B.I.O.S. FINAL REPORT No. 1159
ITEM No. 21

THE USES OF ZINC IN GERMANY

This report is issued with the warning that, if the subject matter should be protected by British Patents or Patent applications, this publication cannot be held to give any protection against action for infringement.

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

THE USES OF ZINC IN GERMANY

Reported by

R.L. Stubbs, M. of S.
B.D. Darrah, " " "
J.J. Lowe, " " "

B.I.O.S. Trip No. 1175

BIOS. Target Nos:
See Table of Contents.

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE
32, Bryanston Square, W.1.

TABLE OF CONTENTS

Subject | Page No.

PREFACE

In September, 1945, a team was sent to Germany under the auspices of the Ministry of Supply with instructions to collect full information on German wartime developments in all uses of zinc in metallic form. The team was composed of the following members:-

Mr. R. Lewis Stubbs (Leader)
Mr. J.J. Lowe (Deputy Leader)
Mr. B.D. Darrah
Mr. H.G. Ridge
Mr. H. Waterhouse
Mr. V.J. West
Mr. J.M. Hutton

It travelled about 4,500 miles and visited some 72 separate works during a tour which lasted 45 days. Most of the works visited were in the British or American zones, but some were in Berlin. The team operated mainly in two sections, the first of which, comprising Messrs. Stubbs, Ridge and Darrah, dealt with all uses of zinc, while Messrs. Lowe, Waterhouse, West and Hutton concentrated mainly on die casting.

This Report, being intended to treat the German industry as a whole, mentions individual works in the main text only when they appear to be of interest in some particular respect. They are, however, fully dealt with in Appendix 13. The Report is divided into eight main chapters, subordinate items, such as specifications, the composition of alloys and lists of manufacturers being relegated to the Appendices. Photographs taken by the team are reproduced in the text. The metric system has been adhered to throughout, and all tonnages are metric.

Except for the section on die casting, written by Mr.Lowe and his colleagues, and part of the section on zinc coatings written by Mr.Ridge, the Report has been wholly compiled by Messrs. Stubbs and Darrah.

A complete list and abstracts of the documents collected by the team and deposited at the Ministry of Supply is given in Appendix 14. Of these only a few are referred to in the text.

All members of the team were unanimous in expressing their appreciation of the arrangements made by the Ministry of Supply, the military authorirites in the various zones and the Control Commission in the British zone. Apart from minor and inevitable transport delays due to a shortage of vehicles, all went as well as could be hoped in view of prevailing difficulties.

CHAPTER I

INTRODUCTION

1 THE BACKGROUND

In 1939 Germany was the world's second largest producer and consumer of zinc, the U.S.A. being the first. She was the largest producer of zinc ores in Europe, although the home supplies never satisfied her smelting capacity and concentrates were imported.

For some years before the war, this production had been supplemented by imports from Belgium, Poland and Norway, and her supplies had exceeded consumption. In 1938 and 1939 this excess had been at least 20,000 tons and, as the result of stock piling commenced as early as 1934, stocks at the outbreak of war are believed to have amounted to more than 200,000 tons. During the war Germany's supplies were augmented by 120,000 tons a year by the inclusion in her home smelting capacity of the Silesian works, as well as by the capture of the large output in the occupied countries - particularly in Poland and Belgium which, after Germany, were the largest producers in Europe.

Statistics drawn up by the team and given in this Report show that during 1939-43 Germany's annual net supply of zinc after deducting exports was approximately 325,000 tons. Her annual consumption during 1940-43 appears to have exceeded the supply by 40 to 65,000 tons, but in the other war years supplies exceeded consumption. There is little doubt that Germany had throughout the war enough zinc to meet all normal demands. While one can only guess the stocks held at the end of the war, owing to the lack of information about the use of the prewar stocks, the smelters visited were of the opinion that they were at least as great as those of 1939.

The supply position with regard to the other common non-ferrous metals naturally affected wartime developments in the use of zinc. Whereas according to the Metallgesellschaft, the supplies of lead, while still sufficient, declined from 260,000 tons in 1939 to 180,000 in 1944, aluminium production increased from 200,000 tons in 1939 to nearly 250,000 tons in 1944, the supplies exceeding consumption except in 1940. On the other hand, supplies of primary copper declined steadily from more than 210,000 tons in 1939 to less than 50,000 in 1944; and great efforts were made to recover copper from scrap, the shortage becoming increasingly serious throughout the war.

