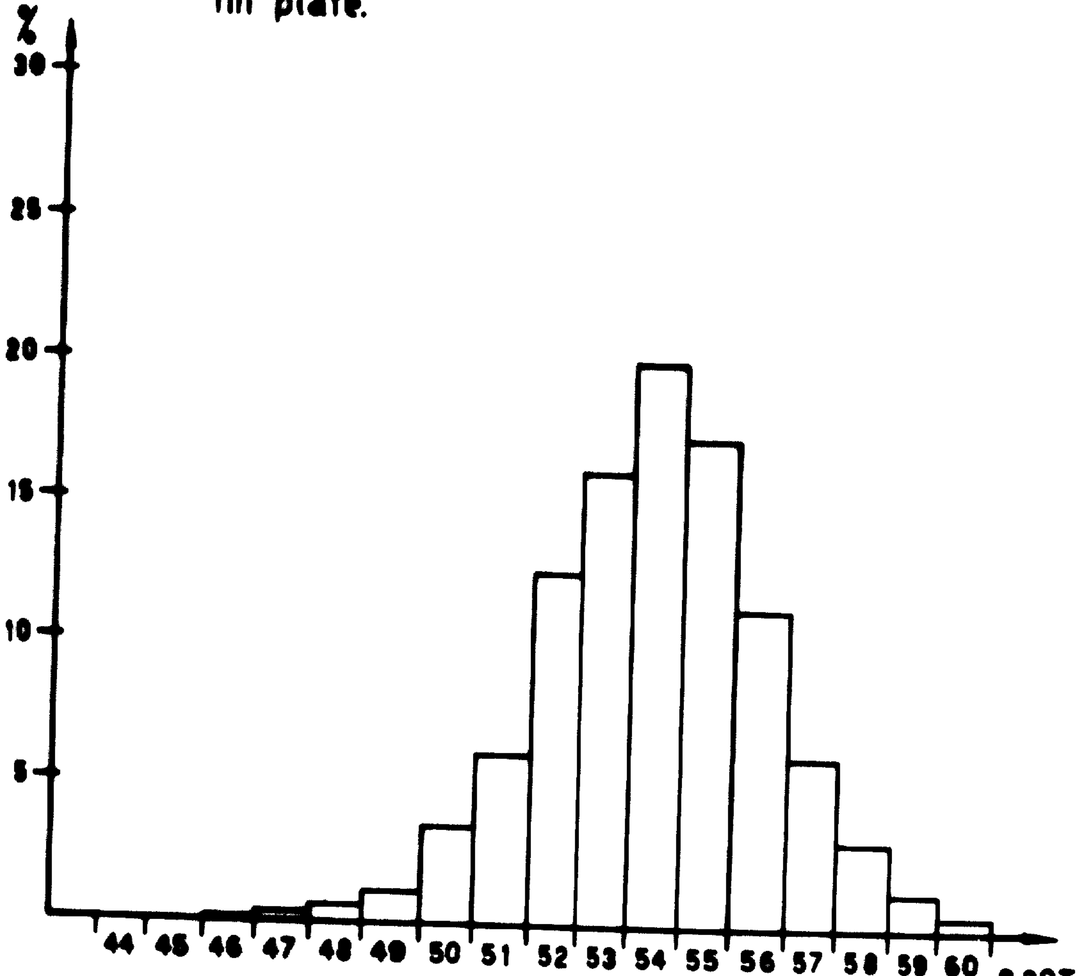

Fig.: 3 - Hardness Rockwell 30T after annealing - Temper T3.

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