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Extent of Damage and Destruction in Selected
German Industries

Order of magnitude estimates have been prepared of the probable level of physical productive capacity after the end of hostilities for the following basic industries:

1. Steel
2. Coke
3. Aluminum
4. Rubber
5. Chemicals
6. Petroleum and Synthetic Oil
7. Electric Power
8. Rail Transportation

A note is also included on the housing position (9).

This list does not purport to cover the whole picture; the industries selected are those heavily capitalized basic industries in which damage to plant equipment by air attack has been considered a factor of some significance. The estimates are based upon available reconnaissance and underground reports, taking account only of known damage from air attack to date. They make no allowances for possible destruction by the Germans or possible further serious damage by ground action. All the estimates give capacity figures assuming that a three month period of rubble clearance and short term repair, utilizing stocks of materials, is carried out by local labor and available. This means, in the case of industrial plant, that damaged buildings may be re-roofed, or machinery salvaged, cleaned of debris and replaced in service; or in the case of railways, cratered marshalling yards may be levelled and track relaid. It does not assume any replacement of major equipment actually destroyed.

Some heavily capitalized basic industries, such as mining, have suffered no major or systematic damage from air attack, and capacity in these can be assumed at least as great as pre-war. In others, such as inland water-transport, all damage is of an essentially short term nature, and can be repaired in less than the three months allotted.

The general picture, to the extent that these industries are representative, is one of sufficiency of capacity in terms of 1937 and pre-1937 output. Damage due to air attack has been sufficient to overcome increases in capacity in the course of the war and the general excess of capacity over "normal" peace-time utilization, only in a few industries. The outstanding ones, as shown by the list, are:

- a) Oil, where a sustained and vigorously pressed offensive has reduced production capacity of refineries, synthetic plants, and substitute sources combined to about a third of peacetime consumption.
- b) Synthetic ammonia, where conversion of plant to synthetic oil production, and subsequent damage thereto has reduced capacity to below 50% of peacetime capacity.

All in all, as a rough figure it can be stated, under the above assumptions that basic industrial capacity in terms of plant will be capable of an output little less than that of pre-war years. At the least, after rubble clearance and the repair of short-term damage, capacity in the basic industries as a whole will be sufficient for production at about 80% of the 1937 level. It must be emphasized that this statement refers only to plant capacity, considered in isolation. It abstracts from many more important problems which must be solved before production at this level can be achieved. These include the problems of labor supply, management organization, raw material imports, possible shortages of specific key supplies, repair parts and special machinery, and the involved problems of the repercussions of certain specific shortages, such as the shortage of serviceable I/P, on general industrial production.

I. STEEL

| Year | Iron Ore Production (Fe content) | Crude Steel Production | Apparent Finished Steel Consumption Production - Imports - Exports = Net | | | |
|------|----------------------------------|------------------------|---|---------------|-------|--------|
| | | | (in thousands of metric tons) | | | |
| 1935 | 1,849 | 16,144 | 11,419 | 847 | 3,818 | 9,853 |
| 1936 | 2,259 | 18,780 | 13,414 | 433 | 3,365 | 16,432 |
| 1937 | 2,759 | 19,386 | 14,118 | 382 | 3,565 | 16,915 |
| 1938 | 3,100 | 22,800 | 16,937 | 433 | 2,780 | 13,601 |
| 1943 | - | 24,990 | 17,750 | -- Nominal -- | -- | 17,750 |
| 1944 | - | 20,000 | 14,250 | -- Nominal -- | -- | 14,250 |

Note: area covered includes Saar but not Austria

1. Pre-war situation -- Considerations of the German steel industry frequently ignore certain basic facts. In 1938, almost the most productive year of the industry, less than one half million Germans were employed in mining iron ore or in the production of iron and steel; domestic iron ore met little more than 10% of the industry's requirements; and a finished steel production of just under 16 million tons sufficed for industrial expansion, domestic requirements, military preparations and for exports of 2 3/4 million tons.