Against this background it was natural that Germany should turn to zinc and zinc alloy as substitutes for brass and that zinc should be used on a commercial scale in ways only tried experimentally in other countries. While many of these might not be thought practical if copper could be had, their development is of considerable interest and has therefore been treated in some detail.

Before discussing them, it is however appropriate to consider the steps taken, and the organizations set up, to control and foster such developments.

a) Reichsstelle für Eisen und Metalle All metals produced and consumed in Germany were controlled by the Government through the Reichsstelle für Eisen und Metalle of Berlin (the State Department for Iron and Metals). Control was exercised over mine and smelter production as well as over consumption.

Each year or half year the miners and smelters provided the Reichsstelle with estimates of the quantity and quality of their production. These estimates were generally accepted and embodied in the programme laid down for producers. The Reichsstelle then had a full summary of estimated output.

Consumption was controlled by licensing the sale and purchase of metal and alloys according to use. The Reichsstelle also controlled the type of alloys to be manufactured and prohibited the use of certain alloys for civilian purposes. Only a proportion of a smelter's output was generally assigned for consumption and thus at the end of the war most smelters had big stocks in hand.

The team saw Herr Gierow of the Reichsstelle in Berlin who said that quotas for different industries were arranged in agreement with the Reichswirtschaftsministerium, and the metal then allocated to the users through the various trade groups (Wirtschaftsgruppe).

The control of consumption appears to have been somewhat loose when compared with that exercised in the U.K., but this may have been due to the more abundant supplies. On the other hand, the use of copper was evidently most closely controlled, as will be seen from the efforts described later to develop new zinc alloys to replace those which used as little as 2 or 3% of copper.

The Reichsstelle appears to have had several offices scattered about in Berlin, but according to Herr Gierow, most had been completely destroyed. He added that many files had been evacuated to a nearby village, now in the Russian zone, and probably burnt. The director, Herr Ernst, was believed to be in prison in the Russian zone, and of his four assistants only Herr Gierow remained, the others having vanished.

The Reichsstelle was divided into seven main departments dealing with: planning; organization, (apparently the main department handling the detailed production programmes for all metals as well as imports and exports); use of stocks; licensing; substitution; legal; administration.

b) Zinkberatungsstelle G.m.b.H. In 1939 it was clear that in the event of war the manufacture and use of brass would have to be restricted and that zinc alloys would be used to replace it. Most fabricators of brass would therefore have to learn how to use the new metal; and if they were

to achieve maximum production with the least difficulty, they would obviously need considerable technical assistance.

The Reichsstelle therefore asked the zinc producers to pool their knowledge and experience and to set up an independent central advisory body. Thus in September 1939 the Zinkberatungsstelle G.m.b.H., a non-trading body with offices in Berlin, was formed and financed by the Metallgesellschaft A.-G., Unterharzer Berg und Hüttenwerke G.m.b.H. and Bergwerksgesellschaft G. von Giesche's Erben. Its activities were supervised by a Board comprising Herr Herttrich of the Reichsstelle, Bergrat Hast of Unterharzer, Direktor Lakwey of G. von Giesche, and Direktor Seiffert of Berzelius, a Metallgesellschaft subsidiary. Dr. H. Pontani was in charge of the Beratungsstelle until March 1944 and Dr. K. Bayer from April 1944. Both Dr. Pontani and Dr. Bayer previously held important technical positions in the firm of G. von Giesche's Erben.

The office of the Beratungsstelle was completely destroyed towards the end of the war, but many of the files, kept in duplicate, survived and were seen at the Unterharzer works near Goslar.

Dr. Bayer was interrogated by the team at his home in Berlin and from information given by him and checked from other sources, it was evident that the bureau had been largely successful in achieving its objects and had won an excellent reputation.

In conjunction with the Reichsstelle it played an important part in standardizing composition and reducing the number of alloys made by the different manufacturers. It also promoted the development of new alloys and arranged for their subsequent acceptance by the Reichsstelle. The bureau had no laboratories of its own and its investigations were conducted through its various committees in the laboratories of its supporters or by independent government bodies such as the Kaiser Wilhelm Institute. According to the Metallgesellschaft, the main committees and their chairmen were:-

a) Scientific Questions - Prof. Koster.
b) Supplies - Dr. Pontani, Dr. Bayer.
c) The Use of Scrap - Dr. Pontani.

The bureau also kept in touch with research work and tests being carried out in government and private laboratories and in many cases collated the results. Such reports are reviewed later.

Consumers were afforded technical assistance either by letter or by personal visits or demonstrations. In 1940 a series of information sheets was started. It was followed in October 1941 by the Taschenbuch (Zinc Hand-Book), a volume of some 350 pages which was revised in October 1942. It contains much of the basic information about the use of zinc and zinc alloys required by users. A third and enlarged edition was ready for printing at the end of the war. A list of all publications issued by

the Beratungsstelle is given in Appendix 14.

2 THE USES OF ZINC

Before 1939 the pattern of use on the whole resembled that of other countries, although there were some differences in the technique of use. For example, zinc alloys were more often chill and sand cast than pressur die cast, but for all practical purposes the composition of the alloys and the quantities consumed resembled those in other countries.

Galvanizing and electro-galvanizing were also carried on in much the same manner as elsewhere, although here again there was a difference in the technique of galvanizing, the dry galvanizing method being predominant. Owing partly to the cheapness of labour, sheets were usually dipped by hand rather than machine galvanized.

More rolled zinc was consumed in proportion, owing to its wider application in building as well as to its use in fabricated articles. In general, rolling techniques and method of use closely followed U.K. practice.

There was in fact nothing outstanding in German methods of using zinc before the war - in some respects their practice being superior, in others, inferior.

With the advent of war the whole pattern of the use of zinc soon changed, great emphasis being put on the use of zinc alloys as a substitute for brass and, to a lesser extent, for aluminium and lead. On account of the comparatively abundant supplies available, however, it was not until 1941 and 1942 that strenuous efforts were made to reduce consumption for purposes not strictly connected with the war, and even as late as 1945 zinc was still being used for certain galvanizing work for which it had long been completely forbidden in the U.K.

Whereas in England the casting alloys received most attention during the war, the Germans did most work on forming alloys; and the development and use of these alloys were by far the main feature in the war-time industry. Great strides were made in this field and it is hoped that the composition, properties and uses of the various German alloys, fully described in this Report, will prove of permanent interest to investigators on this subject. Many brass works turned over almost entirely to zinc alloys which were rolled, extruded, hot-stamped, drawn into wire and tubes and deep drawn. No similar state of affairs ever existed in the U.K. or the U.S.A. where copper was comparatively abundant at all times during the war; and it is doubtful whether any such developments have taken place elsewhere, except perhaps in Italy.

The technique of fabrication varied according to the composition of the particular alloy used; and the work of the fabricators was handicapped

by the frequent changes introduced in the composition of the alloys due to the increasing shortages of various alloying constituents - especially copper. The frequency of these changes bears witness to the acute difficulties in supply experienced in one of the main German industries.

One interesting feature in the use of wrought alloys was the close attention paid to methods of casting billets, semi-continuous casting such as was previously used on aluminium having been developed and used with zinc alloys. It is doubtful whether any units specially built for the semi-continuous casting of zinc alloys were in action before the war, but they were certainly common by 1943 - 1944.

While many of the new uses proved adequate at the time, others were very inferior, in particular such uses as zinc alloy wire for electrical conductors and zinc alloy taps for water. It is to be noted that most of the developments in wrought zinc alloys and even those in rolling were carried out by brass fabricators working in conjunction with the alloy makers.

We were surprised to find that during the war pressure die casting was used on a comparatively small scale compared with the U.K. and the U.S.A., its potentialities not having been fully exploited and indeed only partly realised towards the end of the war. On the other hand, sand gravity die casting and centrifugal castings were used on a much larger scale than in the U.K.; and much greater use was made of zinc alloys for bearings, particularly in heavy machines.

Other uses such as galvanizing, spraying, rolling etc., do not seem to have been much affected by war conditions, except that non-essential peacetime applications were gradually curtailed in order to save metal for essential wartime purposes.

Very few works visited by the team could be regarded as modern by British standards, although on the whole plant had been well maintained and was in excellent condition. The location of all the more modern works in South Germany, and not in the Ruhr, was a significant fact. The use of expensive equipment had frequently been avoided by improvised devices designed and made on the spot. Safety standards were poor and conditions in many of the factories would not have been allowed in the U.K.