2. Present situation -- Despite extensive attack, chiefly directed against rolling, casting and forging facilities, crude steel capacity sufficient to equal 1937 production still exists in Germany. Rubble removal and basic repairs such as are normally undertaken by the labor force and workshops of steel plants could bring German crude steel productive capacity back to within 5-10% of its 1938 performance within three months.

II. COKE

| A. Production (1000 tons) and 1943 Percentage Capacity Distribution | | | | | |
|---|--------------|---------------|-------------|-------------------|----------------|
| Year | Ruhr (73.6%) | Aachen (3.2%) | Saar (8.6%) | U. Silesia (7.5%) | Others (41.1%) |
| 1935 | 22,958 | 1,246 | 2,350 | 1,173 | 2,475 |
| 1936 | 27,411 | 1,253 | 2,730 | 1,550 | 2,901 |
| 1937/8 | 32,171 | 1,344 | 2,920 | 1,978 | 3,250 |
| 1938/9 | 34,458 | 1,453 | 3,176 | 2,018 | 3,295 |
| 1942/3 | 35,424 | 1,306 | 3,304 | 2,550 | 4,989 |
| 1943 | 35,450 | 1,324 | 3,504 | 2,600 | 4,800 |

COKE (continued)

| B. Calculated Apparent Consumption by Uses, 1937 and 1943 | | |
|---|----------------------------|-----------------------------|
| | 1937 | 1943 |
| | Production--40,905,000tons | Production--47,678,000 tons |
| | App.cons. --32,662,000tons | App.cons. --41,425,000 tons |
| Blast furnaces & foundries | 51.6% | 49.2% |
| Synthetic oil | 1.2% | 12.4% |
| Household | 23.4% | 20.5% |
| Synthetic Ammonia | 1.4% | 1.1% |
| Calcium carbide | 1.7% | 4.4% |
| Lead and zinc | .5% | .3% |
| Miscellaneous | 18.2% | 12.1% |

1. Pre-war situation -- Without anything like a comparable increase in installed capacity, Germany raised her coke production over 65% from 1935 to 1938. Advantage was taken of the Ruhr coal deposits and most of the coke tonnage increase occurred in that area. Chief users remained fairly constant with iron and steel and household purchasers consuming a half and a quarter respectively. Net exports remained fairly constant, tonnage-wise, but declined from about 20% to some 12% of production, percentagewise.

2. Present situation -- A slight further increase in production was registered during the war years, as was an increased allocation to synthetic oil production, largely at the expense of household and miscellaneous industrial consumers. Discarded for systematic attack early in the war, area raids followed by attack upon the benzol facilities at the batteries during 1944-45 have resulted in a significant impairment in immediate productive capabilities. Assuming no further impairment as a result of temporary cessation of operation and consequent possible damage due to uncontrolled cooling, comparison with 1943 production after 3 months of cleaning up and minor patching would probably show the following situation:

| <u>Ruhr</u> | <u>Aachen</u> | <u>Saar</u> | <u>U. Silesia</u> | <u>Others</u> | <u>Total</u> |
|-------------|---------------|-------------|-------------------|---------------|--------------|
| 74% | 100% | 100% | 100% | 68-100% | 80% |

III. ALUMINUM

1. Pre-war situation -- In 1933 Germany's 35,000 ton installed aluminum reduction capacity produced 18,900 tons of primary metal. This capacity was expanded rapidly to yield an output tonnage of 37,200, 70,800, 97,500 and 127,600 in the successive years from 1934 to 1937. To this, net imports of 2-3000tons were added each year. Despite an eight-fold increase in domestic production of bauxite over the same period, 1937's 93,000 tons of ore met requirements of less than 20% of the metal output.

2. Present situation -- Of Germany's current 250,000 ton aluminum capacity, less than 20% is incapable of producing because of damage, less than 10% can be supplied from domestic bauxite production.

IV. RUBBER

Synthetic Rubber

In this highly capitalized industry, Germany currently

has undamaged capacity to produce about 80,000 tons of synthetic rubber per year. In addition, damaged capacity is equivalent to perhaps $\frac{1}{4}$ of this volume. Virtually the entire industry was created since 1937.