CHAPTER II

STATISTICS

The collection of statistics was not one of the main objects of the team. In the course of general enquiries, however, a certain amount of statistical data illustrating the main trends in both consumption and supply naturally came to hand. These figures, which were obtained from various sources, show some slight discrepancies; but no attempt has been made to reconcile them since they do not affect the balance of the picture as a whole.

This Chapter is divided into the following sections: 1 ZINC - Supply; 2 ZINC - Consumption (general, rolled zinc, high purity zinc alloys, coatings); 3 CADMIUM - Supply and Consumption; 4 FLOWSHEETS. Details of imports and exports of slab zinc and rolled zinc are given in Appendix 11. All figures are in metric tons.

1 ZINC - Supply

SOURCES OF INFORMATION

a) Reichsstelle Eisen und Metalle, a body formed some time before the war to control the production and allocation of all metals in Germany. The production figures quoted in the following tables were derived from this source and the team was assured that they were the actual production figures and not estimates, except in the case of H.P. zinc. It may be of interest to add that the Reichsstelle had not then been visited by any other team, although it has probably been fully investigated by this time. The Reichsstelle had several offices in Berlin, each dealing with a separate aspect of the metal control; but the team was informed that the other sections had been burnt out or otherwise destroyed, and that it was therefore unlikely that any detailed official figures for consumption would be found.

b) The Metallgesellschaft A.-G., which is well known for its statistics of metals. The office files were found to be undamaged and the statistical department provided detailed information on both production and consumption. It was understood, however, that in most cases their figures were estimates only, since the German Government had refused them access to official data. In the following tables, the figures for imports and exports as well as those for remelted metal represent such estimates. In fact, there is a remarkable measure of agreement between the Metallgesellschaft estimates of production and the actual production figures provided by the Reichsstelle, the difference seldom exceeding 1 per cent, except for 1944, when the estimate was some 30,000 tons

too high - a graphic example of the rapid disintegration of German economy.

TOTAL SUPPLY

The following table shows German and Austrian production and includes that from the following countries:-

Sudetengau from October, 1938.
Upper Silesia from September, 1939.
Lower Styria from April, 1942.

The production of the following smelters is therefore included from the time of their incorporation in the Reich:-

Sudetan - Dudek and Kuttersohitz.
Silesia - Giesche (Kattowitz), Hohenlohe and Schlesag.
Lower Styria - Cilli.

The mine production figures shown in the table were supplied by the Metallgesellschaft. For details of imports and exports, see Appendix II.

	1938	1939	1940	1941	1942	1943	1944
MINE PRODUCTION	220,000	235,000	242,000	240,000	235,000	265,000	250,000
SMELTER PRODUCTION							
H.P.Zinc (over 99.975%)	68,000	78,000	104,191	111,600	115,100	122,200	84,000
Other Slab Zinc	126,332	163,547	213,432	209,106	198,384	191,893	176,089
TOTAL METAL PRODUCTION	194,332	241,547	317,623	320,706	313,484	314,093	260,089
Zinc Dust	6,860	12,906	14,650	12,159	7,436	9,033	8,537
Remelted Zinc (estimated)	15,200	15,000	15,000	15,000	15,000	15,000	15,000
Imports	81,866	55,483	31,293	11,535	20,162	26,550	8,518
TOTAL SUPPLY	298,258	324,936	378,566	359,400	356,082	364,676	292,144
less exports	6,888	12,367	24,252	35,751	30,174	35,133	16,524
NET SUPPLY	291,816	316,285	354,314	323,649	325,908	329,543	275,620

INDIVIDUAL SMELTER PRODUCTION

It will be noted from the above table that the supply of zinc rose rapidly in 1939 and 1940, the rise being due to increased supplies from smelters.

The following table, giving the output of individual smelters, shows that this increase was largely due to the incorporation into the Reich of the Giesche Kattowitz and other Polish smelters; although, among the Reich smelters, the Unterharz increased its production from 8,623 tons in 1938 to 33,518 tons in 1944, this plant having been greatly enlarged during the war.

	1938	1939	1940	1941	1942	1943	1944
Altenberg	26,637	26,202	27,315	26,058	22,367	18,864	16,419
Berzelius	32,135	34,269	31,103	29,777	28,734	29,444	27,696
Giesche (Mag.)	52,331	52,725	55,024	50,205	49,795	53,851	25,797
" (Oberspree)	8,046	6,599	4,663	4,630	3,280	3,605	1,988
Grillo	4,835	4,786	4,679	4,820	4,200	4,983	4,206
Stolberg	41,903	40,150	41,836	39,928	36,910	36,635	25,554
Unterharzer	8,623	12,233	15,861	24,821	25,373	26,739	33,518
Unterweser	17,853	17,143	15,303	15,611	17,011	16,312	14,226
	192,363	194,107	195,784	195,850	187,670	190,433	149,404
Cilli				3,170	6,557	6,513	4,775
Dudek	642	4,454	4,536	2,938			
Giesche (Katte.)		18,309	56,516	55,503	52,957	52,194	47,959
Hohenlohe		5,216	15,817	16,459			
Kutterschitz	1,327	5,218	5,293	6,175	8,418	8,157	8,104
Schlesag		14,243	39,677	40,611	57,882	56,796	49,847
	194,332	241,547	317,623	320,706	313,484	314,093	260,089
Less H.P. Zinc from zinc from other works:					1,100	398	1,076
TOTAL	194,332	241,547	317,623	320,706	312,384	313,695	259,013

In the case of the last six smelters, some of the figures represent production for part of the year only, i.e. subsequent to their incorporation in the Reich. The following table shows their production in the respective year before incorporation:-

	1938	1939	1940	1941
Gilli				1,609
Dudek	1,721			
Giesche (Katte.)		37,358		
Hohenlohe		10,879		
Kutterschitz	4,167			
Schlesag		32,675		

The full names and exact locations of all smelters are given in Appendix 4.

It will be observed from these statistics of Individual Smelter Production that the possible total production of the smelters now in the British Zone - viz; Altenberg, Berzelius, Grillo, Stolberg and Unterharz - amounts to approximately 140,000 tons. There is only one smelter in the U.S. Zone, Unterweser (near Bremen), with a maximum production of 18,000 tons; and two in the Russian Zone, Giesche, Magdeburg and Giesche, Oberspree, with a possible total production of 63,000 tons.

Although only four smelters - Altenberg, Berzelius, Grillo and Unterharz - were visited by the team and none appeared to be very seriously damaged, it has since been heard that severe damage was inflicted on the Stolberg and Giesche, Magdeburg plants. Moreover, the Russians are said to have removed some of the plant from the Giesche, Oberspree works.

HIGH PURITY ZINC

The Reichsstelle provided figures for the production of individual smelters up to 1942. Although the totals of these figures do not entirely agree with those given in the first table in this section, also from the same source, the differences are unimportant.

Individual production in 1943-44 was estimated by the Unterhazer Berg and Hüttenwerke. It is thought, however, that these figures probably represent targets fixed by the Government and that Unterharzer were not really informed of the production actually reached.

	1938	1939	1940	1941	1942	1943	1944
Berzelius	5,930	6,749	12,574	15,481	15,525	20,000	20,000
Giesche (Mag.)	52,331	52,725	54,879	50,205	49,795	54,000	34,800
Unterharzer		7,260	13,269	15,340	22,789	22,300	22,000
Giesche (Katt.)		6,671	20,341	19,590	19,442	18,000	18,000
Schlesag		1,158	3,128	3,295	3,915	3,000	3,000

METALLIC ZINC DUST

The following table shows the actual weight of zinc dust produced in 1938-44. These figures include the output of the Sudeten, Silesian and Styrian Smelters from the time of their incorporation in the Reich.