It is likely that capacity is more than adequate to satisfy immediate peacetime requirements, if such requirements are of the magnitude of pre-war consumption. Domestic consumption rates of new rubber in various years were approximately as follows:

| | |
|---------------------|-----------------------|
| 1928 - 32 (average) | 44,000 tons per annum |
| 1935 | 50,000 " " " |
| 1937 | 85,000 " " " |
| 1943 | 120,000 " " " |

Since the bulk of rubber supplies in Germany is consumed in tire production, any forecast of post-war requirements must take account of output and holdings of motor vehicles and fuel. These industries are not likely to flourish, and the synthetic rubber producing industry, therefore, appears to have excess capacity.

The following plant information is relevant:

| <u>Location</u> | <u>Present capacity</u> <u>per annum</u> <u>(metric tons)</u> | <u>Remarks</u> |
|-----------------|---|--|
| Schkopau | 35,000-60,000 tons | Reported production ranges from 30,000 to 50,000 tons. The plant is undamaged. |
| Hüls | 30,000 tons | Reputed production ranges from 30,000 to 60,000 tons. The plant was heavily damaged in June 1943. The majority of the installations have since been repaired or reconstructed. |
| Ludwigshafen | ? | Reported production of 20,000 tons before heavy raids. Plant heavily damaged in latter 1944 and early 1945. |
| Leverkusen | ? | Capacity of less than 10,000 tons reported. Plant damaged. |

Other reported producers, on a very small scale, are located at Saarau and Rheinfelden.

Reclaim Rubber

It appears that in this not very highly capitalized industry, Germany has adequate reclaim capacity for the immediate post-war period. As indicated above, requirements for reclaim will be largely conditioned by the volumes of motor vehicles and motor fuel available; these are not likely to sponsor full utilization of the reclaim industry.

The growth of the reclaim industry is indicated by the following estimated figures on scrap rubber imports:

| | <u>Metric Tons</u> <u>(net exports)</u> |
|---------------|--|
| Prior to 1933 | |
| 1935 | 9,000 |
| 1936 | 11,000 |
| 1937 | 45,000 |
| 1938 | 16,000 |

Reclaim manufacture has been estimated at 40,000 to 60,000 tons per year during the war. Considerable bomb damage has been inflicted on a number of reclaim producers. Present operable capacity is probably between 30,000 and 45,000 tons per annum.

Rubber Fabrication

Tire capacity has been more seriously reduced through bombing than synthetic rubber or reclaim capacity. Plants with well over half of total German capacity have suffered varying degrees of substantial damage. It is not clear, however, exactly how this affects the post-war period, for some of the peacetime facilities (molds and the like) were probably stored when war production shifted to aircraft tires and large truck tires. In consequence, the proportion of damage to current operating capacity should be equivalent to a somewhat smaller proportion in terms of post war capacity. Offsetting this qualification of damage are the cases in which power plant, mixing, and other general installations are damaged: such damage represents impaired peacetime capacity.

In summary, tire capacity, which expanded during wartime and which then experienced serious bomb damage, may be inadequate to resume output at adequate levels until the elapse of a repair and adjustment period. The state of the Continental, Hanover plants is crucial, since over half of all capacity is located here. The condition of truck tire and automobile tire producers is estimated as follows.

| <u>Plant and Location</u> | <u>Estimated</u> <u>original</u> <u>capacity</u> (tires per month) | <u>Damage</u> <u>Remarks</u> |
|--|---|--|
| Continental, Hanover | 400,000- 500,000 | Old plant severely damaged in early 1944. Reconstruction undertaken. Probably damaged since. New plants probably in relatively good condition. |
| Dunlop, Hansa | 100,000 | Further damaged in Jan. 1945 |
| Gummiwerke, Fulda, Fulda | 60,000 | Slight additional damage in Jan. '45. |
| Petzeler, Munich | 50,000 | Severe damage to raw rubber mixing (Jan. '45) |
| Phoenix, Munich | 50,000 | Major damage (Jan. 1945) |
| Peters Union (Continental), Frankfurt | 25,000 | Damaged, unrepai red(Aug.44). |

| | | |
|---------------------------|--------|---|
| Deka, Ketschendorf, Spree | 25,000 | No reports of damage. |
| Englebert, Aachen | 25,000 | Damaged; reptd. on by investigating commission. |
| Michelin, Karlsruhe | 10,000 | Severe damage to main bldg (Jan. 45). |

The German capacity for the manufacture of other rubber products is probably satisfactory. Some plants have been damaged in area raids; these plants have never been systematically attacked as a target system.