1938	1939	1940	1941	1942	1943	1944
6,860	12,906	14,650	12,159	7,436	9,033	8,537

According to the Metallgesellschaft the average production of zinc dust at each works in 1942 was as follows:-

Altenberg	934
Berzelius	1,504
Grillo	367
Unterweser	625
Stolberg	3,905
Dudek	9
Kutterschitz	714
Schlesag	4,040

ZINC CONCENTRATES

No effort was made to procure output figures of the German zinc and lead ore mines, but Unterharzer supplied, among other information, the following table showing the estimated output of concentrates (zinc content) originating from German mines:

	1940	1941	1942	1943	1944
Giesche, Beuthen	30,240	39,120	39,000	37,320	36,480
Unterharzer	28,200	22,440	24,000	25,200	25,200
Stolberg	31,800	31,200	29,160	29,760	26,820
Stein V	11,520	21,600	24,000	24,000	18,720
Flotation Siegen	1,440	432	600	600	600
Flotation Meggen	1,440	1,800	1,980	1,980	2,040
Oberharz	3,120	3,300	3,300	3,240	2,640
Altenberg	9,840	6,780	7,680	7,200	6,480
Bleiberg	2,520	3,600	4,164	3,480	3,840
Giesche, Kattewitz	37,800	36,000	36,000	37,200	28,920
Schlesag	22,800	25,200	22,200	24,240	23,400
Miess		2,160	1,140	1,596	1,560
Himmelfahrt				960	1,800

2 ZINC - Consumption

A GENERAL

SOURCES OF INFORMATION

No official figures similar to those for supply could be obtained, and it seems unlikely that any such figures were compiled in detail. The Government allocated to various industries a quota of metal, and this in turn was handled by the trade group in each industry; and the actual amount of metal purchased and its ultimate use appears not to have been fully known. Herr Gierow of the Reichsstelle für Eisen und Metalle stated emphatically that official figures showing the details of consumption could never be supplied. A further difficulty was that a smaller quantity of zinc than that produced was usually assigned for consumption and, at the end of the war, large stocks had been accumulated at both smelters' and consumers' works. A semi-official estimate of consumption on broad lines was, however, prepared for the Russian Government by Dr. Günther Brandt, now of the Deutsche Zentralverwaltung der Industrie, a division of the former Reichswirtschaftsministerium. Dr. Brandt also provided estimates for consumption in 1941 according to destination.

Unofficial figures or consumption were given by the Metallgesellschaft, and these figures have been used as a basis in the main consumption table. It was however found possible to check and expand them very considerably and to prepare supplementary tables for each use from data collected from the smelters visited - Altenberg, Berzelius, Grillo, and Unterharzer, and also from the Giesche representatives in Berlin. These smelters also furnished full details of their production and sales of alloys and zinc products. This information in turn was again checked and expanded at the consumers' works visited, where trends were discussed.

Rolled zinc was the only branch of consumption on which really accurate figures were available. The Zinkwalzwerksverband, the Association of German Zinc Rollers, collected statistics from its members, and although its offices were not visited, copies of the statistics were procured from members.

No other use was covered by a single association; and although we believe the figures compiled by the team provide a reliable guide to consumption, they are not so accurate as those for rolled zinc.

CONSUMPTION

The estimated consumption of zinc in Germany from 1938-1944 is shown in this table compiled by the team.

	1938	1939	1940	1941	1942	1943	1944
Rolled Zinc	74,000	86,000	129,000	140,000	140,000	78,000	60,000
H.P. Casting Alloys	6,000	8,000	16,000	28,000	43,000	49,000	49,000
H.P. Forming Alloys	5,000	5,000	31,000	33,000	47,000	34,000	27,000
Brass	80,000	65,000	42,000	43,000	24,000	16,000	12,000
Coatings	80,000	95,000	110,000	120,000	100,000	84,000	75,000
Zinc Oxide	18,000	21,000	25,000	20,000	17,000	18,000	18,000
Other Uses	7,000	10,000	12,000	15,000	17,000	20,000	15,000
Total:	270,000	290,000	365,000	399,000	388,000	299,000	256,000

While it is not possible to divide the total consumption figures between high purity zinc and other grades, it is clear from the estimates of the Metallgesellschaft that in 1938 somewhat less than one-third of the total was high purity zinc; but the proportion rose to over one-third in later years, presumably owing to the use of high purity zinc alloys to replace brass. The production figures in the previous section confirm this view.

The figures and sources of information for rolled zinc, high purity zinc alloys and zinc coatings are given below under those headings.

Since a separate team was to undertake an investigation on the German zinc oxide and lithopone industries, we paid no special attention to this subject. While the figures for pigments and chemicals provided by Dr. G. Brandt have been taken into account, there is little doubt that, according to the information received from the Metallgesellschaft and the German smelters, they are too low; and they have been amended accordingly.