V. CHEMICALS

The condition of the German chemical industry is here indicated by reference to sulphuric acid, alkali, fixed nitrogen, and pharmaceuticals. Sulphuric acid and alkali are commonly viewed as the most fundamental branches of the industry; fixed nitrogen and pharmaceuticals are mentioned here because of their importance in agriculture and public health respectively. It should be noted that two major branches of the chemical industry, synthetic rubber and synthetic and substitute oil products, are dealt with under separate headings.

Sulphuric Acid

Sulphuric acid production in Germany developed about as follows:

| | <u>Monohydrate</u> (in millions of metric tons) |
|-----------------------|---|
| 1931 | 1.1 |
| 1936 | 1.6 |
| 1941 | 2.5 |
| 1945 (annual rate) | 1.5 |

Plants with an aggregate capacity somewhat in excess of 0.5 million tons have been damaged; severity of the damage is not known. Current producing capacity, therefore, appears to be between 1.5 and 2.3 million tons per annum, a capacity quite adequate for probable post war needs. The chief use of sulphuric acid is in the chemical industry. The bulk of it is required for production of rayon and staple fibers, nitrogenous fertilizers, and organic intermediates and dyestuffs. It is of interest that economical production of sulphuric acid has hitherto required pyrites, which Germany must import. Less economical output can be procured through the use of gypsum, of which Germany has large deposits.

Alkali

Alkali production in Germany developed as follows:

| | <u>Soda Ash</u> | <u>Caustic Soda</u> |
|----------------|-------------------------------|---------------------|
| | (in thousands of metric tons) | |
| 1931 | 600 | 175 |
| 1936 | 725 | 350 |
| 1941-43 (aver) | 1,000 | 500 |

There has been a moderate decline in output due to bombing of the very important alkali plant at Bitterfeld and the important plants at Oppau and Leverkusen. The extent of damage to these plants, which account for perhaps one-fourth of total production, is not known. After taking account of probable damage to other producers, it appears that operable capacity is $2/3$ to $3/4$ of the peak reached during the war, a volume more than adequate for probable post war needs. The bulk of alkali production in peacetime is used in production of rayon and staple fiber, soap, glass, textiles, pulp and paper, alumina, and other chemicals.

Fixed Nitrogen

The peak years in production of synthetic ammonia and cyanamide were 1938/39 when synthetic ammonia output reached 700,000 metric tons of nitrogen and cyanamide production totalled a further 140,000 tons. By-product ammonia contributed another 120,000 tons. Of this total, agriculture consumed 750,000 tons, industry 130,000 tons, and net exports and minor changes in stocks accounted for the remainder. Total capacity in 1938/39 was estimated to be about 1.2 to 1.5 million tons.

The current position is thought to be poor because of bomb damage and because of conversion of some synthetic ammonia facilities to production of synthetic oil. Considerably more than half of total capacity was at Leuna and Oppau, both of which plants have been very heavily damaged by bombing. Further, important by-product ammonia plants have been damaged in the sustained series of attacks on coke oven plants. It is therefore considered that German fixed nitrogen capacity will not be adequate for post war requirements until a period for repair and adjustment has elapsed.

Pharmaceuticals

Germany's large pharmaceutical industry has suffered severe damage from bombing during the war. It is uncertain whether operable capacity is adequate to meet immediate post war requirements. In any event, it is clear that a period for repair and adjustment would be required to restore some of the damaged firms to useful production. Of the major firms, the Bayer plants were undamaged at the end of 1944 while the Merck (Darmstadt), Knoll (Ludwigshafen), and Schering (Berlin) plants have been very heavily damaged. There are, of course, other small plants.

VI. PETROLEUM & SYNTHETIC OIL OUTPUT

Pre-war German capacity for oil products totalled 4 to 5 million tons. Of this, 2 million tons represented refinery capacity (dependent for $2/3$ of its feedstock on imports), and the remainder represented synthetic and substitute product capacity. Since 1933, Germany has built up her oil industry to a total capacity of 9 million tons through construction of numerous synthetic plants.

The sustained air offensive since mid-1944 has reduced capacity to a level of 2.4 million tons, of which the bulk represents substitute capacity (benzol from coke oven tar, regenerated lubes, etc.):

/Annual

| | <u>Annual Capacity</u> <u>(in millions of metric</u> <u>tons)</u> |
|-------------------------|---|
| Synthetic Plants | .3 |
| Refineries | .7 |
| Capacity for substitute | 1.4 |

Damage and destruction to synthetic plants has reduced capacity by 4.7 million tons, to refineries by 1.3 million tons, to substitute sources by 600,000 tons.

Germany's operable oil producing and processing capacity is equivalent to only about 1/3 of her 1937 requirements in quantitative terms and even less in terms of satisfactory product distribution. The following oil consumption data is relevant:

Germany's Oil Consumption

| | <u>millions of metric tons</u> |
|------|--------------------------------|
| 1933 | 3.7 |
| 1935 | 5.0 |
| 1937 | 6.7 |

Consumption Pattern (1937)

| | <u>Percent</u> |
|---------------------|----------------|
| Road transport | 56 |
| Industry (incl. rr) | 23 |
| Shipping - overseas | 13 |
| - inland | 1 |
| Agriculture | 4 |
| Domestic use | <u>3</u> |
| | 100 |

VII. ELECTRIC POWER

1) In 1937, Germany had an installed plant capacity for producing power of 15,000 MW. Production of power was 49.0 M KWH, giving an average plant factor of 35%.

2) In 1943, it is estimated that installed capacity had risen to 23,000 MW. Output had increased to 87.6 M KWH. Thus the plant factor rose to 43%.

The chief new consumers were the electrochemical industries, which altogether consumed about 32% of the total output. Synthetic oil alone accounted for 12%, and aluminum production for 6%.

3) Wartime damage due to air action is estimated to have affected less than 20% of installed capacity. Most of the damage was suffered by those power stations operated on the same coal workings as synthetic oil plants. Otherwise electric power was not systematically attacked. Damage is not so concentrated in any area that considerable local shortages must be expected.

/4)

4) 80% of installed capacity, operating even at the 1937 plant factor is more than sufficient to produce the power required to meet needs at the level of 1937.

VIII. RAIL TRANSPORTATION

1) The 20,000 steam locomotives* and 600,000 freight cars in the hands of the German Reichsbahn in 1937 served to haul some 500 million tons of freight for a performance of 80,000 million ton km. Passenger traffic ran to 50,000 million person km.

Permanent way and servicing facilities of the rail system were superabundant, and could have handled a much greater volume of traffic.

Even rolling stock was not being used to maximum intensity in 1937, and the system, - by means of the economies adopted in wartime - could have handled at least 20% more traffic without any additional equipment.

2) During the course of the war, large re-allocations of rolling stock and locomotives over all the European railway system under German domination took place. There were net withdrawals from Western Europe, and great additions to the Eastern front and Balkan areas. The retreat of the Germans back to the old Reich frontiers resulted in further re-allocations, as stock was either withdrawn, lost to the Allies on the Eastern, Western and Southern fronts, or destroyed.

In the last six months, the railway system of Western Germany has been subject to intense air attack. This has destroyed some rolling stock, and damaged permanent way facilities, marshalling yards, and locomotive depots.

3) It is estimated that the war's end will find Germany, Austria and Czechoslovakia with some 27,000 locomotives, as compared with 26,000 in the same areas before the war. If we allow Austria and Czechoslovakia their pre-war stocks of 1800 and 4200, Germany will end up with some 21,000 steam locomotives, as compared with 20,000 before the war. However, pre-war, some 15% were on the average available for service, while the immediate post-war figure will probably be as low as 60%, since many units will require minor repairs and a substantial number of major overhauls which will have been neglected in the last several months. It is believed that within three or four months this figure can be brought up to 70 to 80%. So that in terms of motive power, Germany will find herself in a position about the same as her pre-war position. There will have been a qualitative deterioration in stock so that roughly 75% of pre-war motive power will be available.