The figure for zinc in brass has been calculated on information provided by Dr. Brandt and the Metallgesellschaft. The figure for Other Uses has also been compiled on the basis of information supplied by the Metallgesellschaft.

SEMI-OFFICIAL CONSUMPTION ESTIMATES

The following table in metric tons, showing the consumption of zinc according to its main uses, was obtained from Dr. G. Brandt and can be regarded as a reliable semi-official estimate. In most respects it confirms the figures in the main consumption table.

The tonnages of brass are gross and do not represent the zinc content.

only a general indication of the tonnage used in each.

	1938	1939	1940	1941	1942	1943	1944
Hot-Dip Galvanizing:							
Sheet:	13,000	10,000	10,000	10,000	12,000	15,000	13,000
Other:	65,360	83,020	97,670	107,490	85,900	67,250	60,430
Electro-Deposition:	1,400	1,700	2,000	2,150	1,800	1,500	1,350
Sherardizing:	120	140	165	180	150	125	110
Spraying:	120	140	165	180	150	125	110
Total:	80,000	95,000	110,000	120,000	100,000	84,000	75,000

3 CADMIUM - Supply and Consumption

SOURCES OF INFORMATION

The information on supply was obtained from the same sources as that on the supply of zinc, viz; the Reichsstelle Eisen und Metalle and the Metallgesellschaft. The production figures obtained from the former were said to be actual figures and not estimates; but it is thought that the export and import figures from the latter are estimates only.

TOTAL SUPPLY

The following table, in metric tons, shows German and Austrian production and includes that from Upper Silesia from September, 1939, from the following Smelters - Giesche (Kattowitz), Honenlohe and Schlesag:

	1938	1939	1940	1941	1942	1943	1944
PRODUCTION	437	477	531	608	484	496	404
Imports	100	253	86	1	72	10	7
TOTAL SUPPLY	537	730	617	609	556	506	411
less exports	50	47	62	37	128	108	29
NET SUPPLY	487	683	555	572	428	398	382

INDIVIDUAL SMELTER PRODUCTION

It will be observed from the above table that production rose rapidly in 1940 & 1941, but then fell again to the 1938-39 level. The following table

APPENDIX 12

THE CORROSION PROTECTION OF ZINC & ZINC ALLOYS WITH METALLIC FINISHES

Translation of a paper by H.D.Graff v. Schweinitz & G.Wassermann. Metallwirtschaft. Vol. 21. No. 49/50. 11th December, 1942. Pages 750-754.

Present Knowledge - Applications - Properties of Protective Coatings on Various Zinc Alloys: M.B.V., Sulphide and Silicate Treatments - Discussion on Superiority of the Silicate Treatments - Resistance of Silicate Treated Specimens towards Sea Water, Steam, Acids Alkalis and Atmospheric Corrosion - Summary.

Although zinc is a typical base metal, it shows astonishingly good corrosion resistance under conditions of atmospheric exposure. For the purposes of roof covering, rain water gutters etc., zinc is capable of resisting the weather for decades without any additional protection. Under such conditions the metal covers itself with a dense grey protective coating of basic zinc carbonate and sulphate(1), which causes the bright metallic appearance of the material to disappear rapidly.

Like unalloyed zinc, the zinc alloys widely used at the present time as substitute material also possess good corrosion resistance. Nevertheless, for many purposes the natural protective film is insufficient. For this reason various surface treatments have been developed with the object of increasing the corrosion resistance of zinc and zinc alloys. Chief among these treatments are phosphating and chromating. Both of these treatments are also specially suitable as a pretreatment for lacquering. In addition to these, electro deposited coatings of other metals are used for surface protection.

Both chromating and phosphating have one disadvantage, namely that they produce coloured films which completely hide the metallic appearance of the metal. For purposes in which it is desirable to preserve the bright metallic surface of the zinc, the known surface treatments are not suitable. In such cases one might imagine that a specially good surface protection could be obtained on zinc by coating the surface with a colourless lacquer. In most cases, however, this procedure is not possible because, as is well known, the adhesion of lacquers to metallic zinc surfaces is very bad. This is particularly the case where the material is exposed to the weather or to particularly severe corrosive conditions, when the lacquer film becomes partly detached. Corrosion attack under the lacquer film then proceeds more strongly than would be the case in the complete absence of a protective film.

Experimental work was therefore undertaken with the object of finding a