Against this must be placed French, Italian, Belgian, and Dutch claims amounting to about some 10,000 locomotives. In the rest of this discussion it is assumed that they are not satisfied.

* Electric locomotives are not quantitatively important, and are not discussed.

The freight-car position is difficult to assess; on balance the short term unserviceability will be somewhat greater than for locomotives. After three months, the position will be roughly the same.

The damage to major repair installations has not been significantly great. Nor has long term damage to locomotive servicing facilities at the running sheds been great enough even in Western Germany to interfere with operation of available motive power.

In Western Germany, fairly serious and widespread damage has been done to marshalling yards, bridges, and other permanent way facilities. This will have reduced the permanent way capacity in this area by more than half. Nearly all of this damage is temporary, and can be repaired with locally produced materials in three months, provided sufficient labour is allocated thereto.

4) After short term damage to rolling stock and permanent way has been made good, about 75% of the pre-war motive power and rolling stock will be available. Permanent way facilities will allow as intense utilization of this equipment as labour supply permits. Therefore, by continuation of present war-time economy measures and restrictions on passenger traffic, roughly as much freight transport should be possible as in 1937.

5) In the first three months after the war's end - or thereafter if short term damage is not repaired - overall capacity in Germany will suffice for no more than 75% of pre-war traffic. In Western Germany damage to permanent way may limit traffic even further.

IX. HOUSING

1. Pre-war situation -- A preliminary Economic Warfare Division study indicates that a housing "shortage" existed in Germany before the war, both in terms of quality and quantity. There were only 18.1 million dwelling units for the 20.4 million households (18.4 million families and 2.0 million single-person households) shown by the census of May 1939. In addition to the 2.3 million dwellings thus apparently occupied by more than one household, a further 2 million were sub-standard and due for replacement. Considerable variations existed in the housing position from town to town, so that while the ratio of households to dwellings averaged 1.12 for Germany as a whole it ranged from .99 for Schweinfurt to 1.33 for Wilhelmshaven.

2. Present situation -- Civilian and military deaths have partly served to offset the considerable destruction of housing by air bombardment for Germany as a whole. A conservative estimate of total deaths through Allied action of 2.5 million up to January 1, 1945, plus the wartime interference with maintenance or increase in size of households, balances against 2 million dwellings damaged beyond repair and 5-6 million damaged but repairable. New construction is believed to have been small enough military installations and barracks near dispersed factories may offer additional emergency housing. Because of the uneven distribution of damage, re-establishment of the pre-war population pattern would result in housing shortages far greater than pre-war. A comparison of the overall situation as of January 1945 with that in May 1939 might be summarized as follows:

(figures in millions): /

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| | <u>Number of Households</u> | <u>Number of Dwellings</u> | <u>Households per Dwelling</u> |
|-----------------|---------------------------------|--------------------------------|------------------------------------|
| May 1939 ----- | 20.4 | 18.1 | 1.12 |
| January 1945 -- | 19.2 | 16.6 | 1.16 |

Some indication of the situation in various cities including damaged but repairable dwellings, may be found in the following table (cities marked # are in the American Zone):

| <u>Towns</u> | <u>Households per Dwelling January 1945</u> |
|------------------------|---|
| Stettin | 2.4 |
| Hamburg | 2.3 |
| #Kassel | 2.2 |
| #Bremen | 2.0 |
| Hannover | 2.0 |
| #Frankfurt | 1.8 |
| #Friedrichshafen | 1.8 |
| Konigsberg | 1.8 |
| #Stuttgart | 1.8 |
| #Augsburg | 1.7 |
| Dortmund | 1.7 |
| Essen | 1.6 |
| Munster | 1.6 |
| Berlin | 1.5 |
| #Schweinfurt | 1.5 |
| Leipzig1..... | 1.5 |
| Rostock | 1.4 |

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